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Jefferson County Map Modernization Project Jefferson County, Montana

Hydrologic Analysis Report

Montana Department of Natural Resource Conservation

October 31, 2019

Pioneer Technical Services, 106 Pronghorn Trail, Suite A, Bozeman, MT 59718

www.pioneer-technical.com

Jefferson County Map Modernization Project
Jefferson County, Montana
Hydrologic Analysis Report

Prepared for:
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Natural Resources & Conservation
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Helena, MT 59601

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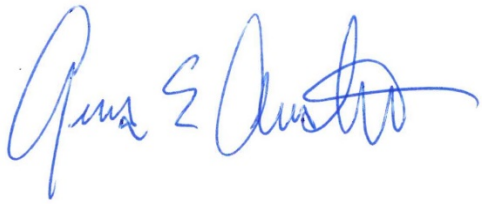
Jefferson County Map Modernization Project

Jefferson County, Montana

Hydrologic Analysis Report

October 31, 2019

I hereby certify that all work products (maps, reports, etc.) prepared for this project were done so under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Montana.



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EXECUTIVE SUMMARY

Flood flow frequency calculations were conducted for a 77 mile reach of the Boulder River mainstem and a 19.1 mile reach of Prickly Pear Creek mainstem. The Boulder River mainstem study reach extends from the confluence of the Boulder River with the Jefferson River to its headwaters near the Continental Divide. The Prickly Pear Creek mainstem study reach extends from the Jefferson County line to its headwaters in the Elkhorn Mountains. Flood flow frequency calculations were conducted for tributaries along both the Boulder River and Prickly Pear Creek mainstem, as well as tributaries along the Jefferson River mainstem. The Jefferson River tributaries study reach extends from Whitehall, MT to the Jefferson County line.

The hydrology of the Jefferson River, Boulder River, and Prickly Pear Creek basins are primarily snowmelt driven, although significant flows can result from precipitation events. Land use in Jefferson County is primarily agricultural with irrigated farming and ranching operations.

Six tributary reaches and two lakes analyzed in this report flow to the Jefferson River, a tributary to the Missouri River, located east of the Continental Divide in southwest Montana. The tributary watersheds are formed by the Highland Mountains to the west and the Boulder Range to the north. The Jefferson River tributary study reaches are split into 3 watershed basins with a total area of 423 square miles.

The Boulder River is a major tributary to the Jefferson River located east of the Continental Divide in southwestern Montana. The Boulder River tributaries originate near the Continental Divide and throughout the Boulder Range and the Elkhorn Mountains. The study watershed basin area of the Boulder River mainstem and tributaries encompasses the entire Boulder River watershed area of approximately 769 square miles. Nine tributaries and one lake analyzed in this report flow to the Boulder River mainstem.

Prickly Pear Creek is a major tributary to the Missouri River located east of the Continental Divide in Southwestern Montana. The river tributaries originate in the Boulder Range to the north and the Elkhorn Mountains to the south. The study watershed basin area of Prickly Pear Creek mainstem and tributaries encompasses a watershed area of 247 square miles. Four tributaries analyzed in this report flow to Prickly Pear Creek mainstem.

The primary cause of flooding throughout Jefferson County is spring snowmelt. Ice jams and precipitation events can also contribute to flooding. There are historical records from several U.S. Geological Survey (USGS) stream gages that date back to 1911 documenting flood history.

Past studies for Jefferson County are limited. Within Jefferson County, there is one Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Whitehall, MT (FEMA, 2007). The USGS Report *Methods for Estimating Flood Frequency at Ungaged Sites in Montana Based on Data through Water Year 2011* (Sando, et al., 2015b) was an important study, which included flood frequency analysis for several study reaches within Jefferson County.

Flood flow frequency analysis was conducted to develop peak flow discharge estimates for the 50-, 10-, 4-, 2-, 1-, and 0.2 percent annual chance events. The 1%+ (plus) annual chance event was also calculated. Peak flow estimates were calculated at 53 locations (3 gaged sites and 50 ungaged sites). Estimates at the gaged sites were conducted using Bulletin 17C methodologies. At the ungaged sites, peak flow estimates were calculated using the regional regression equation method, the drainage area gage transfer method, and the two-station logarithmic equation method. These methods conform to standard engineering practices. The drainage area gage transfer and two-station logarithmic methods were determined to produce the more accurate peak flow estimates at ungaged flow nodes when it was possible to use these methods.

The flood flow frequency estimates for the USGS stream gages used in this study produced peak discharge estimates that are similar to estimates from previous USGS studies.

The hydrologic analysis documented in this report conforms to FEMA standards for enhanced level studies, and the recommended flows of this analysis are deemed reliable and suitable for future floodplain studies and hydraulic analyses.

1 INTRODUCTION

As part of the Jefferson Countywide Map Modernization project, the Montana Department of Natural Resources and Conservation (DNRC) contracted Pioneer Technical Services, Inc. (Pioneer) to complete a comprehensive peak flow hydrologic analysis for Jefferson Countywide study reaches. Pioneer conducted flood flow frequency calculations on 5 primary study areas. The first study area was tributaries to the Jefferson River around Whitehall, MT, which included 6 tributaries and 2 reservoirs. The second and third study area was a 77.0-mile reach of the Boulder River mainstem, 9 of its tributaries, and 1 lake. The fourth and fifth study area was a 27-mile reach of the Prickly Pear Creek mainstem and 4 of its tributaries. All reaches were contained in Jefferson County. The Jefferson Countywide study area watershed encompassed a combined 1,439 square miles. The hydrologic analysis in this report has been organized into 5 hydrologic study areas:

1. Jefferson River Tributaries.
2. Boulder River Mainstem.
3. Boulder River Tributaries.
4. Prickly Pear Creek Mainstem.
5. Prickly Pear Creek Tributaries.

Information gathered from this analysis will be used for both enhanced level and enhanced level with floodway hydraulic analyses and floodplain mapping. **Figure 1-1** shows the project study reaches.

1.1 Background Information

The FEMA administers the National Flood Insurance Program (NFIP). As part of this program, FEMA supports flood hazard studies and prepares flood hazard maps and related documents. The Jefferson County study area is located in predominantly rural environments. Study reaches flow through or near the small communities of Whitehall, Boulder, Basin, Jefferson City, Clancy, and Montana City, MT. The existing floodplain mapping for Jefferson County in the study area includes 162 miles of Approximate Zone A and 0.7 miles of Detailed Zone AE in the town of Whitehall, MT.

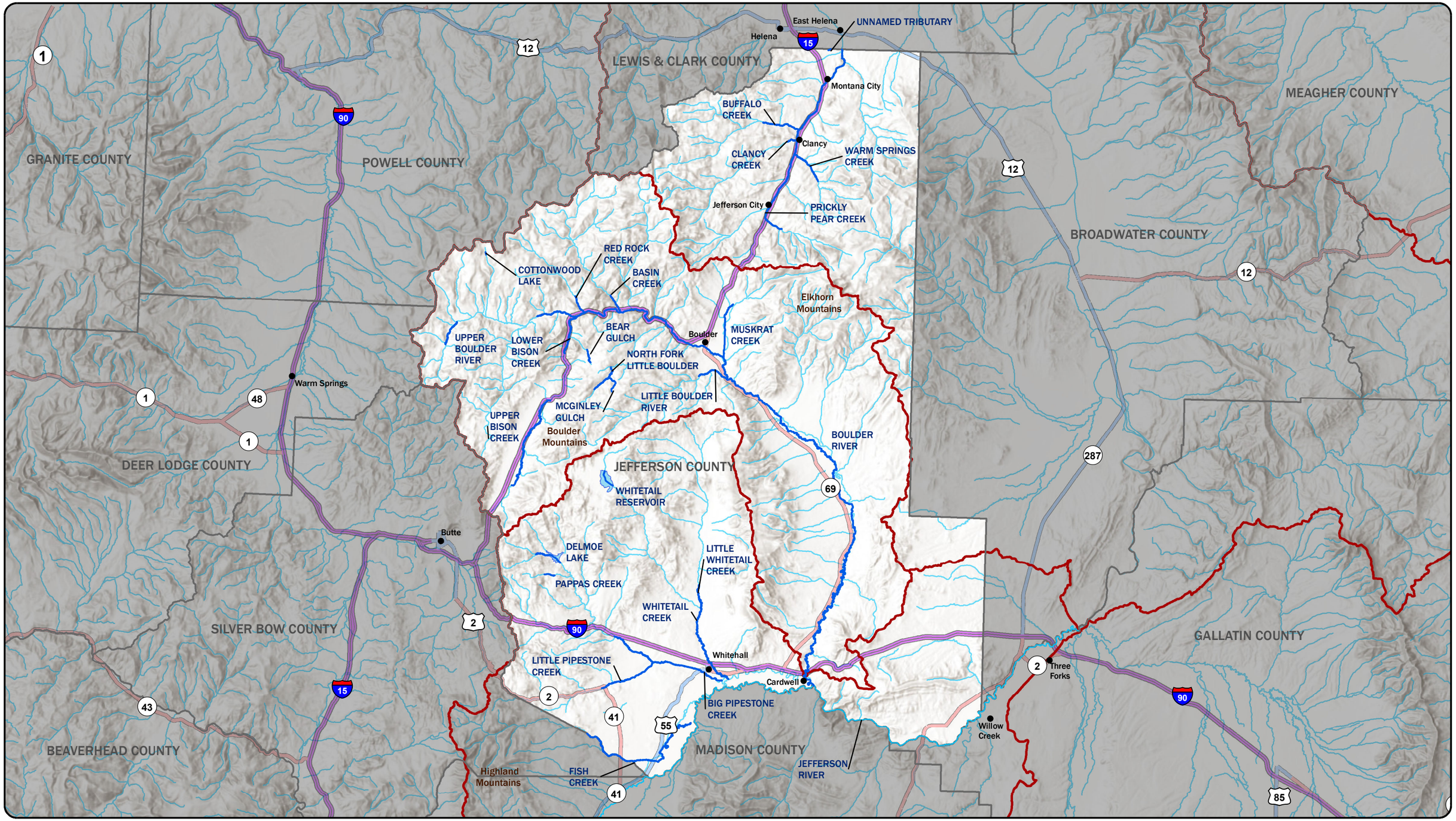
Approximate Zone A flood maps are developed using approximate methodologies and are not based on detailed hydraulic analysis. This level of flood mapping is often used in rural areas with low populations. Base Flood Elevations (BFEs) or flood depths are not identified in Approximate Zone A mapping (a BFE is the computed elevation to which floodwater is estimated to rise during a base flood). As a result, areas designated with Zone A flood mapping are difficult for local communities to manage and administer.

Enhanced and base level mapping are similar in that both use standard hydrologic and hydraulic modeling methods to estimate BFEs and flood inundation areas. Both require the same topographic accuracy. However, base level analysis may not include mapping the 500-year floodplain delineation, BFEs, or developing flood profiles. Base level analysis may allow some flexibility in the acquisition and modeling of bathymetric and structure survey data, and generally does not include floodway

delineation. Although enhanced level analysis often includes floodway delineation, it is not always required (FEMA, 2016a).

The DNRC, in partnership with FEMA and Jefferson County, initiated work to produce a new floodplain study along existing study reaches in Jefferson County. The Jefferson countywide floodplain study will provide the groundwork for completing floodplain mapping in Jefferson County. This report documents the hydrologic analysis methodology and results completed on the study areas. The analysis includes peak discharge estimate calculations for the 50-, 10-, 4-, 2-, 1-, and 0.2-percent Annual Exceedance Probability (AEP) Peak Discharges at key flow change locations (such as Hydrologic Unit Code [HUC] 12 [HUC 12], significant tributary confluences, stream gages, and population centers) along the study reach. This report conformed to FEMA standards for enhanced level studies (FEMA, 2019: SID #84).

As part of this study, the DNRC contracted with the United States Geological Survey (USGS) to perform a Bulletin 17C flood frequency analysis for 11 selected USGS streamgages in Jefferson County using gage data through 2017 (Sando, et al., 2019). A detailed summary of the 2019 USGS gage analysis is included in the subsequent Hydrologic Analysis sections for each study area. The results of the USGS gage analysis provided for this study are a courtesy data release while the information is being processed for publication. This report information will be updated upon the USGS data release publication.



LEGEND

- TOWNS
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 3.5 7 14
Miles

FIGURE 1-1

PIONEER TECHNICAL SERVICES, INC.

DATE: 9/13/2019

JEFFERSON COUNTY
MAP MODERNIZATION
STUDY AREA

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-1-1.mxd

2 JEFFERSON RIVER TRIBUTARIES

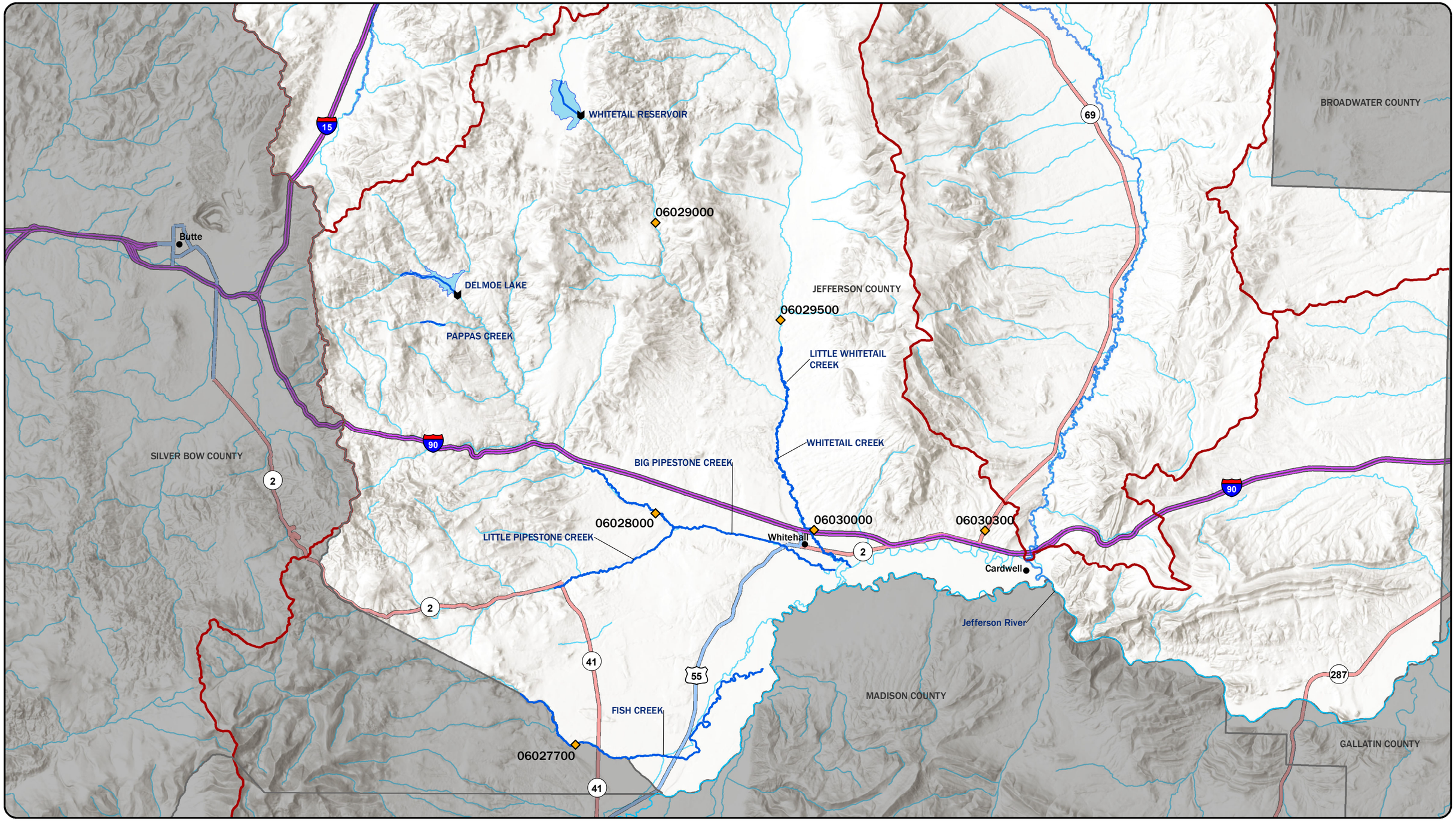
2.1 Jefferson River Tributaries Introduction

2.1.1 Basin Description

Three primary Jefferson River tributaries in the study area (Whitetail Creek, Big Pipestone Creek, and Fish Creek) report to the Jefferson River, joining the Madison River to form the Missouri River. At 84 miles long, the Jefferson River is formed by the confluence of the Big Hole and Beaverhead Rivers. The Jefferson River tributaries watershed encompasses approximately 423 square miles. The Jefferson River tributary study reaches are shown in Figure 2-1.

The Jefferson River tributaries' basin elevations within the study area range from approximately 6,900 feet in the southern Boulder Range to approximately 4,330 feet at Whitehall, MT. The overall basin elevations range from over 10,000 feet in the Highland Mountains to 4,330 feet at Whitehall, MT. The terrain varies from a high alpine environment in its headwaters to a heavily cultivated landscape in the Jefferson Valley with expansive irrigated pasture lands, bracketed by rolling foothills. The hydrology of the basin is primarily snowmelt driven.

Land use in the Jefferson River basin is primarily agricultural with irrigated farming and ranching operations. Most of the intensely farmed land in the Jefferson valley is within the Jefferson River floodplain. Whitehall is the primary community in the Jefferson River tributaries study area.



LEGEND

- DAMS
- INACTIVE USGS STREAM GAGE
- TOWNS
- JEFFERSON RIVER TRIBUTARY STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1.5 3 6
Miles

FIGURE 2-1

PIONEER TECHNICAL SERVICES, INC.

DATE: 9/10/2019

JEFFERSON RIVER TRIBUTARIES STUDY AREA

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-2-1.mxd

2.1.2 Flood History

The primary flooding cause on Jefferson River tributary study reaches is spring snowmelt mixed with rain (according to historical records). There are historical records from 6 tributary USGS stream gages within the study area that document flooding history. Only 3 gages have 10 or more years of record. Gages with less than 10 years of record were not used in this analysis. The gages are listed below:

1. Fish Creek near Silver Star, MT (06027700).
2. Whitetail Creek near Whitehall, MT (06029000).
3. Jefferson River tributary No. 2 near Whitehall, MT (06030300).

The USGS stream gage Fish Creek near Silver Star, MT (06027700) has a 33-year period of record (1959-1991). The annual peak flow record for the Fish Creek Gage is shown in Figure 2-2. The Fish Creek drainage is one of the 3 tributary drainage basins in the Jefferson River tributaries study area being evaluated in this report.

The USGS stream gage Whitetail Creek near Whitehall, MT (06029000) has a 19-year period of record (1950-1953, 1955-1968, 1981). The annual peak flow record for the Whitetail Creek gage is shown in Figure 2-3. The Whitetail Creek gage is located under a dam that forms Whitetail Reservoir, resulting in the gage having a Major Dam Regulation (R-MAJ) classification. Gages with a single upstream dam whose drainage area exceeds 20% of the drainage area of the gage drainage area are classified as R-MAJ. The gage is located upstream of the Whitetail Creek reach in the Jefferson River tributaries study area.

The USGS stream gage Jefferson River tributary No. 2 near Whitehall, MT (06030300) has a 55-year period of record (1958-2010). The annual peak flow record for the Jefferson River tributary No. 2 gage is shown in Figure 2-4. The Jefferson River tributary No. 2 gage is not located on any of the 3 tributaries being evaluated in this report.

Peak flow recurrence intervals shown in Figure 2-2, Figure 2-3, and Figure 2-4 are based on previously published flood frequency analysis results through Water Year 2011 (Scientific Investigations Report [SIR] 2015-5019-C) (Sando, et al., 2015a).

Reports that document the flooding mechanisms on the study area are limited. These reports reference a flood that occurred in May 1981. This flood is discussed in more detail in Section 2.2. The primary cause of flooding in nearby areas is spring snowmelt combined with rain and ice jams. Since limited documentation of flooding mechanisms exist outside of the May 1981 flood, it can be inferred that flooding occurs by similar mechanisms.

Figure 2-2 shows that the peak flood of record for Fish Creek near Silver Star, MT occurred in 1978 with a flow of 250 cubic feet per second (cfs), exceeding the 10% (10-year) AEP flow of 208 cfs. The second highest flood on record occurred in 1975 with a flow of 240 cfs, exceeding the 10% AEP flow. The third highest flood on record occurred in 1967 with a flow of 228 cfs, exceeding the 10% AEP flow. In the 33-year period of record for the Fish Creek near Silver Star, MT (06027700) gage, the 10% AEP flow has been equaled or exceeded 5 times (in 1965, 1972, 1975, 1978 and 1981). All the annual peak flows in Fish Creek occurred in the months of March and June. The peak flow of record occurred in March.

Figure 2-2 Fish Creek near Silver Star, MT (06027700)

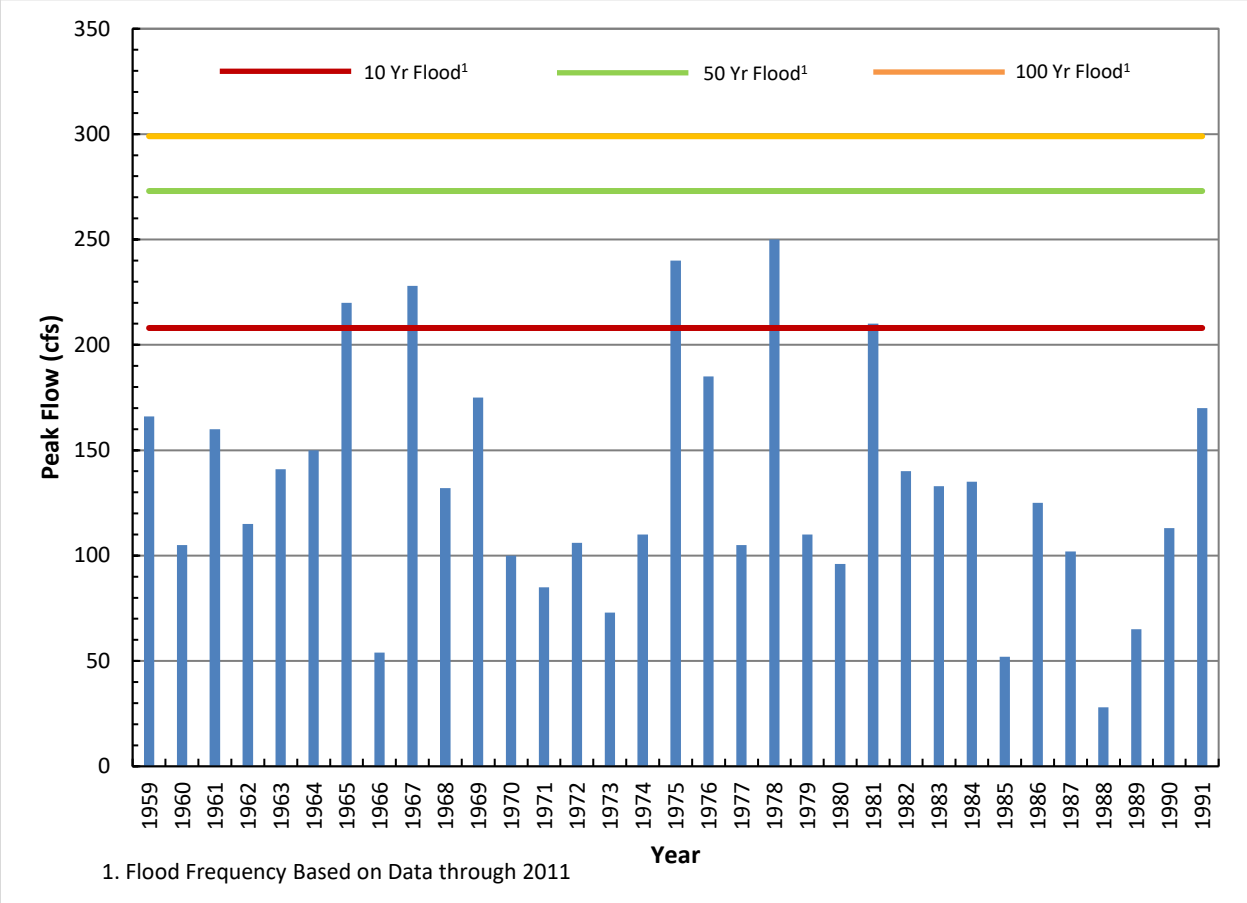


Figure 2-3 shows that the peak flood of record for Whitetail Creek below Whitetail Reservoir occurred in 1981 with a flow of 142 cfs, exceeding the 10% (10-year) AEP flow of 118 cfs. The second highest flood on record occurred in 1951 with a flow of 126 cfs, exceeding the 10-year flow. The third highest flood on record occurred in 1967 with a flow of 120 cfs. This gage is located below Whitetail Dam, and records indicate dam regulation affected the flows recorded. In the 19-year period of record at the Whitetail Creek near Whitehall, MT (06029000) gage, the 10% AEP flow has been equaled or exceeded 3 times (1951, 1967, 1981). The annual peak flows occurred between the months of May and June. The peak flow of record occurred in May.

Figure 2-3 Whitetail Creek near Whitehall, MT (06029000)

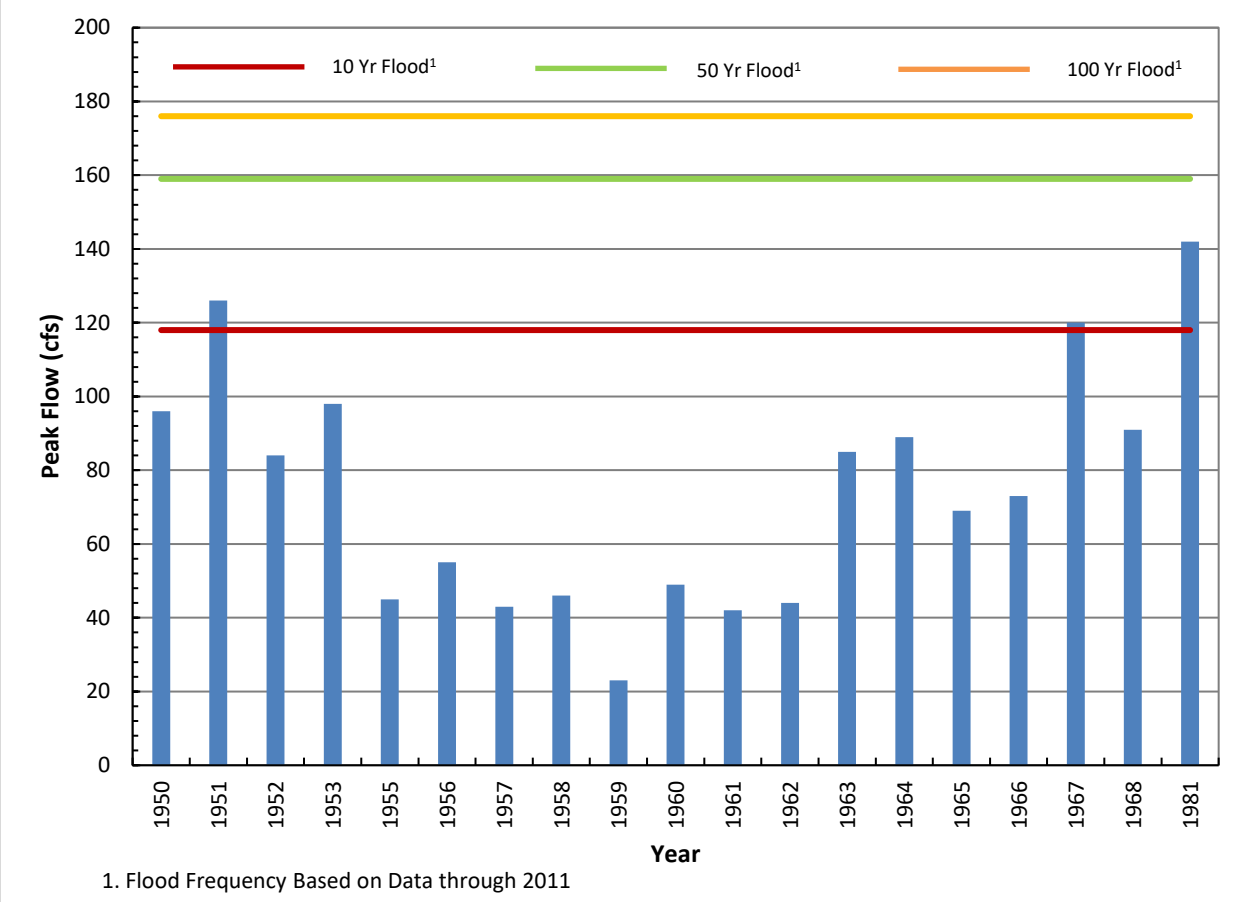
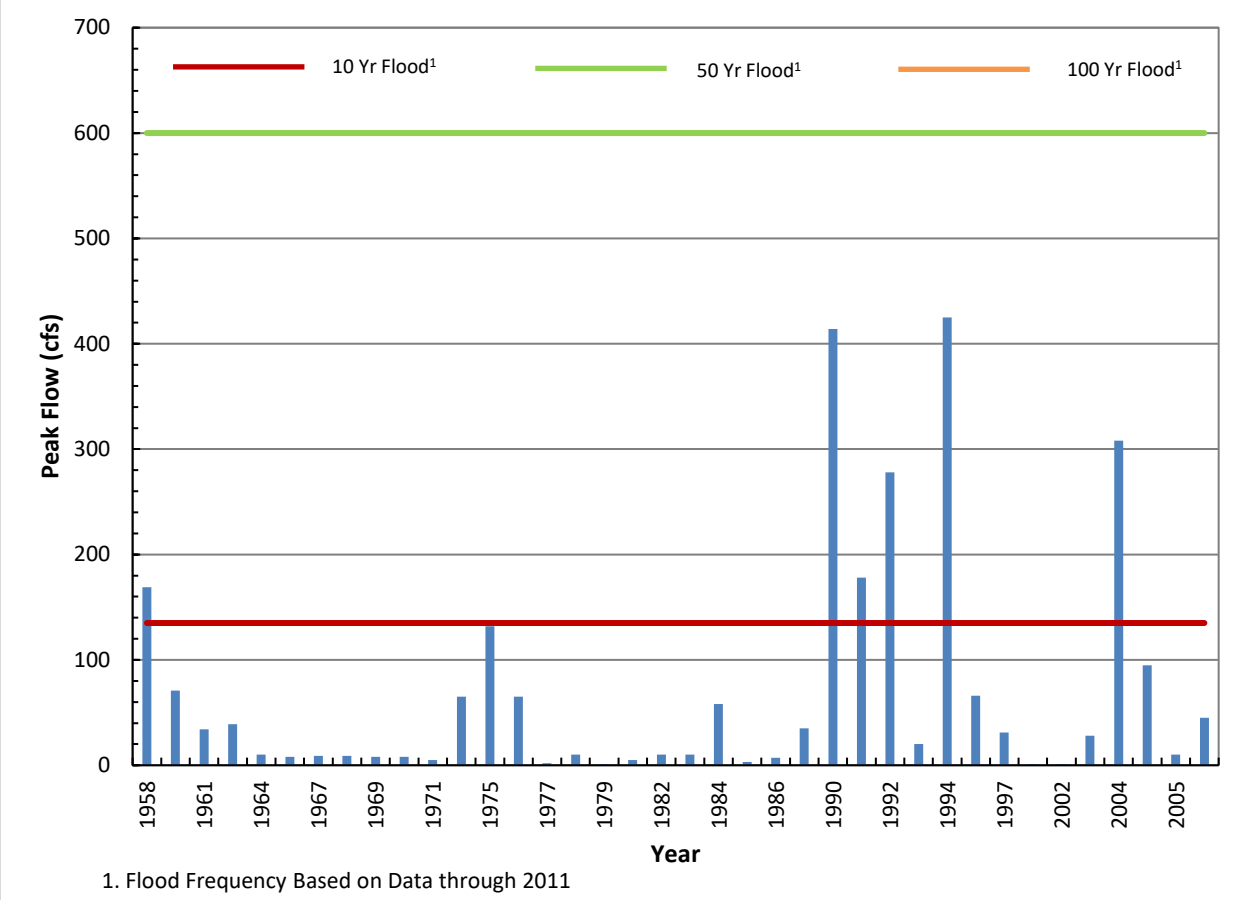


Figure 2-4 shows that the peak flood of record for Jefferson River tributary No. 2 near Whitehall, MT (06030300) occurred in 1994 with a flow of 425 cfs, exceeding the 10% (10-year) AEP flow of 135 cfs. The second highest flood on record occurred in 1990 with a flow of 414 cfs, exceeding the 10-year flow. The third highest flood on record occurred in 2011 with a flow of 308 cfs, exceeding the 10-year flow. In the 55-year period of record for the Jefferson River tributary No. 2 near Whitehall, MT (06030300) gage, the 10% AEP flow has been equaled or exceeded 6 times (in 1958, 1990, 1991, 1992, 1994, and 2004). The annual peak flows occurred between the months of June-August. The peak flow of record occurred in June.

Figure 2-4 Jefferson River tributary No. 2 near Whitehall, MT (06030300)



2.2 Past Studies and Existing Flood Data

Past flood studies along the Jefferson tributary study reaches are limited. Studies relevant to this hydrologic study are those that include peak flow frequency analyses. Within the study reach, a FEMA FIS exists for the town of Whitehall, MT. There is no countywide FIS for Jefferson County.

Table 2-1 shows a summary of effective floodplain mapping.

Table 2-1 Jefferson County Floodplain Mapping Summary.

	Map Panel Summary				Study Details			
County	**Community**	**# of FIRM Panels**	**FIRM Panel Effective Date**	**FIS Date**	**Stream**	**Approx (mi)**	**Detailed (mi)**	**Total (mi)**
Jefferson County	Jefferson County Unincorporated	5	6/17/1986	NA	Big Pipestone Creek, Delmoe Lake, Fish Creek, Fish Creek Splits, Little Pipestone Creek, Little Whitetail Creek, Pappas Creek, Whitetail Creek, Whitetail Reservoir	51	NA	51
Jefferson County	Town of Whitehall	2	9/19/2007	9/9/2007	Whitetail Creek,	NA	0.7	0.7

Source: FEMA Map Service Center.
FIRM: Flood Insurance Rate Map. FIS: Flood Insurance Studies.
mi: Miles measured along channel alignment.

In addition to FEMA FIS reports, there are three USGS reports and a USDA report that address the study area. These studies and investigations are discussed in more detail in the following sections.

2.2.1 Town of Whitehall Flood Insurance Study (2007)

The Town of Whitehall FIS investigated the existence and severity of flood hazards in Whitehall, MT. As part of the FIS, Whitetail Creek was studied using detailed methods. Base flood elevations were established as part of the study. The hydrologic analysis was completed by The Schemmer Associates in 2003 (FEMA, 2007).

A detailed flood elevation study was performed along Whitetail Creek. The downstream reach edge was approximately 1.89 miles downstream of the Railroad Bridge. The upstream reach edge was approximately 1.11 miles upstream of Interstate 90 (I-90). The hydrology was developed using regional regression equations. The results of the hydrologic analysis for the stream are listed in Table 2-2.

Table 2-2 Whitetail Creek Summary of Discharges from the Town of Whitehall FIS

Flooding Source and Location (Flow Node)	Drainage Area (sq mi)	Peak Discharges (cfs)			
		10-Year	50-Year	100-Year	500-Year
Whitetail Creek at Whitehall, MT	177	1,260	2,100	2,540	3,670

Source: FEMA
sq mi: square miles. cfs: cubic feet per second.

2.2.2 Big Pipestone Creek Flood Plain Management Study (1984)

The Big Pipestone Creek Flood Plain Management Study (USDA SCS, 1984) was conducted in 1984 by USDA Soil Conservation Service (in cooperation with Jefferson County, Whitehall Town Council, Jefferson Valley Conservation District, and Montana DNRC). The study reach involved a 6.5-channel-mile reach on Big Pipestone Creek, which flows west to east along the south side of Whitehall. The study developed information for the study area that included hydrology, hydraulics, and flood hazards as well as possible solutions to problems in the area. The goals of the study were categorized into 4 objectives:

1. Obtain floodplain information.
2. Identify feasible measures to reduce flood hazards along the south edge of Whitehall.
3. Identify alternatives to stop channel headcutting and bank erosion resulting from past man-made modifications.
4. Establish sound floodplain management in accordance with Montana law.

The study included peak discharges with recurrence intervals of 10, 25, 50, and 100 years for 3 ungaged locations within the study reach. The ungaged locations were above and below the confluence with Little Pipestone Creek and at the confluence with Jefferson Slough. The final peak discharge-frequency curve was developed using the SCS TR20 Project Formulation-Hydrology computer model. Table 2-3 summarizes the peak flow data calculated for 3 ungaged sites.

Table 2-3 Summary of Discharges from Big Pipestone Creek Study

Big Pipestone Creek Study Reach Description (Flow Node)	Drainage Area (sq mi)	Peak Discharges (cfs)			
		10-Yr.	50-Yr.	100-Yr.	500-Yr.
Just above confluence with Little Pipestone Creek	114.4	345	1,055	1,580	3,030
Just below confluence with Little Pipestone Creek	161.3	475	1,480	2,180	4,100
At confluence with Jefferson Slough	170	480	1,515	2,225	4,200

Source: USDA
sq mi: square miles. cfs cubic feet per second.

The study documented the flooding mechanisms of the May 1981 flood that disrupted multiple communities in and near Jefferson County. According to the report, the flood was caused by rainfall with minimal contribution from snowmelt. The winter of 1981 was one of the driest on record, resulting in nearly no snowpack in the mountains at the time of the flood. A rainy spring and snowmelt saturated the soil prior to the storm. A major rainstorm centered around the Boulder River and Prickly Pear Creek produced peak floods greater than the 100-year frequency in that area. Big Pipestone Creek experienced a peak flood between the 10-year and 20-year event. Weather station readings recorded 1.6 to 1.9 inches of rainfall over a 24-hour period in the Big Pipestone Creek watershed. To the north, the storm center produced rainfall up to 3.5 inches in a 24-hour period.

2.2.3 Water-Resources Investigations Report 03-4308

The investigation for USGS Water Resources Investigations Report (WRIR) 03-4308 developed annual peak discharges with recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years (*T*-year floods) for 660 gaged sites in Montana and in adjacent areas of Idaho, Wyoming, and Canada, based on data through Water Year 1998 (Parret & Johnson, 2004). The flood-frequency information was used in regression analyses to develop equations relating *T*-year floods to various basin and climatic characteristics, active-channel width, and bankfull width. The equations can be used to estimate flood frequency at ungaged sites. Flood-frequency data typically were determined by fitting a log-Pearson Type III probability distribution using methods described by the Interagency Advisory Committee on Water Data (IACWD) Bulletin 17B (IACWD, 1982). Table 2-4 provides the WRIR 03-4308 peak discharge summary for 3 USGS gages in the Jefferson River tributaries study area. The USGS Station Number 06029000, Whitetail Creek near Whitehall, MT, is regulated upstream by the Whitetail Reservoir Dam. All 19 years of record for this site are regulated peak flow records.

Table 2-4 - WRIR 03-4308 Jefferson River Tributary Peak Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Years of Record	Peak Discharges, Return Interval (years) (cfs)						
				5-year	10-year	25-year	50-year	100-year	200-year	500-year
06027700	Fish Creek near Silver Star, MT	39	33	176	208	246	273	299	325	358
06029000	Whitetail Creek near Whitehall, MT	30	19	101	123	149	168	187	206	231
06030300	Jefferson River tributary No. 2 near Whitehall, MT	4.5	41	59	137	331	579	955	1,500	2,590

Source: USGS
Based on systematic data through 1998. USGS: U.S. Geological Survey. sq mi: square miles, cfs: cubic feet per second.

2.2.4 Scientific Investigations Report 2015-5019

The USGS SIR 2015-5019-C included updated AEP peak discharges with AEPs of 66.7, 50, 42.9, 20, 10, 4, 2, 1, 0.5, and 0.2 % (return intervals of 1.5, 2, 2.33, 5, 10, 25, 50, 100, 200, and 500 years, respectively) for 725 gaged sites in or near Montana, based on data through Water Year 2011 (Sando, et al., 2015a). Flood-frequency data were determined by fitting a log-Pearson Type III probability distribution using methods described by the IACWD, Bulletin 17B (IACWD, 1982). The study was part of a larger study to develop an online StreamStats application for Montana, in conjunction with computing streamflow characteristics at gage stations, and estimate peak flow flood frequency at ungaged sites. Table 2-5 provides the SIR 2015-5019-C discharge summary for selected Jefferson River tributary gages. The USGS SIR 2015-5019-F (Sando, et al., 2015b) selected 537 gaging stations from the gage study. The 537 gaging stations were segregated based on the following criteria: contributing drainage area less than about 2,750 square miles, peak-flow records unaffected by major regulation, small redundancy with nearby stations, and representation of peak-flow frequencies at sites within Montana. The study used regression analyses to develop equations relating AEP flows to various basin and climatic characteristics. The relationships developed for this study resulted in lower mean standard errors of prediction than previous regression analyses.

Table 2-5 SIR-2015-5019-C Jefferson River Tributary Peak Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Period of Record in Years	Peak Discharge (cfs)						
				5-year	10-year	25-year	50-year	100-year	200-year	500-year
06027700	Fish Creek near Silver Star, MT	39	33	176	208	246	273	299	325	358
06029000	Whitetail Creek near Whitehall, MT	30	19	98	118	142	159	176	192	213
06030300	Jefferson River tributary No. 2 near Whitehall, MT	4.5	54	54	135	340	600	984	1,520	2,550

Source: USGS
Based on systematic data through 2011. USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.

2.2.5 Scientific Investigations Report 2018-5046

The USGS SIR 2018-5046 included updated AEP peak discharges with AEPs of 50, 42.9, 20, 10, 4, 2, 1, 0.5, and 0.2 % (return intervals of 2, 2.33, 5, 10, 25, 50, 100, 200, and 500 years, respectively) for 99 gaged sites in or near Montana, based on data through Water Year 2015 (Sando & McCarthy, 2018). Flood-frequency data typically were determined by fitting a log-Pearson Type III probability distribution using an Expected Moments Algorithm analysis and other methods described by England and others in Bulletin 17C (England, et al., 2018). The AEP peak discharges for the Jefferson River tributary No. 2 near Whitehall, MT gage were updated as part of the report. Table 2-6 provides the SIR 2018-5046 peak discharge summary for the gage.

Table 2-6 SIR 2018-5046 Jefferson River Tributary Peak Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Period of Record in Years	Type of peak-flow frequency analysis	Peak Discharge (cfs)						
					5-year	10-year	25-year	50-year	100-year	200-year	500-year
06030300	Jefferson River tributary No. 2 near Whitehall, MT	4.5	55	At-Site	55	158	456	876	1,540	2,530	4,510

Source: USGS
USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.

2.2.6 Additional Previous Studies

Additional related previous studies conducted within the Jefferson River tributaries study reach involve mining impacts, sediment management, fisheries management, irrigation history, and watershed characterization reports. Specific studies for Big Pipestone Creek, Delmoe Lake, Whitetail Creek, and Whitetail Reservoir were conducted. All other studies referenced multiple tributaries to the Jefferson River in Jefferson County:

Big Pipestone Creek:

- *Effluent Mixing Characteristics Below Four Wastewater-Treatment Facilities in Southwestern Montana, 1997* (Cleasby, 1999).
- *Whitetail-Pipestone Travel Management Draft Environmental Impact Statement* (USDA, 2006).

Delmoe Lake

- *Delmoe Lake Dam Butte, Montana Jefferson County MT – 117* (CH2M Hill, 1980)

Jefferson River Tributaries:

- *Aquatic Surveys and Assessment within the Butte BLM District* (Stagliano, 2006).
- *Jefferson River Metals Project Area TMDLs* [Total Maximum Daily Loads] *and Water Quality Improvement Plan* (Montana DEQ, 2014).
- *Upper Jefferson River Tributary Sediment TMDLs* [Total Maximum Daily Loads] *& Framework Water Quality Improvement Plan* (Montana DEQ, 2009).
- *Watershed Resources Survey: History of Land and Water Use on irrigated Areas, Jefferson County, Montana* (State Engineer's Office, 1956).
- *Watershed Restoration Plan* (Dodge, 2010).

Whitetail Creek:

- *Upper Jefferson River Tributary Sediment TMDLs & Framework Water Quality Improvement Plan – Appendix A* (Montana DEQ, 2009).

Whitetail Reservoir

- *Whitetail Dam, Whitehall, MT, Jefferson MT Inspection Report* (HKM Associates, 1991).

2.2.7 Flood Protection Measures

The U.S. Army Corps of Engineers maintains the National Inventory of Dams (NID), a database that keeps record of all the dams across the county. The NID identifies hazard potential, dam height, ownership, purpose, dam type, and administrative data. Within the Jefferson River tributaries study area 3 dams were identified.

There are no major flood-control structures on Fish Creek, Little Pipestone Creek, or Little Whitetail Creek. Keogh Dam is a minor dam on Little Whitetail Creek that is classified as having low flood hazard potential (ACOE, 2019).

The Delmoe Lake Dam exists on Big Pipestone Creek at an elevation of approximately 6000 ft. The dam is operated by the Pipestone Water Users Association and regulated under the MT DNRC Dam Safety program. A 1980 study (CH2M Hill, 1980) determined the Delmoe dam was likely to fail in the event of the PMF. The dam was identified as having a high flood hazard potential (ACOE, 2019).

The Whitetail Reservoir Dam is located on Whitetail Creek at approximately 7200 ft. The dam was identified as having a high flood hazard potential (ACOE, 2019). A 1991 study (HKM Associates, 1991) determined the dam would not overtop and fail during the PMF.

2.3 Hydrologic Analyses and Results

The purpose of the hydrologic analyses conducted as part of this project was to develop peak flow discharge estimates for the 50-, 10-, 4-, 2-, 1-, 0.2% and 1%+ AEP events at key flow change locations (such as at significant tributaries confluences, stream gages, and population centers) along the study reach. The analysis was organized into 2 sections:

1. USGS Stream Gage Analysis.
2. Ungaged Flow Node Analysis.

Throughout the study area, 14 flow change nodes (flow nodes) within the Jefferson River tributary study area, including 2 reservoirs, were identified as having significant changes in streamflow or being at a critical location. Of the 14 flow nodes in the study area, 1 is located at an inactive USGS stream gage site on Fish Creek. The study tributaries in this report were based on the Jefferson Country Modernization Study Area Map provided by the DNRC. The river stations used in this report were based on Jefferson River tributaries S_Hydro_Reach, delineated by Pioneer as part of this report. LiDAR topography was not available for the study reach at the time this work was performed, therefore the S_Hydro_Reach alignments were developed using Google imagery. The Jefferson River tributaries S_Hydro_Reach alignments begin at the junctions of Whitetail Creek, Big Pipestone Creek, and Fish Creek with the Jefferson River. The study reach upstream extents are shown in Figure 2-1.

2.3.1 USGS Stream Gage Analysis

The DNRC contracted USGS to perform peak flow analysis for selected stream gages in Jefferson County as part of this hydrologic analysis. Eleven gages were analyzed by USGS within Jefferson County, and 3 of those fall within the Jefferson River tributary study area. The USGS gage flood frequency analysis summary, data and calculations are provided in Appendix A. Bulletin 17C methods were used to estimate the 50-, 42.9, 20-, 10-, 4-, 2-, 1-, 0.5-, 0.2-percent annual exceedance probabilities (AEPs) and the 1% + (plus) AEP (Sando, et al., 2019). The USGS methodologies used for the gage analyses presented in this report are documented in USGS SIR 2018-5046 (Sando & McCarthy, 2018).

There is 1 USGS stream gage located on the Jefferson River tributary Fish Creek study reach at river mile 11.5 (USGS gaging station Fish Creek near Silver Star, MT (06027700)). Two additional USGS gages are located near the study area with over 10 years of record. USGS gaging station Whitetail Creek near Whitehall, MT (06029000) is located approximately 8.1 miles upstream of the Whitetail Creek study reach. USGS gaging station Jefferson River tributary No. 2 near Whitehall, MT (06030300) is located east of the study reaches near the intersection of Montana Highway 69 and I-90.

The oldest records date back to 1950 at USGS gaging station Whitetail Creek near Whitehall, MT (06029000). The Whitetail Creek near Whitehall, MT (06029000) gage has not been active since 1981. The USGS classifies this gage as regulated due to the upstream Whitetail Dam. Currently, all the USGS gaging stations in or near the Jefferson Tributary study reach are discontinued. Figure 2-1 shows the study area and the USGS gaging station locations on and near the study reaches. Table 2-7 summarizes the USGS stream gages within or near the Jefferson River tributaries study reach. FEMA guidance (FEMA, 2019) indicates that gage station records equal or exceeding 10 years in length are applicable to all types of studies.

Table 2-7 Jefferson River Tributaries USGS Gages

USGS Station Number	Station Name	Regulation Status as of 2014	Total Number of Years of Peak-Flow Records	Total Period of Record, in Water Years	2017 Status
06027700	Fish Creek near Silver Star, MT	U	33	1959-1991	Inactive
06029000	Whitetail Creek near Whitehall, MT	R (MAJ-dam)	55	1950-1953, 1955-1968, 1981	Inactive
06030300	Jefferson River tributary No. 2 near Whitehall, MT	U	19	1958-2012	Inactive

Source: Sando et al., 2019
USGS: U.S. Geological Survey.

Flood frequency gage-based estimates can be affected by the climatic conditions during the time period the peak-flow data were collected, influencing how the peak-flow frequency results represent long-term hydrologic conditions (Sando, et al., 2015c). Weighting the gage analysis peak flow estimates with the regional regression peak flow estimates adjusts the gage site frequency analysis to account for climatic conditions outside the gaged site period of record (Sando, et al., 2015c). As a standard practice, USGS weights all the at site peak flow estimates, unless a record extension was performed, or the site was classified as a major regulated structure. Methods used to weight the at site peak flow estimates are documented in the USGS SIR 2018-5046 (Sando & McCarthy, 2018)

USGS performed the gage analysis and weighted with regional regression equations analysis for 9 of the 11 gages in the Jefferson Countywide study area (Sando, et al., 2019).

USGS gaging station Whitetail Creek near Whitehall, MT (06029000) is considered a regulated gage, therefore the systematic record was not weighted with regional regression equations. Table 2-8 shows

the results for systematic and weighted flood frequency estimates with regional regression equations for gages within or near the Jefferson River tributary study area.

Table 2-8 Jefferson River Tributaries Gage Flood Frequency Estimates

Node/USGS Station ID	Location Description	Peak Flood Frequency Method	AEP Estimated Discharge (cfs)					
			50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
			2-year	10-year	25-year	50-year	100-year	500-year
06027700	Fish Creek near Silver Star, MT	At Site	125	210	249	276	301	356
		RRE wtd	125	212	252	282	311	380
06029000	Whitetail Creek near Whitehall, MT	At-Site	67	116	140	158	174	212
06030300	Jefferson River Tributary No.2 near Whitehall, MT	At Site	5.9	164	402	664	990	1,950
		RRE wtd	7.4	122	253	366	490	793

Source: Sando et al., 2019
At-Site: Systematic Data; RRE wtd: Systematic data weighted with regional regression equation (RRE) (Southwest Region).
USGS: U.S. Geological Survey. cfs: cubic feet per second.

2.3.1.1 *1% + Peak Flow Estimates*

The 1%+ AEP event was calculated by the USGS (Sando, et al., 2019) to provide a confidence range that the 1% flood frequency peak flow estimates are likely to fall within. For gage analysis, FEMA guidance (FEMA, 2019) defines the 1-percent-plus flood elevation as a flood elevation derived by using discharges that are at the upper 84-percent confidence limit as calculated in the gage analysis for the 1-percent-annual-chance event for the Flood Risk Project. The USGS used the methods for estimating synthetic statistics outlined in Bulletin 17C Appendix 7, to estimate the upper 84 percent confidence limit of the Log Pearson III frequency Curve at the 1-percent-annual-chance event.

The Jefferson River tributaries 1%+ flood frequency peak flow estimates for USGS gages are listed in Table 2-9.

Table 2-9 USGS 1%+ Flood Frequency Estimates 2019

USGS Station Number	Station Name	1% + AEP Peak discharge, At-Site (cfs)	1%+ AEP Peak discharge, RRE wtd (cfs)
06027700	Fish Creek near Silver Star, MT	395	358
06029000	Whitetail Creek near Whitehall, MT	240	NA
06030300	Jefferson River tributary No. 2 Near Whitehall, MT	2980	760

Source: Sando et al., 2019
RRE wtd: Systematic data weighted with regional regression equation (RRE) (Southwest Region).
USGS: U.S. Geological Survey. cfs: cubic feet per second. AEP: annual exceedance probability.

2.3.2 Flow Change Node Locations

Future flood studies will use hydraulic models that are composed of geometric data and streamflow data. To accurately model the Jefferson River tributary study reaches, the locations of major tributary confluences and other flow change locations must be identified. Hydrologic analysis results will be used as the streamflow data input at the tributary confluences within the hydraulic model.

Generally, the hydraulic models simulate flood events using steady-state conditions and, therefore, the peak flow rate calculated at a flow node is projected to the next upstream flow node. This method was followed for the hydrologic analysis calculations. Flow nodes were assigned immediately upstream of tributary junctions; this method of locating the flow nodes was employed so that the additional flow resulting from the tributary confluence was accurately reflected to the reach downstream of the confluence.

For study reaches that did not extend to a tributary junction, flow nodes were placed at the downstream end of the study reaches. A detailed review of the study area was performed to identify all potential flow change locations (flow nodes) on the Jefferson River tributary study reaches. Flow nodes were located on HUC 12-digit watershed boundaries. The HUC 12-digit watershed boundaries represent the smallest USGS-delineated watershed area available in GIS format. Flow nodes were placed upstream of reservoir dams. These flow nodes were placed to determine the total flow into the reservoir in a peak flow event. At each flow node, a drainage basin area was delineated, and streamflow values were calculated for the various recurrence interval floods.

Using ArcGIS, 3 flow nodes (Whitetail Creek, Big Pipestone Creek, and Fish Creek) were located just upstream of each tributary's confluence with the Jefferson River mainstem. Seven additional flow nodes were added upstream of the confluence flow nodes for mainstem Whitetail Creek, Big Pipestone Creek, and Fish Creek. These included 2 reservoir nodes at Whitetail Reservoir and Delmoe Lake. The reservoir nodes were located just upstream of the lake outlet and represent the unregulated flow into the bodies of water. At the downstream boundary, 2 flow nodes were located upstream of where study reach sub-tributaries (Little Whitetail Creek and Little Pipestone Creek) join the tributary mainstems. A node was located upstream of the confluence flow node on Little Pipestone Creek. A final node was located on Pappas Creek, a remote study reach that joins with Big Pipestone Creek about 7,500 feet downstream of the flow node, for a total of 14 flow nodes.

Three methods were used to generate flow node drainage basins. The primary method involved calculating drainage basins with StreamStats, a USGS software that produces peak flow data and drainage basin area. Complex, low-gradient topography on the lower reach of Fish Creek required additional methods to calculate drainage basins for Node 1200 and 1300. For Node 1200, ArcGIS (Esri's Geographic Information Systems [GIS] mapping software) was used to calculate the drainage area. For Node 1300, two separate StreamStats drainage basins were computed and combined using ArcGIS (neither ArcGIS or StreamStats produced a singular drainage basin that accounted for all drainage area reporting to Node 1300). ArcGIS was used to calculate the combined area of the two StreamStats basins.

Table 2-10 summarizes the 14 flow nodes used in the study. Figure 2-5 shows the Jefferson Tributaries flow nodes and their corresponding sub basins.

Due to their drainage area size, these ungaged flow nodes do not have a Geographic Names Information System (GNIS) hydrographic feature name. Therefore, a location description was developed for each ungaged flow node.

To address the issue of coincident peaks between the study tributaries and the Jefferson River mainstem, FEMA guidance requirements for coincident peaks were referenced. For coincident peaks to be evaluated, FEMA guidance (FEMA, 2016b) requires the following criteria be met:

1. The ratio of the drainage areas lies between 0.6 and 1.4.
2. The arrival times of flood peaks are similar for the 2 combining watersheds.
3. The likelihood of both watersheds being covered by the storm is high.

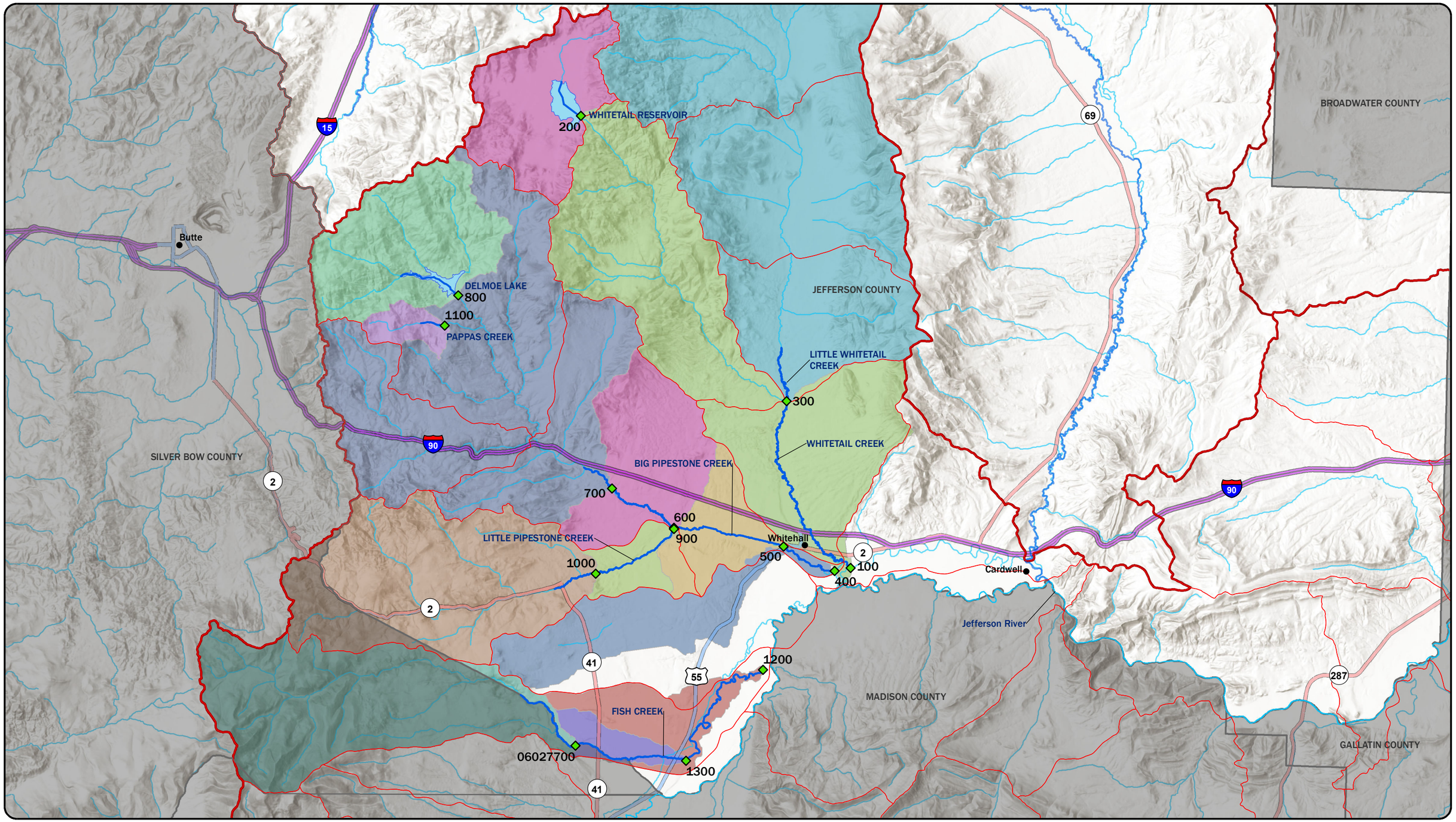
The study tributaries do not meet these drainage area ratio criteria. Study tributaries and the Jefferson River mainstem are not gaged at their respective confluences. Therefore, data to determine criteria No. 2 were not available. The Jefferson River mainstem drainage area at the tributary confluences is one or more orders of magnitude greater than the tributary basin areas, therefore there is a low likelihood that both watersheds would be covered by the same storm. Consequently, it was determined that the tributaries do not meet the FEMA criteria for coincident peaks.

Table 2-10 Flow Node and USGS Gage Station Information Used in Hydrologic Analyses

Node/USGS Station ID	Location Description	Tributary River Station[1] (mi)	Calculated Basin Area[2] (sq mi^2)	Tributary	DA_U/DA_G
06029000	**Whitetail Creek near Whitehall, MT (outside of study reach not used as flow node)**	**NA**	**30**	**Whitetail Creek**	**-**
100	Whitetail Creek at junction with Jefferson River	0.0	184	Whitetail Creek	6.1
200	Whitetail Reservoir Outlet	0.0	19	Whitetail Creek	-
300	Little Whitetail Creek at junction with Whitetail Creek	0.1	101	Little Whitetail Creek	-
400	Big Pipestone Creek at junction with Jefferson River	0.0	187	Big Pipestone Creek	-
500	Big Pipestone Creek upstream of Pleasant Valley Ditch	2.6	169	Big Pipestone Creek	-
600	Big Pipestone Creek upstream of junction with Little Pipestone Creek	7.1	114	Big Pipestone Creek	-
700	Big Pipestone Creek Downstream of Hot Springs Road	11.0	95	Big Pipestone Creek	-
800	Delmoe Lake Outlet	0.0	24	Delmoe Lake	-
900	Little Pipestone Creek upstream of junction with Big Pipestone Creek	0.0	46	Little Pipestone Creek	-
1000	Little Pipestone Creek downstream of Hot Springs Road	4.1	41	Little Pipestone Creek	-
1100	Pappas Creek	0.0	3	Pappas Creek	-
1200[3*]	Fish Creek at junction with Jefferson River	0.0	52	Fish Creek	1.3
1300[4*]	Fish Creek upstream of Jefferson River Slough Recharge	6.9	43	Fish Creek	1.2
06027700	**Fish Creek Near Silver Star, MT**	**11.5**	**39**	**Fish Creek**	**-**

1. River miles start at the downstream extent of each study reach (mi: miles).
2. Source: USGS StreamStats and Esri ArcGIS.
3. Watershed generated using Esri ArcGIS.
4. Watershed delineated by combining 2 USGS StreamStats-generated watersheds.

*Node within recommended DAu/DA_G range of 0.5 to 1.5.
USGS: U.S. Geological Survey. cfs: cubic feet per second, sq mi: square miles. DAU: Drainage area at ungaged site. DAG: Drainage area at gaged site.



LEGEND

- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- JEFFERSON RIVER TRIBUTARY STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS
- FLOW CHANGE NODE
  - 100
- 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300
- 06027700

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1.5 3 6
Miles

FIGURE 2-5

PIONEER TECHNICAL SERVICES, INC.

JEFFERSON RIVER TRIBUTARIES FLOW NODE LOCATIONS

DATE: 9/12/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-2-5.mxd

2.3.3 Flood Frequency Estimates at Ungaged Sites

To calculate peak flood discharge estimates at the ungaged flow nodes, Pioneer considered methods described in USGS SIR 2015-5109-F (Sando, et al., 2015b). These methods included estimating flood frequency using regional flood-frequency relations (regression analysis) and estimating flood frequency on gaged streams by translating gaged data to ungaged locations (drainage-area ratio adjustment or logarithmic interpolation between 2 gaged sites). Since no 2 gages exist on the same stream reach, the log interpolation method was not considered for this analysis.

2.3.3.1 *Regional Regression Equation Method*

The SIR 2015-5019-F report (Sando, et al., 2015b) provides guidance on conditions where regional regression equations may not yield reliable results. These guidelines include the following:

1. A site where the basin characteristics are outside the range of values used to develop the regression equations.
2. A site that is affected by regulation or urbanization.

The ungaged flow nodes located on Jefferson River tributaries are within the range of values used to develop the Southwest Region regression equations and therefore meet the first guideline described above.

The USGS Montana Streamtats regional regression equations were developed using unregulated gages. The SIR 2015-5019-F report considers a gaging station unregulated if the cumulative drainage area of an upstream dam is less than 20% of the gaging station's drainage area (Sando, et al., 2015b). All the ungagged flow nodes listed in Table 2-10 with the exception of Nodes 600 and 700, are considered unregulated. Nodes 600 and 700 (Big Pipestone Creek upstream of junction with Little Pipestone Creek and Big Pipestone Creek downstream of Hot Springs Road) classify as regulated under this definition (20.6% and 24.8% of drainage area regulated by an upstream dam).

The USGS 20% guidance used for defining the regulation status of gaging stations in Montana and the applicability of regional regression equations to ungagged sites, is a non-rigorous guidance threshold that was primarily based on affected drainage area. The regulation guidance does not account for storage capacity of the dams, total diversions of streamflow, or any other metrics that may be used to determine regulation. Therefore, at sites where the percent of regulated watershed is close to 20%, the regional regression equations may provide a reasonable AEP peak flow estimate.

Because Nodes 600 and 700 are so close to the guidance threshold, the non-rigorous basis for the USGS regulation guidance threshold and the lack of stream gages on Big Pipestone Creek, it was decided to include Nodes 600 and 700 in the regression analysis.

Due to the absence of gage data or previous hydrologic\hydraulic studies at the Delmoe Lake and Whitetail reservoirs (Nodes 200 and 800), regional regression equations were used to determine the AEP peak flows estimates for the reservoir inflow.

The regression equations, listed in SIR 2015-5019-F (Sando, et al., 2015b), use a drainage area (A) and percentage of drainage basin above 6,000 feet elevation (E_{6000}) as shown below in the following set of equations:

$$Q_{50} = 2.49A^{0.930}(E_{6000}+1)^{0.095}$$
$$Q_{10} = 31.9A^{0.796}(E_{6000}+1)^{-0.177}$$
$$Q_{4} = 79.8A^{0.750}(E_{6000}+1)^{-0.274}$$
$$Q_{2} = 142A^{0.721}(E_{6000}+1)^{-0.336}$$
$$Q_{1} = 238A^{0.696}(E_{6000}+1)^{-0.391}$$
$$Q_{0.2} = 655A^{0.649}(E_{6000}+1)^{-0.501}$$

Where
Q_x is the X AEP peak flow magnitude, in cfs.
A is the contributing drainage area, in square miles.
E_{6000} is the percent of basin area above 6,000 feet.

The 1%+ (plus) AEP event for regional regression estimates was calculated using FEMA guidance methodologies. For regional regression analyses, the 1-percent-plus flood elevation is defined as a flood elevation derived by using discharges that include the predictive error for the regression equation discharge calculation for the Flood Risk Project. This error is then added to the 1percent annual chance discharge to calculate the new 1 percent plus discharge (FEMA, 2019).

The average standard error of prediction or *average standard error of estimate* percentage (SEP, in percent) from SIR 2015-5019-F (Sando, et al., 2015b) was used to define the equation's statistical confidence upper limit of plus 1 standard error (FEMA, 2016b). The resulting upper limit of plus 1 standard error was used to determine the 1%+ (plus) flood frequency peak flow estimates. Appendix B provides the 1%+ (plus) regional regression flood frequency calculations for the study ungaged flow nodes.

Due to low gradient and coarse topography, several nodes required additional effort to calculate drainage area (A) and percentage of drainage basin over 6,000 feet (E_{6000}). For watershed areas not calculated in StreamStats, the drainage area and area above 6,000 feet was calculated using ArcGIS.

The Southwest Hydrologic Region regional regression equation input variables are shown in Table 2-11. Regional regression flood frequency peak flow estimates are listed in Table 2-12. For the 4 tributary basins that include more than 1 flow node (Whitetail, Big Pipestone, Little Pipestone and Fish Creek), Figure 2-6, Figure 2-7, Figure 2-8 and Figure 2-9 plot the calculated peak discharges and correlating drainage areas. Results indicate increasing flow magnitude with increasing drainage size for all 4 reaches.

Table 2-11 Regional Regression Variables

Node/USGS Station ID	Location Description	Study Reach River Station (miles)	Tributary	Basin Area (sq mi)	E_{6000} (%)
06027700	**USGS Gage Station Number 06027700: Fish Creek near Silver Star, MT**	**11.5**	**Fish Creek**	**39**	**76**
1300	Fish Creek upstream of Jefferson Slough recharge	6.9	Fish Creek	43	69
1200	Fish Creek at junction with Jefferson River	0.0	Fish Creek	52	56
1100	Pappas Creek	0.0	Pappas Creek	3	100
1000	Little Pipestone Creek south of Montana Highway 2	4.1	Little Pipestone Creek	41	51
900	Little Pipestone Creek upstream of junction with Big Pipestone Creek	0.0	Little Pipestone Creek	46	45.7
800	Delmoe Lake Outlet	0.0	Delmoe Lake	24	100
700	Big Pipestone Creek Downstream of Hot Springs Road	11.0	Big Pipestone Creek	95	70.1
600	Big Pipestone Creek upstream of junction with Little Pipestone Creek	7.1	Big Pipestone Creek	114	58.8
500	Big Pipestone Creek upstream of Pleasant Valley Ditch.	2.6	Big Pipestone Creek	169	52
400	Big Pipestone Creek at junction with Jefferson River	0.0	Big Pipestone Creek	187	47.1
300	Little Whitetail Creek at junction with Whitetail Creek	0.1	Little Whitetail Creek	101	39.3
200	Whitetail Reservoir Outlet	0.0	Whitetail Reservoir	19	100
100	Whitetail Creek at junction with Jefferson River	0.0	Whitetail Creek	184	43.8

USGS: U.S. Geological Survey. sq mi: square miles.
E6000 (%): percentage of basin over 6,000 feet in elevation.

Table 2-12 Regional Regression Flood Frequency Peak Flow Estimates

Node/USGS Station ID	Location Description	Southwest Region Regression Estimated Discharge (cfs)						
		50% Annual Chance 2-year	10% Annual Chance 10-year	4% Annual Chance 25-year	2% Annual Chance 50-year	1% Annual Chance 100-year	0.2% Annual Chance 500-year	1% + 100-year
06027700	**USGS Gage Station Number 06027700: Fish Creek near Silver Star, MT**	**113**	**273**	**379**	**464**	**558**	**803**	**970**
1300[1]	Fish Creek upstream of Jefferson Slough recharge	123	300	418	513	620	896	1,080
1200[1]	Fish Creek at junction with Jefferson River	145	364	512	632	768	1,120	1,340
1100	Pappas Creek	11	35	53	68	86	135	150
1000	Little Pipestone Creek south of Montana Highway 2	114	304	438	548	674	1,010	1,170
900	Little Pipestone Creek upstream of junction with Big Pipestone Creek	125	337	488	612	755	1,140	1,310
800	Delmoe Lake Outlet	73	174	241	293	352	503	612
700	Big Pipestone Creek Downstream of Hot Springs Road	258	563	755	904	1,070	1,490	1,860
600	Big Pipestone Creek upstream of junction with Little Pipestone Creek	301	672	909	1,090	1,300	1,830	2,260
500	Big Pipestone Creek upstream of Pleasant Valley Ditch.	429	938	1,260	1,510	1,790	2,500	3,110
400	Big Pipestone Creek at junction with Jefferson River	466	1,030	1,390	1,680	1,990	2,800	3,460
300	Little Whitetail Creek at junction with Whitetail Creek	258	651	921	1,140	1,390	2,050	2,420
200	Whitetail Reservoir Outlet	61	149	208	255	308	444	535
100	Whitetail Creek at junction with Jefferson River	457	1,040	1,410	1,700	2,030	2,880	3,530

1. Peak flow estimated by Pioneer using southwest regional regression equations.

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 2-6 Whitetail Creek Regional Regression Flood Frequency Analysis

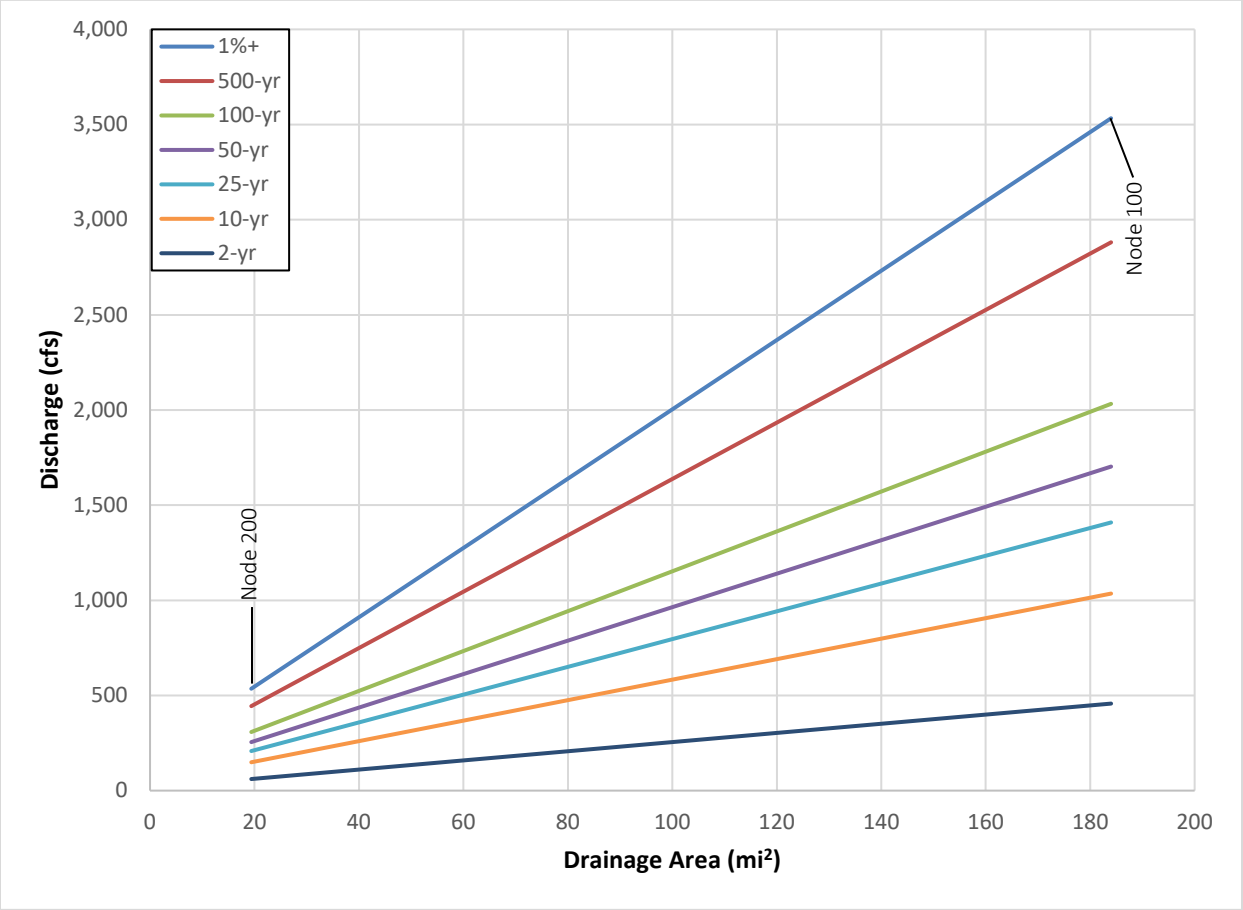


Figure 2-7 Big Pipestone Creek Regional Regression Flood Frequency Analysis

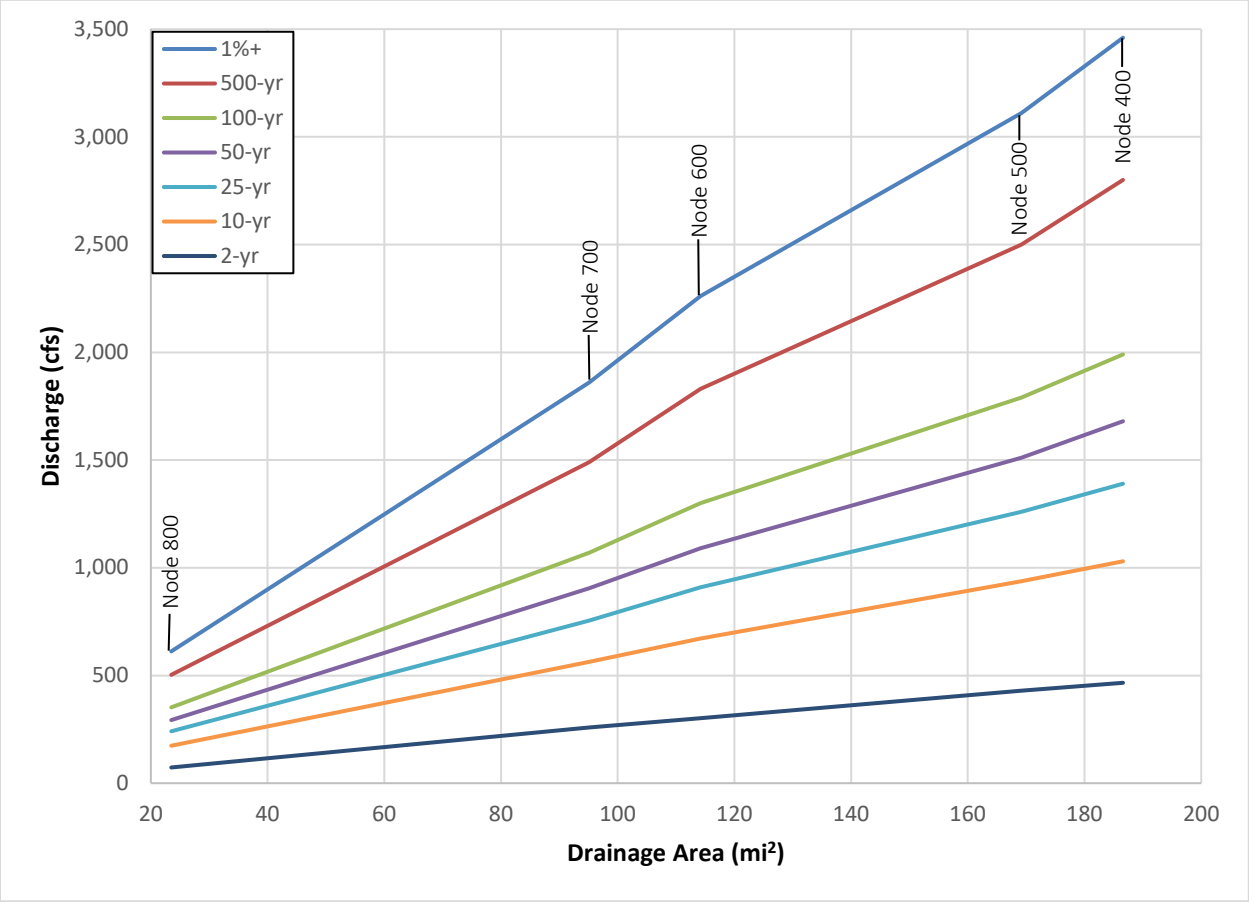


Figure 2-8 Little Pipestone Creek Regional Regression Flood Frequency Estimates

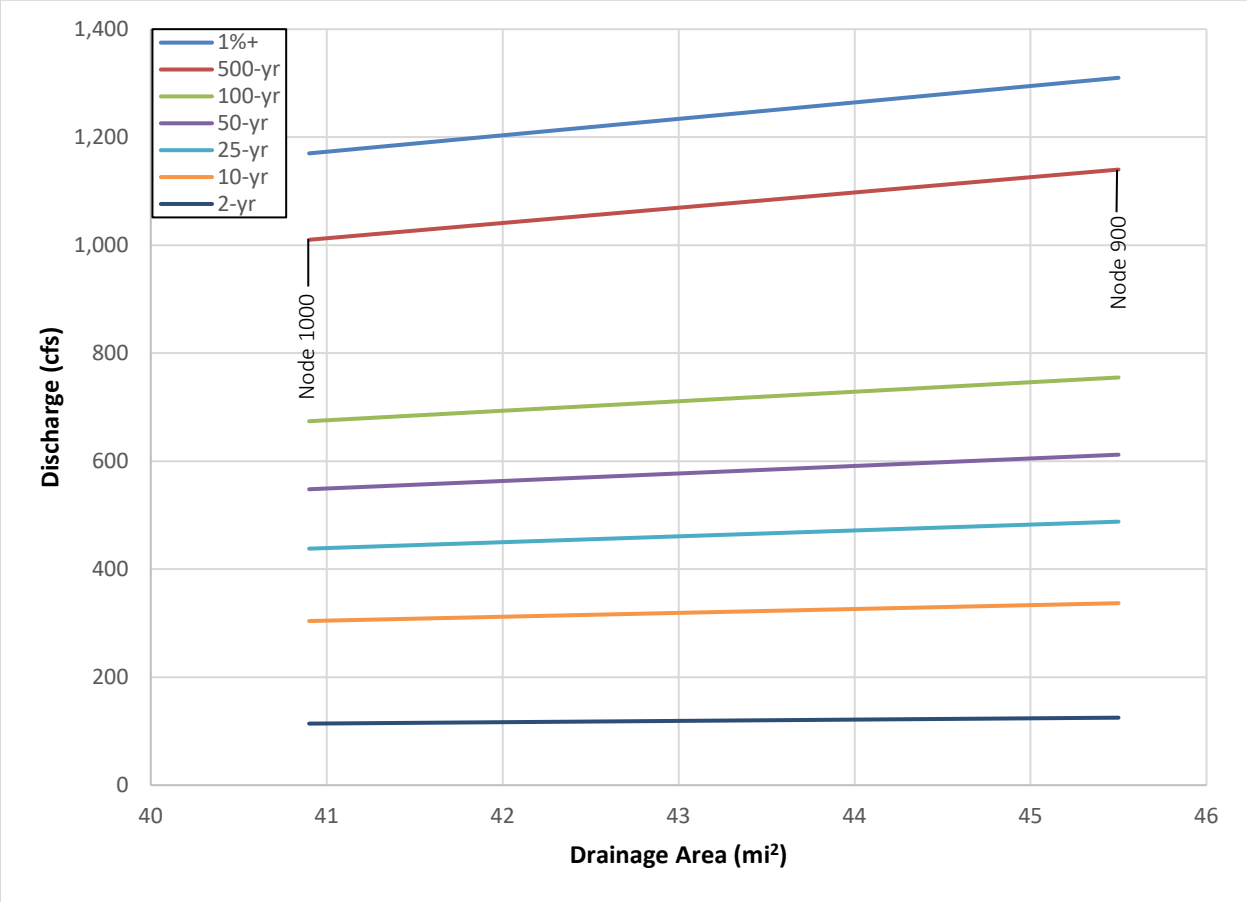
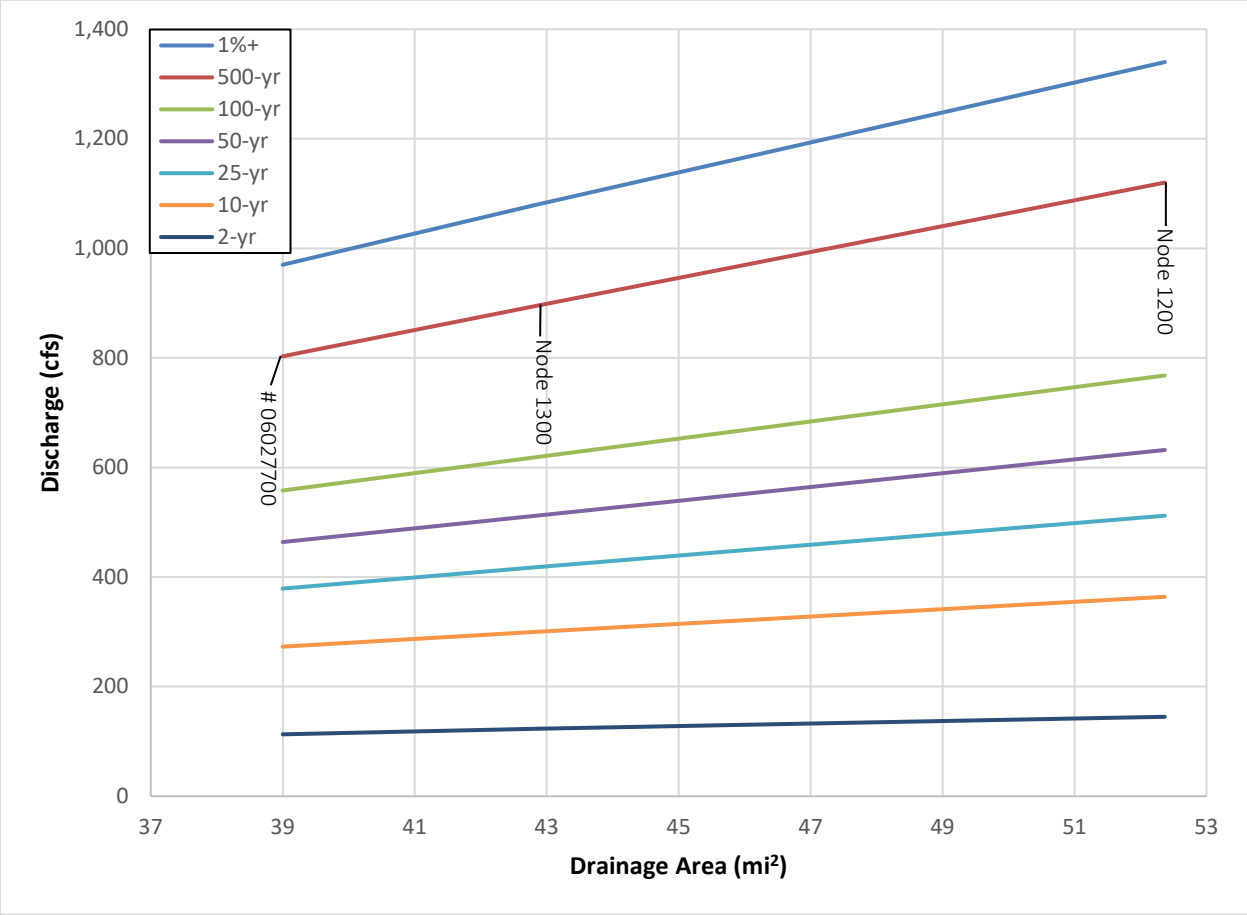


Figure 2-9 Fish Creek Regional Regression Flood Frequency Estimates



2.3.3.2 *Drainage Area Gage Transfer Method*

The ungaged flow nodes on Fish Creek and Whitetail Creek are located downstream of a single gage site. The ungaged flow node drainage areas on Fish Creek met the SIR 2015-5019-F guidance criteria for the drainage area gage transfer method, see Table 2-10 (i.e., are within the ratio of 1.5 to 0.5 of the gage drainage area) (Sando, et al., 2015b). Therefore, the drainage area gage transfer method can be used to calculate peak flow frequency estimates at ungaged flow nodes on the Fish Creek portion of the study reach.

Ungaged flow nodes 1200 and 1300 located downstream of the Fish Creek near Silver Star, MT (06027700) gage and node 100 downstream of the Whitetail Creek near Whitehall, MT (06029000) gage were considered for applying the drainage area gage transfer method. Limitations for this method include a recommended drainage area ratio between 0.5 and 1.5. This method, listed in SIR 2015-5019-F, uses a drainage area ratio of the ungaged flow node to the gaged station to transfer flow estimates from the gaged site to the ungaged site as shown below in the following equation (Sando, et al., 2015b):

$$Q_{AEP,U} = Q_{AEP,G}\left(\frac{\mathrm{DA}_U}{\mathrm{DA}_G}\right)^{\exp_{AEP}}$$

Where

$Q_{AEP,U}$ is the AEP-percent peak flow at the ungaged site, in cfs.

$Q_{AEP,G}$ is the AEP-percent peak flow at the gaged site, in cfs.

DA_G is the drainage area at the gaged site, in square miles.

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

$\exp_{AEP}$ is the regression coefficient for a simple ordinary least squares (OLS) regression relating to the log of the AEP-percent peak flow to log of drainage area within each region.

Node 100 on Whitetail Creek and nodes 1200 and 1300 on Fish Creek were considered and checked to be within the recommended range. Whitetail Creek Node 100 is not within the recommended DA_u/DA_G range of 0.5 to 1.5 and was therefore not considered for the gage transfer method. Fish Creek Nodes 1200 and 1300 were within the drainage area ratio. Flow node drainage area ratios are shown in Table 2-10.

The applicable regression coefficients (Sando, et al., 2015b) provided in Table 2-13 were used in these calculations. The USGS regional regression weighted values were selected for use in the drainage area gage transfer calculations. USGS Gage 06027700 Fish Creek near Silver Star, MT has 33 years of record, it has not been active for over 25 years. The regional regression weighted values are the same or slightly higher (10 cfs at the 1% AEP peak discharge) than the systematic gage data. The regional regression weighted values may account for climactic conditions outside of the gages period of record and were therefore selected. The drainage area transfer method results are shown in Table 2-14 and Figure 2-10.

Table 2-13 Drainage Area Gage Transfer Regression Coefficients

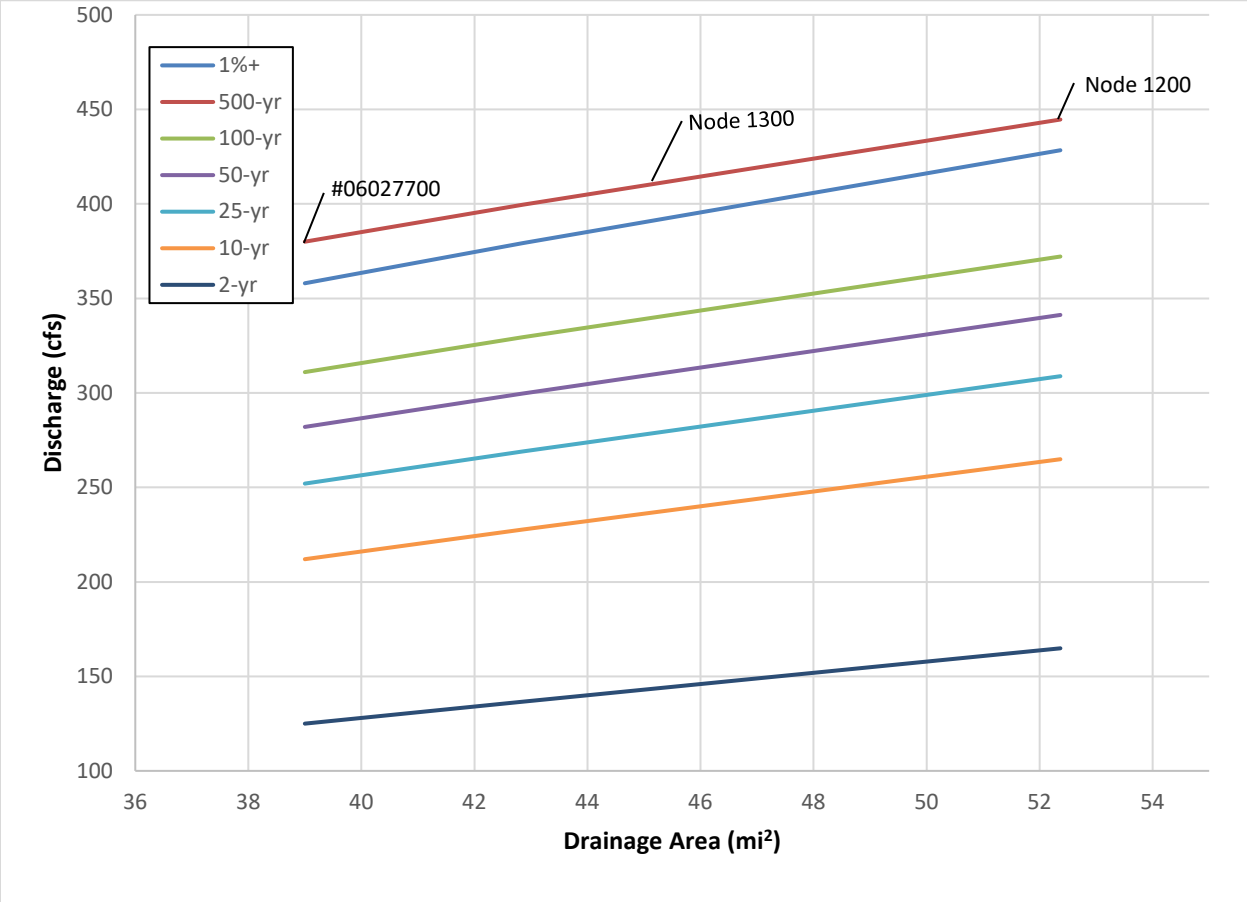
AEP-percent Peak Flow	exp_{AEP}
Q_{50}	0.939
Q_{10}	0.755
Q_{4}	0.690
Q_{2}	0.647
Q_{1}	0.609
$Q_{0.2}$	0.533

Table 2-14 Drainage Area Gage Transfer Method Results for Flow Node Locations Downstream of USGS Gage 06027700 Fish Creek near Silver Star, MT

Node/USGS Station ID	Location Description	Drainage Area Gage Transfer Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Change	1%+
		2-year	10-year	25-year	50-year	100-year	500-year	100-year
06027700	**USGS Gage Fish Creek near Silver Star, MT**	**125**	**212**	**252**	**282**	**311**	**380**	**358**
1300	Fish Creek upstream of Jefferson Slough recharge	137	228	269	300	329	400	379
1200	Fish Creek at junction with Jefferson River	165	265	309	341	372	445	428

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 2-10 Fish Creek Drainage Area Gage Transfer Results



2.4 Jefferson River Tributaries Discussion

Pioneer conducted a peak discharge frequency analysis for 6 tributaries and 2 reservoirs that report to the Jefferson River. The Jefferson River tributaries study reach extends 7 miles along the Jefferson River mainstem. Information gathered from this analysis will be used to support the Jefferson County hydraulic analyses and floodplain mapping studies.

Previous flood studies on the Jefferson River tributaries study reaches are limited. Relevant earlier flood studies include the SIR 2015-5019-C (Sando, et al., 2015a), the Town of Whitehall, MT FIS published in 2007 that includes flood frequency analysis for the Whitetail Creek and Big Pipestone Creek study reach (FEMA, 2007), and the Big Pipestone Creek Flood Plain Management Study published in 1984 (USDA SCS, 1984) that included flood frequency analysis for the Big Pipestone Creek study reach.

This hydrologic analysis developed flood frequency estimates for both gaged and ungaged sites, including 2 reservoirs. Due to the limited available data and the site remoteness, it is anticipated the 2 reservoirs will be mapped as Zone A SFHA's. Peak flow estimates were calculated at 14 locations (flow nodes) within the watershed (1 gaged site and 13 ungaged sites). The ungaged sites (flow nodes) were located at HUC 12 boundaries, major tributaries, population centers, and at the bottom of study reaches.

Flood frequency estimates at gaged sites were conducted by the USGS (Sando, et al., 2019) using Bulletin 17C methodologies (England, et al., 2018). Flood flow frequency estimates at ungaged flow nodes were conducted using regional regression methods and gage transfer methods (Sando, et al., 2015b). Three USGS stream gaging stations [Whitetail Creek near Whitehall, MT (06029000); Jefferson River tributary No. 2 near Whitehall, MT (06030300); and Fish Creek near Silver Star, MT (06027700)] exist within or near the study area. The USGS gages Whitetail Creek near Whitehall, MT (06029000) and Jefferson River tributary No. 2 near Whitehall, MT (06030300) were not used in this analysis. The Whitetail Creek near Whitehall, MT gage was outside of the recommended drainage area ratio range (DA_U/DA_G) of 0.5 to 1.5 (Sando, et al., 2015b) for the nearest ungaged flow nodes. The Jefferson River tributary No. 2 near Whitehall, MT gage is not on a study reach.

Review of the flow estimates for USGS gage 06030300 Jefferson River Tributary No. 2 near Whitehall, MT indicate the 1% AEP at site peak flow estimate (990 cfs) are greater than the weighted with regional regression 1% plus peak flow estimate (760 cfs).

This significant difference between the at site and the RRE wtd estimates may be related to the gage small watershed area (4.5 square miles). Measured annual peak flows range from 0 cfs to 425 cfs and occur during every month except November and December. Due to the small watershed area reporting to this gage, peak flows at this gage are likely produced by smaller, localized precipitation events. Although there are smaller watersheds represented in the

Southwest Region regional regression data set, in general, the regional regression equations are based on gages with larger watersheds.
This bias towards larger watersheds may result in the regional regression estimates not being sensitive to smaller localized precipitation events. As a result, the regional regression equation AEP peak flow estimates at this site do not compare well with the AEP peak flows based on gage analysis at this specific site.

The poor correlation between regional regression peak estimates and at site peak flow estimates at this site does not reflect on the southwest regional regression equations reasonableness for the study area. Comparison with the Fish Creek near Silver Star gage (06027700) shows that the at site 1% AEP peak flow (301 cfs) is 84% of the weighted regional regression 1% plus peak flow estimate (358 cfs).

USGS gage 06027700 Fish Creek near Silver Star, MT was used to estimate AEP peak flow values on ungaged Fish Creek nodes 1200 and 1300. The Fish Creek gage is located 11.5 miles upstream from the Fish Creek study reach confluence with the Jefferson River. At-site peak flow data were weighted with regional regression equations to develop AEP flows for the Fish Creek gage. The weighted peak flow values were also used in the gage transfer method. The applicability of using weighted with regional regression equations as opposed to at site data was investigated. It was determined the majority of peak flows on Fish Creek occurred in May and June, suggesting a primarily snowmelt driven peak flow population. Fish Creek has similar hydrologic characteristics to other gages in the southwest hydrologic region used to develop the regional regression equations. Weighted frequency estimates generally improve accuracy of peak flows (Sando, et al., 2015c). The regional regression equation weighted at site estimates provide a slightly conservative estimate (3% higher than at site) and likely accounts for climactic conditions outside the gage period of record (no gage data for over 25-years). For these reasons the peak flows that were calculated using at-site data weighted with regional regression equations were selected for the recommended flood discharge estimate on USGS gage 06027700 Fish Creek near Silver Star, MT.
The gage-based AEP estimates meet standard hydrologic flood frequency practice gage recommendations including the following:

- A 32-year period of record that exceeds the minimum 10-year period of record FEMA guidance (FEMA, 2019).
- Estimates are weighted with regional regression peak flow estimates to account for climatic conditions outside of the study's gage period of record (FEMA, 2019).

Higher confidence is typically associated with flood frequency estimates that are based on measured stream flows, such as in the gage transfer methods. For these reasons, the gage transfer method was selected for the recommended flood discharge estimates on nodes 1200 and 1300.

Regional regression equations are based on comparisons of peak flows and basin characteristics for a given region (Sando, et al., 2015b). As a result, regional regression equations are used for

estimating peak flows when gage data does not exist, or the gage period of record is too short. A minimum 10 years of gage data is recommended to perform gage peak flow analysis. Due to the absence of applicable gage data outside of the Fish Creek drainage, regional regression method peak flow estimates were selected for nodes 100 through 1100.

Flow nodes were placed upstream of the Whitetail Reservoir (200) and Delmoe Lake (800) reservoir. The purpose of these nodes is to estimate the AEP peak discharge into the lake during peak flow events. It is anticipated that Whitetail Reservoir and Delmoe lake will be mapped as approximate Zone A SFHA's.

Due to the absence of gage data, regression equations were used to determine peak flows on Big Pipestone Creek. Flow nodes 600 and 700 are downstream from the Delmoe Lake reservoir and marginally exceed the USGS 20% regulation guidance threshold (20.6% and 24.8% respectively).

The regional regression estimates at flow nodes 600 and 700 are consistent with downstream and adjacent tributary peak flow estimate magnitudes and are representative of a peak flow estimate associated with full pool condition initial condition (no flow attenuation) at Delmoe Lake.

Based on the lack of stream gages on Big Pipestone Creek, the complexity and uncertainty associated with rainfall-runoff models, the non-rigorous basis for the USGS regulation guidance threshold, the minor exceedance of the USGS regulatory guidance threshold and the regional regression estimates consistency with downstream and adjacent peak flow estimates, the regional regression peak flow estimates were selected for flow nodes 600 and 700.

Table 2-15 provides a comparison between the Whitehall 2007 flood Insurance study (2007 FIS). Discharges were developed using USGS Regional Equations. The regional regression equations were developed using 19 years of gage data on 36 gaging stations in the same hydrologic unit as the Whitetail Creek location (FEMA, 2007). Peak discharges developed in the 2007 FIS report were compared with node 100, Whitetail Creek at Junction with Jefferson River. The comparison indicates the 1% AEP discharge estimate from this report was 20% lower compared to the 2007 FIS estimate. The comparison supports the reasonableness of the AEP peak discharges developed for this study.

Table 2-15 Comparison of Discharges with 2007 FIS for Whitehall, MT

Flooding Source and Location	Drainage Area (mi^2)	10 % Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Whitetail Creek at Whitehall, MT (2007 FIS Study)	177	1,260	2,100	2,540	3,670
Whitetail Creek at Junction with Jefferson River 2019 (Node 100)	184	1,040	1,700	2,030	2,880

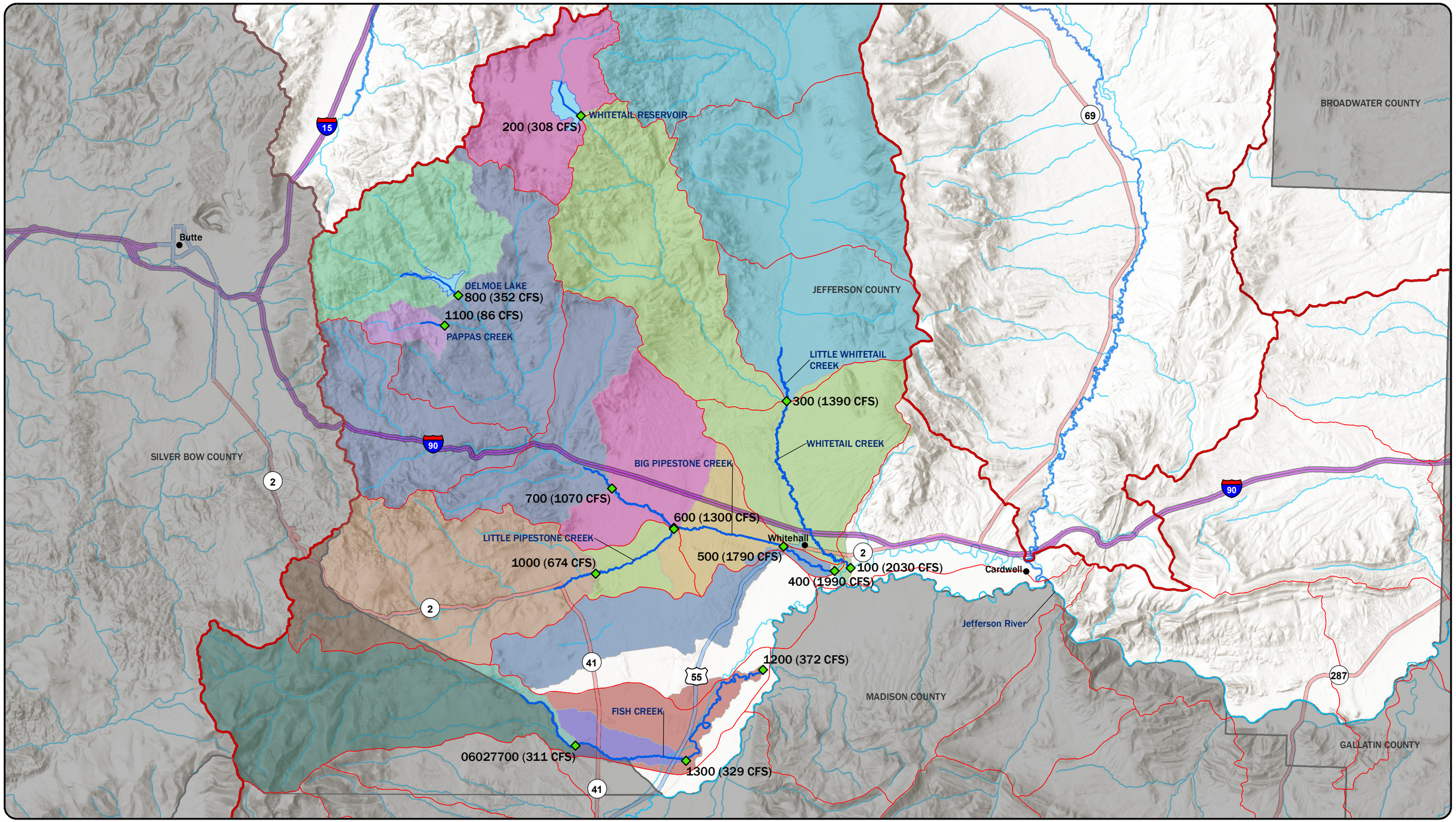
Table 2-16 summarizes the recommended flood frequency discharge rates for the Jefferson River tributary study reaches. Figure 2-11 shows the recommended 1% AEP discharge for each flow node location. The hydrologic analysis results provided in Table 2-16 represent the recommended discharges at each flow node location throughout the study reach. The methods used for hydrological analysis are industry accepted methods [Bulletin 17C (England, et al., 2018), SIR 2015-5019-C (Sando, et al., 2015a) and SIR 2015-5019-F (Sando, et al., 2015b)] based on Jefferson River tributaries basin characteristics. This hydrologic analysis conforms to FEMA standards for enhanced level studies, and the recommended flows of this analysis are deemed reliable and suitable for future floodplain studies and hydraulic analyses.

Table 2-16 Recommended Flood Discharge Estimates Using Regression and Gage Transfer Analysis

Node/USGS Station ID	Location Description	AEP Peak Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year-plus
06027700[2]	**USGS Gage Station Number 06027700: Fish Creek near Silver Star, MT**	**125**	**212**	**252**	**282**	**311**	**380**	**358**
1300[1]	Fish Creek upstream of Jefferson Slough recharge	137	228	269	300	329	400	379
1200[1]	Fish Creek at junction with Jefferson River	165	265	309	341	372	445	428
1100[3]	Pappas Creek	11	35	53	68	86	135	150
1000[3]	Little Pipestone Creek south of Montana Highway 2	114	304	438	548	674	1,010	1,170
900[3]	Little Pipestone Creek upstream of junction with Big Pipestone Creek	125	337	488	612	755	1,140	1,310
800[3]	Delmoe Lake Outlet	73	174	241	293	352	503	612
700[3]	Big Pipestone Creek Downstream of Hot Springs Road	258	563	755	904	1,070	1,490	1,860
600[3]	Big Pipestone Creek upstream of junction with Little Pipestone Creek	301	672	909	1,090	1,300	1,830	2,260
500[3]	Big Pipestone Creek upstream of Pleasant Valley Ditch.	429	938	1,260	1,510	1,790	2,500	3,110
400[3]	Big Pipestone Creek at junction with Jefferson River	466	1,030	1,390	1,680	1,990	2,800	3,460
300[3]	Little Whitetail Creek at junction with Whitetail Creek	258	651	921	1,140	1,390	2,050	2,420
200[3]	Whitetail Reservoir Outlet	61	149	208	255	308	444	536
100[3]	Whitetail Creek at junction with Jefferson River	457	1,040	1,410	1,700	2,030	2,880	3,530

1. Analyzed with USGS Gage Transfer Method.
2. Analyzed by USGS using RRE weighted At-Site method.
3. Analyzed with USGS RRE method.

USGS: U.S. Geological Survey. cfs: cubic feet per second. RRE: regional regression equation.



LEGEND

- FLOW NODES (DISCHARGE)
- TOWNS
- HUC 12 BOUNDARIES
- JEFFERSON RIVER TRIBUTARY STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS
- FLOW CHANGE NODE
  - 100
- 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300
- 06027700

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1.5 3 6
Miles

FIGURE 2-11

PIONEER TECHNICAL SERVICES, INC.

JEFFERSON RIVER TRIBUTARIES RECOMMENDED 1-PERCENT AEP DISCHARGE

DATE: 9/12/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-2-11.mxd

3 BOULDER RIVER AND TRIBUTARIES

3.1 Introduction

3.1.1 Basin Description

3.1.1.1 *Boulder River Mainstem*

The Boulder River mainstem begins near the Continental Divide and flows north approximately 6 miles before turning east, flows approximately 17 miles before turning south, and flows approximately 37 miles before terminating at the Jefferson River. The Jefferson River joins the Madison River to form the headwaters of the Missouri River. The Boulder River watershed encompasses approximately 769 square miles.

Elevations within the study reach range from approximately 6,464 feet near the Continental Divide to 4,260 feet at the confluence with the Jefferson River. The overall basin elevations for the Boulder River mainstem watershed basin range from 9,414 feet at Crow Peak to 4,260 feet at the confluence with the Jefferson River. The terrain varies from a high alpine environment in its headwaters to a heavily cultivated landscape in the Boulder valley with expansive irrigated pasture lands, bracketed by rolling foothills. The hydrology of the basin is primarily snowmelt driven.

Land use in the Boulder River basin is primarily agricultural with irrigated farming and ranching operations. Most of the intensely farmed land in the Boulder valley is within the Boulder River floodplain. The towns of Boulder and Basin are the primary communities in the Boulder River mainstem study area.

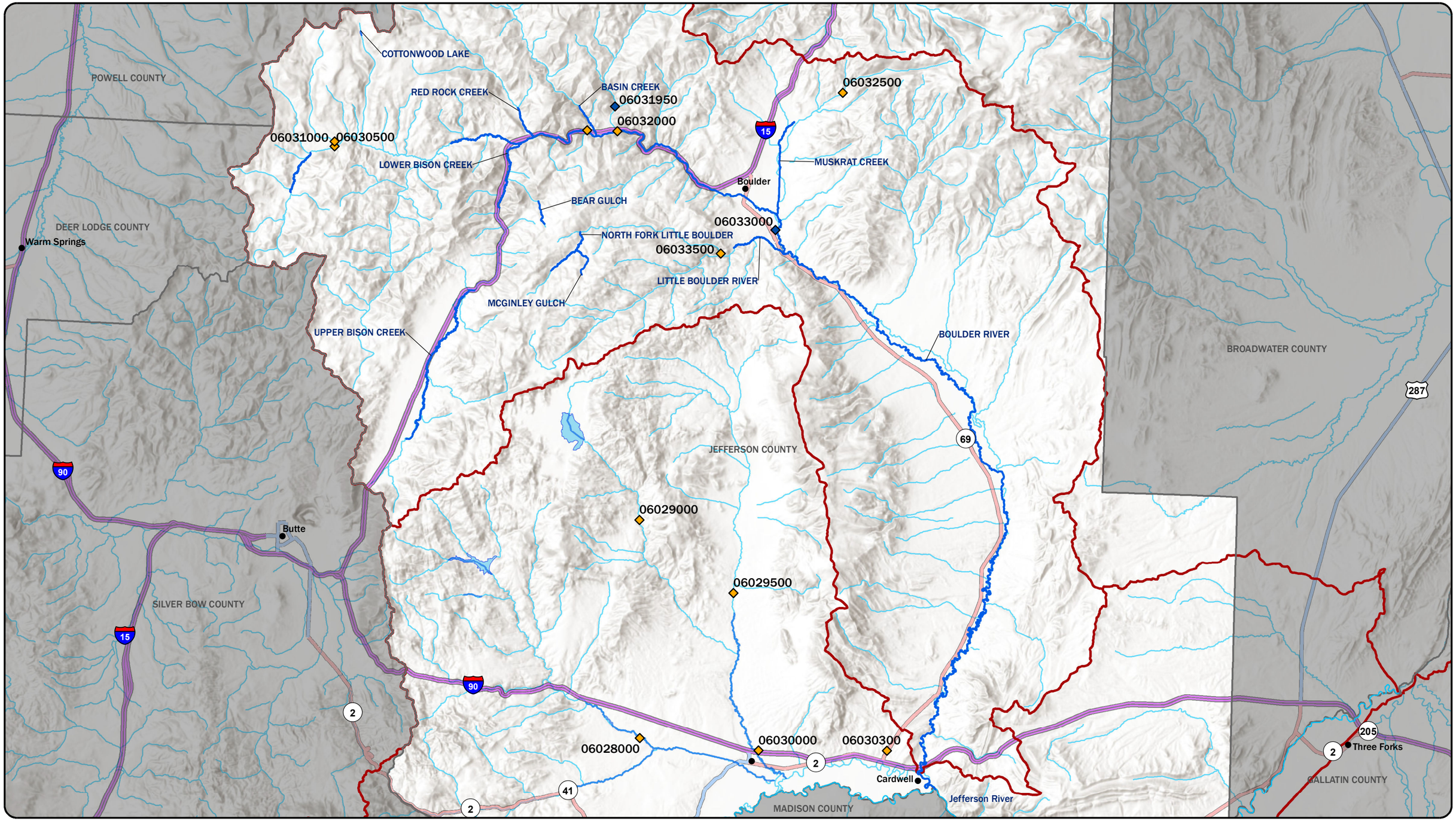
3.1.1.2 *Boulder River Tributaries*

All 9 Boulder River tributaries in the study area report to the Boulder River, which is a major tributary to the Jefferson River. The study watershed for the Boulder River tributaries encompasses approximately 238 square miles. The tributaries are formed in the Boulder Range near the Continental Divide and the Elkhorn Mountains. The watershed is formed by the Boulder Range from the north, south, and west, and the Elkhorn Mountains from the east.

The Boulder River tributary study reaches elevations range from approximately 7,434 feet in the central Boulder Range to 4,791 feet south of Boulder, MT. The overall basin elevations range from approximately 9,381 feet at Elkhorn Peak to approximately 4,794 feet south of Boulder, MT. The terrain varies from a high alpine environment for most tributaries to a heavily cultivated landscape in the Muskrat Valley with expansive irrigated pasture lands, bracketed by rolling foothills. The hydrology of the basin is primarily snowmelt driven.

Land use in the Boulder River basin is primarily agricultural with irrigated farming and ranching operations. Most of the intensely farmed land in the Boulder valley is within the Boulder River

floodplain. The primary community in the Boulder River tributary study area is Basin. Figure 3-1 shows the Boulder River mainstem and tributary study reaches.



LEGEND

- ACTIVE USGS STREAM GAGE
- INACTIVE USGS STREAM GAGE
- TOWNS
- BOULDER RIVER STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 2 4 8
Miles

FIGURE 3-1

BOULDER RIVER STUDY AREA

PIONEER TECHNICAL SERVICES, INC.

DATE: 9/10/2019

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3.1.2 Flood History

The primary flooding mechanisms on the Boulder River and its tributaries are spring snowmelt mixed with rain (according to historical records). Reports that document the flooding mechanisms on the Boulder River are limited. These reports reference a flood that occurred in May 1981. The primary cause of the flood was rainfall, which is an atypical flooding mechanism in southwest Montana. This event is discussed in more detail in Section 3.2. There are historical records from 3 USGS stream gages with a minimum of 10 years of record within the study area that document flooding history. The gages are listed below:

1. Boulder River above Rock Creek, near Basin, MT (06030500).
2. Cataract Creek near Basin, MT (06031950).
3. Boulder River near Boulder, MT (06033000).

The USGS stream gage Boulder River above Rock Creek, near Basin, MT (06030500) has a 12-year period of record (1947-1953, 1955-1957, 1975, 1981). The annual peak flow of record for the Boulder River above Rock Creek gage is shown in Figure 3-2. The gage is located upstream of the lower Boulder River study reach and downstream of the upper Boulder River study reach.

The USGS stream gage Cataract Creek near Basin, MT (06031950) has a 45-year period of record (1973-2017). The annual peak flow record for the Cataract Creek gage is shown in Figure 3-3. The gage is located east of the Basin Creek study reach in the adjacent drainage.

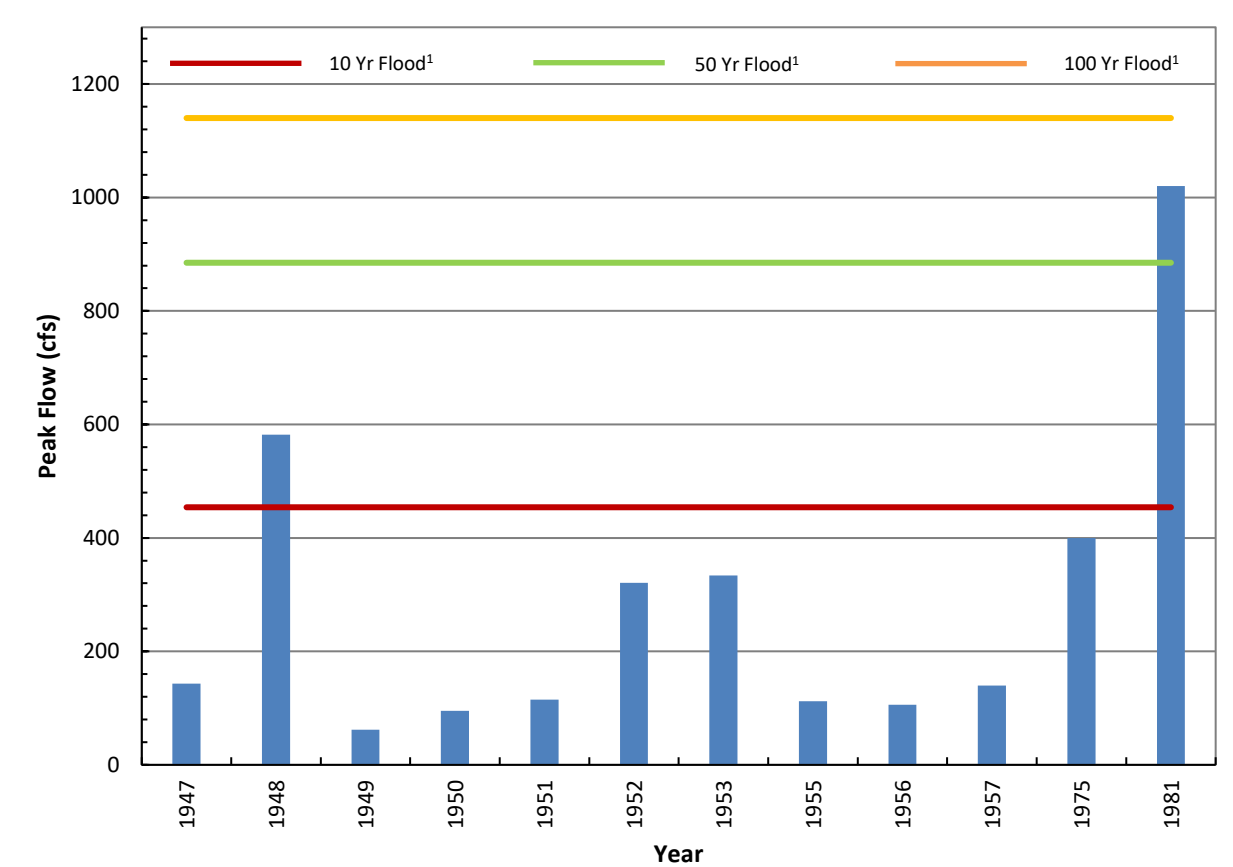
The USGS stream gage Boulder River near Boulder, MT (06033000) has a 78-year period of record (1929-1932, 1934-1972, 1975, 1981, 1985-2017). The annual peak flow record for the Boulder River near Boulder, MT is shown in Figure 3-4. The gage is located on the lower Boulder River study reach.

Peak flow recurrence intervals shown in Figure 3-2, Figure 3-3, and Figure 3-4 are based on previously published flood frequency analysis through Water Year 2011 (SIR 2015-5019-C) (Sando, et al., 2015a).

Records that document the flood mechanisms on the Boulder River mainstem are limited. Since the primary cause of flooding on the Boulder River mainstem is spring snowmelt and ice jams, it can be inferred that tributary flooding occurs by similar mechanisms.

Figure 3-2 shows that the peak flood of record for Boulder River above Rock Creek, near Basin, MT occurred in 1981 with a flow of 1,020 cfs, exceeding the 2% (50-year) AEP flow of 885 cfs. The second highest flood on record occurred in 1948 with a flow of 582 cfs, exceeding the 10% (10-year) AEP flow of 454 cfs. The third highest flood on record occurred in 1975 with a flow of 400 cfs. In the 12-year period of record for the Boulder River above Rock Creek, near Basin MT, the 10% AEP flow has been equaled or exceeded 2 times (in 1948 and 1981). The annual peak flows occurred between the months of May and June. The peak flow of record occurred in May 1981.

Figure 3-2 Boulder River above Rock Creek near Basin, MT (06030500)



1. Flood Frequency Based on Data through 2011

Figure 3-3 shows that the peak flood of record for Cataract Creek near Basin, MT (06031950) occurred in 1981 with a flow of 3,150 cfs, exceeding the 1% (100-year) AEP flow of 1,610 cfs. The second highest flood on record occurred in 1995 with a flow of 934 cfs, exceeding the 10% (10-year) AEP flow of 518 cfs. The third highest flood on record occurred in 2011 with a flow of 820 cfs exceeding the 10-year flow. In the 45-year period of record for the Cataract Creek near Basin, MT (06031950) gage, the 10% AEP flow has been equaled or exceeded 5 times (1975, 1981, 1995, 1996, and 2011). The annual peak flows occurred between the months of May and June. The peak flow of record occurred in May of 1981.

Figure 3-3 Cataract Creek near Basin, MT (06031950)

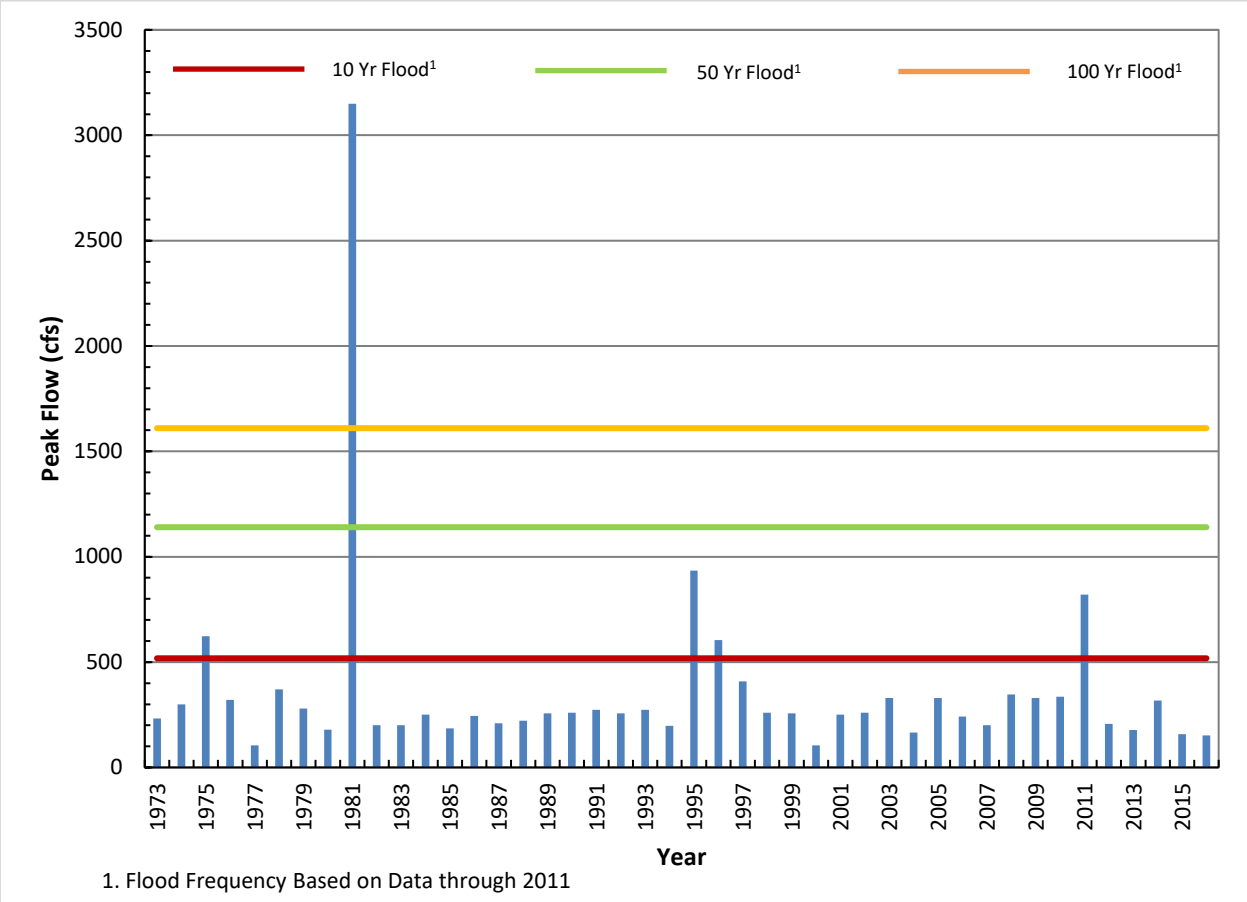
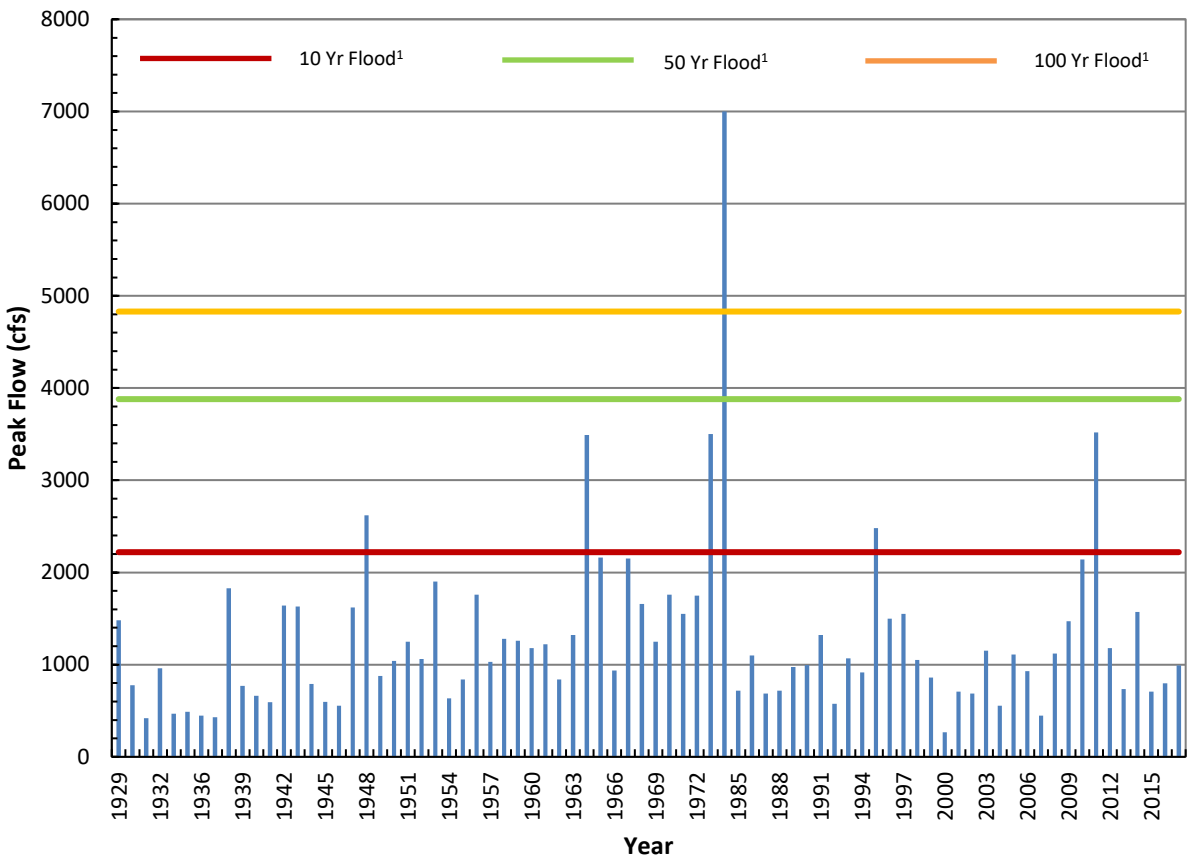


Figure 3-4 shows that the peak flood of record for Boulder River near Boulder, MT (06033000) occurred in 1981 with a flow of 7,000 cfs, exceeding the 1% (100-year) AEP flow of 4,830 cfs. The second highest flood on record occurred in 2011 with a flow of 3,520 cfs, exceeding the 10% (10-year) AEP flow of 2,220 cfs. The third highest flow on record occurred in 1975 with a flow of 3,500 cfs, exceeding the 10-year flow. In the 78-year period of record for the Boulder River near Boulder, MT (06033000) gage, the 10% AEP flow has been equaled or exceeded 6 times (1948, 1964, 1975, 1981, 1995, and 2011). The annual peak flows occurred between the months of May and June. The peak flow of record occurred in May of 1981.

Figure 3-4 Boulder River near Boulder, MT (06033000)



1. Flood Frequency Based on Data through 2011

3.2 Past Studies and Existing Flood Data

Past flood studies on the Boulder River mainstem and tributary study reaches are limited. Studies relevant to this hydrologic study are those that include peak flow frequency analyses. Within the study reach, a FEMA Flood Insurance Rate Map (FIRM) exists for the town of Boulder, MT and Jefferson County unincorporated areas. There is no FIS on the town of Boulder or within Jefferson County unincorporated areas. Table 3-1 shows a summary of Boulder River and tributaries floodplain mapping.

Table 3-1 Boulder River and Tributaries Floodplain Mapping Summary

	Map Panel Summary				Study Details			
County	**Community**	**# of FIRM Panels**	**FIRM Panel Effective Date**	**FIS Date**	**Stream**	**Approx (mi)**	**Detailed (mi)**	**Total (mi)**
Jefferson County	Jefferson County Unincorporated	8	6/17/1986	NA	Basin Creek, Basin Creek (Extension), Bear Gulch, Bison Creek (Lower), Bison Creek (Upper), Boulder River (Lower), Boulder River (Upper), Cottonwood Lake, Little Boulder River, McGinley Gulch, Muskrat Creek, N. Fork Little Boulder River, Red Rock Creek	98	NA	98
Jefferson County	Town of Boulder	1	4/15/1986	NA	Boulder River (Lower)	NA	2.1	2.1

Source: FEMA Map service Center.
FIRM: Flood Insurance Rate Map. FIS: Flood Insurance Studies. mi: mile. NA: not applicable.

In addition to FEMA FIRM panels, there are three USGS reports relevant to this study. These studies and investigations are discussed in more detail in the sections below.

3.2.1 Water Resources Investigation Report 03-4308

The investigation for USGS WRIR 03-4308 developed annual peak discharges with recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years (*T*-year floods) for 660 gaged sites in Montana and in adjacent areas of Idaho, Wyoming, and Canada, based on data through Water Year 1998 (Parret & Johnson, 2004). The flood-frequency information was used in regression analyses to develop equations relating *T*-year floods to various basin and climatic characteristics, active-channel width, and bankfull width. The equations can be used to estimate flood frequency at ungaged sites. Flood-frequency data typically were determined by fitting a log-Pearson Type III probability distribution using methods described by the IACWD Bulletin 17B (IACWD, 1982). Table 3-2 provides the WRIR 03-4308 peak discharge summary for 3 USGS gages in the Boulder River Mainstem and Tributaries Study Area.

Table 3-2 WRIR 03-4308 Boulder River Mainstem and Tributaries Peak Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Period of Record in Years	Peak Discharges (cfs)						
				5-year	10-year	25-year	50-year	100-year	200-year	500-year
06030500	Boulder River above Rock Creek, near Basin, MT	24.4	12	323	463	692	909	1170	1480	1990
06019500	Cataract Creek near Basin, MT	30.5	26	414	557	798	1030	1320	1670	2270
06033000	Boulder River near Boulder, MT	381	59	1740	2280	3080	3780	4570	5450	6800

Source: USGS
Based on systematic data through 1998. USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.

3.2.2 Scientific Investigations Report 2015-5019

The USGS SIR 2015-5019-C included updated AEP peak discharges with AEPs of 66.7, 50, 42.9, 20, 10, 4, 2, 1, 0.5, and 0.2% (return intervals of 1.5, 2, 2.33, 5, 10, 25, 50, 100, 200, and 500 years, respectively) for 725 gaged sites in or near Montana, based on data through Water Year 2011 (Sando, et al., 2015a). Flood-frequency data were determined by fitting a log-Pearson Type III probability distribution using methods described by the IACWD, Bulletin 17B (IACWD, 1982). The study was part of a larger study to develop an online StreamStats application for Montana, in conjunction with computing streamflow characteristics at gage stations, and estimate peak flow flood frequency at ungaged sites. Table 3-3 provides the SIR 2015-5019-C discharge summary for selected Boulder River mainstem and tributaries study area gages.

Table 3-3 SIR-2015-5019-C Boulder River Mainstem and Tributaries Peak Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Period of Record in Years	Peak Discharge (cfs)						
				5-year	10-year	25-year	50-year	100-year	200-year	500-year
06030500	Boulder River above Rock Creek, near Basin, MT	24.4	12	318	454	676	885	1140	1440	1920
06019500	Cataract Creek near Basin, MT	30.5	39	375	518	807	1140	1610	2280	3640
06033000	Boulder River near Boulder, MT	381	72	1680	2220	3080	3880	4830	5960	7790

Source: USGS
Based on systematic data through 2011. USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.

The USGS SIR 2015-5019-F (Sando, et al., 2015b) selected 537 gaging stations from the gage study. The 537 gaging stations were segregated based on the following criteria: contributing drainage area less than about 2,750 square miles, peak-flow records unaffected by major regulation, small redundancy with nearby stations, and representation of peak-flow frequencies at sites within Montana. The study used regression analyses to develop equations relating AEP flows to various basin and climatic characteristics. The relationships developed for this study resulted in lower mean standard errors of prediction than previous regression analyses.

3.2.3 Scientific Investigations Report 2018-5046

The USGS SIR 2018-5046 included updated AEP peak discharges with AEPs of 50, 42.9, 20, 10, 4, 2, 1, 0.5, and 0.2% (return intervals of 2, 2.33, 5, 10, 25, 50, 100, 200, and 500 years, respectively) for 99 gaged sites in or near Montana, based on data through Water Year 2015 (Sando & McCarthy, 2018). Flood-frequency data typically were determined by fitting a log-Pearson Type III probability distribution using an Expected Moments Algorithm analysis and other methods described by England and others in Bulletin 17C (England, et al., 2018). The AEP peak discharges for the Boulder River above Rock Creek, near Basin, MT (06030500) gage was updated as part of the report. Table 3-4 provides the SIR 2018-5046 peak discharge summary for the gage.

Table 3-4 SIR 2018-5046 Boulder River Mainstem and Tributaries Peak Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Period of Record in Years	Type of peak-flow frequency analysis	Peak Discharge (cfs)						
					5-year	10-year	25-year	50-year	100-year	200-year	500-year
06030500	Boulder River above Rock Creek, near Basin, MT	24.4	12	At-Site	314	442	640	815	1020	1240	1600
06030500	Boulder River above Rock Creek, near Basin, MT	24.4	--	RRE wtd	285	394	555	686	831	974	1190

Source: USGS
USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.
RRE wtd: Systematic data weighted with regional regression equation (RRE).

3.2.4 Additional Previous Studies

From May 22-23, 1981, the Boulder River and Prickly Pear Creek basins experienced record flooding. Both the Boulder River and Prickly Pear Creek approached flows equal to the 500-year event. Above average rainfall in early May saturated the ground, followed by a larger storm from May 21-22. These conditions, combined with snowmelt, produced record flooding. Six bridges on major state highways were damaged or destroyed and 25 major bridge approaches were washed out. A 10-county area was declared a national disaster by Presidential proclamation (Parret, et al., 1982).

The Big Pipestone Creek Flood Plain Management Study documented the flooding mechanisms of the May 1981 flood that disrupted multiple communities in and near Jefferson County. According to the report, the flood was caused by rainfall with minimal contribution from snowmelt, which is considered unusual for a mountainous area. The winter of 1981 was one of the driest on record, resulting in nearly no snowpack in the mountains at the time of the flood. A rainy spring and snowmelt saturated the soil prior to the storm. A major rainstorm centered around the Boulder River and Prickly Pear Creek produced peak floods greater than the 100-year frequency in that area. Big Pipestone Creek experienced a peak flood between the 10-year and 20-year event. Weather station readings recorded 1.6 to 1.9 inches of rainfall over a 24-hour period in the Big Pipestone Creek watershed. To the north (in the Boulder River basin), the storm center produced rainfall of up to 3.5 inches in a 24-hour period.

Additional related previous studies conducted within Jefferson County involve mining impacts, sediment management, fisheries management, irrigation history, and watershed characterization reports. Specific studies for Basin Creek, Boulder River, Jefferson River tributaries, Muskrat Creek, and Red Rock Creek were conducted. All other studies referenced multiple tributaries to the Jefferson River in Jefferson County (refer to the list below):

Basin Creek:

- *Crystal Mine Operable Unit ROD* [Record of Decision] (US EPA, 2015).
- *Integrated Investigations of Environmental Effects of Historical Mining in the Basin and Boulder Mining Districts, Boulder River Watershed, Jefferson County, Montana* (USGS, 2004).
- *Second Five-Year Review Report Basin Mining Area Superfund Site, Jefferson County, Montana* (CH2MHILL, 2013).

Boulder River:

- *Bison Creek-Boulder River Drainage Divide Area Landform Origins, Jefferson County, Montana, USA* (Clausen, 2012).
- *Boulder-Elkhorn Metals TMDLs and Framework Water Quality Improvement Plan* (Montana DEQ, 2012).
- *Characterizing the Aquatic Health in the Boulder River Watershed, Montana* (Farag, et al., 1998).
- *Metal and Arsenic Levels in Drinking Water at Two Montana Superfund Sites* (Neuman, et al., 2010).
- *Sediment, Nutrients, and Temperature TMDLs and Water Quality Improvement Plans for the Boulder-Elkhorn Planning Area* (Montana DEQ, 2013).
- *The Boulder River Watershed Study, Jefferson County, Montana – Chapter B of Integrated Investigations of Environmental Effects of Historical Mining in the Basin and Boulder Mining Districts, Boulder River Watershed, Jefferson County, Montana* (Church, et al., 2004).

Muskrat Creek:

- *Westslope Cutthroat Trout Restoration in Muskrat Creek, Boulder River Drainage, Montana: Progress Report for Fisheries* (Shephard & Nelson, 2004).

3.2.5 Flood Protection Measures

The U.S. Army Corps of Engineers maintains the National Inventory of Dams (NID), a database that keeps record of all the dams across the county. The NID identifies hazard potential, dam height, ownership, purpose, dam type, and administrative data. 2 dams were identified in the Boulder River mainstem and tributary study areas (ACOE, 2019).

There are no major flood control structures on the Boulder River, Basin Creek, Red Rock Creek, North Fork Little Boulder River, Little Boulder River, Bear Gulch, Bison Creek, or Muskrat Creek. The B and B Fish Pond is a minor dam on Bison Creek that is classified as having low flood hazard potential (ACOE, 2019).

3.3 Hydrologic Analysis and Results

The purpose of the hydrologic analyses conducted as part of this project was to develop peak flow discharge estimates for the 50-, 10-, 4-, 2-, 1-, 0.2% and 1%+ AEP events at key flow change locations (such as at significant tributaries confluences, stream gages, and population centers) along the study reach. The analysis was split into 2 parts: Boulder River mainstem and Boulder River tributaries hydrologic analysis, organized into 2 sub-sections:

1. USGS Stream Gage Analysis.
2. Ungaged Flow Node Analysis.

3.3.1 Boulder River Mainstem

Throughout the study area, 15 flow nodes on the Boulder River mainstem study reach were identified as having significant changes in streamflow or being at critical locations. Of the 15 flow nodes on the study reach, 1 is located at an active USGS stream gage. The study extents in this report were based on the Jefferson County Modernization Study Area Map provided by the DNRC. The river stations used in this report were based on the Boulder River mainstem S_Hydro_Reach, delineated by Pioneer using Google imagery. The Boulder River mainstem S_Hydro_ Reach alignment begins at the junction of the Jefferson River Slough. The upstream extent of the study reach ends near the headwaters of the Boulder River by the Continental Divide.

3.3.1.1 *USGS Stream Gage Analysis*

The USGS performed peak flow analysis for selected stream gages in Jefferson County as part of this hydrologic analysis (Sando, et al., 2019). Eleven gages were analyzed by USGS within Jefferson County, and 2 of those fall within the Boulder River mainstem study area. The USGS gage flood frequency analysis summary, data and calculations are provided in Appendix A. Bulletin 17C methods were used to estimate the 50-, 42.9, 20-, 10-, 4-, 2-, 1-, 0.5-, 0.2-percent annual exceedance probabilities (AEPs) and the 1% + (plus) AEP. This gage analysis was published in an August 2019 USGS data release (Sando, et al., 2019). The USGS methodologies used for the gage analyses presented in this report are documented in USGS SIR 2018-5046 (Sando & McCarthy, 2018).

The USGS gaging station Boulder River near Boulder, MT (06033000) is on the study reach located at river mile 51.8. The USGS gaging station Boulder River above Rock Creek, near Basin, MT (06030500) is located approximately 1.1 miles downstream of the Upper Boulder River study reach origin.

The oldest records date back to 1929 at USGS gaging station Boulder River near Boulder, MT (06033000). This gage remains active. The USGS gaging station Boulder River above Rock Creek, near Basin, MT (06030500) has not been active since 1981. Figure 3-1 shows the study reach and the USGS gaging station locations along and near the study reach. The FEMA guidance document (FEMA, 2019) indicates that gage station records equal or exceeding 10 years in length are applicable to all types of studies. Both gages mentioned above meet this criterion.

As discussed previously, the AEP peak discharges were updated for 725 gaged sites in or near Montana, based on data through Water Year 2011 (Sando, et al., 2015a). Flood-frequency data were determined using methods described by the IACWD Bulletin 17B (IACWD, 1982). The study was part of a larger study to develop an online StreamStats application for Montana. Both USGS gages in and near the study reach were included in this analysis.

In 2018, the USGS adopted Bulletin 17C guidelines to provide flood frequency estimates for stream gages (England, et al., 2018). The USGS collaborated with DNRC to conduct a flood frequency analysis for Jefferson County using gage data through 2017 and Bulletin 17C methods (Sando, et al., 2019). The USGS only performed flood frequency analysis on gages with a minimum 10 years of record within Jefferson County. Eleven gages were analyzed within Jefferson County and 2 of those are located on the Boulder River. The USGS flood frequency analysis is located in Appendix A. This longer period of record should produce more accurate peak discharge estimates than those based on a shorter period of record. The USGS flood frequency analysis results based on data through water year 2017 were employed in this hydrologic analysis. Table 3-5 summarizes the USGS stream gages analyzed by the USGS (active and inactive) along the Boulder River mainstem.

Table 3-5 Boulder River Mainstem USGS Gages

USGS Station Number	Station Name	Regulation Status as of 2014	Total Number of Years of Peak-Flow Records	Total Period of Record, in Water Years	2017 Status
06030500	Boulder River above Rock Creek, near Basin, MT	U	12	1947-1953, 1955-1957, 1975, 1981	Discontinued
06033000	Boulder River near Boulder, MT	U	78	1929-1932, 1934-1972, 1975, 1981, 1985-2017	Active

Source: Sando, et al., 2019.
USGS: U.S. Geological Survey.

Flood frequency gage-based estimates can be affected by the climatic conditions during the time period the peak-flow data were collected, influencing how the peak-flow frequency results represent long-term hydrologic conditions (Sando, et al., 2015c). Weighting the gage analysis peak flow estimates with the regional regression peak flow estimates adjusts the gage site frequency analysis to account for climatic conditions outside the gaged site period of record (Sando, et al., 2015c). The USGS report SIR 2015-5019-D (Sando, et al., 2015c) tabulated gage analysis peak flow estimates, regional regression peak flow estimates, and weighted gage peak flow estimates.

To account for gage data records through water year 2017 and Bulletin #17C gage frequency analysis methods, USGS preformed gage analysis and additional weighted with regional regression equations analysis (Sando, et al., 2019). The weighting method is described in SIR 2018-5046 (Sando & McCarthy, 2018).

To address the non-congruent periods of record, the MOVE.3 (Maintenance of Variance Extension, Type 3) method was used to extend the historical gage record for USGS gage station Boulder River above Rock Creek, near Basin MT (06030500).

As discussed previously, USGS performed gage analysis and additional weighted with regional regression equations analysis (Sando, et al., 2019). Flood frequency peak flow estimates using the extended record data set established a congruent period of record for the Boulder River mainstem stream gages. Using the extended record data set will minimize the potential error associated with non-congruent periods of record. Table 3-6 shows the results for systematic, weighted, and MOVE.3 flood frequency estimates for gages on the Boulder River mainstem.

Table 3-6 Boulder River Mainstem Gage Flood Frequency Estimates

Node/USGS Station ID	Location Description	Peak Flood Frequency Method	Estimated Discharge (cfs)					
			50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
			2-year	10-year	25-year	50-year	100-year	500-year
06030500*	Boulder River above Rock Creek, near Basin, MT	At Site	154	393	562	711	880	1.370
		MOVE.3	120	331	497	653	840	1.430
06033000	Boulder River near Boulder, MT	At-Site	1,030	2,190	3,050	3,840	4,770	7,650
		RRE wtd	1,030	2,180	2,990	3.700	4,460	6,450

Source: Sando et al., 2019
USGS: U.S. Geological Survey cfs: cubic feet per second.
RRE wtd: Systematic data weighted with regional regression equation (RRE).

3.3.1.2 *1%+ Peak Flow Analysis*

The 1%+ AEP event was calculated by the USGS (Sando, et al., 2019) to provide a confidence range that the 1% flood frequency peak flow estimates are likely to fall within. For gage analysis, FEMA guidance (FEMA, 2019) defines the 1-percent-plus flood elevation as a flood elevation derived by using discharges that are at the upper 84-percent confidence limit as calculated in the gage analysis for the 1-percent-annual-chance event for the Flood Risk Project. The USGS used the methods for estimating synthetic statistics outlined in Bulletin 17C Appendix 7, to estimate the upper 84 percent confidence limit of the Log Pearson III frequency Curve at the 1-percent-annual-chance event. The Boulder River mainstem 1%+ flood frequency peak flow estimates are listed in Table 3-7.

Table 3-7 USGS 1%+ Flood Frequency Estimates 2017

USGS Station Number	Station Name	Drainage Area (sq mi)	1% + AEP Peak discharge, At-Site (cfs)	1% + AEP Peak discharge, RRE wtd (cfs)	1% + AEP Peak discharge, MOVE.3 (cfs)
06030500	Boulder River above Rock Creek, near Basin, MT	24.4	1430	NA	3250
06033000	Boulder River below Boulder, MT	381	7860	5540	NA

Source: Sando et al., 2019.
USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.
RRE wtd: Systematic data weighted with regional regression equation (RRE).

3.3.1.3 *Flow Change Node Locations*

Future flood studies will use hydraulic models that are composed of geometric data and streamflow data. To accurately model the Boulder River mainstem, the locations of major tributary confluences and other flow change locations must be identified. The hydrologic analysis results will be used as the streamflow data input at the tributary confluences within the hydraulic model.

Generally, the hydraulic models simulate flood events using steady-state conditions and, therefore, the peak flow rate calculated at a flow node is projected to the next upstream flow node. This method was followed for the hydrologic analysis calculations. Flow nodes were assigned immediately upstream of major tributaries; this method of locating the flow nodes was employed so that the additional flow resulting from the tributary confluence was accurately reflected to the reach downstream of the confluence.

A detailed review of the study area was performed to identify all potential flow change locations (flow nodes). HUC 12-digit watershed boundaries were used to initially locate the flow nodes. The HUC 12-digit watershed boundaries represent the smallest USGS-delineated watershed areas available in GIS format. Using ArcGIS, flow nodes were located just upstream of the HUC 12 boundary intersection with the Boulder River mainstem. To avoid excessive flow changes between HUC 12 boundary nodes, additional flow nodes were located immediately downstream of towns, at the beginning of study reaches, or where intermediate tributaries within the HUC 12 boundaries intersected the study reach.

At each flow node, a drainage basin area was delineated, and streamflow values were calculated for the various recurrence interval floods. Three methods were used to generate flow node drainage basins. The primary method, used for most flow nodes, involved calculating drainage basins with StreamStats, a USGS software that produces peak flow data and drainage basin area. Complex, low-gradient topographic conditions in the lower study reach required additional methods to calculate drainage basins for nodes 400 through 700. Three StreamStats drainage basins were computed and combined using ArcGIS for Node 600. ArcGIS was used to calculate

the combined area of the 3 StreamStats basins. Nodes 400, 500 and 700 initial drainage basins resulted in narrow watersheds that followed the Boulder River floodplain. The watersheds were expanded to the nearest HUC 12 boundary for nodes 400, 500 and 700.

This study used the nearest GNIS hydrographic feature name for the ungaged flow node names. In some cases, these features (typically tributary streams) flow into the Boulder River just downstream of the flow node. Nodes were also named for nearby towns and USGS gage station numbers if placed at gage locations.

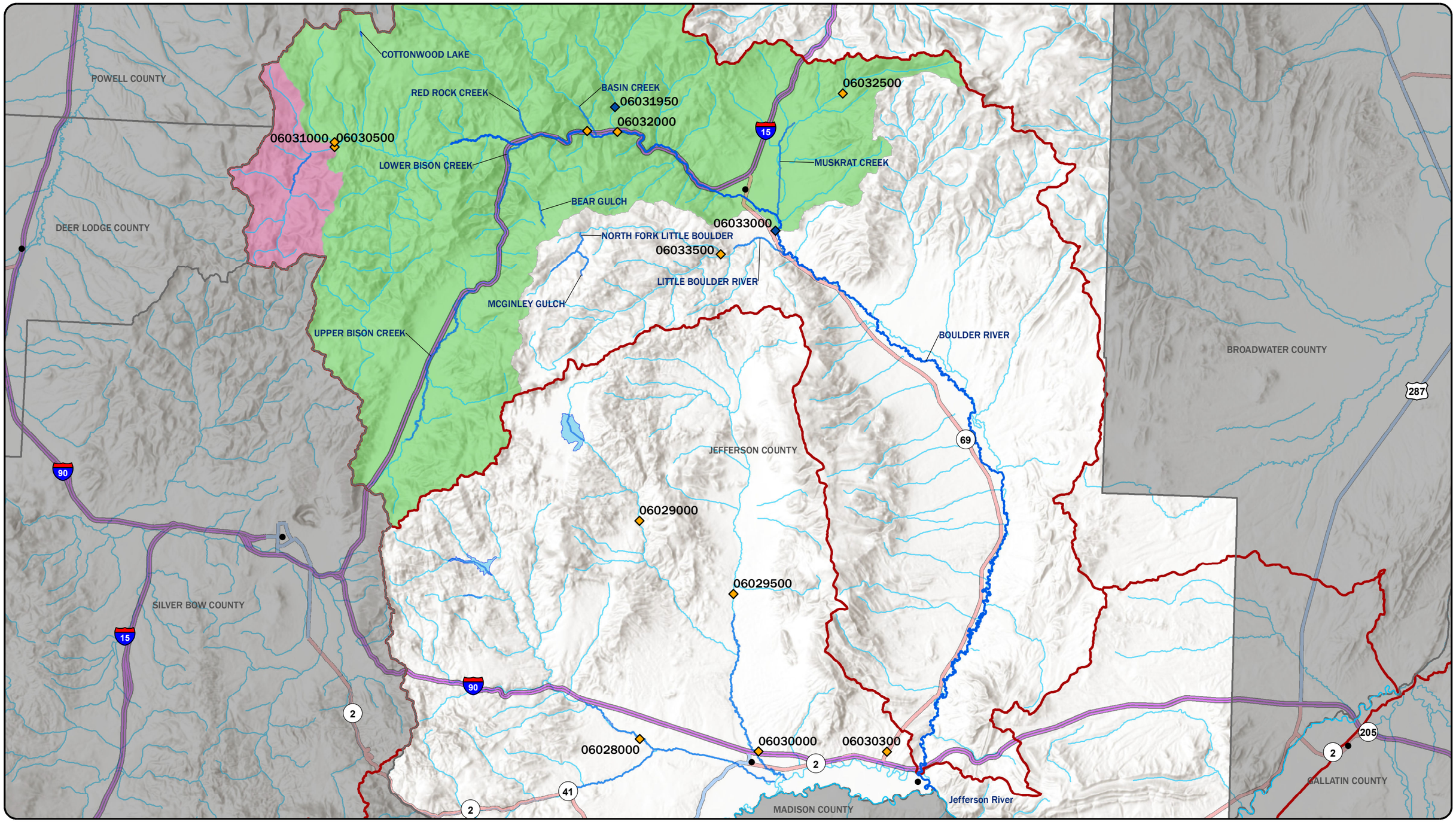
Table 3-8 lists the flow node and gage station Information used in the analyses. A total of 15 flow nodes were identified throughout the study reach, including 1 gaged location and 14 ungaged locations. Figure 3-5 shows the USGS gaging stations analyzed and the correlating watershed areas within the study area. Figure 3-6 maps the flow node locations and corresponding watershed areas from Table 3-8.

Table 3-8 Flow Node and USGS Gage Station Information Used in Hydrologic Analyses

Node/USGS Station ID	Location Description	River Station (mi)	Calculated Basin Area[2] (sq mi)	Study Reach	DA_U/DA_G
100	Boulder River at junction with Jefferson River	0.0	769	Lower Boulder	2.0
200	Conrow Creek	7.6	745	Lower Boulder	2.0
300	Dunn Creek	20.2	682	Lower Boulder	1.8
400[3]	Cabin Gulch	28.5	640	Lower Boulder	1.7
500[3]	Quinn Creek	33.7	582	Lower Boulder	1.5
600[4]	Dry Creek	37.9	526	Lower Boulder	1.4
700[3]	McCarthy Creek	44.2	466	Lower Boulder	1.2
06033000	**Boulder River near Boulder, MT**	**51.8**	**381**	Lower Boulder	-
800	Boulder, MT	53.2	334	Lower Boulder	0.9
900	High Ore Creek	58.6	323	Lower Boulder	0.9
1000	Cataract Creek	63.3	263	Lower Boulder	0.7
1100	Basin Creek	64.2	220	Lower Boulder	0.6
1200	Red Rock Creek	67.9	190	Lower Boulder	0.5
1300	Lower Bison Creek	68.6	112	Lower Boulder	0.3
06030500	**Boulder River above Rock Creek, near Basin, MT (outside of study reach gage not used as flow node)**	**NA**	**24**	**Upper Boulder**	**-**
1400	Headwaters Boulder River	0.0	19	Upper Boulder	0.8

1. River miles start at the downstream extent of each study reach (mi: miles).
2. Source: USGS StreamStats and Esri ArcGIS.
3. Watershed delineated using USGS HUC 12-digit watershed boundary.
4. Watershed delineated by combining 2 USGS StreamStats generated watersheds.

DA_u: Drainage area at ungaged site. DA_G: Drainage area at gaged site. USGS: U.S. Geological Survey. sq mi: square miles.



LEGEND

- ACTIVE USGS STREAM GAGE
- INACTIVE USGS STREAM GAGE
- TOWNS
- BOULDER RIVER MAINSTEM STUDY REACH
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS
- USGS BASINS
  - 06030500
  - 06033000

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 2 4 8
Miles

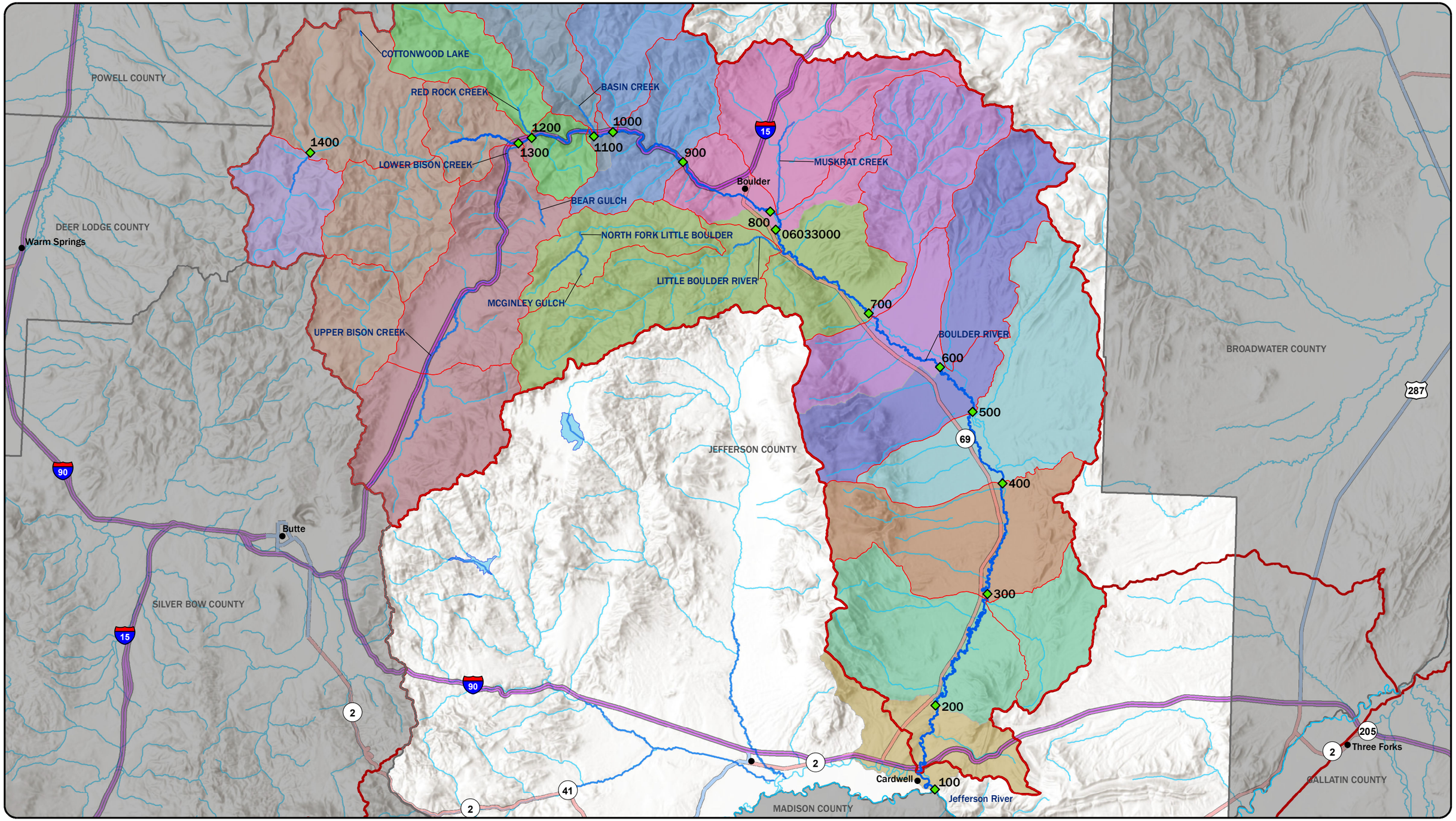
FIGURE 3-5

PIONEER TECHNICAL SERVICES, INC.

DATE: 9/10/2019

BOULDER RIVER MAINSTEM USGS WATERSHEDS

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-3-5.mxd



LEGEND

- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- BOULDER RIVER MAINSTEM STUDY REACH
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS
- FLOW CHANGE NODE: 100
- 200, 300, 400, 500, 600, 700
- 06033000, 800, 900, 1000, 1100, 1200
- 1300, 1400

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 2 4 8
Miles

FIGURE 3-6

PIONEER TECHNICAL SERVICES, INC.

BOULDER RIVER MAINSTEM FLOW NODE LOCATIONS

DATE: 9/10/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-3-6.mxd

3.3.1.4 *Flood Frequency Estimates at Ungaged Sites*

To calculate peak flood discharge estimates at the ungaged flow nodes, Pioneer considered methods described in USGS SIR 2015-5109-F (Sando, et al., 2015b). These methods included estimating flood frequency using regional flood-frequency relations (regression analysis) and estimating flood frequency on gaged streams by translating gaged data to ungaged locations (drainage-area ratio adjustment or logarithmic interpolation between 2 gaged sites).

Two USGS gaging stations (Boulder River above Rock Creek, near Basin, MT and Boulder River near Boulder, MT) were used for the Boulder River mainstem study reach. Nodes 800 through 1300 are located between the 2 gaging stations, therefore the 2-site logarithmic interpolation method was used to estimate peak flows for these flow nodes.

Node 1400 is located upstream of USGS gage station Boulder River above Rock Creek, near Basin, MT (06030500). Nodes 800 through 1300 are located between 2 USGS gage stations and were not analyzed using the gage transfer method. Nodes 100 through 700 are located downstream of the Boulder River near Boulder, MT (06033000) gage. Nodes 500 through 700 meet the SIR 2015-5019-F (Sando, et al., 2015b) guidance criteria for the drainage area gage transfer method (i.e., are within the ratio of 1.5 to 0.5 of the gage drainage area [see Table 3-8]) when analyzed with the Boulder River near Boulder, MT gage. Node 1400 meets the SIR 2015-5019-F guidance criteria when analyzed with the Boulder River above Rock Creek gage. The drainage area gage transfer method was used to analyze nodes not located between 2 gages.

In addition to the above methods, the regional regression method is also applicable to the entire Boulder River mainstem study reach. All 15 flow nodes are considered unregulated and flow nodes within the Southwest Region have watershed areas that are within the watershed area limits as defined by SIR 2015-5019-F (Sando, et al., 2015b). Therefore, it was determined that regional regression equations were applicable to the Boulder River Mainstem Study Reach at all 15 flow nodes. In addition to logarithmic interpolation and gage transfer method, regional regression equations were used to develop peak flow estimates.

3.3.1.5 *Regional Regression Equation Method*

The SIR 2015-5019-F report (Sando, et al., 2015b). provides guidance on conditions where regional regression equations might not yield reliable results. These limiting guidelines include the following:

1. A site where the basin characteristics are outside the range of values used to develop the regression equations.
2. A site that is affected by regulation or urbanization.

The SIR 2015-5019-F report considers a gaging station unregulated if the cumulative drainage area of an upstream dam is less than 20% of the drainage area to the gaging station (Sando, et al., 2015b). Ungaged flow nodes located on the Boulder River mainstem are not regulated and are within the range of values used to develop the Southwest Region regional regression

equations. The USGS software StreamStats generated regional regression flow discharges for the 50-, 10-, 4-, 2-, 1-, and 0.2% AEP events for 11 of the 15 flow nodes. Due to complex low-gradient topography mentioned above, Pioneer estimated flow discharges for the 50-, 10-, 4-, 2-, 1-, and 0.2% AEP events using the regional regression method on Nodes 400 through 700. Pioneer calculated regional regression flow discharges for the 1%+ (plus) AEP event on all nodes. The regression equations, presented in SIR 2015-5019-F (Sando, et al., 2015b), use drainage area (A) and percentage of drainage basin above 6,000 feet elevation (E_{6000}) as shown below in the following set of equations:

$$Q_{50} = 2.49A^{0.930}(E_{6000}+1)^{0.095}$$
$$Q_{10} = 31.9A^{0.796}(E_{6000}+1)^{-0.177}$$
$$Q_{4} = 79.8A^{0.750}(E_{6000}+1)^{-0.274}$$
$$Q_{2} = 142A^{0.721}(E_{6000}+1)^{-0.336}$$
$$Q_{1} = 238A^{0.696}(E_{6000}+1)^{-0.391}$$
$$Q_{0.2} = 655A^{0.649}(E_{6000}+1)^{-0.501}$$

Where

Q_x is the X AEP peak flow magnitude, in cfs.

A is the contributing drainage area, in square miles.

E_{6000} is the percent of basin area above 6,000 feet.

The 1%+ (plus) AEP event for regional regression estimates was calculated using FEMA guidance methodologies. For regional regression analyses, the 1-percent-plus flood elevation is defined as a flood elevation derived by using discharges that include the predictive error for the regression equation discharge calculation for the Flood Risk Project. This error is then added to the 1percent annual chance discharge to calculate the new 1 percent plus discharge (FEMA, 2019).

The average standard error of prediction or *average standard error of estimate* percentage (SEP, in percent) from SIR 2015-5019-F (Sando, et al., 2015b) was used to define the equation's statistical confidence upper limit of plus 1 standard error (FEMA, 2016b). The resulting upper limit of plus 1 standard error was used to determine the 1%+ (plus) flood frequency peak flow estimates. Appendix B provides the 1%+ (plus) regional regression flood frequency calculations for the study ungaged flow nodes.

Due to low gradient and coarse topography, several nodes required additional effort to calculate drainage area (A) and percentage of drainage basin over 6,000 feet (E_{6000}). For watershed areas not calculated in StreamStats, the area above 6,000 feet was calculated using ArcGIS.

The Southwest Hydrologic regional regression equation input variables are shown in Table 3-9. Regional regression flood frequency peak flow estimates are listed in Table 3-10. Figure 3-7 plots the calculated peak discharges and correlating drainage areas. Results indicate increasing flow magnitude with increasing drainage area.

Table 3-9 Regional Regression Variables

Node/USGS Station ID	Location Description	Study Reach River Station (miles)	Basin Area (sq mi)	E_{6000}
1400	Headwaters Boulder River	0	19	100
1300	Lower Bison Creek	68.6	112	95
1200	Red Rock Creek	67.9	190	95
1100	Basin Creek	64.2	220	94
1000	Cataract Creek	63.3	263	94
900	High Ore Creek	58.6	323	92
800	Boulder, MT	53.2	334	89
06033000	**Boulder River at USGS Gage Station 06033000 Boulder River near Boulder, MT**	**51.8**	**381**	**81**
700[1]	McCarthy Creek	44.2	466	77
600[1]	Dry Creek	37.9	526	74
500[1]	Quinn Creek	33.7	582	71
400[1]	Cabin Gulch	28.5	640	66
300	Dunn Creek	20.2	682	63
200	Conrow Creek	7.6	745	59
100	Boulder River at junction with Jefferson River	0	769	57

1. E_{6000} calculated by ArcGIS.

USGS: U.S. Geological Survey. sq mi: square miles.

E_{6000} (%): percentage of basin over 6,000 feet in elevation.

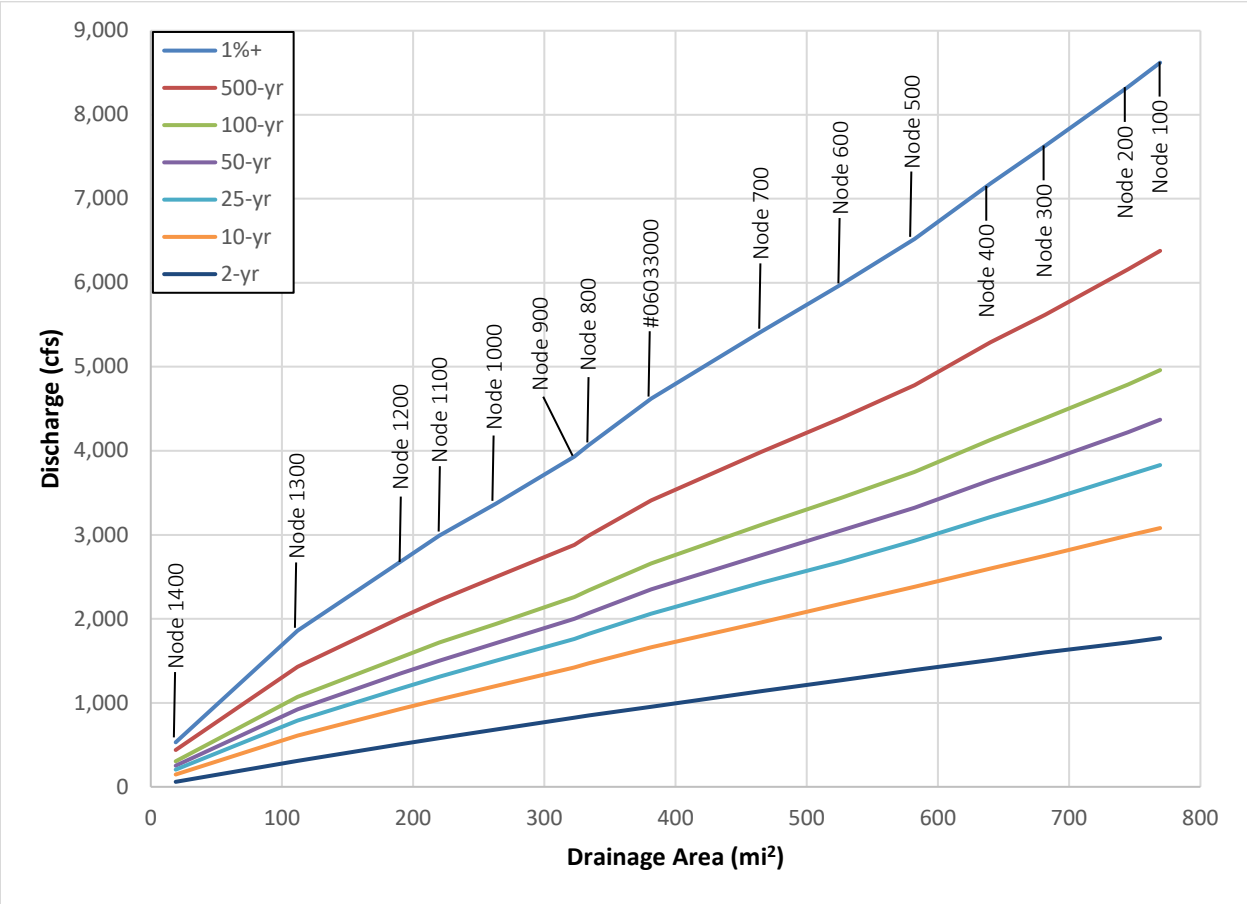
Table 3-10 Regional Regression Flood Frequency Peak Flow Estimates

Node/USGS Station ID	Location Description	Southwest Region Regression Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year
1400	Headwaters Boulder River	60	147	205	252	304	439	528
1300	Lower Bison Creek	309	608	787	921	1,070	1,430	1,860
1200	Red Rock Creek	506	928	1,170	1,350	1,540	2,010	2,680
1100	Basin Creek	578	1,040	1,310	1,500	1,720	2,220	2,990
1000	Cataract Creek	683	1,200	1,500	1,710	1,940	2,500	3,370
900	High Ore Creek	825	1,420	1,760	2,000	2,260	2,880	3,930
800	Boulder, MT	849	1,470	1,820	2,070	2,340	2,990	4,070
06033000	**Boulder River at USGS Gage Station 06033000 Boulder River near Boulder, MT**	**952**	**1,660**	**2,060**	**2,350**	**2,660**	**3,410**	**4,620**
700[1]	McCarthy Creek	1,140	1,960	2,430	2,760	3,120	3,990	5,420
600[1]	Dry Creek	1,270	2,180	2,680	3,050	3,440	4,390	5,980
500[1]	Quinn Creek	1,390	2,380	2,930	3,320	3,750	4,780	6,520
400[1]	Cabin Gulch	1,510	2,600	3,210	3,650	4,130	5,290	7,180
300	Dunn Creek	1,600	2,750	3,400	3,870	4,390	5,620	7,630
200	Conrow Creek	1,720	2,990	3,710	4,220	4,790	6,160	8,330
100	Boulder River at junction with Jefferson River	1,770	3,080	3,830	4,370	4,960	6,380	8,620

1. Peak flow estimated by Pioneer using southwest regional regression equations.

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 3-7 Boulder River Mainstem Regional Regression Flood Frequency Estimates



3.3.1.6 *Drainage Area Gage Transfer Method*

Ungaged flow nodes located upstream of USGS gage Boulder River above Rock Creek, near Basin, MT (06030500) and below Boulder River near Boulder, MT (06033000) were considered for applying the drainage area gage transfer method. Limitations for this method include a recommended drainage area ratio between 0.5 and 1.5. This method, listed in SIR 2015-5019-F (Sando, et al., 2015b), uses a drainage area ratio of the ungaged flow node to the gaged station to transfer flow estimates from the gaged site to the ungaged site as shown in the following equation:

$$Q_{AEP,U} = Q_{AEP,G}\left(\frac{\mathrm{DA}_U}{\mathrm{DA}_G}\right)^{\exp_T}$$

Where

$Q_{AEP,U}$ is the AEP-percent peak flow at the ungaged site, in cfs.

$Q_{AEP,G}$ is the AEP-percent peak flow at the gaged site, in cfs.

DA_G is the drainage area at the gaged site, in square miles.

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

$\exp_{AEP}$ is the regression coefficient for a simple OLS regression relating to the log of the AEP-percent peak flow to log of drainage area within each region.

Nodes 100-700 and node 1400 were considered for gage transfer. Gage transfer was not calculated between the 2 Boulder River gages. Four of the flow node drainage areas ratios are within the recommended range (Table 3-8). The USGS gage Boulder River near Boulder, MT (06033000) has 78 years of record. The regional regression weighted discharge is significantly different at the 1%+ AEP discharge (30% lower). Due to this significant difference, the at-site data were selected to calculate peak flows on nodes 100-700, as gage data with a long period of record is often more reliable than regression equations. Extended record data (MOVE.3) on USGS gage Boulder River above Rock Creek, near Basin, MT (06030500) was selected to calculate peak flows on node 1400 to account for the limited period of record (12 years) at the gage. The associated record extension correlation coefficient is 0.84 (Appendix A). (Calculations were performed for all flow nodes mentioned above for subsequent comparison to regional regression equation peak flow estimates.

The applicable regression coefficients provided in Table 3-11 were used in these calculations. The drainage area transfer method results are shown in Table 3-12, and Figure 3-8.

Table 3-11 Drainage Area Gage Transfer Regression Coefficients

AEP-percent Peak Flow	exp_{AEP}
Q50	0.939
Q10	0.755
Q4	0.690
Q2	0.647
Q1	0.609
Q0.2	0.533

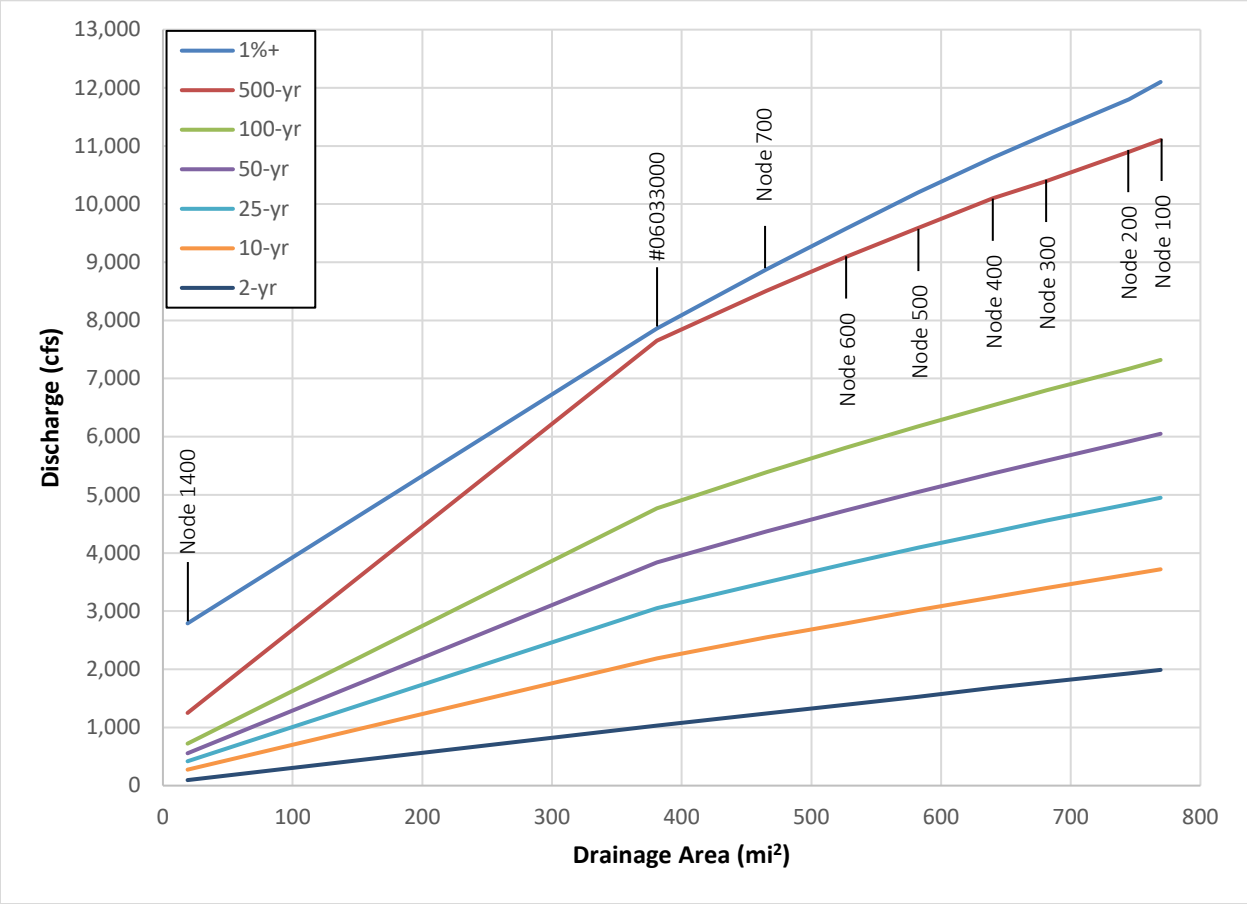
Table 3-12 Drainage Area Gage Transfer Method Results for Flow Node Locations near USGS gage 06030500 Boulder River above Rock Creek, near Basin MT and USGS gage 06033000 Boulder River near Boulder, MT

Node/USGS Station ID	Location Description	Drainage Area Gage Transfer Estimated Discharge (cfs)						
		Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year
1400[3]	Headwaters Boulder River	95	274	419	556	722	1,250	2,790
06030500[1]	**USGS Gage Station 06030500 Boulder River above Rock Creek, near Basin, MT**	**120**	**331**	**497**	**653**	**840**	**1,430**	**3,250**
06033000[2]	**USGS Gage Station 06033000 Boulder River near Boulder, MT**	**1,030**	**2,190**	**3,050**	**3,840**	**4,770**	**7,650**	**7,860**
700[3]	McCarthy Creek	1,240	2,550	3,500	4,370	5,390	8,510	8,880
600[3]	Dry Creek	1,390	2,790	3,810	4,730	5,810	9,090	9,570
500[3]	Quinn Creek	1,530	3,020	4,090	5,050	6,180	9,590	10,200
400	Cabin Gulch	1,680	3,240	4,360	5,370	6,540	10,100	10,800
300	Dunn Creek	1,780	3,400	4,560	5,590	6,800	10,400	11,200
200	Conrow Creek	1,930	3,630	4,840	5,920	7,170	10,900	11,800
100	Boulder River at junction with Jefferson River	1,990	3,720	4,950	6,050	7,320	11,100	12,100

1. Peak flow estimated from extended record analysis, correlation coefficient =0.84.
2. Peak flow estimated from at-site gage analysis
3. Node within recommended DA_U/DA_G range of 0.5 to 1.5. DA_U: Drainage area at ungaged site. DA_G: Drainage area at gaged site.

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 3-8 Boulder River Mainstem Drainage Area Gage Transfer Results



3.3.1.7 *Two-Station Logarithmic Interpolation Method*

Pioneer used the log interpolation method listed in SIR 2015-5019-F (Sando, et al., 2015b) for analysis on ungaged sites between two gaged sites. Nodes 800 through 1300 fall between USGS gage station Boulder River near Boulder, MT (06033000) and USGS gage station Boulder River above Rock Creek, near Basin, MT (06030500). In this method, the logarithm of the flood-frequency discharge estimates at the ungaged site is linearly interpolated based on discharge estimates and drainage basin areas of the upstream and downstream gaged sites. This method is listed in the equation below from SIR 2015-5019-F:

$$\log Q_{AEP,U} = \log \mathrm{Q}_{AEP,G1} + \frac{\log \mathrm{Q}_{AEP,G2} - \log \mathrm{Q}_{AEP,G1}}{\log \mathrm{DA}_{G2} - \log \mathrm{DA}_{G1}} (\log \mathrm{DA}_U - \log \mathrm{DA}_{G1})$$

Where

log	is the base 10 logarithm.
$Q_{AEP,U}$	is the AEP-percent peak flow at the ungaged site, in cfs.
$Q_{AEP,G1}$	is the AEP-percent peak flow at the upstream gaged site, in cfs.
$Q_{AEP,G2}$	is the AEP-percent peak flow at the downstream gaged site, in cfs.
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.
DA_U	is the drainage area at the ungaged site, in square miles.

Table 3-13 shows the calculation results using the regional regression at-site gage estimates (USGS gage 06033000) and extended period (USGS gage 06030500). Figure 3-9 plots the relationship between the calculated discharge estimates and correlating drainage area. Results indicate estimated flow at the ungaged flow nodes increase with increasing drainage area.

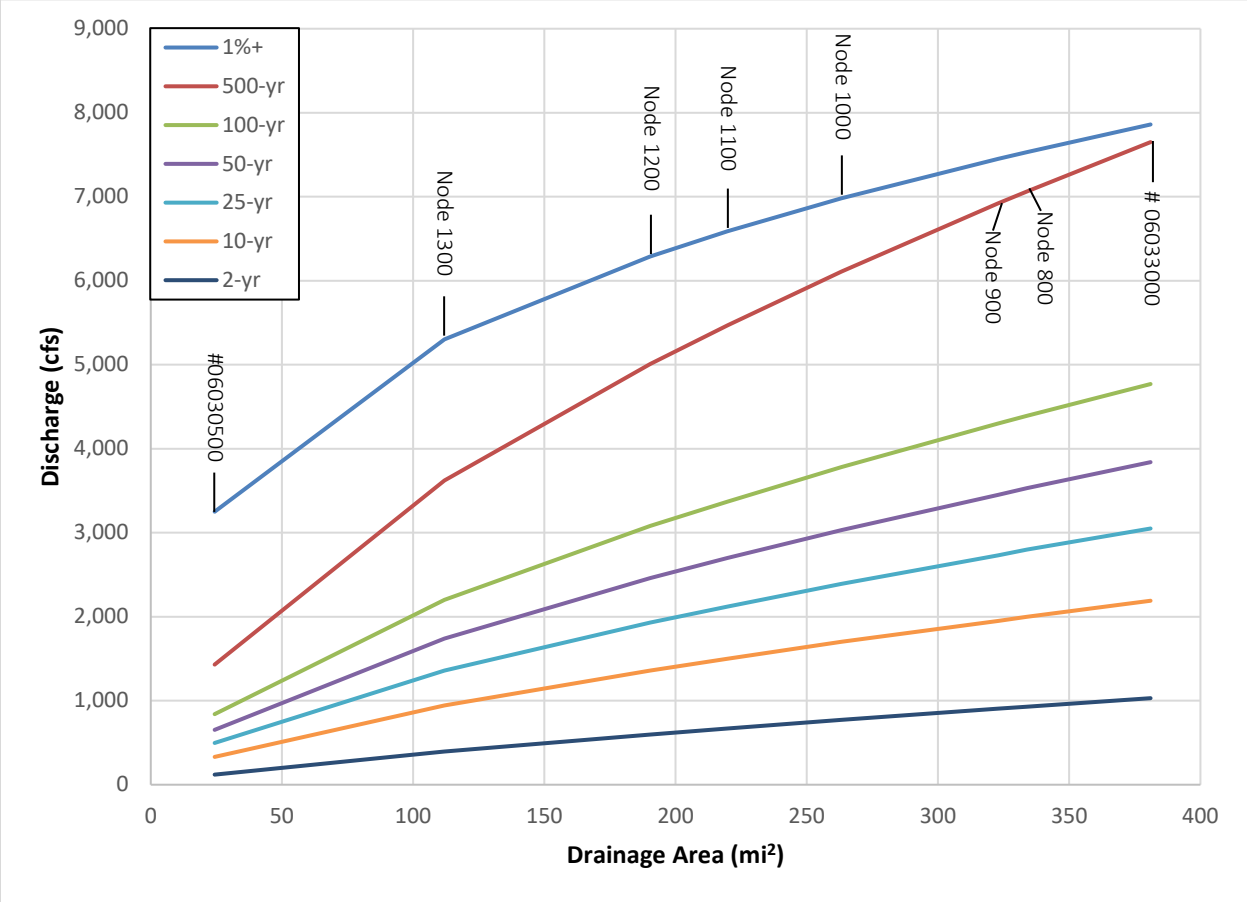
Table 3-13 Two-Station Log Interpolation Flow Node Peak Flow Estimates

Node/USGS Station ID	Location Description	Log Interpolation of RRE Weighted and Extended Record Gaged Analysis						
		Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year
06030500[1]	**Boulder River above Rock Creek, near Basin, MT**	**120**	**331**	**497**	**653**	**840**	**1,430**	**3,250**
1300	Lower Bison Creek	395	944	1,360	1,740	2,200	3,620	5,300
1200	Red Rock Creek	599	1,360	1,930	2,460	3,080	5,010	6,290
1100	Basin Creek	670	1,500	2,120	2,700	3,370	5,470	6,590
1000	Cataract Creek	771	1,700	2,390	3,030	3,780	6,110	6,980
900	High Ore Creek	905	1,950	2,730	3,450	4,300	6,920	7,450
800	Boulder, MT	929	2,000	2,800	3,530	4,390	7,060	7,530
06033000[2]	**USGS Gage Station 06033000 Boulder River near Boulder, MT**	**1,030**	**2,190**	**3,050**	**3,840**	**4,770**	**7,650**	**7,860**

1. Peak flow estimated from extended record analysis
2. Peak flow estimated from at-site gage analysis

USGS: U.S. Geological Survey. RRE: regional regression equation. cfs: cubic feet per second.

Figure 3-9 Boulder River Mainstem Log Interpolation Gage Analysis Results



3.3.2 Boulder River Mainstem Discussion

Pioneer conducted a peak discharge frequency analysis for the Boulder River mainstem study reach, which is split between the upper Boulder River and lower Boulder River study reach. The lower Boulder study reach extends 73 miles from the confluence of the Boulder River with a Jefferson River slough. The upper Boulder River study reach begins 7 miles upstream from the most upstream extent of the lower Boulder River study reach and extends 2 miles. Information gathered from this analysis will be used to support the Jefferson Countywide Modernization hydraulic analyses and floodplain mapping studies.

Previous flood studies on the Boulder River mainstem are limited. The most relevant earlier flood study was the SIR 2015-5019-C (Sando, et al., 2015a).

This hydrologic analysis developed flood frequency estimates for both gaged and ungaged sites. Peak flow estimates were calculated at 15 locations (flow nodes) within the watershed (1 gaged site and 14 ungaged sites). The ungaged sites (flow nodes) were located at HUC 12 boundaries, major tributaries, population centers, and at the end of study reaches.

Flood frequency estimates at the gaged sites were conducted by USGS (Sando, et al., 2019) using Bulletin 17C methodologies (England, et al., 2018). Flood flow frequency estimates at ungaged flow nodes were conducted using regional regression methods, gage transfer methods, and two-station logarithmic interpolation (Sando, et al., 2015b).

Two USGS stream gaging stations exist on the Boulder River: Boulder River near Boulder, MT (06033000) and Boulder River above Rock Creek near Basin, MT (06030500). Both gages were used to estimate AEP peak flow values for the study reach. The Boulder River near Boulder, MT gage is located 51.8 miles upstream from the Boulder River mainstem study reach confluence with the Jefferson River. The Boulder River above Rock Creek near Basin, MT gage is located 1.2 miles downstream of the Upper Boulder River study reach origin.

The 2 stream gaging stations used in this study have non-congruent periods of record. Non-congruent periods of record can influence peak flow estimates between gaged sites within the drainage area and may introduce error to the peak flow frequency estimates. To eliminate the potential issues associated with non-congruent periods of record, USGS performed an extended record analysis (MOVE.3) on gage site Boulder River above Rock Creek, near Basin, MT (06030500) to match the period of record for Boulder River near Boulder, MT (06033000). Per Bulletin 17C guidance, a minimum correlation of 0.8 is required when using extended record analysis. The correlation for USGS gages 060630500 and 06033000 is 0.84 (Sando, et al., 2019). The period of record used was from 1929-1932, 1934-1972, 1975, 1981, 1985-2017.

The USGS weighted the Boulder River near Boulder, MT gage (06033000) with regional regression equations. This resulted in significantly lower peak flows (~30% lower at the 1%+ AEP discharge) when compared to the at-site data. Due to the significant difference and the 78-year period of record, at-site peak flow data were used on USGS gage 06033000 to develop peak

flows using the gage transfer and logarithmic interpolation method. Extended record data were used on USGS gage 06030500 (as higher confidence is typically associated with longer periods of record) to develop peak flows using the gage transfer and logarithmic interpolation method. The Boulder River mainstem watershed in this study is considered unregulated. The basin parameters for the flow nodes evaluated in this study fall within the range of basin and climatic characteristics used to develop the regional regression equations. Therefore, regional regression method peak flow estimates are applicable to this study.

Flood frequency estimates at the gaged sites were conducted using Bulletin 17C methodologies (England, et al., 2018) by the USGS (Appendix A). Flood flow frequency estimates at ungaged flow nodes were conducted using regional regression methods, gage transfer, and two-station logarithmic interpolation (Sando, et al., 2015b). Flow Nodes 800 through 1300 were located between USGS gage station Boulder River near Boulder, MT (06033000) and USGS gage station Boulder River above Rock Creek, near Basin, MT (06030500). The two-station logarithmic interpolation method was used for these flow nodes. The gage transfer method was used for all flow nodes outside of the two gages. Regional regression equations were used for all flow nodes. The AEP peak flow 1%+ (plus) estimates were developed for all gaged and ungaged locations using standard FEMA methodologies (FEMA, 2019).

Regional regression equations are based on comparisons of peak flows and basin characteristics for a given region (Sando, et al., 2015b). As a result, regional regression equations can be used for estimating peak flows when gage data do not exist, or the period of record is too short to represent the historic climate. A minimum 10 years of gage data is recommended to perform gage peak flow analysis; the gages used in this analysis surpass that minimum.

The gage data and the gage-based flood frequency estimating methods meet the hydrologic flood frequency standard practice criteria and guidance for Nodes 500 through 1200 and 1400. Nodes 100 through 400 have a DA_U/DA_G ratio that is outside the maximum recommended value of 1.5. To determine which calculation method better represents peak flow values at ungaged flow nodes where the DA_U/DA_G ratio is outside the SIR 2015-5019-F guidelines (Sando, et al., 2015b), regional equation results were compared with drainage area transfer peak flow estimates at ungaged flow nodes that meet the SIR 2015-5019-F DA_U/DA_G guidelines. The comparison indicated that the regional regression equations are significantly lower.

The gage-based AEP estimates meet standard hydrologic flood frequency practice guidance including the following:

- A 78-year period of record that exceeds the minimum FEMA guidance (FEMA, 2019).

Higher confidence is typically associated with flood frequency estimates that are based on measured stream flows, such as in the gage transfer and two-station logarithmic method. For these reasons, the gage transfer method was selected for the recommended flood discharge estimates.

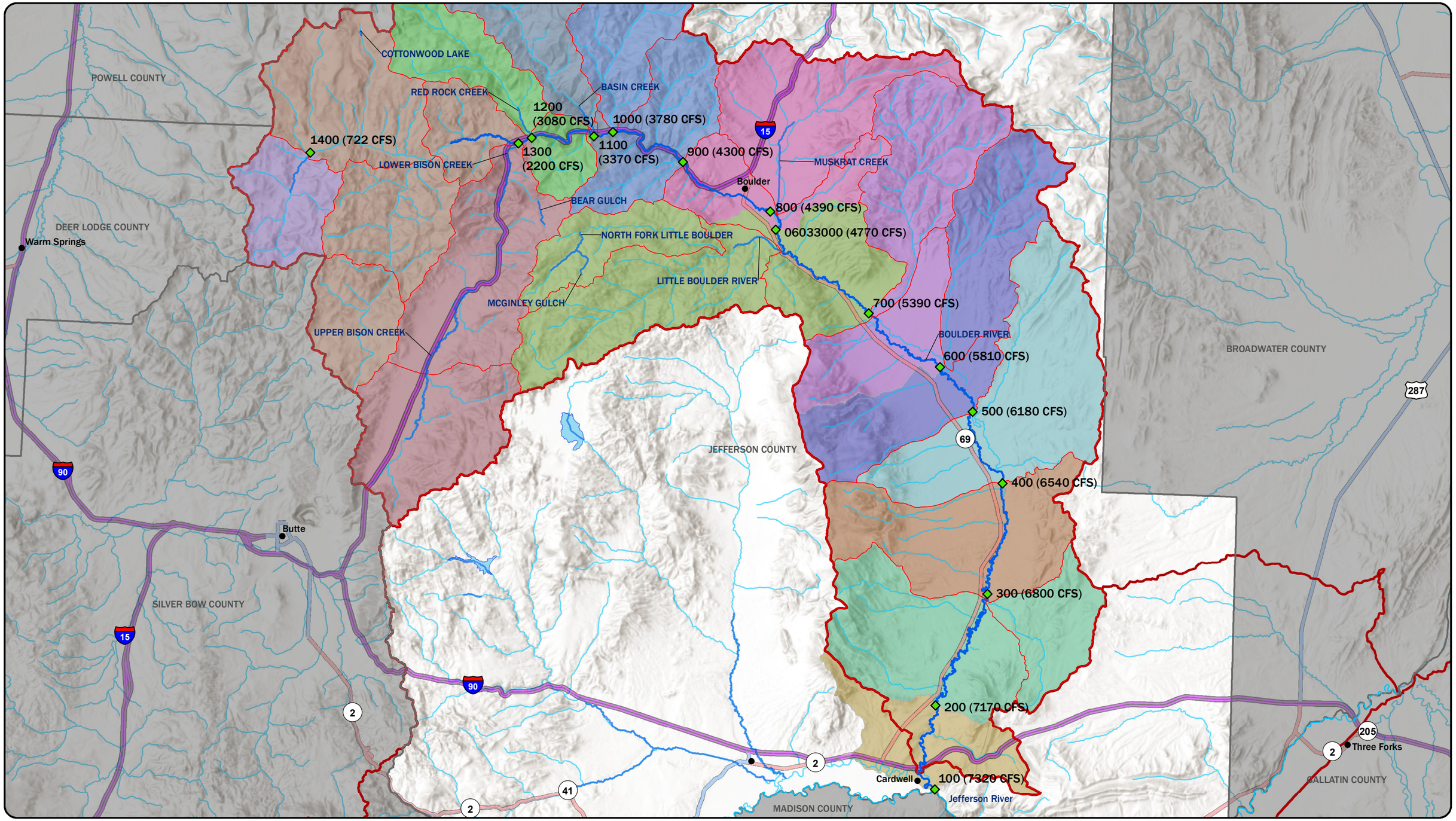
Table 3-14 summarizes the recommended flood frequency discharge rates for the Boulder River mainstem study reach. Figure 3-10 shows the recommended 1% AEP discharge for each flow node location. The hydrologic analysis results provided in Table 3-14 represent the recommended discharges at each flow node location throughout the study reach. The methods used for hydrological analysis are industry accepted methods [Bulletin 17C (England, et al., 2018), SIR 2015-5019-C (Sando, et al., 2015a) and SIR 2015-5019-F (Sando, et al., 2015b)] based on the Boulder River mainstem basin characteristics. This hydrologic analysis conforms to FEMA standards for enhanced level studies, and the recommended flows of this analysis are deemed reliable and suitable for future floodplain studies and hydraulic analyses.

Table 3-14 Recommended Flood Discharge Estimates Using Gage Transfer and Log Interpolation Analysis

Node/USGS Station ID	Location Description	Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% + Annual Chance
		2-year	10-year	25-year	50-year	100-year	500-year	100-year +
1400[1]	Headwaters Boulder River	95	275	419	556	722	1,250	2,790
1300[3]	Lower Bison Creek	395	944	1,360	1,740	2,200	3,620	5,300
1200[3]	Red Rock Creek	599	1,360	1,930	2,460	3,080	5,010	6,290
1100[3]	Basin Creek	670	1,500	2,120	2,700	3,370	5,470	6,590
1000[3]	Cataract Creek	771	1,700	2,390	3,030	3,780	6,110	6,980
900[3]	High Ore Creek	905	1,950	2,730	3,450	4,300	6,920	7,450
800[3]	Boulder, MT	929	2,000	2,800	3,530	4,390	7,060	7,530
06033000[2]	**Boulder River at USGS Gage Station 06033000 Boulder River near Boulder, MT**	**1,030**	**2,190**	**3,050**	**3,840**	**4,770**	**7,650**	**7,860**
700[1]	McCarthy Creek	1,240	2,550	3,500	4,370	5,390	8,510	8,880
600[1]	Dry Creek	1,390	2,790	3,810	4,730	5,810	9,090	9,570
500[1]	Quinn Creek	1,530	3,020	4,090	5,050	6,180	9,590	10,200
400[1]	Cabin Gulch	1,680	3,240	4,360	5,370	6,540	10,100	10,800
300[1]	Dunn Creek	1,780	3,400	4,560	5,590	6,800	10,400	11,200
200[1]	Conrow Creek	1,930	3,630	4,840	5,920	7,170	10,900	11,800
100[1]	Boulder River at junction with Jefferson River	1,990	3,720	4,950	6,050	7,320	11,100	12,100

1. Analyzed with USGS Gage Transfer Method.
2. Analyzed with USGS at-site gage data.
3. Analyzed with USGS Two-Station Logarithmic Method.

USGS: U.S. Geological Survey. cfs: cubic feet per second.



LEGEND

- FLOW NODES (DISCHARGE)
- TOWNS
- HUC 12 BOUNDARIES
- BOULDER RIVER MAINSTEM STUDY REACH
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS
- FLOW CHANGE NODE: 100
- 200, 300, 400, 500, 600, 700
- 06033000, 800, 900, 1000, 1100, 1200
- 1300, 1400

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 2 4 8
Miles

FIGURE 3-10

PIONEER TECHNICAL SERVICES, INC.

BOULDER RIVER MAINSTEM RECOMMENDED 1-PERCENT AEP DISCHARGE

DATE: 9/12/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-3-10.mxd

3.3.3 Boulder Tributaries

Throughout the study area, 13 flow nodes on the Boulder River tributary study reaches, including 1 lake, were identified as having significant changes in streamflow or being at a critical location. All flow nodes are located at ungaged locations. The study tributaries in this report were based on the Jefferson County Modernization Study Area Map provided by the DNRC. The river stations used in this report were based on the Boulder River Tributaries S_Hydro_Reach delineated by Pioneer based on Google imagery. The Boulder River Tributaries S_Hydro_Reach alignments begin at the junction of Little Boulder River, Muskrat Creek, Basin Creek, Red Rock Creek, and Bison Creek with the Boulder River mainstem. The Cottonwood Lake study reach ends at the Cottonwood Lake outlet. The upstream extent of the study reaches ends at 8 locations North Fork Little Boulder River, McGinley Gulch, Muskrat Creek, Basin Creek, Red Rock Creek, Bear Gulch, Upper Bison Creek, and Cottonwood Lake.

3.3.3.1 *USGS Stream Gage Analysis*

There is 1 USGS stream gage located on a Boulder River tributary with over 10 years of record. The USGS gaging station Cataract Creek near Basin, MT (06031950) is located on Cataract Creek about 1.3 miles upstream of the confluence with the Boulder River mainstem. The gage record dates to 1973. The gage is currently active, however this gage is not on a study reach.

As discussed previously, the AEP peak discharges were updated for 725 gaged sites in or near Montana, based on data through Water Year 2011 (Sando, et al., 2015a). Flood-frequency data were determined using methods described by the IACWD Bulletin 17B (IACWD, 1982). The study was part of a larger study to develop an online StreamStats application for Montana. Both USGS gages in and near the study reach were included in this analysis.

In 2018, the USGS adopted Bulletin 17C guidelines to provide flood frequency estimates for stream gages (England, et al., 2018). The USGS collaborated with DNRC to conduct a flood frequency analysis for Jefferson County using gage data through 2017 using Bulleting 17C methods (Sando, et al., 2019). The USGS only performed flood frequency analysis on gages with a minimum 10 years of record within Jefferson County. Eleven gages were analyzed within Jefferson County and 1 of those is located on a Boulder River Tributary. The USGS flood frequency analysis is in Appendix A. This longer period of record should produce more accurate peak discharge estimates than those based on a shorter period of record. The USGS flood frequency analysis results based on data through 2017 were employed in this hydrologic analysis. **Table 3-15** summarizes the USGS stream gages analyzed by the USGS (active and inactive) on Boulder River tributaries.

Table 3-15 Boulder River Tributary USGS Gages

USGS Station Number	Station Name	Regulation Status as of 2014	Total Number of Years of Peak-Flow Records	Total Period of Record, in Water Years	2017 Status
06031950	Cataract Creek near Basin, MT	U	45	1973-2017	Active

Source: Sando et al., 2019.
USGS: U.S. Geological Survey.
U denotes unregulated streams.

Flood frequency gage-based estimates can be affected by the climatic conditions during the time period the peak-flow data were collected, influencing how the peak-flow frequency results represent long-term hydrologic conditions (Sando, et al., 2015c). Weighting the gage analysis peak flow estimates with the regional regression peak flow estimates adjusts the gage site frequency analysis to account for climatic conditions outside the gaged site period of record (Sando, et al., 2015c). The USGS report SIR 2015-5019-D (Sando, et al., 2015c) tabulated gage analysis peak flow estimates, regional regression peak flow estimates, and weighted gage peak flow estimates.

As discussed previously, USGS performed gage analysis and weighted with regional regression equations analysis (Sando, et al., 2019). The weighting method is described in SIR 2018-5046 (Sando & McCarthy, 2018). Table 3-16 shows the results for systematic and weighted flood frequency estimates for gages on Boulder River tributaries.

Table 3-16 Boulder River Tributary Gage Flood Frequency Estimates

Node/USGS Station ID	Location Description	Peak Flood Frequency Method	Estimated Discharge (cfs)					
			50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
			2-year	10-year	25-year	50-year	100-year	500-year
06031950	Cataract Creek near Basin, MT	At-Site	235	543	872	1,250	1,780	2,540
		RRE wtd	232	515	774	1,000	1,240	1,470

Source: Sando et al.., 2019
USGS: U.S. Geological Survey. cfs: cubic feet per second.
RRE wtd: Systematic data weighted with regional regression equation (RRE).

Due to the USGS gage station Cataract Creek near Basin, MT (06031950) not being on a study reach, the gage was not considered for this hydrologic analysis.

3.3.3.2 *1%+ Peak Flow Analysis*

The 1%+ AEP event for gage analysis was calculated by USGS (Sando, et al., 2019) as previously described to provide a confidence range that the 1% flood frequency peak flow estimates are likely to fall within. The upper 84% confidence limit calculated in the gage analysis was used by

USGS to determine the 1% flood frequency peak flow estimates (FEMA, 2019). The Cataract Creek 1%+ flood frequency peak flow estimates are listed in Table 3-17.

Table 3-17 USGS 1%+ Flood Frequency Estimates 2017

USGS Station Number	Station Name	Drainage Area (sq mi)	1% + AEP Peak discharge, At-Site (cfs)	1% + AEP Peak discharge, RRE wtd (cfs)
06031950	Cataract Creek near Basin, MT	30.5	3,210	1,710

Source: Sando et al., 2019.
USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.
RRE wtd: Systematic data weighted with regional regression equation (RRE).

3.3.3.3 *Flow Change Node Locations*

Future flood studies will use hydraulic models that are composed of geometric data and streamflow data. To accurately model the Boulder River tributaries, the locations of major tributary confluences and other flow change locations must be identified. Hydrologic analysis results will be used as the streamflow data input at the tributary confluences within the hydraulic model. A detailed review of the study area was performed to identify all potential flow change locations (flow nodes) within the Boulder River tributaries. At each flow node, a drainage basin area was delineated, and streamflow values were calculated for the various recurrence interval floods. The USGS software StreamStats was used to generate flow node drainage basin areas.

Generally, the hydraulic models simulate flood events using steady-state conditions and, therefore, the peak flow rate calculated at a flow node is projected to the next upstream flow node. This method was followed for the hydrologic analysis calculations. Flow nodes were assigned immediately upstream of tributary junctions; this method of locating the flow nodes was employed so that the additional flow resulting from the tributary confluence was accurately reflected to the reach downstream of the confluence.

For study reaches that did not extend to a tributary junction, flow nodes were placed at the downstream end of the study reaches. Flow nodes were located on HUC 12-digit watershed boundaries. The HUC 12-digit watershed boundaries represent the smallest USGS-delineated watershed area available in GIS format. Flow nodes were placed upstream of lake outlets within the study area. These flow nodes were placed to determine the total flow into a lake during a peak flow event.

Using ArcGIS, 5 flow nodes (Little Boulder River, Muskrat Creek, Basin Creek, Red Rock Creek, Bison Creek) were located just upstream of each tributary confluence with the Boulder River mainstem. Two additional flow nodes were added on the Bison Creek study reach. Two nodes were located on the North Fork Little Boulder River, a remote study reach that joins with the Little Boulder River study reach about 8 miles downstream. One node was located on McGinley

Gulch upstream of the confluence with the North Fork Little Boulder River. One node was located on Bear Gulch, a remote study reach that joins with Bison Creek about 2 miles downstream of the flow node. One node was located at the Cottonwood Lake outlet, a remote study reach that joins with the Boulder River mainstem about 5 miles downstream of the flow node. There is no outlet control structure or significant storage capacity at Cottonwood Lake, therefore Cottonwood Lake is modeled as stream flow node In total, there were 12 flow nodes.

Due to their drainage area size, the ungaged flow nodes do not have a GNIS hydrographic feature name. Therefore, a location description was developed for each ungaged flow node.

Table 3-18 summarizes the flow nodes used in the study. Figure 3-11 shows the Boulder River tributary flow nodes and corresponding drainage basins.

To address the issue of coincident peaks between the study tributaries and the Boulder River mainstem, FEMA guidance requirements assuming coincident peaks were referenced. For the assumption of coincident peaks to be appropriate, FEMA guidance documents (FEMA, 2016b) require the following criteria be met:

1. The ratio of the drainage areas lies between 0.6 and 1.4.
2. The arrival times of flood peaks are similar for the 2 combining watersheds.
3. The likelihood of both watersheds being covered by the storm is high.

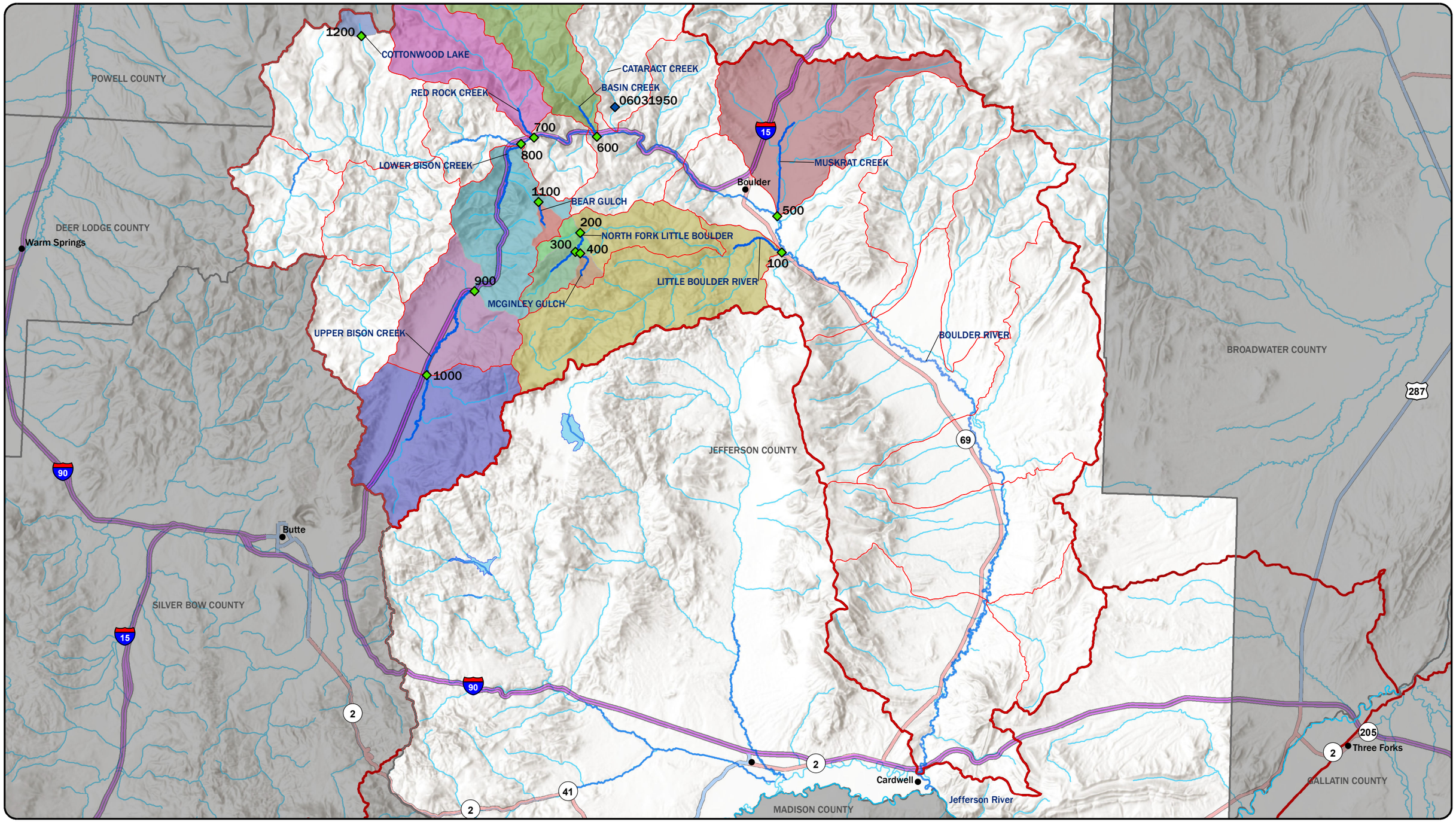
The study tributaries do not meet these drainage area ratio criteria. Study tributaries and the Boulder River mainstem are not gaged at the tributary/mainstem confluence. Therefore, data to determine criteria No. 2 were not available. The Boulder River mainstem drainage area at the tributary confluences is larger, often one or more orders of magnitude greater than the tributary basin areas, therefore there is a low likelihood that both watersheds would be covered by the same storm. Consequently, it was determined that the tributaries do not meet the FEMA criteria for coincident peaks.

Table 3-18 Flow Node and USGS Gage Station Information Used in Hydrologic Analyses

Node/USGS Station ID	Location Description	Tributary River Station[1] (mi)	Calculated Basin Area[2] (sq mi)	Tributary
100	Little Boulder River	0.2	59	Little Boulder River
200	North Fork Little Boulder River	0.0	7	N. Fork Little Boulder River
300	North Fork Little Boulder River upstream of junction with McGinley Gulch	1.4	4	N. Fork Little Boulder River
400	McGinley Gulch upstream of junction with North Fork Little Boulder River	0.2	1	McGinley Gulch
500	Muskrat Creek	0.0	40	Muskrat Creek
600	Basin Creek	0.0	42	Basin Creek
700	Red Rock Creek	0.0	21	Red Rock Creek
800	Bison Creek	0.0	78	Bison Creek
900	Upper Bison Creek end of reach	0.0	56	Bison Creek
1000	Upper Bison Creek HUC 12 Basin Boundary	8.7	35	Bison Creek
1100	Bear Gulch	0.0	1	Bear Gulch
1200	Cottonwood Lake	0.0	2	Cottonwood Lake

1. River miles start at the downstream extent of each study reach (mi: miles).
2. Source: USGS StreamStats and Esri ArcGIS.

USGS: U.S. Geological Survey.. sq mi: square miles.



LEGEND

- ACTIVE USGS STREAM GAGE
- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- BOULDER RIVER TRIBUTARY STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS

FLOW CHANGE NODE: 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 2 4 8
Miles

FIGURE 3-11

PIONEER TECHNICAL SERVICES, INC.

BOULDER RIVER TRIBUTARIES FLOW NODE LOCATIONS

DATE: 9/12/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-3-11.mxd

3.3.3.4 *Flood Frequency Estimates at Ungaged Sites*

To calculate peak flood discharge estimates at the ungaged flow nodes, Pioneer considered methods described in USGS SIR 2015-5019-F (Sando, et al., 2015b). These methods included estimating flood frequency using regional flood-frequency relations (regression analysis) and estimating flood frequency on gaged streams by translating gaged data to ungaged locations (drainage-area ratio adjustment or logarithmic interpolation between two gaged sites).

The ungaged flow nodes on Basin Creek and Red Rock Creek are located near USGS gage Cataract Creek near Basin, MT (06031950). The ungaged flow areas were not on the same stream, therefore a gage transfer analysis was not considered. Since no two gages exist on the same stream reach, the log interpolation method was not considered for this analysis.

The regional regression method was used for all Boulder River tributary study reaches. All 12 flow nodes are not regulated by upstream dams, and flow nodes within the Southwest Region have watershed areas that are within the watershed area limits as defined by SIR 2015-5019-F (Sando, et al., 2015b). Therefore, it was determined that regional regression equations were applicable to the Boulder River tributary study reaches at all 12 flow nodes. No other method was considered in this analysis. Peak flow estimates for the 50, 10-, 4-,2-, 1-, 0.2% and 1%+ (plus) AEP events were calculated at each flow node.

3.3.3.5 *Regional Regression Equation Method*

The SIR 2015-5019-F report (Sando, et al., 2015b) provides guidance on conditions where regional regression equations might not yield reliable results. These limiting guidelines include the following:

1. A site where the basin characteristics are outside the range of values used to develop the regression equations.
2. A site that is affected by regulation or urbanization.

All ungaged flow nodes located on the Boulder River tributary study reaches are not regulated and are within the range of values used to develop the Southwest Region regression equations. The regression equations, in SIR 2015-5019-F (Sando, et al., 2015b), use a drainage area (A) and percentage of drainage basin above 6,000 feet elevation (E_{6000}) as shown in the following set of equations:

$$Q_{50} = 2.49A^{0.930}(E_{6000}+1)^{0.095}$$
$$Q_{10} = 31.9A^{0.796}(E_{6000}+1)^{-0.177}$$
$$Q_{4} = 79.8A^{0.750}(E_{6000}+1)^{-0.274}$$
$$Q_{2} = 142A^{0.721}(E_{6000}+1)^{-0.336}$$
$$Q_{1} = 238A^{0.696}(E_{6000}+1)^{-0.391}$$
$$Q_{0.2} = 655A^{0.649}(E_{6000}+1)^{-0.501}$$

Where

Q_x is the X AEP peak flow magnitude, in cfs.
A is the contributing drainage area, in square miles.
E_{6000} is the percent of basin area above 6,000 feet.

The 1%+ (plus) AEP event was calculated using FEMA guidance methodologies (FEMA, 2019) for all the flow nodes to provide a confidence limit of plus 1 standard error that the 1% flood frequency peak flow estimates were likely to fall below. For the regional regression estimates, the average standard error of prediction or *average standard error of estimate* percentage (SEP, in percent) from SIR 2015-5019-F (Sando, et al., 2015b) was used to define the equation's statistical confidence upper limit of plus 1 standard error (FEMA, 2016b). The resulting upper limit of plus 1 standard error was used to determine the 1%+ (plus) flood frequency peak flow estimates. Appendix B provides the 1%+ (plus) regional regression flood frequency calculations for the study flow nodes.

The Southwest Hydrologic regional regression equation input variables are shown in Table 3-19. Regional regression flood frequency peak flow estimates are listed in Table 3-20. Figure 3-12 and Figure 3-13 plots the calculated peak discharges and correlating drainage areas for the Little Boulder River and Bison Creek respectively. Results indicate increasing flow magnitude with increasing drainage area on both the Little Boulder River and Bison Creek.

Table 3-19 Regional Regression Variables

Node/USGS Station ID	Location Description	Study Reach River Station (miles)	Tributary	Basin Area (sq mi)	E_{6000} (%)
1200	Cottonwood Lake	0.0	Cottonwood Lake	2	100
1100	Bear Gulch	0.0	Bear Gulch	1	100
1000	Upper Bison Creek HUC 12 Basin Boundary	8.7	Bison Creek	35	100
900	Upper Bison Creek end of reach	0.0	Bison Creek	56	100
800	Bison Creek	0.0	Bison Creek	78	96
700	Red Rock Creek	0.0	Red Rock Creek	21	89
600	Basin Creek	0.0	Basin Creek	42	96
500	Muskrat Creek	0.0	Muskrat Creek	40	25
400	McGinley Gulch upstream of junction with North Fork Little Boulder River	0.2	McGinley Gulch	1	100
300	North Fork Little Boulder River upstream of junction with McGinley Gulch	1.4	North Fork Little Boulder River	4	100
200	North Fork Little Boulder River	0.0	North Fork Little Boulder River	7	100
100	Little Boulder River	0.2	Little Boulder River	59	75

USGS: U.S. Geological Survey. sq mi: square miles.
E_{6000} (%): percentage of basin over 6,000 feet in elevation.

Table 3-20 Regional Regression Flood Frequency Peak Flow Estimates

Node/USGS Station ID	Location Description	StreamStats/Southwest Regression Region						
		Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year-plus
1200	Cottonwood Lake	5.6	20	31	40	52	84	90
1100	Bear Gulch	5.3	18	29	38	50	81	86
1000	Upper Bison Creek HUC 12 Basin Boundary	106	240	326	393	467	654	812
900	Upper Bison Creek end of reach	162	345	458	545	641	879	1,110
800	Bison Creek	220	454	596	704	823	1,120	1,430
700	Red Rock Creek	64	161	226	279	339	492	589
600	Basin Creek	123	277	374	450	535	747	930
500	Muskrat Creek	105	338	520	679	868	1,400	1,510
400	McGinley Gulch upstream of junction with North Fork Little Boulder River	4.9	17	27	36	47	77	82
300	North Fork Little Boulder River upstream of junction with McGinley Gulch	14	43	64	82	103	160	179
200	North Fork Little Boulder River	25	69	101	128	158	238	275
100	Little Boulder River	165	378	516	624	745	1,050	1,300

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 3-12 Little Boulder River and North Fork Little Boulder River Regional Regression Flood Frequency Analysis

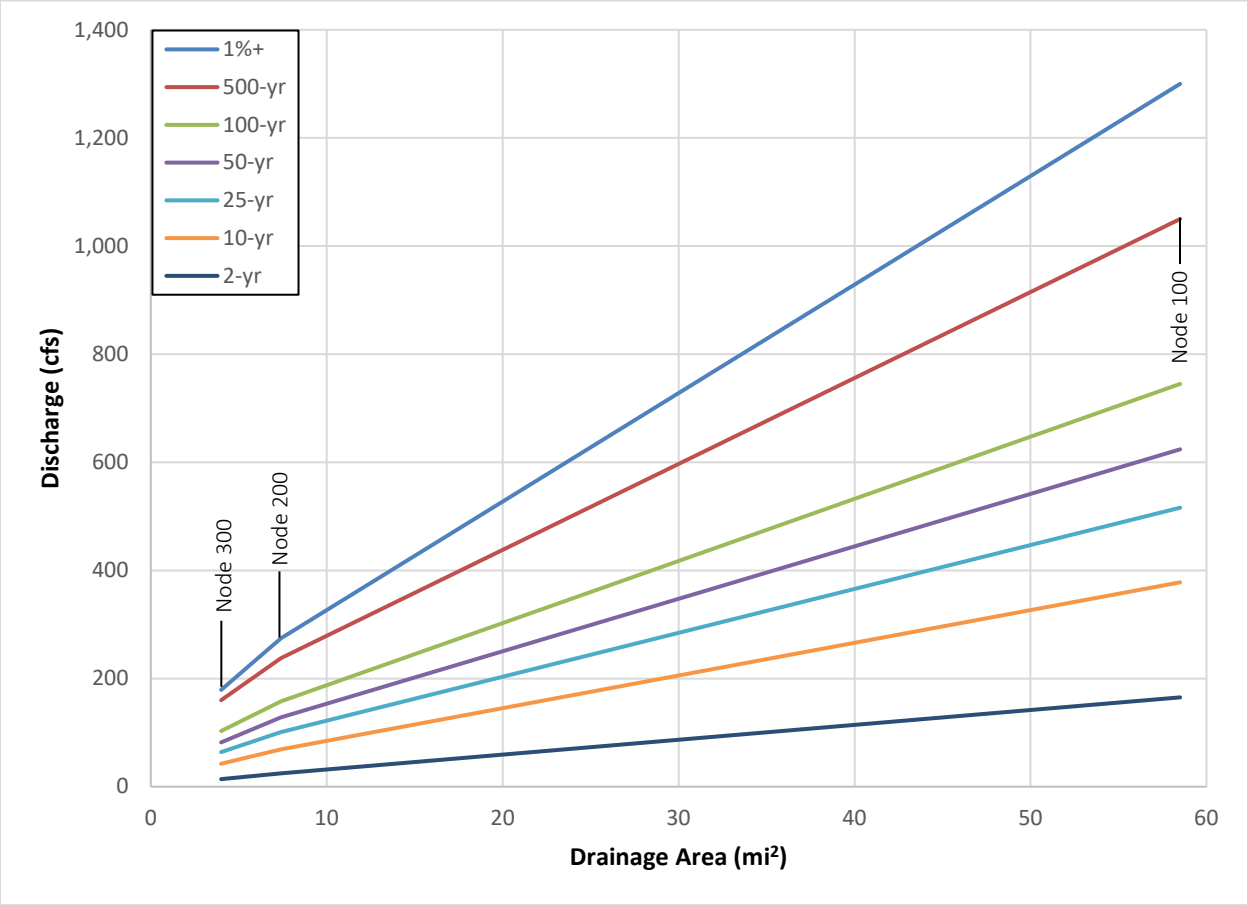
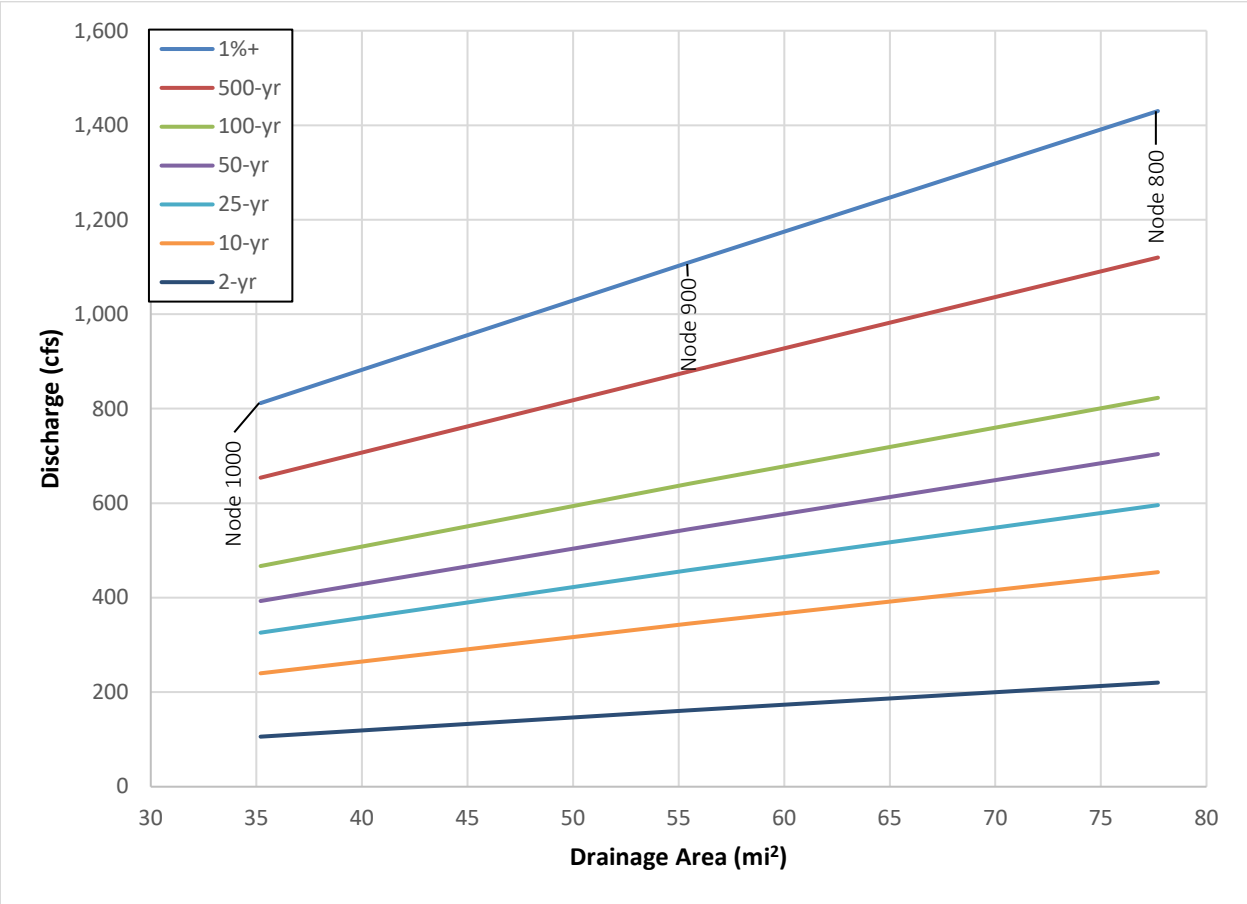


Figure 3-13 Bison Creek Regional Regression Flood Frequency Analysis



3.3.4 Boulder River Tributaries Discussion

Pioneer conducted a peak discharge frequency analysis for 9 tributaries and 1 lake that report to the Boulder River mainstem. The Boulder River tributaries study reach extends approximately 23 miles along the Boulder River mainstem. Information gathered from this analysis will be used to support the Jefferson County hydraulic analyses and floodplain mapping studies. Previous flood studies on Boulder River tributary study reaches are limited. Relevant earlier flood studies include the SIR 2015-5019-C (Sando, et al., 2015a).

This hydrologic analysis developed flood frequency estimates for both gaged and ungaged sites, including 1 lake. Peak flow estimates were calculated at 12 ungaged locations (flow nodes) within the watershed. The flow nodes were located at junctions with the Boulder River mainstem, junctions with other study reaches, HUC 12 boundaries, reach origins, and lake outlets.

Regional regression peak flow estimates were compared with at-site data on USGS gage 06031950 Cataract Creek near Basin, Montana, a tributary to the Boulder River not on a study reach, but close to several study reaches. Regional regression peak flow estimates were significantly lower than the at-site data peak flow estimates. Flood history on the upper Boulder River watershed suggest a mixed peak flow population. The southwest hydrologic region regional regression equations are derived from gages that primarily have snowmelt driven peak flow populations. Specific mixed population gages in the southwest hydrologic unit may not be well represented by the southwest regional regression equations. The Cataract Creek gage is not located on a study tributary and was therefore not used in this analysis.

Although the regional regression equations may under-estimate flow based at the Cataract Creek USGS gage 06031950, the studied tributaries do not contain gages or any additional flow data and the Montana StreamStats regional regression equations are the best available information for the Boulder Tributaries and were selected as the best available AEP peak flow estimates.

No stream gages exist in the study reach that could be used for gage transfer or two-station logarithmic analysis. Due to the absence of gage data, the most applicable available method was the regional regression equations. Therefore, flood flow frequency estimates were conducted using regional regression methods.

One node was placed at the outlet of Cottonwood Lake (1300). This node is at the outlet of a an uncontroled lake and is therefore not considered regulated per SIR 2015-5019-F (Sando, et al., 2015b). The purpose of this node is to determine the total discharge into the lake during peak flow events. There is no outlet structure on Cottonwood Lake or significant storage capacity, therefore reservoir routing is not applicable.

Regional regression equations are based on comparisons of peak flows and basin characteristics for a given region (Sando, et al., 2015b). As a result, regional regression equations are beneficial

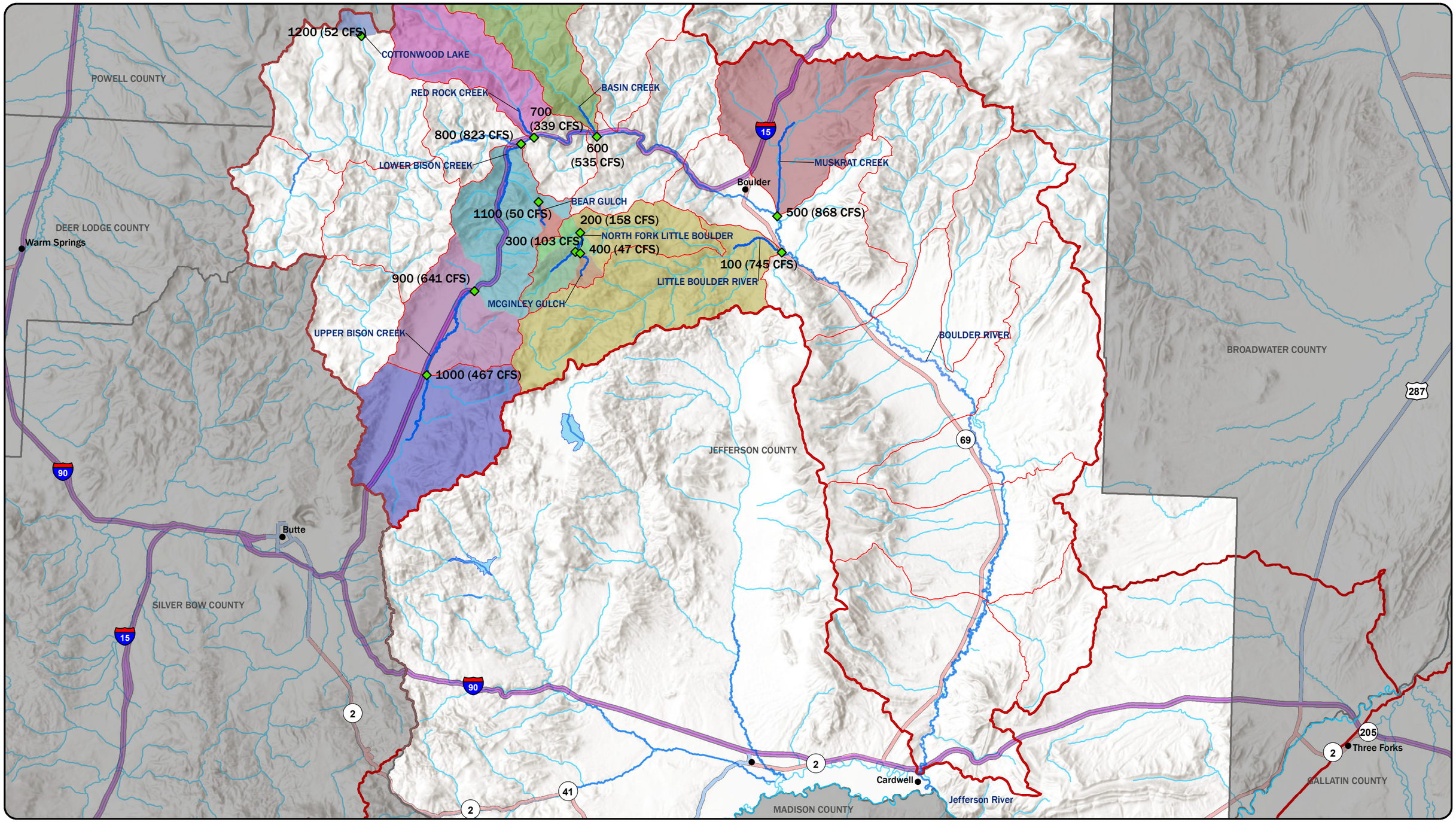
for estimating peak flows when gage data does not exist. Regional regression equations peak flow estimates were selected for the recommended flood discharge estimates for all nodes on the Boulder River tributary study reaches.

Table 3-21 summarizes the recommended flood frequency discharge rates for the Boulder River tributaries study reach. Figure 3-14 shows the recommended 1% AEP discharge for each flow node location. The hydrologic analysis results provided in Table 3-21 represent the recommended discharges at each flow node location throughout the study reach. The methods used for hydrological analysis are industry accepted methods (SIR 2015-5019-F (Sando, et al., 2015b)) based on Boulder River tributaries basin characteristics. This hydrologic analysis conforms to FEMA standards for enhanced level studies, and the recommended flows of this analysis are deemed reliable and suitable for future floodplain studies and hydraulic analyses.

Table 3-21 Recommended Flood Discharge Estimates Using Regression Analysis

Node/USGS Station ID	Location Description	Peak Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year-plus
1200	Cottonwood Lake	5.6	20	31	40	52	84	90
1100	Bear Gulch	5.3	18	29	38	50	81	86
1000	Upper Bison Creek HUC 12 Basin Boundary	106	240	326	393	467	654	812
900	Upper Bison Creek end of reach	162	345	458	545	641	879	1,110
800	Bison Creek	220	454	596	704	823	1,120	1,430
700	Red Rock Creek	64	161	226	279	339	492	589
600	Basin Creek	123	277	374	450	535	747	930
500	Muskrat Creek	105	338	520	679	868	1,400	1,510
400	McGinley Gulch upstream of junction with North Fork Little Boulder River	4.9	17	27	36	47	77	82
300	North Fork Little Boulder River upstream of junction with McGinley Gulch	14	43	64	82	103	160	179
200	North Fork Little Boulder River	25	69	101	128	158	238	275
100	Little Boulder River	165	378	516	624	745	1,050	1,300

USGS: U.S. Geological Survey. cfs: cubic feet per second.



LEGEND

- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- BOULDER RIVER TRIBUTARY STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- JEFFERSON RIVER MAINSTEM
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- LAKES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- PRIMARY
- STREAMS
- FLOW CHANGE NODE
  - 100
  - 200
  - 300
  - 400
  - 500
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  - 700
  - 800
  - 900
  - 1000
  - 1100
  - 1200

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 2 4 8
Miles

FIGURE 3-14

PIONEER TECHNICAL SERVICES, INC.

BOULDER RIVER TRIBUTARIES RECOMMENDED 1-PERCENT AEP DISCHARGES

DATE: 9/12/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-3-14.mxd

4 PRICKLY PEAR CREEK AND TRIBUTARIES

4.1 Introduction

4.1.1 Basin Description

4.1.1.1 *Prickly Pear Creek Mainstem*

The Prickly Pear Creek mainstem begins in the Elkhorn Mountains and flows northwest approximately 8 miles before turning northeast, flows approximately 18 miles before turning north, and flows approximately 8 miles before terminating at Lake Helena. Lake Helena flows into the Missouri River, located east of the Continental Divide in western Montana. The Prickly Pear Creek mainstem watershed area encompasses approximately 247 square miles.

Elevations within the study area range from approximately 4,842 feet in the Elkhorn mountains to approximately 3,940 feet at the boundary between Jefferson County and Lewis and Clark County. The overall basin elevations for the Prickly Pear Creek mainstem range from 9,364 feet at the summit of Elkhorn Peak to 3,940 feet at the reach origin. The terrain varies from a high alpine environment in its headwaters to narrow inter-mountain valleys. The hydrology of the basin is primarily snowmelt driven.

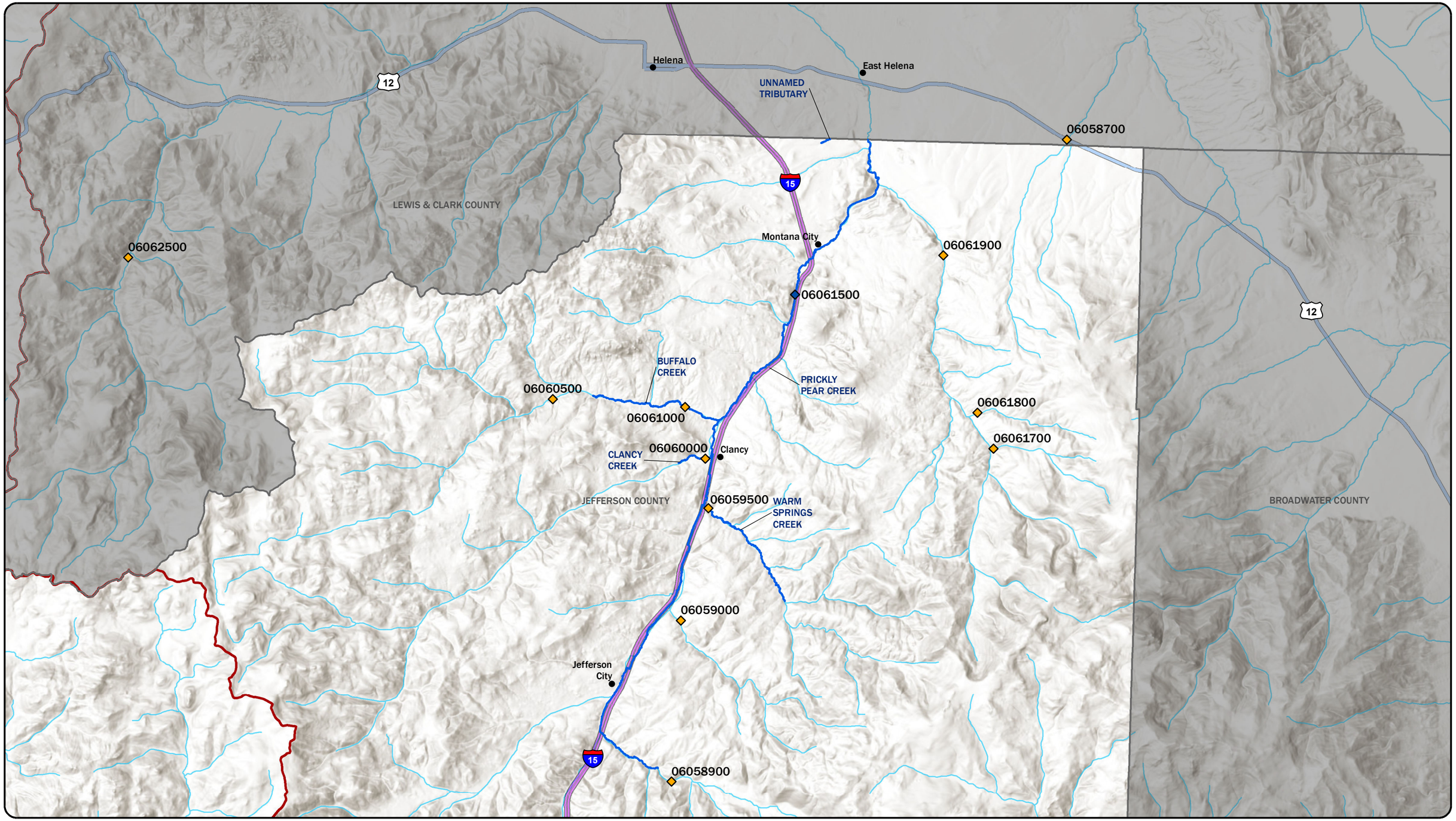
Land use in the study reach is primarily rural with small communities along the Prickly Pear Creek mainstem. Interstate 15 (I-15) also runs southwest to northwest along the canyon created by the Prickly Pear Creek. The primary communities are Jefferson City, Clancy, and Montana City.

4.1.1.2 *Prickly Pear Creek Tributaries*

All 4 Prickly Pear Creek tributary study reaches report to Prickly Pear Creek, which is a major tributary to Lake Helena, which discharges into the Missouri River. The study watershed for the Prickly Pear Creek tributaries encompasses approximately 98 square miles. The tributaries and watershed are formed in the eastern Boulder Range and the northern Elkhorn Range.

The Prickly Pear Creek tributary study reaches' elevations range from approximately 4,563 feet in the mountains to approximately 4,305 feet near Montana City, MT. The overall basin elevations for the Prickly Pear Creek tributaries range from 7,971 feet in the Boulder Range to 4,305 feet at the boundary between Jefferson County and Lewis and Clark County. The terrain varies from a high alpine environment in its headwaters to narrow inter-mountain valleys. The hydrology of the basin is primarily snowmelt driven.

The land use in the study reach is primarily rural with small communities along the Prickly Pear Creek tributaries. The primary community along a Prickly Pear Creek tributary study reach is Clancy, MT. Figure 4-1 shows the Prickly Pear Creek study reach and the Prickly Pear Creek Tributary study reaches.



LEGEND

- ACTIVE USGS STREAM GAGE
- INACTIVE USGS STREAM GAGE
- TOWNS
- PRICKLY PEAR CREEK STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- STREAMS

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1 2 4
Miles

FIGURE 4-1

PRICKLY PEAR CREEK STUDY AREA

PIONEER TECHNICAL SERVICES, INC.

DATE: 9/10/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-4-1.mxd

4.1.2 Flood History

The primary flooding causes on the Prickly Pear Creek mainstem and its tributaries are spring snowmelt mixed with rain (according to historical records). There are historical records for 5 USGS stream gage locations with 10 years of records within the study reach area that document flooding history. Only 1 of these stream gages is located on a stream being studied.

The USGS stream gage Prickly Peak Creek near Clancy, MT (06061500) has a 77-year period of record (1911-1916, 1923-1933, 1946-1953, 1955-1969, 1975, 1979-2002, 2006-2017). The annual peak flow record for the Prickly Pear Creek gage is shown in Figure 4-2. The gage is located on the Prickly Pear Creek study reach.

The USGS stream gage Mitchell Gulch near East Helena, MT (060658700) has a 45-year period of record (1959-2003). The annual peak flow record for the Mitchell Gulch gage is shown in Figure 4-3. The gage is not located on any of the study reaches being evaluated in this report.

The UGGS stream gage McClellan Creek near East Helena, MT (06061900) has a 19-year period of record (1960-1975, 1981, 1989-1990). The annual peak flow record for the McClellan Creek gage is shown in Figure 4-4. The gage is not located on any of the study reaches being evaluated in this report.

The USGS stream gage Crystal Creek near East Helena, MT (06061800) has an 18-year period of record (1961-1975, 1981, 1989-1990). The annual peak flow record for the Crystal Creek gage is shown in Figure 4-5. The gage is not located on any of the study reaches being evaluated in this report.

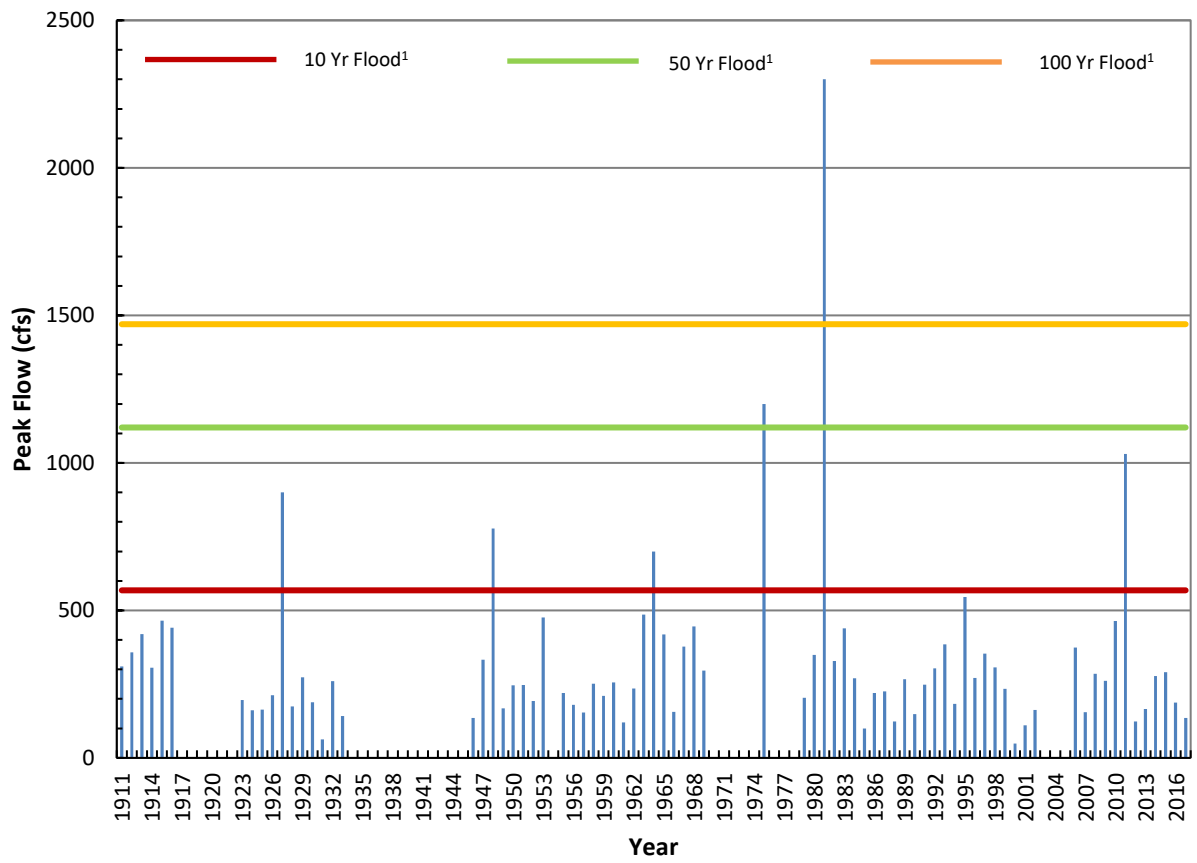
The USGS stream gage Jackson Creek near East Helena, MT (06061700) has an 18-year period of record (1961-1975, 1981, 1989-1990). The annual peak flow record for the Jackson Creek gage is shown in Figure 4-6. The gage is not located on any of the study reaches being evaluated in this report.

Peak flow recurrence intervals shown in Figure 4-2, Figure 4-3, Figure 4-4, Figure 4-5, and Figure 4-6 and are based on previously published flood frequency analysis through Water Year 2011 (SIR 2015-5019-C) (Sando, et al., 2015a).

There are reports that document the flooding events on the Prickly Pear Creek mainstem and its tributaries. These reports reference a flood that occurred in May 1981. The primary cause of the flood was rainfall, which was an atypical flooding mechanism in southwest Montana. This event is discussed in more detail in the next section. The primary cause of flooding in nearby areas is spring snowmelt combined with rain and ice jams. Since limited documentation of flooding mechanisms exist outside of the May 1981 flood, it can be inferred that flooding generally occurs by similar mechanisms as nearby areas.

Figure 4-2 shows that the peak flood of record for Prickly Pear Creek near Clancy, MT (06061500) occurred in 1981 with a flow of 2,300 cfs, exceeding the 1% (100-year) AEP flow of 1,490 cfs. The second highest flood on record occurred in 1975 with a flow of 1,200 cfs, exceeding the 2% (50-year) AEP flow of 1,120 cfs. The third highest flow on record occurred in 2011 with a flow of 1,030 cfs, exceeding the 10% (10-year) AEP flow of 568 cfs. In the 77-year period of record for the Prickly Pear Creek near Clancy, MT (060615000) gage, the 10% AEP flow has been equaled or exceeded 6 times (1927, 1948, 1964, 1975, 1981, and 2011). The annual peak flows occurred between the months of May and June. The peak flow of record occurred in May of 1981, concurrent with the historic flood referenced above.

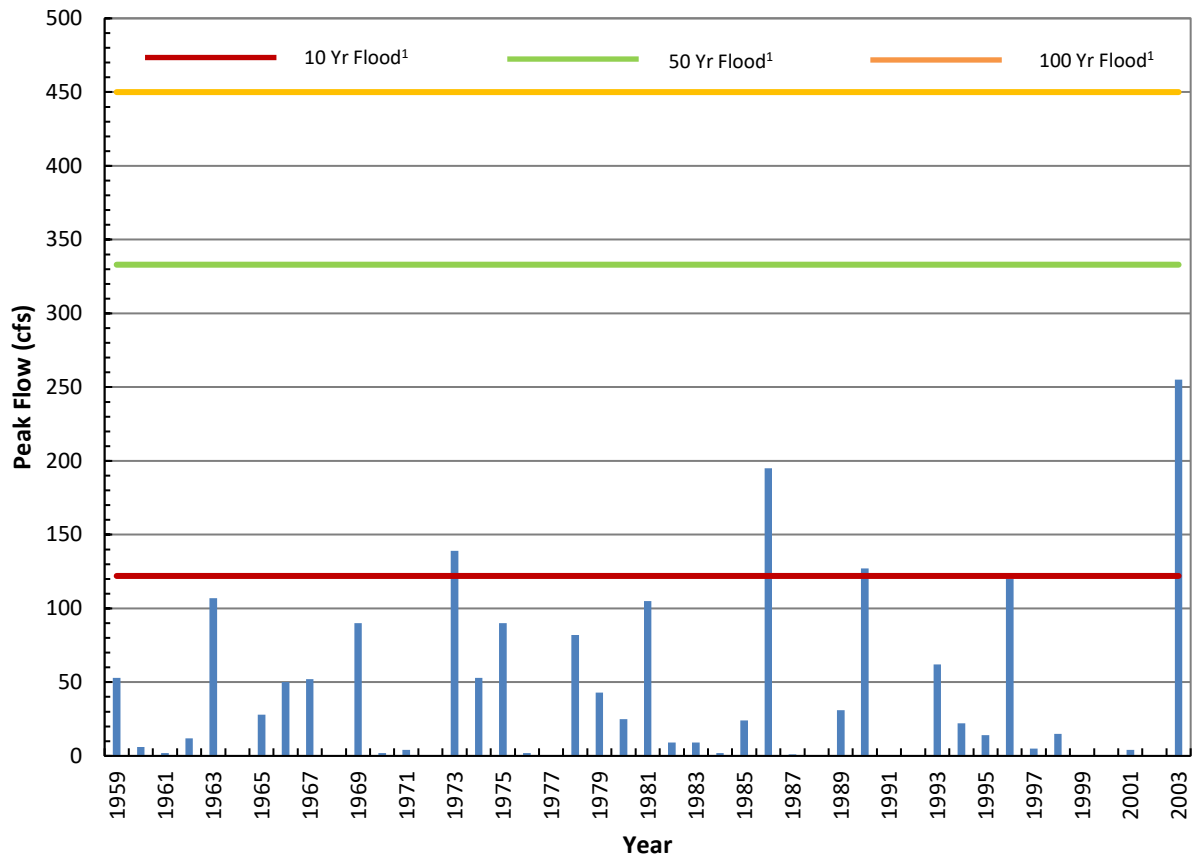
Figure 4-2 Prickly Pear Creek near Clancy, MT (06061500)



1. Flood Frequency Based on Data through 2011

Figure 4-3 shows that the peak flood of record for Mitchell Gulch near East Helena, MT (06058700) occurred in 2003 with a flow of 255 cfs, exceeding the 10% (10-year) AEP flow of 122 cfs. The second highest flood on record occurred in 1986 with a flow of 195 cfs, exceeding the 10-year flow. The third highest flow on record occurred in 1973 with a flow of 139 cfs, exceeding the 10% AEP flow. In the 45-year period of record for the Mitchell Gulch near East Helena, MT (06058700) gage, the 10% AEP flow has been equaled or exceeded 5 times (1973, 1986, 1990, 1996, 2003). The annual peak flows occurred in the months of February, March, August, and September. The peak flow of record occurred in March of 2003.

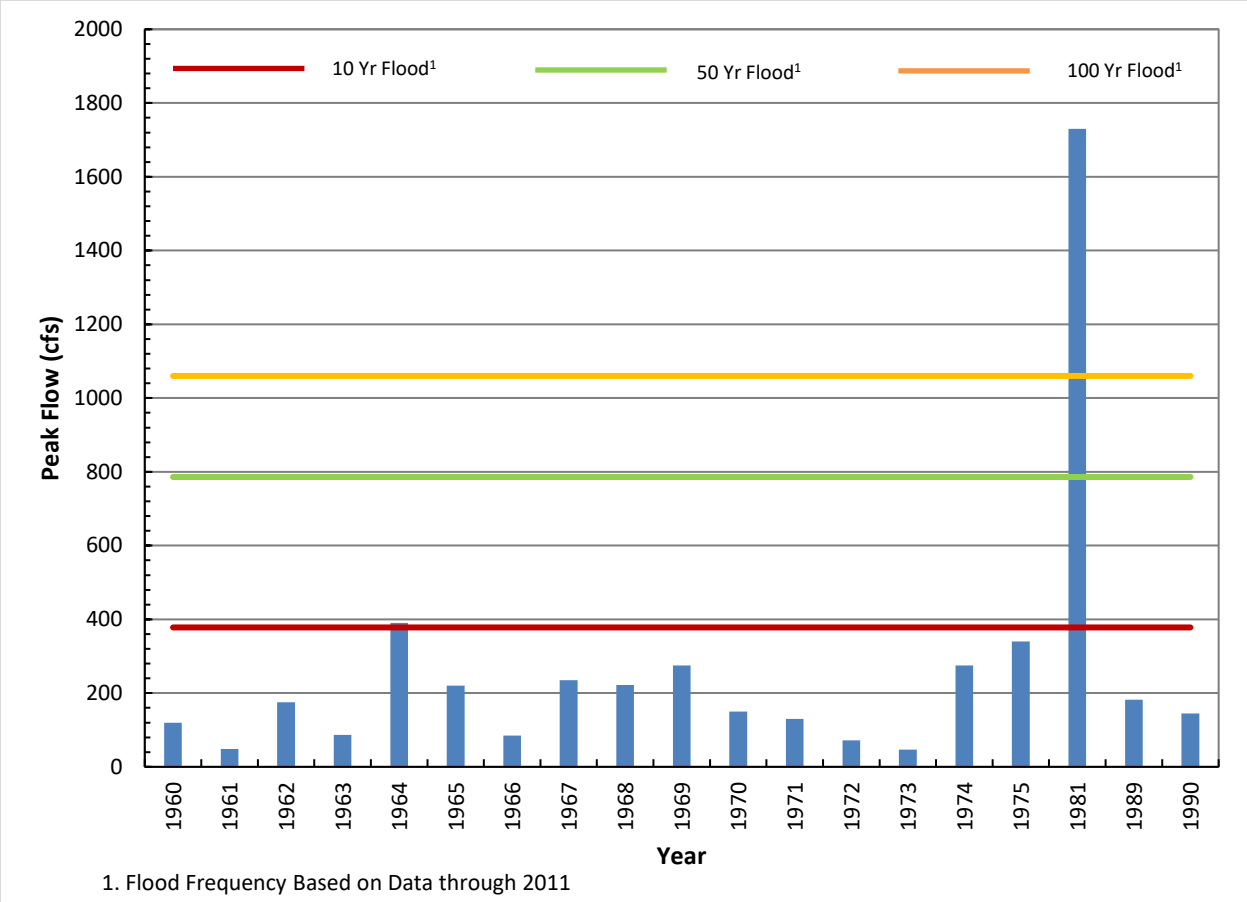
Figure 4-3 Mitchell Gulch near East Helena, MT (06058700)



1. Flood Frequency Based on Data through 2011

Figure 4-4 shows that the peak flood of record for McClellan Creek near East Helena, MT (06061900) occurred in 1981 with a flow of 1,730 cfs, exceeding the 1% (100-year) AEP flow of 1,060 cfs. The second highest flood on record occurred in 1964 with a flow of 390 cfs, exceeding the 10% (10-year) AEP flow. The third highest flow on record occurred in 1975 with a flow of 340 cfs. In the 19-year period of record for the Mitchell Gulch near East Helena, MT (06058700) gage, the 10% AEP flow has been equaled or exceeded 2 times (1964 and 1981). The annual peak flows occurred in May and June. The peak flow of record occurred in May 1981, concurrent with the historic flood referenced above.

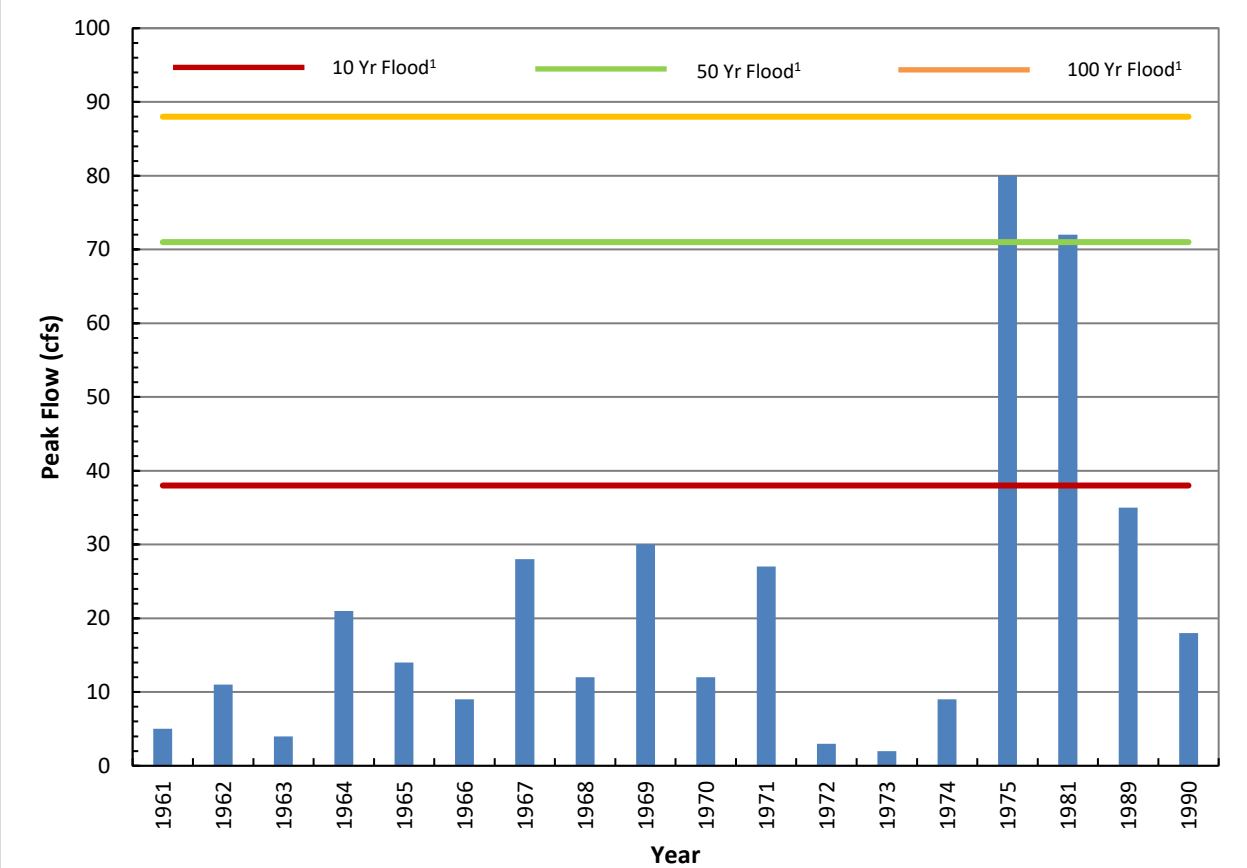
Figure 4-4 McClellan Creek near East Helena, MT (06061900)



1. Flood Frequency Based on Data through 2011

Figure 4-5 shows that the peak flood of record for Crystal Creek near East Helena, MT (06061800) occurred in 1975 with a flow of 80 cfs, exceeding the 2% (50-year) AEP flow of 71 cfs. The second highest flood on record occurred in 1981 with a flow of 72 cfs, exceeding the 50-year flow. The third highest flow on record occurred in 1989 with a flow of 35 cfs. In the 18-year period of record for the Crystal Creek near East Helena, MT (06061800) gage, the 10% AEP flow has been equaled or exceeded 2 times (1975 and 1981). The annual peak flows occurred in May and June. The peak flow of record occurred in June 1975.

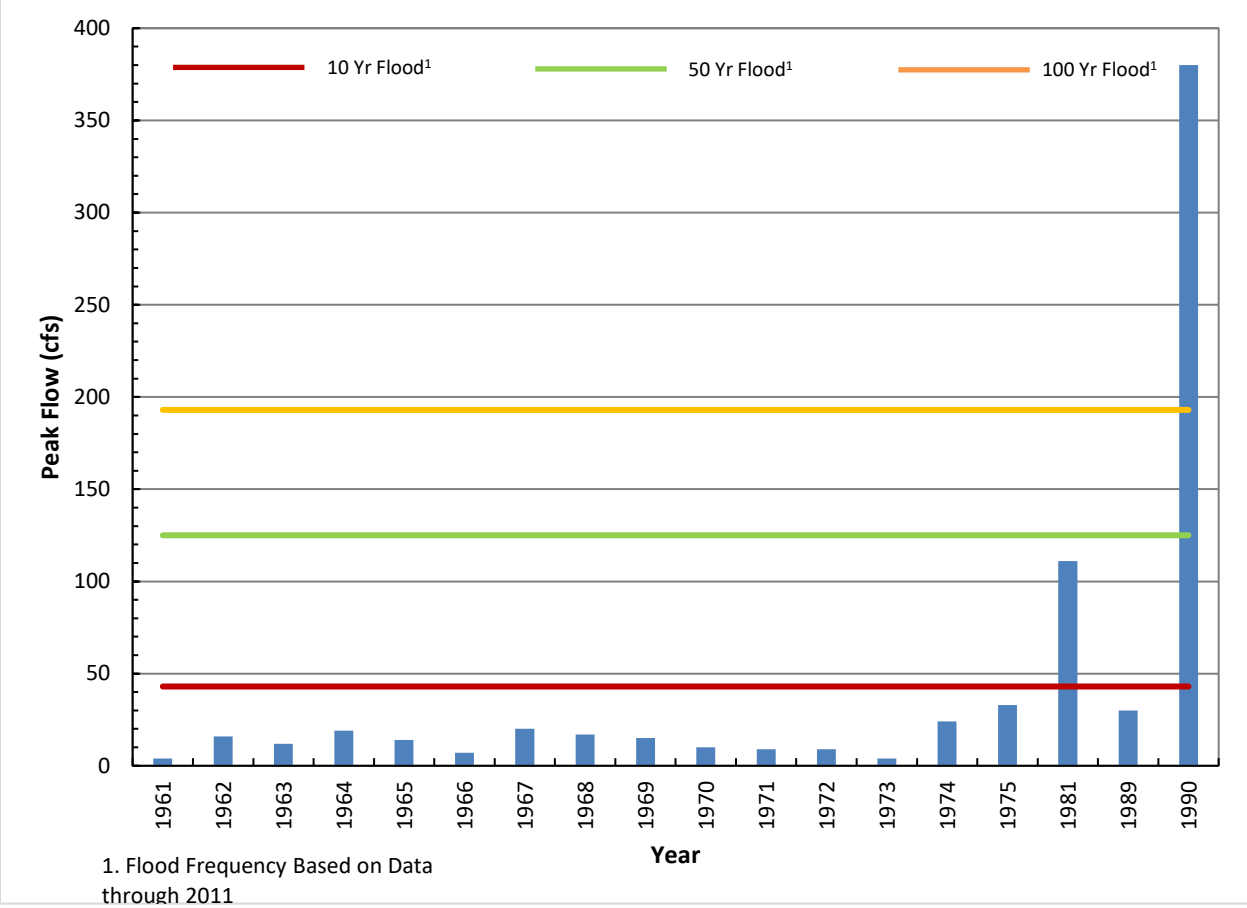
Figure 4-5 Crystal Creek near East Helena, MT (06061800)



1. Flood Frequency Based on Data through 2011

Figure 4-6 shows that the peak flood of record for Jackson Creek near East Helena, MT (06061700) occurred in 1990 with a flow of 380 cfs, exceeding the 1% (100-year) AEP flow of 193 cfs. The second highest flood on record occurred in 1981 with a flow of 111 cfs, exceeding the 10% (10-year) AEP flow of 43 cfs. The third highest flow on record occurred in 1975 with a flow of 33 cfs. In the 18-year period of record for the Crystal Creek near East Helena, MT (06061800) gage, the 10% AEP flow has been equaled or exceeded 2 times (1981 and 1990). The annual peak flows occurred in May, June, and August. The peak flow of record occurred in August 1990.

Figure 4-6 Jackson Creek near East Helena, MT (06061700)



4.2 Past Studies and Existing Flood Data

There are few past flood studies on Prickly Pear Creek mainstem and tributary study reaches. Studies relevant to this hydrologic study are those that include peak flow frequency analyses. Within the study reach, a FEMA FIRM exists for Jefferson County unincorporated areas. No incorporated areas in the Prickly Pear Creek mainstem or tributaries have a FIRM dedicated to that community. There is no FIS on any of the communities within the study reach or within Jefferson County unincorporated areas. Table 4-1 shows a summary of Prickly Pear Creek and Prickly Pear Creek tributaries floodplain mapping.

Table 4-1 Prickly Pear Creek and Tributaries Floodplain Mapping Summary

	Map Panel Summary				Study Details			
County	**Community**	**# of FIRM Panels**	**FIRM Panel Effective Date**	**FIS Date**	**Stream**	**Approx (mi)**	**Detailed (mi)**	**Total (mi)**
Jefferson County	Jefferson County Unincorporated	1	6/17/1986	NA	Unnamed Tributary, Buffalo Creek, Clancy Creek, Warm Springs Creek, Prickly Pear Creek	27	NA	27

Source: FEMA Map service Center.
FIRM: Flood Insurance Rate Map. FIS: Flood Insurance Studies. NA: not applicable. mi: miles.

4.2.1 Water Resources Investigation Report 03-4308

The investigation for USGS WRIR 03-4308 developed peak discharges with recurrence intervals of 2, 5, 10, 25, 50, 100, 200, and 500 years (*T*-year floods) for 660 gaged sites in Montana and in adjacent areas of Idaho, Wyoming, and Canada, based on data through Water Year 1998 (Parret & Johnson, 2004). The flood-frequency information was used in regression analyses to develop equations relating *T*-year floods to various basin and climatic characteristics, active-channel width, and bankfull width. The equations can be used to estimate flood frequency at ungaged sites. Flood-frequency data typically were determined by fitting a log-Pearson Type III probability distribution using methods described by the IACWD Bulletin 17B (IACWD, 1982). Table 4-2 provides the WRIR 03-4308 peak discharge summary for 5 USGS gages in the Prickly Pear Creek study area.

Table 4-2 WRIR 03-4308 Jefferson County Study Reach Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Period of Record in years	Peak Discharges (cfs)						
				5	10	25	50	100	200	500
06058700	Mitchell Gulch near East Helena, MT	8	40	65	127	249	375	532	723	1,030
06061500	Prickly Peak Creek near Clancy, MT	192	77	428	577	813	1,030	1,280	1,580	2,060
06061700	Jackson Creek near East Helena, MT	3	18	30	49	87	131	194	282	454
06061800	Crystal Creek near East Helena, MT	4	18	27	41	61	79	100	123	158
06061900	McClellan Creek near East Helena, MT	33	19	290	419	635	841	1,090	1,400	1,910

Source: USGS
Based on systematic data through 1998. USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.

4.2.2 Scientific Investigations Report 2015-5019

The USGS SIR 2015-5019-C included updated AEP peak discharges with AEPs of 66.7, 50, 42.9, 20, 10, 4, 2, 1, 0.5, and 0.2% (return intervals of 1.5, 2, 2.33, 5, 10, 25, 50, 100, 200, and 500 years, respectively) for 725 gaged sites in or near Montana, based on data through Water Year 2011 (Sando, et al., 2015a). Flood-frequency data were determined by fitting a log-Pearson Type III probability distribution using methods described by the IACWD, Bulletin 17B (IACWD, 1982). The study was part of a larger study to develop an online StreamStats application for Montana, in conjunction with computing streamflow characteristics at gage stations, and estimating peak flow flood frequency at ungaged sites. Table 4-3 provides the SIR 2015-5019-C discharge summary for selected Prickly Pear Creek mainstem and tributaries study area gages.

Table 4-3 SIR-2015-5019-C Prickly Pear Creek Mainstem and Tributaries Peak Discharge Summary

USGS Station Number	USGS Station Name	Drainage Area (sq mi)	Period of Record in Years	Peak Discharge (cfs)						
				5-year	10-year	25-year	50-year	100-year	200-year	500-year
0605870	Mitchell Gulch near East Helena, MT	8	45	63	122	230	333	450	582	774
06061500	Prickly Peak Creek near Clancy, MT	192	77	413	568	841	1,120	1,490	1,920	2,720
06061700	Jackson Creek near East Helena, MT	3	18	26	43	80	125	193	296	514
06061800	Crystal Creek near East Helena, MT	4	18	26	38	56	71	88	106	134
06061900	McClellan Creek near East Helena, MT	33	19	266	378	579	786	1,060	1,400	2,030

Source: USGS
Based on systematic data through 2011. USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.

The USGS SIR 2015-5019-F (Sando, et al., 2015b) selected 537 gaging stations from the gage study. The 537 gaging stations were segregated based on the following criteria: contributing drainage area less than about 2,750 square miles, peak-flow records unaffected by major regulation, small redundancy with nearby stations, and representation of peak-flow frequencies at sites within Montana. The study used regression analyses to develop equations relating AEP flows to various basin and climatic characteristics. The relationships developed for this study resulted in lower mean standard errors of prediction than previous regression analyses.

4.2.3 Lewis and Clark County Flood Insurance Study

The Lewis and Clark County FIS (FEMA, 2012) investigated the existence and severity of flood hazards in Lewis and Clark County and the incorporated towns of Helena and East Helena, MT.

A detailed flood study was performed along Prickly Pear Creek. Peak discharge values were calculated at 2 relevant locations: USGS gage Prickly Pear Creek near Clancy, MT (06061500) and an ungaged location at East Helena, MT. The gage station is within Jefferson County, and the ungaged flow node is approximately 0.5 miles downstream of the Jefferson County Map Modernization Project Prickly Pear Creek reach origin. The hydrology was developed using existing data on the Clancy gage (06061500). Results of the hydrologic analysis for the stream are in Table 4-4.

Table 4-4 Prickly Pear Creek Summary of Discharges from the Lewis and Clark County FIS

Flooding Source and Location	Drainage Area (sq mi)	Peak Discharges (cfs)			
		10-year	50-year	100-year	500-yea
USGS gage 06061500 Prickly Pear Creek near Clancy, MT	192	715	1,400	1,805	3,200
Prickly Pear Creek near Helena, MT	251	890	1,710	2,190	3,500

Source: FEMA.
sq mi: square miles. cfs: cubic feet per second.

4.2.4 Prickly Pear Creek Reconstruction

The Prickly Pear Creek Channel Stability Analysis and Engineering Design Report for the Former East Helena Smelter Facility study (Pioneer, 2013) was an engineering analysis for the reconstruction of Prickly Pear Creek. The project site began about 0.4 miles from the Jefferson County Map Modernization Project Prickly Pear Creek reach origin. A single peak discharge value was developed for the entire reach. The hydrology was developed using the existing gage data on the Clancy gage (06061500). Results of the hydrologic analysis for the stream are listed in Table 4-5.

Table 4-5 Prickly Pear Creek Summary of Discharges from the Channel Stability Analysis and Engineering Design Report

Reach Name	Peak Discharges (cfs)							
	1.5-year	2-year	5-year	10-year	25-year	50-year	100-year	500-year
Prickly Peak Creek near East Helena, MT	252	328	545	730	1,015	1,268	2,190	3,500

Source: Pioneer Technical Services
cfs: cubic feet per second.

4.2.5 Additional Previous Studies

From May 22-23, 1981, the Boulder River and Prickly Pear Creek basins experienced record flooding. Both the Boulder River and Prickly Pear Creek approached flows equal to the 500-year event. Above average rainfall in early May saturated the ground, followed by a large storm from May 21-22. These conditions, combined with snowmelt, produced record flooding. Six bridges on major State highways were damaged or destroyed and 25 major bridge approaches were washed out. A 10-county area was declared a national disaster by Presidential proclamation (Parret, et al., 1982).

The Big Pipestone Creek Flood Plain Management Study (USDA SCS, 1984) documented the flooding mechanisms of the May 1981 flood that disrupted multiple communities in and near Jefferson County. According to the report, the flood was caused by rainfall with minimal contribution from snowmelt, which is considered unusual for a mountainous area. The winter of 1981 was one of the driest on record, resulting in nearly no snowpack in the mountains at the time of the flood. A rainy spring and snowmelt saturated the soil prior to the storm. A major rainstorm centered around the Boulder River and Prickly Pear Creek produced peak floods greater than the 100-year frequency in that area. North of Big Pipestone Creek in the Boulder River and Prickly Pear Creek watersheds, the storm center produced rainfall up to 3.5 inches in a 24-hour period.

Additional related previous studies conducted in the Prickly Pear Creek mainstem and tributaries involve mining impacts, sediment management, fisheries management, irrigation history, and watershed characterization reports. Specific studies for Prickly Pear Creek, Warms Springs Creek, Whitetail Creek, and Whitetail Reservoir were conducted. All other studies referenced multiple tributaries to Prickly Pear Creek:

Prickly Pear Creek

- *Evaluation of Stream Improvements on Prickly Pear Creek* (Montana Fish and Game Commission, 1973).
- *Framework Water Quality Restoration Plan and Total Maximum Daily Loads for the Lake Helena Watershed Planning Area* (US EPA, Tetra Tech, Inc., PBS&J, 2006).
- *Lake Helena Watershed Restoration Plan* (Lewis and Clark County Water Quality Protection District (WQPD), Lake Helena Watershed Group, 2016).
- *Stream Corridor Management Plan* (Streamworks, 1984).
- *Water Quality Characteristics of Montana Streams in a Statewide Monitoring Network, 1999-2003* (Cleasby, et al., 2003).
- *Water Quality Restoration Plan and Total Maximum Daily Loads (TMDLs) for the Lake Helena Watershed Planning Area* (US EPA, Tetra Tech, Inc., Land & Water Consulting, 2004).

Warm Springs Creek

- *Non-Time Critical Removal Action Warm Springs Tailings* (Helena Ranger District, 2013).
- *Arsenic and Metal Loads and Source Areas in the Middle Fork Warm Springs Creek Watershed, Jefferson County, Montana, June 2001* (Cleasby, et al., 2001).

4.2.6 Flood Protection Measures

The U.S. Army Corps of Engineers maintains the National Inventory of Dams (NID), a database that keeps record of all the dams across the county. The NID identifies hazard potential, dam height, ownership, purpose, dam type, and administrative data. No dams were identified in the Prickly Pear Creek mainstem and tributary study areas (ACOE, 2019).

There are no major flood control structures on Prickly Pear Creek, Buffalo Creek, Clancy Creek, Warm Springs Creek, or the unnamed tributary to Prickly Pear Creek. No minor flood control structures exist on any of the study reaches (ACOE, 2019).

4.3 Hydrologic Analysis and Results

The purpose of the hydrologic analyses conducted as part of this project was to develop peak flow discharge estimates for the 50-, 10-, 4-, 2-, 1-, 0.2% AEP events at key flow change locations (such as at significant tributaries confluences, stream gages, and population centers) along the study reach. The analysis was split into 2 parts, Prickly Pear Creek mainstem and Prickly Pear Creek tributaries hydrologic analysis, organized into 2 sub sections:

1. USGS Stream Gage Analysis.
2. Ungaged Flow Node Analysis.

4.3.1 Prickly Pear Creek Mainstem

Throughout the study area, 7 flow nodes on the Prickly Pear Creek mainstem study reach were identified as having significant changes in streamflow or being at critical locations. Of the 7 flow nodes on the study reach, 1 is located at an active USGS stream gage. The study extents in this report were based on the Jefferson County Map Modernization Study Area Map provided by the DNRC. The river stations used in this report were based on the Prickly Pear Creek mainstem S_Hydro_Reach, delineated by Pioneer based on Google imagery. Prickly Pear Creek mainstem S_Hydro_Reach alignment begins at the boundary of Jefferson County with Lewis and Clark County. The upstream extent of the study reach ends near the headwaters in the Elkhorn Range.

4.3.1.1 *USGS Stream Gage Analysis*

In 2018, the USGS adopted Bulletin 17C guidelines to provide flood frequency estimates for stream gages (England, et al., 2018). The USGS collaborated with DNRC for this hydraulic study to conduct a flood frequency analysis for Jefferson County using gage data through 2017 with Bulletin 17C methods. The results of this analysis were published in a USGS August 2019 data release (Sando, et al., 2019) and are included in this report.

There is 1 USGS stream gage located on the study reach. The USGS gaging station Prickly Pear Creek near Clancy, MT (06061500) is located on river mile 5.1 on the Prickly Pear Creek mainstem. The gage record dates back to 1911 and is currently active. The FEMA guidance document (FEMA, 2019) indicated that gage station records equal or exceeding 10 years in length are applicable to all types of studies.

As discussed previously, the AEP peak discharges were updated for 725 gaged sites in or near Montana, based on data through Water Year 2011 (Sando, et al., 2015a). Flood-frequency data were determined using methods described by the IACWD Bulletin 17B (IACWD, 1982). The study was part of a larger study to develop an online StreamStats application for Montana. This gage was included in this analysis.

The USGS only performed flood frequency analysis on gages with a minimum 10 years of record within Jefferson County. Eleven gages were analyzed within Jefferson County and 1 of those is located on the Prickly Pear Creek mainstem. The USGS flood frequency analysis is provided in Appendix A. This longer period of record should produce more accurate peak discharge estimates than those based on a shorter period of record. The USGS flood frequency analysis results based on data through 2017 were employed in this hydrologic analysis. Table 4-6 summarizes the USGS stream gages analyzed by the USGS (active and inactive) on the Prickly Pear Creek mainstem.

Table 4-6 Prickly Pear Creek Mainstem USGS Gages

USGS Station Number	Station Name	Regulation Status as of 2014	Total Number of Years of Peak-Flow Records	Total Period of Record, in Water Years	2017 Status
06061500	Prickly Pear Creek near Clancy, MT	U	77	1911-1916, 1923-1933, 1946-1953, 1955-1969, 1975, 1979-2002, 2006-2017	Active

Source: Sando et al., 2019.
USGS: U.S. Geological Survey. U: Denotes unregulated stream.

Flood frequency gage-based estimates can be affected by the climatic conditions during the time period the peak-flow data were collected, influencing how the peak-flow frequency results represent long-term hydrologic conditions (Sando, et al., 2015c). Weighting the gage analysis peak flow estimates with the regional regression peak flow estimates adjusts the gage site frequency analysis to account for climatic conditions outside the gaged site period of record (Sando, et al., 2015c).

As discussed above, USGS performed gage analysis and weighted with regional regression equations analysis (Sando, et al., 2019). Table 4-7 shows the results for systematic and weighted

flood frequency estimates with regional regression equations for the gage located on the Prickly Pear Creek mainstem.

Table 4-7 Gage Flood Frequency Estimates Weighted with Results from Regional Regression

USGS Station Number	Station name	Peak Flood Frequency Method	AEP Peak Discharge (cfs) for indicated exceedance probability (%)								
			50	42.9	20	10	4	2	1	0.5	0.2
			Peak Discharge (cfs), for indicated return interval (years)								
			2	2.3	5	10	25	50	100	200	500
06061500	Prickly Pear Creek near Clancy, MT	At-Site	242	268	410	566	830	1,090	1,400	1,800	2,470
		RRE wtd	243	270	415	578	865	1,150	1,520	1,970	2,710

Source: Sando et al., 2019
USGS: U.S. Geological Survey. cfs: cubic feet per second.

4.3.1.2 *1%+ Peak Flow Analysis*

The 1%+ AEP event was calculated by USGS (Sando, et al., 2019) in accordance with FEMA guidance (FEMA, 2019) to provide a confidence range that the 1% flood frequency peak flow estimates are likely to fall within. The upper 84% confidence limit calculated in the gage analysis was used by USGS to determine the 1% flood frequency peak flow estimates (FEMA, 2019). The Prickly Pear Creek mainstem 1%+ flood frequency peak flow estimates listed in Table 4-8 below.

Table 4-8 USGS 1%+ Flood Frequency Estimates 2017

USGS Station Number	Station Name	Drainage Area (sq mi)	1% + AEP Peak discharge, At-Site (cfs)	1% + AEP Peak discharge, RRE wtd (cfs)
06061500	Prickly Pear Creek near East Helena, MT	192	2,390	1,930

Source: Sando et al., 2019
USGS: U.S. Geological Survey. sq mi: square miles. cfs: cubic feet per second.
RRE wtd: Systematic data weighted with regional regression equation (RRE).

4.3.1.3 *Flow Change Node Locations*

Future flood studies will use hydraulic models that are composed of geometric data and streamflow data. To accurately model the Prickly Pear Creek mainstem, the locations of major tributary confluences and other flow change locations must be identified. The hydrologic analysis results will be used as the streamflow data input at the tributary confluences within the hydraulic model.

Generally, the hydraulic models simulate flood events using steady-state conditions and, therefore, the peak flow rate calculated at a flow node is projected to the next upstream flow node. This method was followed for the hydrologic analysis calculations. Flow nodes were assigned immediately upstream of major tributaries, this method of locating the flow nodes was

employed so that the additional flow resulting from the tributary confluence was accurately reflected to the reach downstream of the confluence.

A detailed review of the study area was performed to identify all potential flow change locations (flow nodes). HUC 12-digit watershed boundaries were used to initially locate the flow nodes. HUC 12-digit watershed boundaries represent the smallest USGS-delineated watershed areas available in GIS format. Using ArcGIS, flow nodes were located just upstream of the HUC 12 boundary intersection with the Prickly Pear Creek mainstem. To avoid excessive flow changes between HUC 12 boundary nodes, additional flow nodes were located immediately downstream of towns, at the beginning of study reaches, or where intermediate tributaries within the HUC 12 boundaries intersected the study reach. At each flow node, a drainage basin area was delineated, and streamflow values were calculated for the various recurrence interval floods. The USGS software StreamStats was used to generate flow node drainage basin areas.

This study used the nearest GNIS hydrographic name for the ungaged flow node names. In some cases, these features (typically tributary streams) flow into the Prickly Pear Creek just downstream of the flow node. Nodes were also named for nearby towns and USGS gage station numbers if placed at gage locations.

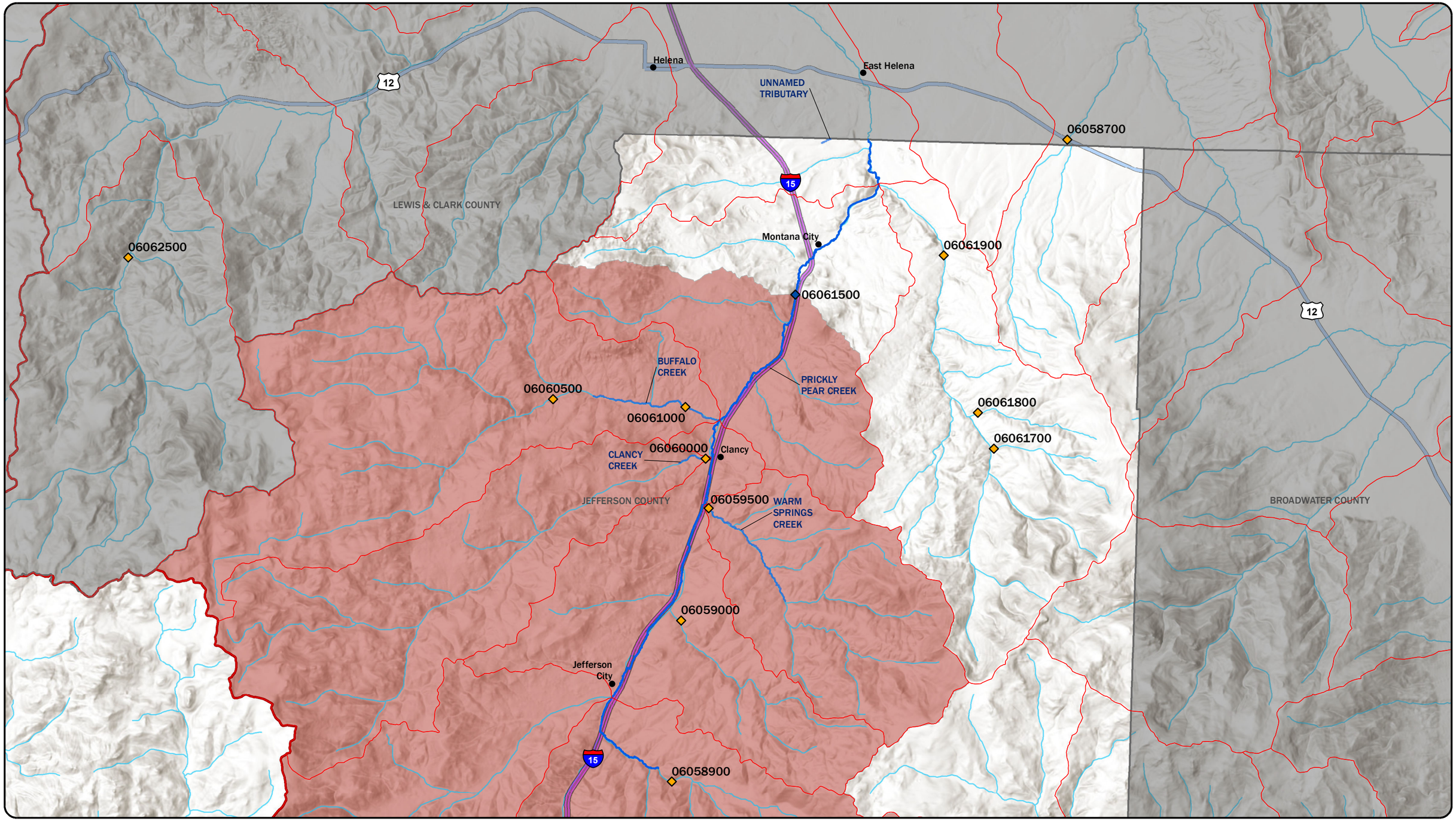
A total of 7 flow nodes were identified throughout the study reach, including 1 gaged location and 6 ungaged locations. Table 4-9 summarizes the flow nodes used in this study. Figure 4-7 shows the USGS gaging station analyzed and the correlating watershed areas within the study area. Figure 4-8 maps the flow node locations and corresponding watershed areas from Table 4-9.

Table 4-9 Flow Node and USGS Gage Station Information Used in Hydrologic Analysis

Node/USGS Station ID	Location Description	River Station (mi)[1]	Calculated Basin Area[2] (sq mi)	Study Reach	DA_U/DA_G
100	Reach origin	0.0	247	Prickly Pear Creek	1.3
200	Middle Prickly Pear Creek	1.5	205	Prickly Pear Creek	1.1
06061500	**USGS Gage Prickly Pear Creek near Clancy, MT**	**5.1**	**192**	**Prickly Pear Creek**	**-**
300	Buffalo Creek	9.0	130	Prickly Pear Creek	0.7
400	Warm Springs Creek	11.3	74	Prickly Pear Creek	0.4
500	Jefferson City, MT	15.9	52	Prickly Pear Creek	0.3
600	Headwaters Prickly Pear Creek	17.4	21	Prickly Pear Creek	0.1

1. River miles start at the downstream extent of each study reach (mi: miles).
2. Area in square miles (sq mi).

USGS: U.S. Geological Survey, mi: miles: sq mi: square miles. DA_U: Drainage area at ungaged site. DA_G: Drainage area at gaged site.



LEGEND

- ACTIVE USGS STREAM GAGE
- INACTIVE USGS STREAM GAGE
- TOWNS
- HUC 12 BOUNDARIES
- PRICKLY PEAR CREEK MAINSTEM STUDY REACH
- JEFFERSON COUNTY STUDY REACHES
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- STREAMS
- USGS BASINS
  - 06061500

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1 2 4
Miles

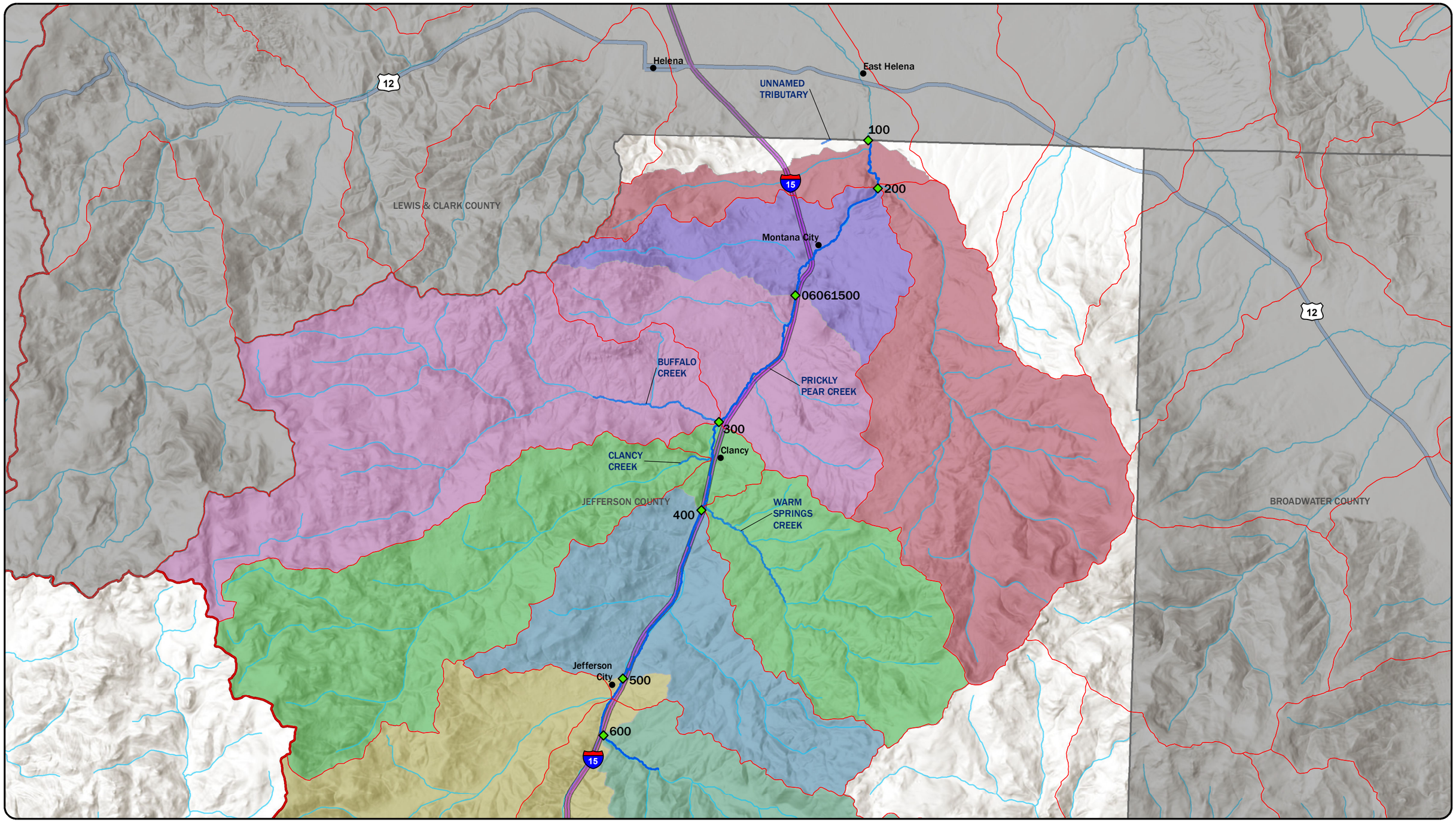
FIGURE 4-7

PIONEER TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK
MAINSTEM
USGS WATERSHEDS

DATE: 9/10/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-4-7.mxd



LEGEND

- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- PRICKLY PEAR CREEK MAINSTEM STUDY REACH
- JEFFERSON COUNTY STUDY REACHES
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- STREAMS

FLOW CHANGE NODE: 100, 200, 06061500, 300, 400, 500, 600

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1 2 4
Miles

FIGURE 4-8

PIONEER TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK
MAINSTEM
FLOW NODE LOCATIONS

DATE: 9/10/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-4-8.mxd

4.3.1.4 *Flood Frequency Estimates at Ungaged Sites*

To calculate peak flood discharge estimates at the ungaged flow nodes, Pioneer considered methods described in USGS SIR 2015-5109-F (Sando, et al., 2015b). These methods included estimating flood frequency using regional flood-frequency relations (regression analysis) and estimating flood frequency on gaged streams by translating gaged data to ungaged locations (drainage-area ratio adjustment or logarithmic interpolation between 2 gaged sites).

One USGS gaging station (Prickly Pear Creek near Clancy, MT) was used for the Prickly Pear Creek mainstem study reach. Nodes 100 and 200 are located downstream of the gage, and nodes 300 through 600 are located upstream of the gage. Nodes 100 through 300 meet the SIR 2015-5019-F guidance criteria for the drainage area gage transfer method (i.e., are within the ratio of 1.5 to 0.5 of the gage drainage area) (Sando, et al., 2015b). Nodes 400 through 600 do not meet the recommended guidance. Drainage area ratios are shown in Table 4-9. The drainage area gage transfer method was used for all nodes in the study reach. The logarithmic interpolation method requires two gages and as only one gage exists on the Prickly Pear Creek mainstem this method was not applicable.

In addition to the above method, the regional regression equation method is also applicable to the entire Prickly Pear Creek mainstem study reach. All 7 flow nodes are not considered regulated and flow nodes are within the Southwest Region watershed limits as defined by SIR 2015-5019-F (Sando, et al., 2015b). Therefore, it was determined that regional regression equations were applicable to the Prickly Pear Creek mainstem study reach and all 7 flow nodes. Gage transfer method and regional regression equations were used to develop peak flow estimates.

4.3.1.5 *Regional Regression Equation Method*

The SIR 2015-5019-F report (Sando, et al., 2015b) provides guidance on conditions where regional regression equations might not yield reliable results. These limiting guidelines include the following:

1. A site where the basin characteristics are outside the range of values used to develop the regression equations.
2. A site that is affected by regulation or urbanization.

The SIR 2015-5019-F report considers a gaging station unregulated if the cumulative drainage area of an upstream dam is less than 20% of the drainage area to the gaging station (Sando, et al., 2015b). Ungaged flow nodes located on Prickly Pear Creek mainstem are not regulated and are within the range of values used to develop the Southwest Region regression equations. The USGS software StreamStats generated regional regression flow discharges for the 50-, 10-, 4-, 2-, 1-, and 0.2% AEP events for all 7 flow nodes. The regression equations, listed in SIR 2015-5019-F (Sando, et al., 2015b), use drainage area (A) and percentage of drainage basin above 6,000 feet elevation (E_{6000}) as shown below in the following set of equations:

$$Q_{50} = 2.49A^{0.930}(E_{6000}+1)^{0.095}$$
$$Q_{10} = 31.9A^{0.796}(E_{6000}+1)^{-0.177}$$
$$Q_{4} = 79.8A^{0.750}(E_{6000}+1)^{-0.274}$$
$$Q_{2} = 142A^{0.721}(E_{6000}+1)^{-0.336}$$
$$Q_{1} = 238A^{0.696}(E_{6000}+1)^{-0.391}$$
$$Q_{0.2} = 655A^{0.649}(E_{6000}+1)^{-0.501}$$

Where

Q_x is the X AEP peak flow magnitude, in cfs.

A is the contributing drainage area, in square miles.

E_{6000} is the percent of basin area above 6,000 feet.

The 1%+ (plus) AEP event was calculated using FEMA guidance methodologies (FEMA, 2019) for all the flow nodes to provide a confidence limit of plus 1 standard error that the 1% flood frequency peak flow estimates were likely to fall below. For the regional regression estimates, the average standard error of prediction or *average standard error of estimate* percentage (SEP, in percent) from SIR 2015-5019-F (Sando, et al., 2015b) was used to define the equation's statistical confidence upper limit of plus 1 standard error (FEMA, 2016b). The resulting upper limit of plus 1 standard error was used to determine the 1%+ (plus) flood frequency peak flow estimates. Appendix B provides the 1%+ (plus) regional regression flood frequency calculations for the study flow nodes.

The Southwest Hydrologic Region regional regression equation input variables are shown in Table 4-10. Regional regression equation flood frequency peak flow estimates are listed in Table 4-11. Figure 4-9 plots the calculated peak discharges and correlating drainage areas. Results indicate increasing flow magnitude with increasing drainage size.

Table 4-10 Regional Regression Variables

Node/USGS Station ID	Location Description	Study Reach River Station (miles)	Basin Area (sq mi)	E_{6000}
600	Headwaters Prickly Pear Creek	17.4	21	61
500	Jefferson City, MT	15.9	52	39
400	Warm Springs Creek	11.3	74	31
300	Buffalo Creek	9.0	130	32
06061500	**USGS Gage Prickly Pear Creek near Clancy, MT**	**5.1**	**192**	**29**
200	Middle Prickly Pear Creek	1.5	205	27
100	Reach origin	0.0	247	27

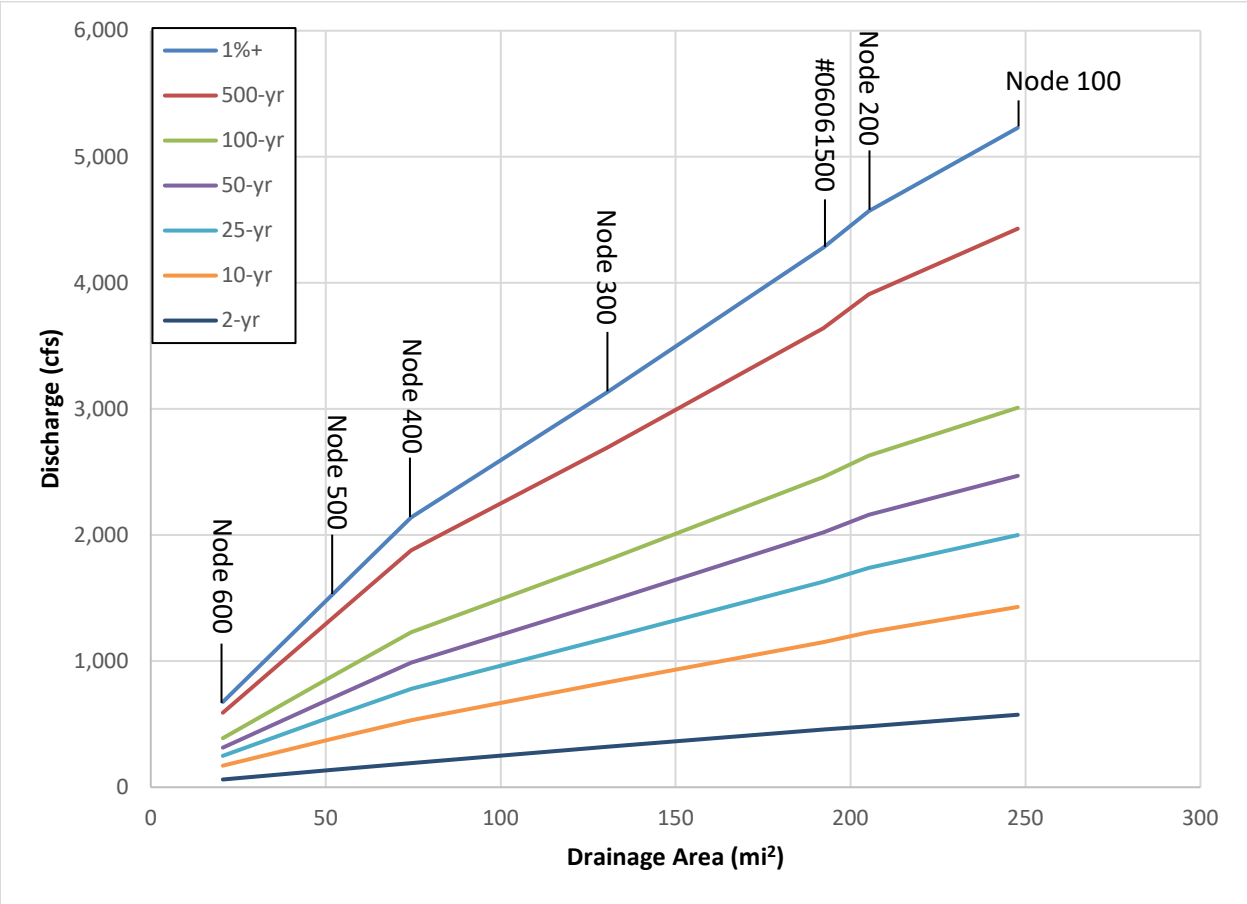
USGS: U.S. Geological Survey. sq mi: square miles.
E_{6000} (%): percentage of basin over 6,000 feet in elevation.

Table 4-11 Regional Regression Flood Frequency AEP Peak Flow Estimates

Node/USGS Station ID	Location Description	Southwest Region Regression AEP Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year
600	Headwaters Prickly Pear Creek	61	171	249	314	389	591	676
500	Jefferson City, MT	139	385	562	710	881	1,340	1,530
400	Warm Springs Creek	191	532	779	987	1,230	1,880	2,140
300	Buffalo Creek	321	830	1,180	1,470	1,800	2,690	3,130
06061500	**USGS Gage Prickly Pear Creek near Clancy, MT**	**457**	**1,150**	**1,630**	**2,020**	**2,460**	**3,640**	**4,280**
200	Middle Prickly Pear Creek	483	1,230	1,740	2,160	2,630	3,910	4,570
100	Reach origin	575	1,430	2,000	2,470	3,010	4,430	5,230

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 4-9 Prickly Pear Creek Mainstem Regional Regression Flood Frequency Estimates



4.3.1.6 *Drainage Area Gage Transfer Method*

Ungaged flow nodes located near USGS gage 06061500 Prickly Pear Creek near Clancy, MT were evaluated using the drainage area gage transfer method. The other four nodes analyzed by USGS (06058700, 06061700, 06061800 and 06061900) are not located on study reaches and therefore were not considered. This method, listed in SIR 2015-5019 F (Sando, et al., 2015b), uses a drainage area ratio of the ungaged flow node to the gaged station to transfer flow estimates from the gaged site to the ungaged site shown below in the following equation:

$$Q_{AEP,U} = Q_{AEP,G}\left(\frac{\mathrm{DA}_U}{\mathrm{DA}_G}\right)^{\exp_{AEP}}$$

Where

$Q_{AEP,U}$ is the AEP-percent peak flow at the ungaged site, in cfs.

$Q_{AEP,G}$ is the AEP-percent peak flow at the gaged site, in cfs.

DA_G is the drainage area at the gaged site, in square miles.

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

$\exp_{AEP}$ is the regression coefficient for a simple OLS regression relating to the log of the AEP-percent peak flow to log of drainage area within each region.

Limitations for this method include a recommended drainage area ratio between 0.5 and 1.5 Three of the flow node drainage area ratios are within the recommended range (Table 4-9). Calculations were performed for all flow nodes for subsequent comparison to regional regression equation peak flow estimates.

Regression coefficients shown in the equation above vary based on the hydrologic region and the AEP. The applicable regression coefficients provided in Table 4-12 were used in these calculations. The USGS regional regression weighted values were selected for use in the drainage area gage transfer calculations. Although the Prickly Pear Creek gage (06061500 USGS Prickly Pear Creek near East Helena, MT) has 77 years of record, it contains numerous data gaps from 1916 to 2017. The regional regression weighted values are slightly higher (less than 10% at the 1% AEP peak discharge) than the systematic gage data. The regional regression weighted values may account for climactic conditions outside of the gages period of record. The drainage area transfer method results are shown in Table 4-13 and Figure 4-10.

Table 4-12 Drainage Area Gage Transfer Regression Coefficients

AEP-percent Peak Flow	exp_{AEP}
Q_{50}	0.939
Q_{10}	0.755
Q_{4}	0.690
Q_{2}	0.647
Q_{1}	0.609
$Q_{0.2}$	0.533

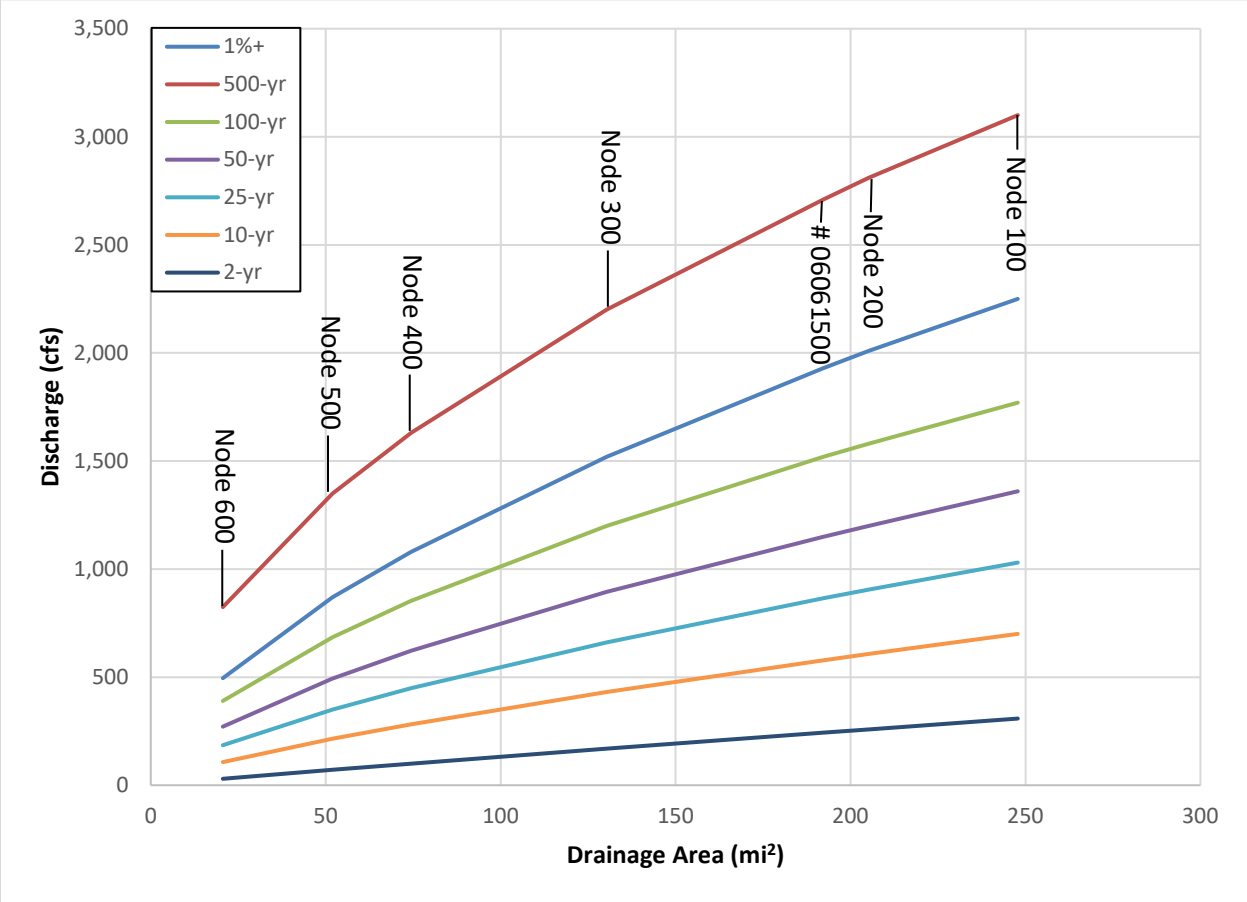
Table 4-13 Drainage Area Gage Transfer Method Results for Flow Node Locations near USGS gage 06061500 Prickly Pear Creek near Clancy, MT

Node/USGS Station ID	Location Description	Drainage Area Gage Transfer Estimated Discharge (cfs)						
		Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year
600	Headwaters Prickly Pear Creek	30	107	185	271	390	824	495
500	Jefferson City, MT	71	215	351	493	685	1,350	870
400	Warm Springs Creek	100	282	449	622	853	1,630	1,080
300[1]	Buffalo Creek	169	431	662	894	1,200	2,200	1,520
06061500	**Prickly Pear Creek Near Clancy, MT**	**243**	**578**	**865**	**1,150**	**1,520**	**2,710**	**1,930**
200[1]	Middle Prickly Pear Creek	258	607	905	1,200	1,580	2,810	2,010
100[1]	Reach origin	308	700	1,030	1,360	1,770	3,100	2,250

1. Denotes node within recommended DA_U/DA_G range of 0.5 to 1.5. (DA_U: Drainage area at ungaged site. DA_G: Drainage area at gaged site.)

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 4-10 Prickly Pear Creek Mainstem Drainage Area Gage Transfer Results



4.3.2 Prickly Pear Creek Mainstem Discussion

Pioneer conducted a peak discharge frequency analysis for the Prickly Pear Creek mainstem study reach. The study reach extends 19 miles from the reach origin at the Jefferson County line. Information gathered from this analysis will be used to support the Jefferson Countywide Modernization hydraulic analyses and floodplain mapping studies.

Previous flood studies on the Prickly Pear Creek mainstem are limited. The most relevant earlier flood study was the SIR 2015-5019-C (Sando, et al., 2015c).

This hydrologic analysis developed flood frequency estimates for both gaged and ungaged sites. Peak flow estimates were calculated at 7 locations (flow nodes) within the watershed (1 gaged site and 6 ungaged sites). The ungaged sites (flow nodes) were located at HUC 12 boundaries, major tributaries, population centers, and at the end of study reaches.

One stream gage, USGS gage Prickly Pear Creek near Clancy, MT (06061500) was used to estimate AEP peak flow values for the study area. The gage is located at river mile 5.1 of the study reach.

The Prickly Pear Creek watershed in this study is considered unregulated. The basin parameters for the flow nodes evaluated in this study fall within the range of basin and climatic characteristics used to develop the regional regression equations. Therefore, regional regression method peak flow estimates are applicable to this study.

Flood frequency estimates at the gaged sites were conducted by USGS (Sando, et al., 2019) using Bulletin 17C methodologies (England, et al., 2018). Flood flow frequency estimates at ungaged flow nodes were conducted using regional regression and gage transfer methods (Sando, et al., 2015b). The USGS weighted at-site peak flow data with regional regression equations to develop annual peak flows for the Prickly Pear Creek gage (Sando, et al., 2019).

Weighted peak flow values were selected for the recommended flood discharge estimate on USGS gage 06061500 Prickly Pear Creek near Clancy, MT and used in the gage transfer method to estimate flows at ungaged nodes. The decision to use regression weighted peak flow estimates rather than at site estimates was based on the gage record data gaps and the close agreement between the two methods. The Prickly Pear Creek gage has 6 gaps in its period of record ranging from 2 years up to 13 years long.

At-site data that are weighted with regional regression equations generally improve frequency estimates (Sando, et al., 2015c). Although specific stream gages in the southwest may not be well represented by the southwest regional regression equations, the 1% AEP at site and weighted peak flow estimates were relatively close for the Prickly Pear Creek at Clancy gage (1400 cfs and 1520 cfs respectively). The regression weighted peak flow estimates provide a slightly more conservative estimate that may account for climactic conditions not accounted for

in the period of record and therefore was selected for this Prickly Pear Creek mainstem study recommended peak flow discharges.

The peak flow 1%+ (plus) estimates were developed for all gaged and ungaged locations using standard FEMA methodologies (FEMA, 2019). The USGS developed 1%+ estimates for at site weighted with regional regression equation values per USGS's *SIR 2018-5046* (Sando & McCarthy, 2018). This method accounts for the at site data variance as well as the regional regression equation variance when determining confidence intervals.

The gage data and gage-based flood frequency estimating methods meet the hydrologic flood frequency standard practice criteria and guidance for nodes 100 through 300. Nodes 400 to 600 have a DA_U/DA_G ratio that is outside the maximum recommended value of 1.5. To determine which calculation method better represents peak flow values at ungaged flow nodes where the DA_u/DA_G ratio is outside the SIR 2015-5019-F guidelines, regional regression equation results were compared with drainage area transfer peak flow estimates at ungaged flow nodes that meet the SIR 2015-5019-F DA_u/DA_G guidelines. The comparison indicated that the regional regression equation estimates were significantly higher (44% higher at node 400 for the 1% AEP peak flow estimate) than the drainage area gage transfer peak flow calculations. Therefore, the gage transfer method was selected for flow nodes outside of the recommended DA_U/DA_G ratio for Prickly Pear Creek Mainstem.

The gage-based AEP estimates meet standard hydrologic flood frequency guidance including the following:

- A 77-year period of record that exceeds the minimum FEMA guidance.
- Estimates may be weighted with regional regression peak flow estimates to account for climatic conditions outside of the study's gage period of record.

Regional regression equations are based on comparison of peak flows and basin characteristics for a given region (Sando, et al., 2015b). As a result, regional regression equations are beneficial for estimating peak flow when gage data do not exist, or the period of record is too short to represent the historic climate. A minimum 10 years of gage data is recommended to perform gage peak flow analysis; the gage used in this analysis surpasses that minimum.

Higher confidence is typically associated with flood frequency estimates that are based on measured stream flows, such as in the gage transfer and two-station logarithmic method. For these reasons, the gage transfer method was selected for the recommended flood discharge estimates for all flow nodes.

Table 4-14 summarizes the recommended 1% AEPs discharges for the Prickly Pear Creek mainstem study reach. Figure 4-11 shows the recommended 1% AEP discharge for each flow node location. The hydrologic analysis results provided in Table 4-14 represent the recommended discharges at each flow node location throughout the study reach. The methods

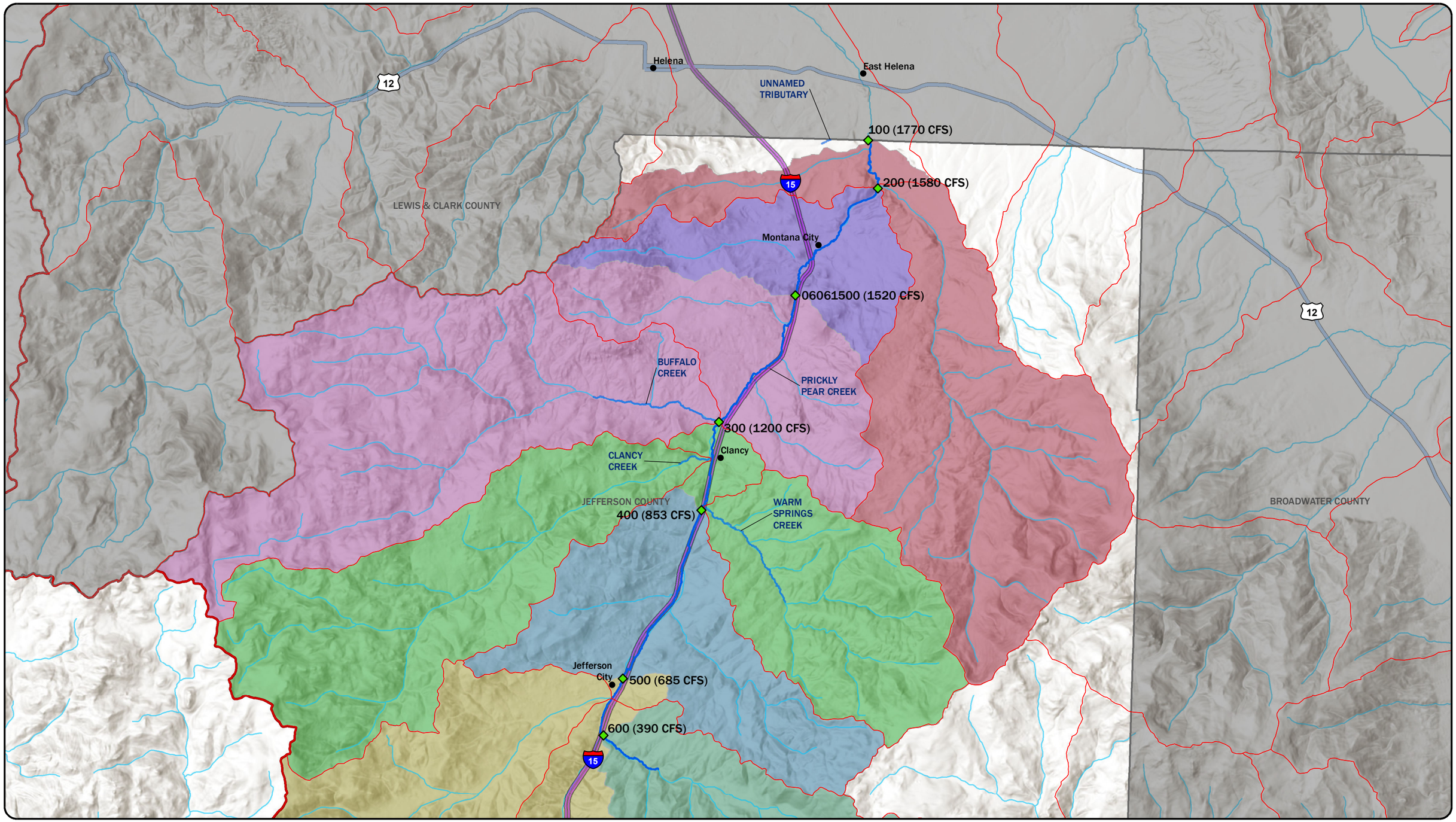
used for the hydrological analysis are industry accepted methods [Bulletin 17C (England, et al., 2018), SIR 2015-5019-C (Sando, et al., 2015a), and SIR 2015-5019-F (Sando, et al., 2015b)] based on the Prickly Pear Creek mainstem basin characteristics. The hydrologic analysis conforms to the FEMA standard for enhanced level studies, and the recommended flows of this analyses are deemed reliable and suitable for future floodplain studies and hydraulic analyses.

Table 4-14 Recommended Flood Discharge Estimates Using Gage Transfer Analysis

Node/USGS Station ID	Location Description	Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% + Annual Chance
		2-year	10-year	25-year	50-year	100-year	500-year	100-year +
600[1]	Headwaters Prickly Pear Creek	30	107	185	271	390	824	495
500[1]	Jefferson City, MT	71	215	351	493	685	1,350	870
400[1]	Warm Springs Creek	100	282	449	622	853	1,630	1,080
300[1]	Buffalo Creek	169	431	662	894	1,200	2,200	1,520
06061500[2]	**Prickly Pear Creek near Clancy, MT**	**243**	**578**	**865**	**1,150**	**1,520**	**2,710**	**1,930**
200[1]	Middle Prickly Pear Creek	258	607	905	1,200	1,580	2,810	2,010
100[1]	Reach origin	308	700	1,030	1,360	1,770	3,100	2,250

1. Analyzed with USGS Gage Transfer Method
2. Analyzed with USGS RRE Weighted Method

USGS: U.S. Geological Survey. cfs: cubic feet per second.



LEGEND

- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- PRICKLY PEAR CREEK MAINSTEM STUDY REACH
- JEFFERSON COUNTY STUDY REACHES
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- STREAMS

FLOW CHANGE NODE: 100, 200, 06061500, 300, 400, 500, 600

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1 2 4 Miles

FIGURE 4-11

PIONEER TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK MAINSTEM RECOMMENDED 1-PERCENT AEP DISCHARGE

DATE: 9/10/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-4-11.mxd

4.3.3 Prickly Pear Creek Tributaries

Throughout the study area, 5 flow nodes on the Prickly Pear Creek tributary study reaches were identified as having significant changes in streamflow or being at a critical location. All flow nodes are located at ungaged locations. The study tributaries in this report were based on the Jefferson County Modernization Study Area Map provided by the DNRC. The river stations used in this report were based on the Prickly Pear Creek tributaries' S_Hydro_Reach delineated by Pioneer based on Google imagery. The Prickly Pear Creek tributaries' S_Hydro_Reach alignments begin at the junction of Buffalo Creek, Clancy Creek, and Warm Springs Creek with Prickly Pear Creek mainstem. A fourth Unnamed tributary begins at the Jefferson County line, joining with Prickly Pear Creek mainstem about 1 mile downstream from the study reach origin. The study reaches upstream extents end at 4 locations at Buffalo Creek, Clancy Creek, Warm Springs Creek, and the Unnamed tributary to Prickly Pear Creek.

4.3.3.1 *USGS Stream Gage Analysis*

In 2018, the USGS adopted Bulletin 17C guidelines to provide flood frequency estimates for stream gages (England, et al., 2018). The USGS collaborated with DNRC to conduct a flood frequency analysis for this Jefferson County study using gage data through 2017 with Bulletin 17C methods (Sando, et al., 2019). The results of this USGS analysis were published in an August 2019 data release (Sando, et al., 2019) and are included in this report.

There are 4 USGS stream gages located on Prickly Pear Creek tributaries (with over 10 years of record): USGS gaging stations Mitchell Gulch near East Helena, MT (06058700), Jackson Creek near East Helena, MT (06061700), Crystal Creek near East Helena, MT (06061800) and McClellan Creek near East Helena, MT (06061900). All 4 gages have periods of record greater than or equal to 18 years (Table 4-15). The FEMA guidance document (FEMA, 2019) indicates that gage station records equal or exceeding 10 years in length are applicable to all types of studies.

The USGS only performed flood frequency analysis on gages with a minimum 10 years of record within Jefferson County. Eleven gages were analyzed within Jefferson County, and 4 of those are on Prickly Pear Creek tributaries (listed above). The USGS flood frequency analysis is provided in Appendix A. This longer period of record should produce more accurate peak discharge estimates than those based on a shorter period of record. USGS flood frequency analysis results based on data through 2017 were employed in this hydrologic analysis. Table 4-15 summarizes the USGS stream gages analyzed by the USGS (active and inactive) on the Prickly Pear Creek tributaries.

Table 4-15 Prickly Pear Creek Tributary USGS Gages

USGS Station Number	Station Name	Regulation Status as of 2014	Total Number of Years of Peak-Flow Records	Total Period of Record, in Water Years	2017 Status
06058700	Mitchell Gulch near East Helena, MT	U	45	1959-2003	Inactive
06061700	Jackson Creek near East Helena, MT	U	18	1961-1975, 1981, 1989-1990	Inactive
06061800	Crystal Creek near East Helena, MT	U	18	1961-1975, 1981, 1989-1990	Inactive
06061900	McClellan Creek near East Helena, MT	U	19	1960-1975, 1981, 1989-1990	Inactive

Source: Sando et al., 2019.
USGS: U.S. Geological Survey. U: Unregulated stream

Flood frequency gage-based estimates can be affected by the climatic conditions during the time period the peak-flow data were collected, influencing how the peak-flow frequency results represent long-term hydrologic conditions (Sando, et al., 2015c). Weighting the gage analysis peak flow estimates with the regional regression peak flow estimates adjusts the gage site frequency analysis to account for climatic conditions outside the gaged site period of record (Sando, et al., 2015c).

As discussed above, USGS performed gage and weighted with regional regression equations analysis (Sando, et al., 2019). The weighting method is described in Bulletin 17C, Appendix 9 (England, et al., 2018). Table 4-16 shows the results for systematic and weighted flood frequency estimates with regional regression equations for gages on the Prickly Pear Creek tributaries.

Table 4-16 Gage Flood Frequency Estimates Weighted with Results from Regional Regression

USGS Station Number	Station name	Peak Flood Frequency Method	AEP Peak Discharge (cfs) for indicated exceedance probability (%)								
			50	42.9	20	10	4	2	1	0.5	0.2
			Peak Discharge (cfs), for indicated return interval (years)								
			2	2.3	5	10	25	50	100	200	500
06058700	Mitchell Gulch near East Helena, MT	At-Site	12	18	69	141	263	368	476	585	724
		RRE wtd	13	20	68	135	250	351	464	587	771
06061700	Jackson Creek near East Helena, MT	At Site	13	15	31	55	113	189	314	516	983
		RRE-wtd	13	15	30	52	94	134	178	224	290
06061800	Crystal Creek near East Helena, MT	At-Site	13	16	30	45	71	94	122	154	205
		RRE-wtd	13	16	30	46	74	100	132	169	231
06061900	McClellan Creek near East Helena, MT	At-Site	151	171	292	442	727	1,030	1,450	2,010	3,070
		RRE wtd	146	165	277	413	646	856	1,090	1,350	1,720

Source: Sando et al., 2019
RRE wtd: Systematic data weighted with regional regression equation (RRE) (Southwest Region).
USGS: U.S. Geological Survey. cfs: cubic feet per second.

4.3.3.2 *1%+ Peak Flow Analysis*

The 1%+ AEP event was calculated by USGS (Sando, et al., 2019) per FEMA guidance documents (FEMA, 2019)to provide a confidence range that the 1% flood frequency peak flow estimates are likely to fall within. The upper 84% confidence limit calculated in the gage analysis was used by USGS to determine the 1%+ flood frequency peak flow estimates (FEMA, 2019). The Prickly Pear Creek tributary 1%+ flood frequency peak flow estimates presented in Table 4-17.

Table 4-17 USGS 1%+ Flood Frequency Estimates 2017

USGS Station Number	Station Name	Drainage Area (sq mi)	1% + AEP Peak discharge, At-Site (cfs)	1% + AEP Peak discharge, RRE wtd (cfs)
06058700	Mitchell Gulch near East Helena, MT	8	1,150	676
06061700	Jackson Creek near East Helena, MT	3	1,400	293
06061800	Crystal Creek near East Helena, MT	4	274	190
06061900	McClellan Creek near East Helena, MT	33	3,980	1,620

Source: Sando et al., 2019
RRE wtd: Systematic data weighted with regional regression equation (RRE).
USGS: U.S. Geological Survey. sq mi: square miles, cfs: cubic feet per second.

None of the 4 USGS stream gages located on Prickly Pear Creek tributaries are located on a study reach. Therefore, the above USGS gages were not considered for this analysis.

4.3.3.3 *Flow Change Node Locations*

Future flood studies will use hydraulic models that are composed of geometric data and streamflow data. To accurately model Prickly Pear Creek tributaries, the locations of major tributary confluences and other flow change locations must be identified. Hydrologic analysis results will be used as the streamflow data input at the tributary confluences within the hydraulic model. A detailed review of the study area was performed to identify all potential flow change locations (flow nodes) within the Prickly Pear Creek tributary study reaches. At each flow node, a drainage basin area was delineated, and streamflow values were calculated for the various recurrence interval floods. The USGS software StreamStats was used to generate flow node drainage basin areas.

Generally, the hydraulic models simulate flood events using steady-state conditions and, therefore, the peak flow rate calculated at a flow node is projected to the next upstream flow node. This method was followed for the hydrologic analysis calculations. Flow nodes were assigned immediately upstream of tributary junctions; this method of locating the flow nodes was employed so that the additional flow resulting from the tributary confluence was accurately reflected to the reach downstream of the confluence.

Flow nodes were placed at the downstream end of the study reaches, generally at a tributary junction. One flow node was located upstream of a confluence with a sub-tributary.

Using ArcGIS, 3 flow nodes (Buffalo Creek, Clancy Creek, Warm Springs Creek) were located just upstream of each tributary confluence with Prickly Pear Creek mainstem. One additional flow node was added at the reach origin of the Unnamed tributary to Prickly Pear Creek mainstem. A node was located just upstream of the Badger Creek confluence on Warm Springs Creek. In total there were 5 flow nodes. Due to their drainage area size, these ungaged flow nodes do not have a GNIS hydrographic feature name. Therefore, a location description was developed for each ungaged flow node.

To address the issue of coincident peaks between the study tributaries and Prickly Pear Creek mainstem, FEMA guidance requirements assuming coincident peaks were referenced. For the assumption of coincident peaks to be appropriate, FEMA guidance documents (FEMA, 2016b) require the following criteria be met:

1. The ratio of the drainage areas lies between 0.6 and 1.4.
2. The arrival times of flood peaks are similar for the 2 combining watersheds.
3. The likelihood of both watersheds being covered by the storm is high.

The study tributaries do not meet these drainage area ratio criteria. Study tributaries and Prickly Pear Creek mainstem are not gaged at the tributary/mainstem confluence. Therefore, data to determine criteria No. 2 were not available. The Prickly Pear Creek mainstem drainage area at the tributary confluences is not within the drainage ratio of 0.6 to 1.4. Consequently, it was determined that the tributaries do not meet the FEMA criteria for coincident peaks. Table 4-18

summarizes the flow nodes used in this study. Figure 4-12 shows the Prickly Pear Creek Tributary flow nodes and sub basins.

Table 4-18 Flow Node Information Used in Hydrologic Analysis

Node/USGS Station ID	Location Description	Tributary River Station[1] (mi)	Calculated Basin Area[2] (sq mi)	Tributary
100	Unnamed Tributary	0.0	1	Unnamed Tributary
200	Buffalo Creek	0.0	44	Buffalo Creek
300	Clancy Creek	0.1	33	Clancy Creek
400	Downstream end of Warm Springs Creek Study Reach	0.1	21	Warm Springs Creek
500	Warm Springs Creek downstream of junction with Badger Creek	1.8	17	Warm Springs Creek

1. River miles start at the downstream extent of each study reach (mi: miles).
2. Basin Area in square miles (sq mi).

USGS: U.S. Geological Survey.

Helena
East Helena
UNNAMED TRIBUTARY
100
06058700
12
15
LEWIS & CLARK COUNTY
Montana City
06061900
BUFFALO CREEK
PRICKLY PEAR CREEK
06061800
06061700
200
Clancy
CLANCY CREEK
300
JEFFERSON COUNTY
400
WARM SPRINGS CREEK
500
BROADWATER COUNTY
Jefferson City

LEGEND

- INACTIVE USGS STREAM GAGE
- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- PRICKLY PEAR CREEK TRIBUTARY STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- STREAMS
- 500

FLOW CHANGE NODE

- 100
- 200
- 300
- 400

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1 2 4
Miles

FIGURE 4-12

PIONEER TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK TRIBUTARIES FLOW NODE LOCATIONS

DATE: 9/12/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-4-12.mxd

4.3.3.4 *Flood Frequency Estimates at Ungaged Sites*

To calculate peak flood discharge estimates at the ungaged flow nodes, Pioneer considered methods described in USGS SIR 2015-5019-F (Sando, et al., 2015b). These methods included estimating flood frequency using regional flood-frequency relations (regression analysis) and estimating flood frequency on gaged streams by translating gaged data to ungaged locations (drainage-area ratio adjustment or logarithmic interpolation between 2 gaged sites). No USGS gages exist on study tributaries. Therefore, gage-based analysis was not considered for the study reach.

The regional regression method was used for all Prickly Pear Creek tributary study reaches. All 5 flow nodes are not regulated by upstream dams, and flow nodes within the Southwest Region have watershed areas that are within the watershed area limits as defined by SIR 2015-5019-F (Sando, et al., 2015b). Therefore, it was determined that regional regression equations were applicable to the Prickly Pear Creek tributary study reaches at all 5 flow nodes. No other method was considered in this analysis. All flow nodes were used to develop peak flow estimates for the 50, 10-, 4-, 2, 1-, 0.2% and 1%+ (plus) AEP events.

4.3.3.5 *Regional Regression Equation Method*

The SIR 2015-5019-F report provides guidance on conditions where regional regression equations might not yield reliable results (Sando, et al., 2015b). These limiting guidelines include the following:

1. A site where the basin characteristics are outside the range of values used to develop the regression equations.
2. A site that is affected by regulation or urbanization.

All ungaged flow nodes located on the Prickly Pear Creek tributary study reaches are not regulated and are within the range of values used to develop the Southwest Region regression equations. The regression equations, presented in SIR 2015-5019-F (Sando, et al., 2015b), use a drainage area (A) and percentage of drainage basin above 6,000 feet elevation (E_{6000}) as shown below in the following set of equations:

$$Q_{50} = 2.49A^{0.930}(E_{6000}+1)^{0.095}$$
$$Q_{10} = 31.9A^{0.796}(E_{6000}+1)^{-0.177}$$
$$Q_{4} = 79.8A^{0.750}(E_{6000}+1)^{-0.274}$$
$$Q_{2} = 142A^{0.721}(E_{6000}+1)^{-0.336}$$
$$Q_{1} = 238A^{0.696}(E_{6000}+1)^{-0.391}$$
$$Q_{0.2} = 655A^{0.649}(E_{6000}+1)^{-0.501}$$

Where

Q_x is the X AEP peak flow magnitude, in cfs.
A is the contributing drainage area, in square miles.
E_{6000} is the percent of basin area above 6,000 feet.

The 1%+ (plus) AEP event was calculated using FEMA guidance methodologies (FEMA, 2019) for all the flow nodes to provide a confidence limit of plus 1 standard error that the 1% flood frequency peak flow estimates were likely to fall below. For the regional regression estimates, the average standard error of prediction or *average standard error of estimate* percentage (SEP, in percent) from SIR 2015-5019-F (Sando, et al., 2015b) was used to define the equation's statistical confidence upper limit of plus 1 standard error (FEMA, 2016b). The resulting upper limit of plus 1 standard error was used to determine the 1%+ (plus) flood frequency peak flow estimates. Appendix B provides the 1%+ (plus) regional regression flood frequency calculations for the study flow nodes Error! Reference source not found. contains the calculations files.

The Southwest Hydrologic Region regression equation input variables are shown in Table 4-19. Regional regression flood frequency peak flow estimates are listed in Table 4-20. The Warm Springs Creek study reach includes 2 flow nodes. Figure 4-13 plots the calculated peak discharges and correlating drainage areas. Results indicate increasing flow magnitude with increasing drainage size.

Table 4-19 Regional Regression Variables

Node/USGS Station ID	Location Description	Study Reach River Station (miles)	Tributary	Basin Area (sq mi)	E_{6000} (%)
500	Warm Springs Creek at Badger Creek	1.8	Warm Springs Creek	17	41.2
400	Warm Springs Creek junction with Prickly Pear Creek	0.1	Warm Springs Creek	21	29.7
300	Clancy Creek	0.1	Clancy Creek	33	35.9
200	Buffalo Creek	0.0	Buffalo Creek	44	30.2
100	Unnamed Tributary	0.0	Unnamed Tributary	1	0

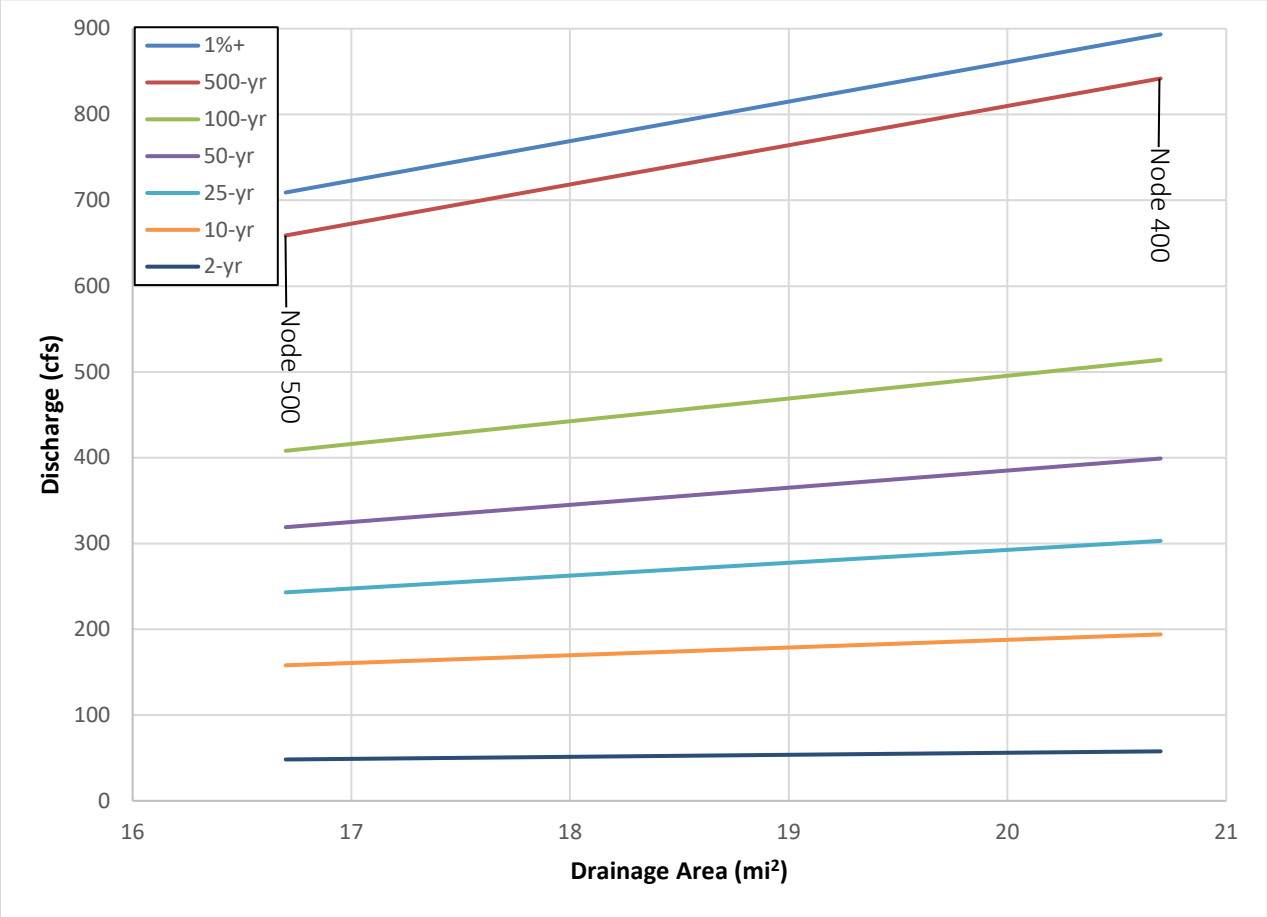
USGS: U.S. Geological Survey. sq mi: square miles.
E_{6000} (%): percentage of basin over 6,000 feet in elevation.

Table 4-20 Regional Regression Flood Frequency AEP Peak Flow Estimates

Node/USGS Station ID	Location Description	StreamStats/Southwest Regression Region						
		Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year-plus
500	Warm Springs Creek at Badger Creek	48	158	243	319	408	659	709
400	Warm Springs Creek junction with Prickly Pear Creek	58	194	303	399	514	842	893
300	Clancy Creek	90	271	407	523	659	1,040	1,150
200	Buffalo Creek	116	350	527	680	858	1,350	1,490
100	Unnamed Tributary	1.6	21	54	98	167	470	290

USGS: U.S. Geological Survey. cfs: cubic feet per second.

Figure 4-13 Warm Springs Creek Regional Regression Flood Frequency Analysis



4.3.4 Prickly Pear Creek Tributaries Discussion

Pioneer conducted a peak discharge frequency analysis for four tributaries that report to Prickly Pear Creek mainstem. The Prickly Pear Creek tributaries study reach extends approximately 11 miles along the Prickly Pear Creek mainstem. Information gathered from this analysis will be used to support the Jefferson County hydraulic analyses and floodplain mapping studies.

Previous flood studies on the Prickly Pear Creek tributaries study reach are limited. Relevant earlier flood studies include the SIR 2015-5019-C (Sando, et al., 2015a).

This hydrologic analysis developed flood frequency estimates for ungaged sites. Peak flow estimates were calculated at 5 ungaged locations (flow nodes) within the watershed. The flow nodes were located at junctions with Prickly Pear Creek mainstem, reach origins, and junctions with other streams.

Flood flow frequency estimates were conducted using regional regression methods. There are 4 USGS gages located on Prickly Pear Creek tributaries with more than 10 years of peak flood record. None of these gages are located on study tributaries. Therefore, gage transfer or two-station logarithmic analysis were not performed in this study.

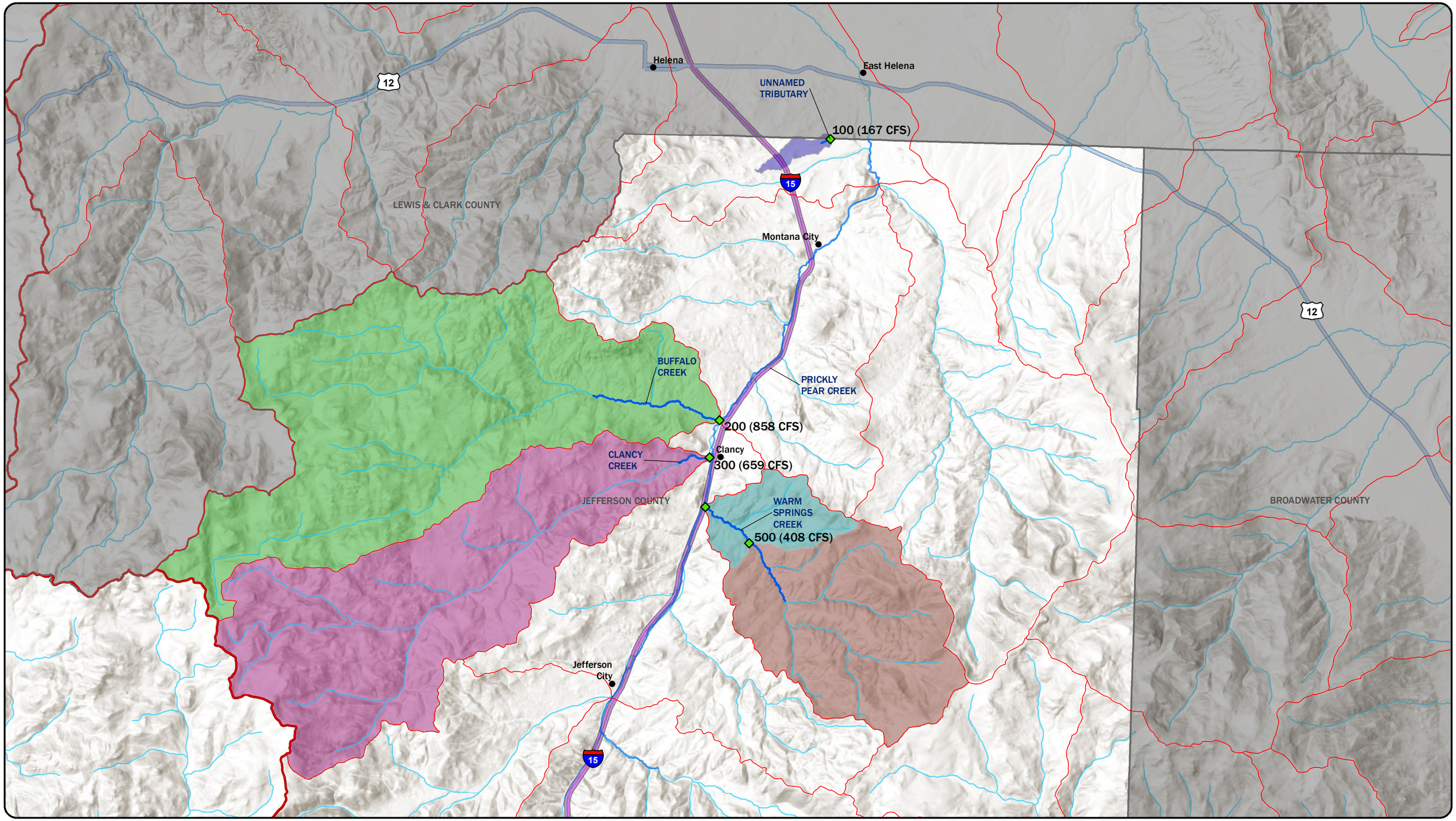
Regional regression equations are based on comparisons of peak flows and basin characteristics for a given region (Sando, et al., 2015b). As a result, regional regression equations are beneficial for estimating peak flows when gage data do not exist.

Table 4-21 summarizes the recommended flood frequency discharge rates for the Prickly Pear Creek tributary study reaches. Figure 4-14 shows the recommended 1% AEP discharge for each flow node location. The hydrologic analysis results provided in Table 4-21 represent the recommended discharges at each flow node location throughout the study reach. The methods used for hydrological analysis are industry accepted methods [SIR 2015-5019-F (Sando, et al., 2015b)] based on Prickly Pear Creek tributaries basin characteristics. This hydrologic analysis conforms to FEMA standards for enhanced level studies, and the recommended flows of this analysis are deemed reliable and suitable for future floodplain studies and hydraulic analyses.

Table 4-21 Recommended Flood Discharge Estimates Using Regression Analysis

Node/USGS Station ID	Location Description	StreamStats/Southwest Regression Region						
		Estimated Discharge (cfs)						
		50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
		2-year	10-year	25-year	50-year	100-year	500-year	100-year-plus
500	Warm Springs Creek at Badger Creek	48	158	243	319	408	659	709
400	Warm Springs Creek junction with Prickly Pear Creek	58	194	303	399	514	842	893
300	Clancy Creek	90	271	407	523	659	1,040	1,150
200	Buffalo Creek	116	350	527	680	858	1,350	1,490
100	Unnamed Tributary	1.6	21	54	98	167	470	290

USGS: U.S. Geological Survey. cfs: cubic feet per second.



LEGEND

- FLOW NODES
- TOWNS
- HUC 12 BOUNDARIES
- PRICKLY PEAR CREEK TRIBUTARY STUDY REACHES
- JEFFERSON COUNTY STUDY REACHES
- COUNTY BOUNDARIES
- HUC 8 BOUNDARIES
- NHS INTERSTATE
- NHS NON-INTERSTATE
- STREAMS

FLOW CHANGE NODE
- 100
- 200
- 300
- 400
- 500

N

DISPLAYED AS:
PROJECTION/ZONE: MONTANA STATE PLANE
DATUM: NAD83/NAVD88
UNITS: INT'L FEET
SOURCE: PIONEER/DNRC/USGS

0 1 2 4
Miles

FIGURE 4-14

PIONEER TECHNICAL SERVICES, INC.

PRICKLY PEAR CREEK TRIBUTARIES RECOMMENDED 1-PERCENT AEP DISCHARGE

DATE: 9/10/2019

Path: G:\DNRC\Jefferson County\CAD-GIS\GIS\JFSNCTY-HYD-PLN-4-14.mxd

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Appendix A

USGS Gage Flood Frequency Analysis

Table 1–1. Information on streamgages for which peak-flow frequency analyses are reported.

[Water year is the 12-month period from October 1 through September 30 and is designated by the year in which it ends. NAD 83, North American Datum of 1983; --, not applicable; U, unregulated; ND, not determined; R, regulated]

Map number (fig. 1; McCarthy and others, 2016)	Streamgage identification number	Streamgage name	Latitude, in decimal degrees (NAD 83)	Latitude, in decimal degrees (NAD 83)	Type of streamgage[1]	Contributing drainage area, in square miles	Data combination[2]	Data correction[3]	Regulation status[4] as of 2014	Number of recorded peak flows	Water years of recorded peak flows	Number of unregulated peak-flow records	Water years of unregulated peak-flow records	Number of regulated peak-flow records	Water years of regulated peak-flow records	Percentage of drainage basin regulated by dams	Regulation status for reported at-site peak-flow frequency analyses
50	06027700	Fish Creek near Silver Star, Montana	45.7709	-112.2502	CONT	39.0	--	--	U	33	1959–91	33	1959–91	0	--	0	U
51	06029000	Whitetail Creek near Whitehall, Montana	46.0226	-112.2079	CONT	30.4	--	--	R (MAJ–dam)	19	1950–53, 1955–68, 1981	0	--	19	1950–53, 1955–68, 1981	63	R
53	06030300	Jefferson River tributary No. 2 near Whitehall, Montana	45.8803	-111.9743	CSG	4.51	--	--	U	55	1958–2012	55	1958–2012	0	--	0	U
54	06030500	Boulder River above Rock Creek, near Basin, Montana	46.2543	-112.5009	CONT	24.4	--	--	U	12	1947–53, 1955–57, 1975, 1981	12	1947–53, 1955–57, 1975, 1981	0	--	0	U
55	06031950	Cataract Creek near Basin, Montana	46.2864	-112.2434	CSG	30.5	--	--	U	45	1973–2017	45	1973–2017	0	--	0	U
56	06033000	Boulder River near Boulder, Montana	46.2110	-112.0917	CONT	381	--	--	U	78	1929–32, 1934–72, 1975, 1981, 1985–2017	78	1929–32, 1934–72, 1975, 1981, 1985–2017	0	--	3	U
96	06058700	Mitchell Gulch near East Helena, Montana	46.5713	-111.8235	CSG	7.93	--	--	U	45	1959–2003	45	1959–2003	0	--	0	U
97	06061500	Prickly Pear Creek near Clancy, Montana	46.5191	-111.9468	CONT	192	--	--	U	77	1911–16, 1923–33, 1946–53, 1955–69, 1975, 1979–2002, 2006–17	77	1911–16, 1923–33, 1946–53, 1955–69, 1975, 1979–2002, 2006–17	0	--	0	U
98	06061700	Jackson Creek near East Helena, Montana	46.4718	-111.8531	CSG	3.45	--	--	U	18	1961–75, 1981, 1989–90	18	1961–75, 1981, 1989–90	0	--	0	U
99	06061800	Crystal Creek near East Helena, Montana	46.4832	-111.8610	CSG	3.90	--	--	U	18	1961–75, 1981, 1989–90	18	1961–75, 1981, 1989–90	0	--	0	U
100	06061900	McClellan Creek near East Helena, Montana	46.5331	-111.8791	CSG	33.3	--	--	U	19	1960–75, 1981, 1989–90	19	1960–75, 1981, 1989–90	0	--	0	U

[1]Abbreviations for type of streamgage are defined as follows:

CONT: continuous streamflow operations.

CSG: crest-stage gage operations.

In cases where both CONT and CSG are indicated for an individual streamgage, the historic operations of the streamgage have included periods of continuous streamflow operations and periods of crest-stage gage operations.

[2]Data combination refers to combining peak-flow records of two or more closely located streamgages on the same channel. Information on combining records of multiple streamgages is presented in table 1–2.

[3]Data correction refers to manual adjustment of specific peak-flow records to provide reliable frequency analyses. Information on manual correction of peak-flow records is presented in table 1–3.

[4]Abbreviations for regulation status are defined as follows:

U, unregulated, where the cumulative drainage area upstream from all dams is less than 20 percent of the drainage area of the streamgage.

R (MAJ–dam): major dam regulation, where a single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.

R (MAJ–canal): major diversion canal regulation, where a large diversion canal is known to be located on the channel upstream from the streamgage.

R (MIN–dams): minor dam regulation, where the cumulative drainage area of all upstream dams exceeds 20 percent of the drainage area of the streamgage, but no single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.

Total: the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation, . The "Total" peak-flow frequency analysis is provided in cases where major regulation affects less than 50 percent of the drainage area of the streamgage and there is uncertainty in the effects of regulation on specific peak-flow characteristics. Also, the "Total" peak-flow frequency analysis is the only peak-flow frequency analysis provided in cases of minor dam regulation.

Table 1–2. Information on data combination by combining records of multiple streamgages.

[Data combination was not applicable for any of the streamgages. Table 1-2 is included in this data release as a placeholder for consistency among similar data releases.]

Table 1–3. Information on data correction of specific peak-flow records.

[Data correction was not applicable for any of the streamgages. Table 1-3 is included in this data release as a placeholder for consistency among similar data releases.]

Table 1–4. Documentation regarding analytical procedures for peak-flow frequency analyses.

[Water year is the 12-month period from October 1 through September 30 and is designated by the year in which it ends. PILF, potentially influential low flow; U, unregulated; --, not applicable; R, regulated; MGBT, multiple Grubbs-Beck test; BP, base period used in the Maintenance of Variance Extension Type III record extension]

Map number (fig. 1; McCarthy and others, 2016)	Streamgage identification number and analysis designation[1]	Streamgage name	Contributing drainage area, in square miles	Regulation status for analysis[2]	Type of peak-flow frequency analysis[3]	Number of peak flows used in the analysis	Water years of peak flows used in the analysis	Primary reason for deviation from standard Bulletin 17C procedures[4]	Log-distribution information for peak-flow data							PILF information				Frequency analysis incorporates historical information? (if Yes, see Table 1-5 for additional information)
									Mean	Standard deviation	Skew type used in analysis	Station skew of the peak-flow data	Generalized skew	Source of generalized skew used in weighted skew determinations	Analysis skew used for the frequency analysis	PILF threshold, cubic feet per second	Type of PILF threshold	Number of systematic peak flows equal to zero	Number of non-zero systematic peak flows less than PILF threshold	
50	06027700.00	Fish Creek near Silver Star, Montana	39.0	U	At-site	33	1959–91	--	2.086	0.192	Weighted	-0.572	-0.070	Bulletin 17B	-0.380	52	MGBT	0	1	--
50	06027700.03	Fish Creek near Silver Star, Montana	39.0	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
51	06029000.10	Whitetail Creek near Whitehall, Montana	30.4	R (MAJ–dam)	At-site	19	1950–53, 1955–68, 1981	--	1.819	0.198	Weighted	-0.472	0.004	Bulletin 17B	-0.256	--	MGBT	0	0	Yes
53	06030300.00	Jefferson River tributary No. 2 near Whitehall, Montana	4.51	U	At-site	55	1958–2012	lower tail	0.581	1.405	Station	-0.819	0.018	--	-0.819	1	Manual	17	0	--
53	06030300.03	Jefferson River tributary No. 2 near Whitehall, Montana	4.51	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
54	06030500.00	Boulder River above Rock Creek, near Basin, Montana	24.4	U	At-site	12	1947–53, 1955–57, 1975, 1981	--	2.195	0.309	Weighted	0.813	0.002	Bulletin 17B	0.141	--	MGBT	0	0	Yes
54	06030500.01	Boulder River above Rock Creek, near Basin, Montana	24.4	U	MOVE.3	78	BP 1929–32, 1934–72, 1975, 1981, 1985–2017	upper tail	2.095	0.324	Station	0.320	0.002	--	0.320	49	Manual	0	7	Yes
55	06031950.00	Cataract Creek near Basin, Montana	30.5	U	At-site	45	1973–2017	upper tail	2.439	0.226	Station	1.960	0.065	--	1.960	146	Manual	0	2	Yes
55	06031950.03	Cataract Creek near Basin, Montana	30.5	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
56	06033000.00	Boulder River near Boulder, Montana	381	U	At-site	78	1929–32, 1934–72, 1975, 1981, 1985–2017	upper tail	3.039	0.227	Station	0.699	0.079	--	0.699	662	Manual	0	13	Yes
56	06033000.03	Boulder River near Boulder, Montana	381	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
96	06058700.00	Mitchell Gulch near East Helena, Montana	7.93	U	At-site	45	1959–2003	lower tail	0.914	1.086	Station	-0.949	0.188	--	-0.949	2	Manual	10	1	--
96	06058700.03	Mitchell Gulch near East Helena, Montana	7.93	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
97	06061500.00	Prickly Pear Creek near Clancy, Montana	192	U	At-site	77	1911–16, 1923–33, 1946–53, 1955–69, 1975, 1979–2002, 2	upper tail	2.418	0.250	Station	0.837	0.172	--	0.837	100	Manual	0	2	Yes
97	06061500.03	Prickly Pear Creek near Clancy, Montana	192	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
98	06061700.00	Jackson Creek near East Helena, Montana	3.45	U	At-site	18	1961–75, 1981, 1989–90	upper tail	1.195	0.407	Station	1.279	0.167	--	1.279	--	MGBT	0	0	Yes
98	06061700.03	Jackson Creek near East Helena, Montana	3.45	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
99	06061800.00	Crystal Creek near East Helena, Montana	3.90	U	At-site	18	1961–75, 1981, 1989–90	--	1.119	0.422	Weighted	-0.211	0.168	Bulletin 17B	-0.042	--	MGBT	0	0	Yes
99	06061800.03	Crystal Creek near East Helena, Montana	3.90	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
100	06061900.00	McClellan Creek near East Helena, Montana	33.3	U	At-site	19	1960–75, 1981, 1989–90	upper tail	2.227	0.312	Station	0.957	0.178	--	0.957	72	Manual	0	2	Yes
100	06061900.03	McClellan Creek near East Helena, Montana	33.3	U	RRE wtd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[1]The streamgage identification number and analysis designation is defined by XXXXXXXX.AB,
where,
XXXXXXXX is the streamgage identification number;
A is the regulation status for the analysis period; and
B is the type of peak-flow frequency analysis.

Values of A (regulation status) are defined as:
A = 0, unregulated;
A = 1, regulated by major regulation; and
A =2, total; that is, the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation (see footnote 2).

Values of B (type of peak-flow frequency analysis) are defined as:
B = 0, at-site peak-flow frequency analysis conducted on recorded data;
B = 1, peak-flow frequency analysis conducted on combined recorded and synthesized data; synthesized data from Maintenance of Variance Extension Type III (MOVE.3) record extension procedure;
B =2, peak-flow frequency analysis determined from regional regression equations (RREs); RRE frequency results not presented in this report; and
B = 3, at-site peak-flow frequency analysis weighted with results from RREs; distributional parameters not available for RRE weighted frequency analyses.

[2]Abbreviations for regulation status are defined as follows:
U, unregulated, where the cumulative drainage area upstream from all dams is less than 20 percent of the drainage area of the streamgage.
R (MAJ–dam): major dam regulation, where a single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
R (MAJ–canal): major diversion canal regulation, where a large diversion canal is known to be located on the channel upstream from the streamgage.
R (MIN–dams): minor dam regulation, where the cumulative drainage area of all upstream dams exceeds 20 percent of the drainage area of the streamgage, but no single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
Total: the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation, . The "Total" peak-flow frequency analysis is provided in cases where major regulation affects less than 50 percent of the drainage area of the streamgage and there is uncertainty in the effects of regulation on specific peak-flow characteristics. Also, the "Total" peak-flow frequency analysis is the only peak-flow frequency analysis provided in cases of minor dam regulation.

[3]Abbreviations for type of frequency analysis are defined as follows:
At-site: peak-flow frequency analysis on recorded data.
RRE wtd: the at-site peak-flow frequency analysis was weighted with results from regional regression equations (RREs).
MOVE.3: peak-flow frequency analysis on combined recorded and synthesized data; synthesized data from Maintenance of Variance Extension Type III (MOVE.3) record extension procedure.

[4]Standard Bulletin 17C (England and others, 2017) procedures are considered to be the use of the weighted skew and the use of the multiple Grubbs-Beck low-outlier test (MGBT) for identifying PILFs. In cases where either the station skew or a manual (analyst-selected) PILF threshold was used, the peak-flow frequency analysis was considered to deviate from standard Bulletin 17C procedures. The abbreviations for the reasons for deviation from standard Bulletin 17C procedures are defined as follows:
reg: the peak-flow records are affected by major dam or canal regulation;
upper tail: the probability plots of the peak-flow records deviate from typical patterns in the upper tail of the frequency curve, generally because of mixed population characteristics; and
lower tail: the probability plots of the peak-flow records deviate from typical patterns in the lower tail of the frequency curve at high annual exceedance probabilities (greater than about 50.0 percent).
[5]U.S. Interagency Advisory Council on Water Data, 1982, Guidelines for determining flood flow frequency: Hydrology Subcommittee, Bulletin 17B, appendixes 1–14, 28 p.

England, J.F. Jr., Cohn, T.A., Faber, B.A., Stedinger, J.R., Thomas Jr., W.O., Veilleux, A.G., Kiang, J.E., and Mason, R.R., 2017, Guidelines for Determining Flood Flow Frequency – Bulletin 17C: U.S. Geological Survey Techniques and Methods book 4, chap. B5, XXX p., https://dx.doi.org/10.3133/tm4–B5/, accessed October 2, 2017 at https://acwi.gov/hydrology/Frequency/b17c/bulletin17c-draft-for-soh-31Aug2017.pdf.

Table 1–5. Documentation regarding incorporating historical information in applicable at-site peak-flow frequency analyses.

[Water year is the 12-month period from October 1 through September 30 and is designated by the year in which it ends. U, unregulated; --, not applicable]

Map number (fig. 1; McCarthy and others, 2016)	Streamgage identification number and analysis designation[1]	Streamgage name	Contributing drainage area, in square miles	Regulation status for analysis[2]	Number of peak flows used in the analysis	Water years of peak flows used in the analysis	Information on peak flows used to define perception thresholds (and associated flow intervals) in ungaged historical periods				
							Number of peak flows used for perception thresholds	Water year of peak flow used for perception threshold	Peak flow used for perception threshold, in cubic feet per second	Number of years in the associated ungaged historical period	Associated ungaged historical period, in water years
51	06029000.10	Whitetail Creek near Whitehall, Montana	30.4	R (MAJ–dam)	19	1950–53, 1955–68, 1981	2	1951	126	1	1954
								1981	142	13	1969–81
54	06030500.00	Boulder River above Rock Creek, near Basin, Montana	24.4	U	12	1947–53, 1955–57, 1975, 1981	3	1948	582	1	1954
								1975	400	18	1958–75
								1981	1,020	42	1976–2017
54	06030500.01	Boulder River above Rock Creek, near Basin, Montana	24.4	U	78	BP 1929–32, 1934–72, 1975, 1981, 1985–2017	2	1975	400	13	1933, 1973–84
								1981	1,020	20	1909–28
55	06031950.00	Cataract Creek near Basin, Montana	30.50	U	45	1973–2017	1	1981	3,150	64	1909–72
56	06033000.00	Boulder River near Boulder, Montana	381	U	78	1929–32, 1934–72, 1975, 1981, 1985–2017	2	1975	3,500	13	1933, 1973–84
								1981	7,000	20	1909–28
97	06061500.00	Prickly Pear Creek near Clancy, Montana	192	U	77	1911–16, 1923–33, 1946–53, 1955–69, 1975, 1979–2002, 2006–17	1	1975	1,200	33	1909–10, 1917–22, 1934–45, 1954, 1970–78, 2003–05
98	06061700.00	Jackson Creek near East Helena, Montana	3.45	U	18	1961–75, 1981, 1989–90	2	1981	111	13	1976–88
								1990	380	21	1991–2011
99	06061800.00	Crystal Creek near East Helena, Montana	3.90	U	18	1961–75, 1981, 1989–90	1	1981	72	13	1976–88
100	06061900.00	McClellan Creek near East Helena, Montana	33.3	U	19	1960–75, 1981, 1989–90	1	1981	1,730	40	1976–88, 1991–2017

[1]The streamgage identification number and analysis designation is defined by XXXXXXXX.AB,
where,
XXXXXXXX is the streamgage identification number;
A is the regulation status for the analysis period; and
B is the type of peak-flow frequency analysis.

Values of A (regulation status) are defined as:
A = 0, unregulated;
A = 1, regulated by major regulation; and
A =2, total; that is, the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation (see footnote 2).

Values of B (type of peak-flow frequency analysis) are defined as:
B = 0, at-site peak-flow frequency analysis conducted on recorded data;
B = 1, peak-flow frequency analysis conducted on combined recorded and synthesized data; synthesized data from Maintenance of Variance Extension Type III (MOVE.3) record extension procedure;
B =2, peak-flow frequency analysis determined from regional regression equations (RREs); RRE frequency results not presented in this report; and
B = 3, at-site peak-flow frequency analysis weighted with results from RREs; distributional parameters not available for RRE weighted frequency analyses.

[2]Abbreviations for regulation status are defined as follows:
U, unregulated, where the cumulative drainage area upstream from all dams is less than 20 percent of the drainage area of the streamgage.
R (MAJ–dam): major dam regulation, where a single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
R (MAJ–canal): major diversion canal regulation, where a large diversion canal is known to be located on the channel upstream from the streamgage.
R (MIN–dams): minor dam regulation, where the cumulative drainage area of all upstream dams exceeds 20 percent of the drainage area of the streamgage, but no single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
Total: the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation, . The "Total" peak-flow frequency analysis is provided in cases where major regulation affects less than 50 percent of the drainage area of the streamgage and there is uncertainty in the effects of regulation on specific peak-flow characteristics. Also, the "Total" peak-flow frequency analysis is the only peak-flow frequency analysis provided in cases of minor dam regulation.

Table 1–6. Documentation regarding the Maintenance of Variance Type III (MOVE.3) record extension procedure for selected streamgages.

[Water year is the 12-month period from October 1 through September 30 and is designated by the year in which it ends. SEP, standard error of prediction, in percent; --, not applicable]

Target streamgage for which peak streamflows were synthesized									Index streamgage(s) used for synthesis of peak streamflows								
Map number (fig. 1; McCarthy and others, 2016)	Streamgage identification number	Streamgage Name	Contributing drainage area, in square miles	Number of recorded peak-flows	Water years of recorded peak flows	Number of years requiring synthesis of peak flows	Water years requiring synthesis of peak flows	Percentage of record synthesized	Streamgage identification number	Streamgage Name	Contributing drainage area, in square miles	Number of peak flows synthesized based on this streamgage	Number of concurrent recorded peak flows for target and index streamgages	Pearson correlation coefficient for concurrent data for target and index streamgage	Weighted average Pearson correlation coefficient[1]	Estimated[2] standard error of MOVE.3 analysis, in percent	Effective record length for the synthesized peak flows, in years
Streamgage on the Boulder River—base period 1929–32, 1934–72, 1975, 1981, 1985–2017 (78 years)																	
54	06030500	Boulder River above Rock Creek, near Basin, Montana	24.4	12	1947–53, 1955–57, 1975, 1981	66	1929–32, 1934–46, 1985–2017	84.6	06033000	Boulder River near Boulder, Montana	381	66	12	0.84	0.84	56.5	5.6

[1]The weighted average Pearson correlation coefficient was determined by multiplying the number of peak flows synthesized based on an index streamgage times the Pearson correlation coefficent for the index streamgage for each index streamgage. The resultant products then were summed and divided by the total number of synthesized peak flows.

[2]A standard error was calculated based on an ordinary least squares (OLS) formulation of the analysis. That OLS standard error was adjusted to an estimated MOVE.3 formulation by multiplying times the following adjustment factor (Wilbert O. Thomas, Michael Baker International, written commun., November 2016):

$AF = 2/(1+\rho)$,

where,

AF is the adjustment factor; and

ρ is the weighted average Pearson correlation coefficient.

Table 1–7. Peak-flow frequency results.

[Water year is the 12-month period from October 1 through September 30 and is designated by the year in which it ends. U, unregulated; R, regulated; --, not applicable; BP, base period used in the Maintenance of Variance Type III record extension]

Map number (fig. 1; McCarthy and others, 2016))	Streamgage identification number and analysis designation[1]	Streamgage name	Contributing drainage area, in square miles	Regulation status for analysis[2]	Type of peak-flow frequency analysis[3]	Number of peak flows used in the analysis	Water years of peak flows used in the analysis	Frequency analysis incorporates historical information? (if Yes, see Table 1-5 for additional information)	Annual peak flow, in cubic feet per second, for indicated annual exceedance probability, in percent									84 percent confidence level for the 1 percent annual exceedance probability peak flow
									50	42.9	20	10	4	2	1	0.5	0.2	
50	06027700.00	Fish Creek near Silver Star, Montana	39.0	U	At-site	33	1959–91	--	125	135	178	210	249	276	301	326	356	395
50	06027700.03	Fish Creek near Silver Star, Montana	39.0	U	RRE wtd	--	--	--	125	135	178	212	252	282	311	340	380	358
51	06029000.10	Whitetail Creek near Whitehall, Montana	30.4	R (MAJ–dam)	At-site	19	1950–53, 1955–68, 1981	Yes	67	73	97	116	140	158	174	191	212	240
53	06030300.00	Jefferson River tributary No. 2 near Whitehall, Montana	4.51	U	At-site	55	1958–2012	--	5.9	10	61	164	402	664	990	1,370	1,950	2,980
53	06030300.03	Jefferson River tributary No. 2 near Whitehall, Montana	4.51	U	RRE wtd	--	--	--	7.4	12	53	122	253	366	490	617	793	760
54	06030500.00	Boulder River above Rock Creek, near Basin, Montana	24.4	U	At-site	12	1947–53, 1955–57, 1975, 1981	Yes	154	175	283	393	562	711	880	1,070	1,370	1,430
54	06030500.01	Boulder River above Rock Creek, near Basin, Montana	24.4	U	MOVE.3	78	BP 1929–32, 1934–72, 1975, 1981, 1985–2017	Yes	120	137	230	331	497	653	840	1,060	1,430	3,250
55	06031950.00	Cataract Creek near Basin, Montana	30.5	U	At-site	45	1973–2017	Yes	235	254	379	543	872	1,250	1,780	2,540	4,080	3,210
55	06031950.03	Cataract Creek near Basin, Montana	30.5	U	RRE wtd	--	--	--	232	250	367	515	774	1,000	1,240	1,470	1,760	1,710
56	06033000.00	Boulder River near Boulder, Montana	381	U	At-site	78	1929–32, 1934–72, 1975, 1981, 1985–2017	Yes	1,030	1,130	1,650	2,190	3,050	3,840	4,770	5,880	7,650	7,860
56	06033000.03	Boulder River near Boulder, Montana	381	U	RRE wtd	--	--	--	1,030	1,130	1,650	2,180	2,990	3,700	4,460	5,290	6,450	5,540
96	06058700.00	Mitchell Gulch near East Helena, Montana	7.93	U	At-site	45	1959–2003	--	12	18	69	141	263	368	476	585	724	1,150
96	06058700.03	Mitchell Gulch near East Helena, Montana	7.93	U	RRE wtd	--	--	--	13	20	68	135	250	351	464	587	771	676
97	06061500.00	Prickly Pear Creek near Clancy, Montana	192	U	At-site	77	1911–16, 1923–33, 1946–53, 1955–69, 1975, 1979–2002, 2006–17	Yes	242	268	410	566	830	1,090	1,400	1,800	2,470	2,390
97	06061500.03	Prickly Pear Creek near Clancy, Montana	192	U	RRE wtd	--	--	--	243	270	415	578	865	1,150	1,520	1,970	2,710	1,930
98	06061700.00	Jackson Creek near East Helena, Montana	3.45	U	At-site	18	1961–75, 1981, 1989–90	Yes	13	15	31	55	113	189	314	516	983	1,400
98	06061700.03	Jackson Creek near East Helena, Montana	3.45	U	RRE wtd	--	--	--	13	15	30	52	94	134	178	224	290	293
99	06061800.00	Crystal Creek near East Helena, Montana	3.90	U	At-site	18	1961–75, 1981, 1989–90	Yes	13	16	30	45	71	94	122	154	205	274
99	06061800.03	Crystal Creek near East Helena, Montana	3.90	U	RRE wtd	--	--	--	13	16	30	46	74	100	132	169	231	190
100	06061900.00	McClellan Creek near East Helena, Montana	33.3	U	At-site	19	1960–75, 1981, 1989–90	Yes	151	171	292	442	727	1,030	1,450	2,010	3,070	3,980
100	06061900.03	McClellan Creek near East Helena, Montana	33.3	U	RRE wtd	--	--	--	146	165	277	413	646	856	1,090	1,350	1,720	1,620

[1]The streamgage identification number and analysis designation is defined by XXXXXXXX.AB,
where,
XXXXXXXX is the streamgage identification number;
A is the regulation status for the analysis period; and
B is the type of peak-flow frequency analysis.

Values of A (regulation status) are defined as:
A = 0, unregulated;
A = 1, regulated by major regulation; and
A =2, total; that is, the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation (see footnote 2).

Values of B (type of peak-flow frequency analysis) are defined as:
B = 0, at-site peak-flow frequency analysis conducted on recorded data;
B = 1, peak-flow frequency analysis conducted on combined recorded and synthesized data; synthesized data from Maintenance of Variance Extension Type III (MOVE.3) record extension procedure;
B =2, peak-flow frequency analysis determined from regional regression equations (RREs); RRE frequency results not presented in this report; and
B = 3, at-site peak-flow frequency analysis weighted with results from RREs; distributional parameters not available for RRE weighted frequency analyses.

[2]Abbreviations for regulation status are defined as follows:
U, unregulated, where the cumulative drainage area upstream from all dams is less than 20 percent of the drainage area of the streamgage.
R (MAJ–dam): major dam regulation, where a single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
R (MAJ–canal): major diversion canal regulation, where a large diversion canal is known to be located on the channel upstream from the streamgage.
R (MIN–dams): minor dam regulation, where the cumulative drainage area of all upstream dams exceeds 20 percent of the drainage area of the streamgage, but no single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
Total: the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation, . The "Total" peak-flow frequency analysis is provided in cases where major regulation affects less than 50 percent of the drainage area of the streamgage and there is uncertainty in the effects of regulation on specific peak-flow characteristics. Also, the "Total" peak-flow frequency analysis is the only peak-flow frequency analysis provided in cases of minor dam regulation.

[3]Abbreviations for type of frequency analysis are defined as follows:
At-site: peak-flow frequency analysis on recorded data.
RRE wtd: the at-site peak-flow frequency analysis was weighted with results from regional regression equations (RREs).
MOVE.3: peak-flow frequency analysis on combined recorded and synthesized data; synthesized data from Maintenance of Variance Extension Type III (MOVE.3) record extension procedure.

Table 1–8. Variance of peak-flow frequency estimates.

[Water year is the 12-month period from October 1 through September 30 and is designated by the year in which it ends. U, unregulated; R, regulated; --, not applicable; BP, base period used in the Maintenance of Variance Type III record extension]

Map number (fig. 1; McCarthy and others, 2016))	Streamgage identification number and analysis designation[1]	Streamgage name	Contributing drainage area, in square miles	Regulation status for analysis[2]	Type of peak-flow frequency analysis[3]	Number of peak flows used in the analysis	Water years of peak flows used in the analysis	Frequency analysis incorporates historical information? (if Yes, see Table 1-5 for additional information)	Variance, in base 10 logarithm, for indicated annual exceedance probability, in percent								
									50	42.9	20	10	4	2	1	0.5	0.2
50	06027700.00	Fish Creek near Silver Star, Montana	39.0	U	At-site	33	1959–91	--	0.0012	0.0012	0.0012	0.0015	0.0022	0.0030	0.0040	0.0053	0.0074
50	06027700.03	Fish Creek near Silver Star, Montana	39.0	U	RRE wtd	--	--	--	0.0012	0.0012	0.0012	0.0015	0.0021	0.0029	0.0038	0.0050	0.0068
51	06029000.10	Whitetail Creek near Whitehall, Montana	30.4	R (MAJ–dam)	At-site	19	1950–53, 1955–68, 1981	Yes	0.0022	0.0021	0.0020	0.0023	0.0031	0.0041	0.0055	0.0072	0.0099
53	06030300.00	Jefferson River tributary No. 2 near Whitehall, Montana	4.51	U	At-site	55	1958–2012	--	0.0448	0.0381	0.0306	0.0330	0.0412	0.0511	0.0644	0.0807	0.1066
53	06030300.03	Jefferson River tributary No. 2 near Whitehall, Montana	4.51	U	RRE wtd	--	--	--	0.0329	0.0285	0.0228	0.0234	0.0272	0.0313	0.0365	0.0424	0.0507
54	06030500.00	Boulder River above Rock Creek, near Basin, Montana	24.4	U	At-site	12	1947–53, 1955–57, 1975, 1981	Yes	0.0077	0.0073	0.0066	0.0071	0.0091	0.0118	0.0156	0.0205	0.0288
54	06030500.01	Boulder River above Rock Creek, near Basin, Montana	24.4	U	MOVE.3	78	BP 1929–32, 1934–72, 1975, 1981, 1985–2017	Yes	0.0017	0.0018	0.0023	0.0030	0.0054	0.0085	0.0128	0.0185	0.0283
55	06031950.00	Cataract Creek near Basin, Montana	30.5	U	At-site	45	1973–2017	Yes	0.0014	0.0019	0.0032	0.0046	0.0090	0.0157	0.0263	0.0412	0.0684
55	06031950.03	Cataract Creek near Basin, Montana	30.5	U	RRE wtd	--	--	--	0.0014	0.0019	0.0031	0.0043	0.0080	0.0129	0.0196	0.0274	0.0385
56	06033000.00	Boulder River near Boulder, Montana	381	U	At-site	78	1929–32, 1934–72, 1975, 1981, 1985–2017	Yes	0.0008	0.0009	0.0013	0.0019	0.0037	0.0062	0.0099	0.0149	0.0237
56	06033000.03	Boulder River near Boulder, Montana	381	U	RRE wtd	--	--	--	0.0008	0.0009	0.0013	0.0019	0.0035	0.0057	0.0088	0.0126	0.0187
96	06058700.00	Mitchell Gulch near East Helena, Montana	7.93	U	At-site	45	1959–2003	--	0.0315	0.0269	0.0201	0.0202	0.0245	0.0304	0.0385	0.0484	0.0636
96	06058700.03	Mitchell Gulch near East Helena, Montana	7.93	U	RRE wtd	--	--	--	0.0253	0.0219	0.0165	0.0163	0.0190	0.0225	0.0271	0.0323	0.0397
97	06061500.00	Prickly Pear Creek near Clancy, Montana	192	U	At-site	77	1911–16, 1923–33, 1946–53, 1955–69, 1975, 1979–2002, 2006–17	Yes	0.0011	0.0012	0.0016	0.0024	0.0048	0.0080	0.0125	0.0184	0.0286
97	06061500.03	Prickly Pear Creek near Clancy, Montana	192	U	RRE wtd	--	--	--	0.0011	0.0012	0.0016	0.0023	0.0045	0.0072	0.0108	0.0151	0.0217
98	06061700.00	Jackson Creek near East Helena, Montana	3.45	U	At-site	18	1961–75, 1981, 1989–90	Yes	0.0141	0.0163	0.0209	0.0240	0.0394	0.0654	0.1072	0.1671	0.2769
98	06061700.03	Jackson Creek near East Helena, Montana	3.45	U	RRE wtd	--	--	--	0.0127	0.0143	0.0169	0.0185	0.0263	0.0360	0.0470	0.0579	0.0712
99	06061800.00	Crystal Creek near East Helena, Montana	3.90	U	At-site	18	1961–75, 1981, 1989–90	Yes	0.0106	0.0105	0.0113	0.0140	0.0203	0.0275	0.0368	0.0483	0.0671
99	06061800.03	Crystal Creek near East Helena, Montana	3.90	U	RRE wtd	--	--	--	0.0098	0.0096	0.0100	0.0119	0.0162	0.0205	0.0256	0.0313	0.0395
100	06061900.00	McClellan Creek near East Helena, Montana	33.3	U	At-site	19	1960–75, 1981, 1989–90	Yes	0.0069	0.0079	0.0107	0.0129	0.0200	0.0305	0.0468	0.0696	0.1109
100	06061900.03	McClellan Creek near East Helena, Montana	33.3	U	RRE wtd	--	--	--	0.0065	0.0074	0.0095	0.0110	0.0157	0.0216	0.0292	0.0377	0.0493

[1]The streamgage identification number and analysis designation is defined by XXXXXXXX.AB,
where,
XXXXXXXX is the streamgage identification number;
A is the regulation status for the analysis period; and
B is the type of peak-flow frequency analysis.

Values of A (regulation status) are defined as:
A = 0, unregulated;
A = 1, regulated by major regulation; and
A =2, total; that is, the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation (see footnote 2).

Values of B (type of peak-flow frequency analysis) are defined as:
B = 0, at-site peak-flow frequency analysis conducted on recorded data;
B = 1, peak-flow frequency analysis conducted on combined recorded and synthesized data; synthesized data from maintenance of variance type III (MOVE.3) record extension procedure;
B =2, peak-flow frequency analysis determined from regional regression equations (RREs); RRE frequency results not presented in this report; and
B = 3, at-site peak-flow frequency analysis weighted with results from RREs; distributional parameters not available for RRE weighted frequency analyses.

[2]Abbreviations for regulation status are defined as follows:
U, unregulated, where the cumulative drainage area upstream from all dams is less than 20 percent of the drainage area of the streamgage.
R (MAJ–dam): major dam regulation, where a single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
R (MAJ–canal): major diversion canal regulation, where a large diversion canal is known to be located on the channel upstream from the streamgage.
R (MIN–dams): minor dam regulation, where the cumulative drainage area of all upstream dams exceeds 20 percent of the drainage area of the streamgage, but no single upstream dam has a drainage area that exceeds 20 percent of the drainage area of the streamgage.
Total: the combined unregulated and regulated peak-flow records for streamgages with peak-flow records before and after the start of regulation, . The "Total" peak-flow frequency analysis is provided in cases where major regulation affects less than 50 percent of the drainage area of the streamgage and there is uncertainty in the effects of regulation on specific peak-flow characteristics. Also, the "Total" peak-flow frequency analysis is the only peak-flow frequency analysis provided in cases of minor dam regulation.

[3]Abbreviations for type of frequency analysis are defined as follows:
At-site: peak-flow frequency analysis on recorded data.
RRE wtd: the at-site peak-flow frequency analysis was weighted with results from regional regression equations (RREs).
MOVE.3: peak-flow frequency analysis on combined recorded and synthesized data; synthesized data from maintenance of variance type III (MOVE.3) record extension procedure.

```
1
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.013.000
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

                         --- PROCESSING OPTIONS ---

                      Plot option         = Graphics device
                      Basin char output   = WATSTORE
                      Print option        = Yes
                      Debug print         = No
                      Input peaks listing = Long
                      Input peaks format  = WATSTORE peak file

                      Input files used:
                         peaks (ascii)  -
                         P:\GageSpecific_FloodFreqs\wymt_ffa_2017A\WYMT_FFA_2017A_WATSTOR
                         E.TXT
                         specifications -
                         P:\GageSpecific_FloodFreqs\wymt_ffa_2017A\PKFQWPSF.TMP

                      Output file(s):
                         main -
                         P:\GageSpecific_FloodFreqs\wymt_ffa_2017A\WYMT_FFA_2017A.PRT

                         bcd  -
                         P:\GageSpecific_FloodFreqs\wymt_ffa_2017A\WYMT_FFA_2017A.BCD


1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.001
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

             Station - 06027700.00  Fish Creek near Silver Star MT


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

                Number of peaks in record            =       33
                Peaks not used in analysis           =        0
                Systematic peaks in analysis         =       33
                Historic peaks in analysis           =        0
                Beginning Year                       =     1959
                Ending Year                          =     1991
                Historical Period Length             =       33
                Generalized skew                     =   -0.070
                     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                           EMA
                PILF (LO) Test Method                     MGBT
                Perception Thresholds:
                     Begin     End       Low     High     Comment
                      1959    1991       0.0       INF
                      DEFAULT

                Interval Data                    =   None Specified
```

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

  WCF002J-CALCS COMPLETED.  RETURN CODE =  2
  EMA003I-PILFS (LOS) WERE DETECTED USING MULTIPLE GRUBBS-BECK TEST   1      52.0
    THE FOLLOWING PEAKS (WITH CORRESPONDING P-VALUES) WERE CENSORED:
          28.0    (0.0154)
  EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                        Kendall's Tau Parameters

                                                          MEDIAN   No. of
                                        TAU    P-VALUE    SLOPE   PEAKS
                                  ---------------------------------------
              SYSTEMATIC RECORD     -0.152      0.221     -1.245    33


1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.002
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

              Station - 06027700.00  Fish Creek near Silver Star MT


            ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                      LOGARITHMIC
                           -------------------------------
                                        STANDARD
                              MEAN     DEVIATION     SKEW
                           -------------------------------
 EMA W/O REG. INFO          2.0855      0.1935     -0.572
 EMA W/REG. INFO            2.0859      0.1923     -0.380

 EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.2021
 EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.2021



    ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

   ANNUAL   EMA W/    EMA W/O     <------ FOR EMA ESTIMATES -------->
EXCEEDANCE  REG INFO  REG INFO    VARIANCE  95% CONFIDENCE INTERVALS
PROBABILITY ESTIMATE  ESTIMATE     OF EST.       LOWER       UPPER

   0.9950      33.3      30.5      0.0144        11.1         47.6
   0.9900      38.5      36.0      0.0107        14.8         52.7
   0.9500      56.3      54.8      0.0046        31.6         70.3
   0.9000      68.1      67.4      0.0030        45.3         82.7
   0.8000      84.8      85.2      0.0019        64.8        101.0
   0.6667     103.2     104.3      0.0015        84.2        121.7
   0.5000     125.3     127.0      0.0012       105.6        147.1
   0.4292     135.4     137.2      0.0012       114.8        158.8
   0.2000     178.0     178.4      0.0012       152.0        212.2
   0.1000     210.5     208.3      0.0015       179.2        261.6
   0.0400     249.1     241.8      0.0022       208.6        334.8
   0.0200     276.0     263.9      0.0030       226.4        396.4
   0.0100     301.4     284.0      0.0040       241.0        464.5
   0.0050     325.8     302.4      0.0053       253.1        540.5
   0.0020     356.5     324.5      0.0074       266.0        656.3
1
```

```
Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.003
Version 7.1         Annual peak flow frequency analysis      Run Date / Time
3/14/2014                                                    11/06/2018 14:25

           Station - 06027700.00  Fish Creek near Silver Star MT


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


  WATER       PEAK   PEAKFQ   <--- Intervals --->
   YEAR      VALUE    CODES     LOW         HIGH   REMARKS
   1959      166.0
   1960      105.0
   1961      160.0
   1962      115.0
   1963      141.0
   1964      150.0
   1965      220.0
   1966       54.0
   1967      228.0
   1968      132.0
   1969      175.0
   1970      100.0
   1971       85.0
   1972      106.0
   1973       73.0
   1974      110.0
   1975      240.0
   1976      185.0
   1977      105.0
   1978      250.0
   1979      110.0
   1980       96.0
   1981      210.0
   1982      140.0
   1983      133.0
   1984      135.0
   1985       52.0
   1986      125.0
   1987      102.0
   1988       28.0
   1989       65.0
   1990      113.0
   1991      170.0


      Explanation of peak discharge qualification codes

     PeakFQ    NWIS
      CODE     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                                                    11/06/2018 14:25

             Station - 06027700.00  Fish Creek near Silver Star MT


   EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

   WATER     RANKED      EMA         INTERVALS
    YEAR   DISCHARGE   ESTIMATE      LOW      HIGH
    1978      250.0     0.0293
    1975      240.0     0.0587
    1967      228.0     0.0881
    1965      220.0     0.1175
    1981      210.0     0.1470
    1976      185.0     0.1764
    1969      175.0     0.2058
    1991      170.0     0.2352
    1959      166.0     0.2646
    1961      160.0     0.2941
    1964      150.0     0.3235
    1963      141.0     0.3529
    1982      140.0     0.3823
    1984      135.0     0.4117
    1983      133.0     0.4412
    1968      132.0     0.4706
    1986      125.0     0.5000
    1962      115.0     0.5294
    1990      113.0     0.5588
    1974      110.0     0.6177
    1979      110.0     0.5883
    1972      106.0     0.6471
    1960      105.0     0.7059
    1977      105.0     0.6765
    1987      102.0     0.7354
    1970      100.0     0.7648
    1980       96.0     0.7942
    1971       85.0     0.8236
    1973       73.0     0.8530
    1989       65.0     0.8825
    1966       54.0     0.9119
    1985       52.0     0.9413
  * 1988       28.0     0.9707

    * DENOTES PILF (LO)

1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.005
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

             Station - 06027700.00  Fish Creek near Silver Star MT


                         EMA REPRESENTATION OF DATA

  WATER <----- OBSERVED-----><-------- EMA -------><-PERCEPTION THRESHOLDS->
   YEAR    Q_LOWER    Q_UPPER    Q_LOWER    Q_UPPER         LOWER       UPPER
   1959      166.0      166.0      166.0      166.0          52.0         INF
```

```
     1960      105.0      105.0      105.0      105.0         52.0        INF
     1961      160.0      160.0      160.0      160.0         52.0        INF
     1962      115.0      115.0      115.0      115.0         52.0        INF
     1963      141.0      141.0      141.0      141.0         52.0        INF
     1964      150.0      150.0      150.0      150.0         52.0        INF
     1965      220.0      220.0      220.0      220.0         52.0        INF
     1966       54.0       54.0       54.0       54.0         52.0        INF
     1967      228.0      228.0      228.0      228.0         52.0        INF
     1968      132.0      132.0      132.0      132.0         52.0        INF
     1969      175.0      175.0      175.0      175.0         52.0        INF
     1970      100.0      100.0      100.0      100.0         52.0        INF
     1971       85.0       85.0       85.0       85.0         52.0        INF
     1972      106.0      106.0      106.0      106.0         52.0        INF
     1973       73.0       73.0       73.0       73.0         52.0        INF
     1974      110.0      110.0      110.0      110.0         52.0        INF
     1975      240.0      240.0      240.0      240.0         52.0        INF
     1976      185.0      185.0      185.0      185.0         52.0        INF
     1977      105.0      105.0      105.0      105.0         52.0        INF
     1978      250.0      250.0      250.0      250.0         52.0        INF
     1979      110.0      110.0      110.0      110.0         52.0        INF
     1980       96.0       96.0       96.0       96.0         52.0        INF
     1981      210.0      210.0      210.0      210.0         52.0        INF
     1982      140.0      140.0      140.0      140.0         52.0        INF
     1983      133.0      133.0      133.0      133.0         52.0        INF
     1984      135.0      135.0      135.0      135.0         52.0        INF
     1985       52.0       52.0       52.0       52.0         52.0        INF
     1986      125.0      125.0      125.0      125.0         52.0        INF
     1987      102.0      102.0      102.0      102.0         52.0        INF
     1988       28.0       28.0        0.0       52.0         52.0        INF
     1989       65.0       65.0       65.0       65.0         52.0        INF
     1990      113.0      113.0      113.0      113.0         52.0        INF
     1991      170.0      170.0      170.0      170.0         52.0        INF
1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.002.001
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

             Station - 06029000.10  Whitetail Creek near Whitehall MT


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

                  Number of peaks in record            =       19
                  Peaks not used in analysis           =        0
                  Systematic peaks in analysis         =       18
                  Historic peaks in analysis           =        1
                  Beginning Year                       =     1950
                  Ending Year                          =     1981
                  Historical Period Length             =       32
                  Generalized skew                     =    0.004
                       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                          EMA
                  PILF (LO) Test Method                     MGBT
                  Perception Thresholds:
                       Begin     End       Low     High     Comment
                        1950    1981       0.0       INF
                        DEFAULT
```

```
                      1954    1954     126.0       INF     1951 HISTORICAL SYSTEMATIC
                      PERIOD 1
                      1969    1981     142.0       INF     1981 HISTORICAL PERIOD
                      1
                 Interval Data                    =   None Specified



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

     EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                        Kendall's Tau Parameters

                                                          MEDIAN   No. of
                                        TAU    P-VALUE    SLOPE   PEAKS
                                  ---------------------------------------
              SYSTEMATIC RECORD      0.020      0.940      0.200    18


  1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.002.002
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

             Station - 06029000.10  Whitetail Creek near Whitehall MT


            ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                     LOGARITHMIC
                          -------------------------------
                                      STANDARD
                             MEAN     DEVIATION     SKEW
                          -------------------------------
  EMA W/O REG. INFO         1.8213      0.1997     -0.472
  EMA W/REG. INFO           1.8192      0.1976     -0.256

  EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.2363
  EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.3156



     ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

    ANNUAL   EMA W/    EMA W/O     <------ FOR EMA ESTIMATES ------->
 EXCEEDANCE  REG INFO  REG INFO    VARIANCE  95% CONFIDENCE INTERVALS
 PROBABILITY ESTIMATE  ESTIMATE     OF EST.       LOWER       UPPER

    0.9950      18.3      16.6      0.0175         5.3         27.6
    0.9900      21.0      19.5      0.0134         7.2         30.4
    0.9500      30.2      29.4      0.0065        16.2         40.2
    0.9000      36.4      36.1      0.0046        22.8         47.1
    0.8000      45.3      45.7      0.0033        32.1         57.2
    0.6667      55.1      56.1      0.0026        41.7         68.7
    0.5000      67.2      68.7      0.0022        52.8         83.0
    0.4292      72.9      74.4      0.0021        57.8         89.7
    0.2000      97.2      98.2      0.0020        78.1        119.7
    0.1000     116.5     116.1      0.0023        93.6        148.5
    0.0400     140.4     136.9      0.0031       111.7        195.9
    0.0200     157.6     151.1      0.0041       123.6        240.4
    0.0100     174.4     164.3      0.0055       133.8        292.4
```

```
    0.0050     190.9     176.8      0.0072       142.5        352.8
    0.0020     212.4     192.1      0.0099       152.1        448.4
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.002.003
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06029000.10  Whitetail Creek near Whitehall MT


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


     WATER       PEAK   PEAKFQ   <--- Intervals --->
      YEAR      VALUE    CODES     LOW         HIGH   REMARKS
     -1981      142.0  H
      1950       96.0
      1951      126.0
      1952       84.0
      1953       98.0
      1955       45.0
      1956       55.0
      1957       43.0
      1958       46.0
      1959       23.0
      1960       49.0
      1961       42.0
      1962       44.0
      1963       85.0
      1964       89.0
      1965       69.0
      1966       73.0
      1967      120.0
      1968       91.0


         Explanation of peak discharge qualification codes

        PeakFQ    NWIS
         CODE     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.002.004
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06029000.10  Whitetail Creek near Whitehall MT


```

EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	INTERVALS LOW	HIGH
-1981	142.0	0.0156		
1951	126.0	0.0567		
1967	120.0	0.1330		
1953	98.0	0.1840		
1950	96.0	0.2350		
1968	91.0	0.2861		
1964	89.0	0.3371		
1963	85.0	0.3881		
1952	84.0	0.4391		
1966	73.0	0.4901		
1965	69.0	0.5411		
1956	55.0	0.5921		
1960	49.0	0.6431		
1958	46.0	0.6942		
1955	45.0	0.7452		
1962	44.0	0.7962		
1957	43.0	0.8472		
1961	42.0	0.8982		
1959	23.0	0.9492		

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.002.005
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06029000.10 Whitetail Creek near Whitehall MT

EMA REPRESENTATION OF DATA

WATER YEAR	<----- OBSERVED-----> Q_LOWER	Q_UPPER	<-------- EMA -------> Q_LOWER	Q_UPPER	<-PERCEPTION THRESHOLDS-> LOWER	UPPER
1950	96.0	96.0	96.0	96.0	0.0	INF
1951	126.0	126.0	126.0	126.0	0.0	INF
1952	84.0	84.0	84.0	84.0	0.0	INF
1953	98.0	98.0	98.0	98.0	0.0	INF
1954	0.0	126.0	0.0	126.0	126.0	INF
1955	45.0	45.0	45.0	45.0	0.0	INF
1956	55.0	55.0	55.0	55.0	0.0	INF
1957	43.0	43.0	43.0	43.0	0.0	INF
1958	46.0	46.0	46.0	46.0	0.0	INF
1959	23.0	23.0	23.0	23.0	0.0	INF
1960	49.0	49.0	49.0	49.0	0.0	INF
1961	42.0	42.0	42.0	42.0	0.0	INF
1962	44.0	44.0	44.0	44.0	0.0	INF
1963	85.0	85.0	85.0	85.0	0.0	INF
1964	89.0	89.0	89.0	89.0	0.0	INF
1965	69.0	69.0	69.0	69.0	0.0	INF
1966	73.0	73.0	73.0	73.0	0.0	INF
1967	120.0	120.0	120.0	120.0	0.0	INF
1968	91.0	91.0	91.0	91.0	0.0	INF
1969	0.0	142.0	0.0	142.0	142.0	INF
1970	0.0	142.0	0.0	142.0	142.0	INF
1971	0.0	142.0	0.0	142.0	142.0	INF
1972	0.0	142.0	0.0	142.0	142.0	INF
1973	0.0	142.0	0.0	142.0	142.0	INF
1974	0.0	142.0	0.0	142.0	142.0	INF
1975	0.0	142.0	0.0	142.0	142.0	INF
1976	0.0	142.0	0.0	142.0	142.0	INF
1977	0.0	142.0	0.0	142.0	142.0	INF
1978	0.0	142.0	0.0	142.0	142.0	INF

```
    1979        0.0      142.0        0.0      142.0        142.0        INF
    1980        0.0      142.0        0.0      142.0        142.0        INF
    1981      142.0      142.0      142.0      142.0        142.0        INF
1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.003.001
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

        Station - 06030300.00  Jefferson River trib no. 2 nr Whitehall MT


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

                Number of peaks in record            =       55
                Peaks not used in analysis           =        0
                Systematic peaks in analysis         =       55
                Historic peaks in analysis           =        0
                Beginning Year                       =     1958
                Ending Year                          =     2012
                Historical Period Length             =       55
                Generalized skew                     =    0.018
                     Standard error                  =    0.640
                     Mean Square error               =    0.410
                Skew option                          = STATION SKEW
                Gage base discharge                  =      0.0
                User supplied high outlier threshold =   --
                User supplied PILF (LO) criterion    =        1.0
                Plotting position parameter          =     0.00
                Type of analysis                            EMA
                PILF (LO) Test Method                      FIXE
                Perception Thresholds:
                     Begin     End       Low     High     Comment
                      1958    2012       0.0       INF
                      DEFAULT

                Interval Data                    =   None Specified



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

    *WCF191I-USER LOW-OUTLIER CRITERION SUPERSEDES  LIMIT CALCULATED BY
             AUTOMATED LOW-OUTLIER DETECTION PROCEDURE.         1.0      0.3
    *WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.    -0.235    -0.306  -1
     WCF002J-CALCS COMPLETED.  RETURN CODE =  2
     EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                        Kendall's Tau Parameters

                                                          MEDIAN   No. of
                                          TAU    P-VALUE    SLOPE   PEAKS
                                   ----------------------------------------
              SYSTEMATIC RECORD      0.068      0.554      0.143    38


1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.003.002
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

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Station - 06030300.00 Jefferson River trib no. 2 nr Whitehall MT

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	LOGARITHMIC		
	MEAN	STANDARD DEVIATION	SKEW
EMA W/O REG. INFO	0.5807	1.4049	-0.819
EMA W/REG. INFO	0.5807	1.4049	-0.819

EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE) 0.0716
EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE) 0.1574

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	EMA W/ REG INFO ESTIMATE	EMA W/O REG INFO ESTIMATE	<------ FOR EMA ESTIMATES -------> VARIANCE OF EST.	95% CONFIDENCE INTERVALS LOWER	UPPER
0.6667		2.9	--	--	--
0.5000	5.9	5.9	0.0448	1.2	13.6
0.4292	10.2	10.2	0.0381	3.1	23.5
0.2000	60.7	60.7	0.0306	27.1	142.9
0.1000	163.6	163.6	0.0330	74.0	445.0
0.0400	402.3	402.3	0.0412	179.4	1511.0
0.0200	663.8	663.8	0.0511	283.4	3183.0
0.0100	990.5	990.5	0.0644	394.4	5998.0
0.0050	1374.	1374.	0.0807	504.0	10500.0
0.0020	1948.	1948.	0.1066	636.6	21040.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06030300.00 Jefferson River trib no. 2 nr Whitehall MT

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

WATER YEAR	PEAK VALUE	PEAKFQ CODES	<--- Intervals ---> LOW	HIGH	REMARKS
1958	169.0				
1959	71.0				
1960	0.0				
1961	34.0				
1962	0.0				
1963	39.0				
1964	10.0				
1965	8.0				
1966	0.0				
1967	9.0				
1968	9.0				
1969	8.0				
1970	8.0				
1971	5.0				
1972	0.0				
1973	0.0				
1974	65.0				

```
      1975      132.0
      1976       65.0
      1977        2.0
      1978       10.0
      1979        1.0
      1980        0.0
      1981        5.0
      1982       10.0
      1983       10.0
      1984       58.0
      1985        3.0
      1986        7.0
      1987        0.0
      1988        0.0
      1989       35.0
      1990      414.0
      1991      178.0
      1992      278.0
      1993       20.0
      1994      425.0
      1995       66.0
      1996        0.0
      1997       31.0
      1998        0.0
      1999        0.0
      2000        0.0
      2001        1.0
      2002        1.0
      2003       28.0
      2004      308.0
      2005       95.0
      2006       10.0
      2007        0.0
      2008        0.0
      2009        0.0
      2010       45.0
      2011        0.0
      2012        0.0


         Explanation of peak discharge qualification codes

        PeakFQ    NWIS
         CODE     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.003.004
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

       Station - 06030300.00  Jefferson River trib no. 2 nr Whitehall MT
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EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	INTERVALS LOW	HIGH
1994	425.0	0.0178		
1990	414.0	0.0356		
2004	308.0	0.0535		
1992	278.0	0.0714		
1991	178.0	0.0892		
1958	169.0	0.1071		
1975	132.0	0.1249		
2005	95.0	0.1428		
1959	71.0	0.1607		
1995	66.0	0.1785		
1974	65.0	0.2142		
1976	65.0	0.1964		
1984	58.0	0.2321		
2010	45.0	0.2500		
1963	39.0	0.2678		
1989	35.0	0.2857		
1961	34.0	0.3035		
1997	31.0	0.3214		
2003	28.0	0.3393		
1993	20.0	0.3571		
1964	10.0	0.4464		
1978	10.0	0.4286		
1982	10.0	0.4107		
1983	10.0	0.3928		
2006	10.0	0.3750		
1967	9.0	0.4821		
1968	9.0	0.4643		
1965	8.0	0.5357		
1969	8.0	0.5179		
1970	8.0	0.5000		
1986	7.0	0.5536		
1971	5.0	0.5893		
1981	5.0	0.5714		
1985	3.0	0.6072		
1977	2.0	0.6250		
1979	1.0	0.6786		
2001	1.0	0.6607		
2002	1.0	0.6429		

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.005
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06030300.00 Jefferson River trib no. 2 nr Whitehall MT

EMA REPRESENTATION OF DATA

WATER YEAR	<----- OBSERVED-----> Q_LOWER	Q_UPPER	<-------- EMA -------> Q_LOWER	Q_UPPER	<-PERCEPTION THRESHOLDS-> LOWER	UPPER
1958	169.0	169.0	169.0	169.0	1.0	INF
1959	71.0	71.0	71.0	71.0	1.0	INF
1960	0.0	0.0	0.0	1.0	1.0	INF
1961	34.0	34.0	34.0	34.0	1.0	INF
1962	0.0	0.0	0.0	1.0	1.0	INF
1963	39.0	39.0	39.0	39.0	1.0	INF
1964	10.0	10.0	10.0	10.0	1.0	INF
1965	8.0	8.0	8.0	8.0	1.0	INF

```
    1966        0.0        0.0        0.0        1.0          1.0        INF
    1967        9.0        9.0        9.0        9.0          1.0        INF
    1968        9.0        9.0        9.0        9.0          1.0        INF
    1969        8.0        8.0        8.0        8.0          1.0        INF
    1970        8.0        8.0        8.0        8.0          1.0        INF
    1971        5.0        5.0        5.0        5.0          1.0        INF
    1972        0.0        0.0        0.0        1.0          1.0        INF
    1973        0.0        0.0        0.0        1.0          1.0        INF
    1974       65.0       65.0       65.0       65.0          1.0        INF
    1975      132.0      132.0      132.0      132.0          1.0        INF
    1976       65.0       65.0       65.0       65.0          1.0        INF
    1977        2.0        2.0        2.0        2.0          1.0        INF
    1978       10.0       10.0       10.0       10.0          1.0        INF
    1979        1.0        1.0        1.0        1.0          1.0        INF
    1980        0.0        0.0        0.0        1.0          1.0        INF
    1981        5.0        5.0        5.0        5.0          1.0        INF
    1982       10.0       10.0       10.0       10.0          1.0        INF
    1983       10.0       10.0       10.0       10.0          1.0        INF
    1984       58.0       58.0       58.0       58.0          1.0        INF
    1985        3.0        3.0        3.0        3.0          1.0        INF
    1986        7.0        7.0        7.0        7.0          1.0        INF
    1987        0.0        0.0        0.0        1.0          1.0        INF
    1988        0.0        0.0        0.0        1.0          1.0        INF
    1989       35.0       35.0       35.0       35.0          1.0        INF
    1990      414.0      414.0      414.0      414.0          1.0        INF
    1991      178.0      178.0      178.0      178.0          1.0        INF
    1992      278.0      278.0      278.0      278.0          1.0        INF
    1993       20.0       20.0       20.0       20.0          1.0        INF
    1994      425.0      425.0      425.0      425.0          1.0        INF
    1995       66.0       66.0       66.0       66.0          1.0        INF
    1996        0.0        0.0        0.0        1.0          1.0        INF
    1997       31.0       31.0       31.0       31.0          1.0        INF
    1998        0.0        0.0        0.0        1.0          1.0        INF
    1999        0.0        0.0        0.0        1.0          1.0        INF
    2000        0.0        0.0        0.0        1.0          1.0        INF
    2001        1.0        1.0        1.0        1.0          1.0        INF
    2002        1.0        1.0        1.0        1.0          1.0        INF
    2003       28.0       28.0       28.0       28.0          1.0        INF
    2004      308.0      308.0      308.0      308.0          1.0        INF
    2005       95.0       95.0       95.0       95.0          1.0        INF
    2006       10.0       10.0       10.0       10.0          1.0        INF
    2007        0.0        0.0        0.0        1.0          1.0        INF
    2008        0.0        0.0        0.0        1.0          1.0        INF
    2009        0.0        0.0        0.0        1.0          1.0        INF
    2010       45.0       45.0       45.0       45.0          1.0        INF
    2011        0.0        0.0        0.0        1.0          1.0        INF
    2012        0.0        0.0        0.0        1.0          1.0        INF
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.004.001
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

          Station - 06030500.00  Boulder River ab Rock Cr nr Basin MT


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

                Number of peaks in record            =       12
                Peaks not used in analysis           =        0
                Systematic peaks in analysis         =       10
                Historic peaks in analysis           =        2
                Beginning Year                       =     1947
                Ending Year                          =     2017
                Historical Period Length             =       71
```

```
                 Generalized skew                      =    0.002
                      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                            EMA
                 PILF (LO) Test Method                      MGBT
                 Perception Thresholds:
                      Begin     End       Low     High     Comment
                       1947    2017       0.0       INF
                       DEFAULT

                       1954    1954     582.0       INF     1948 HISTORICAL SYSTEMATIC
                       PERIOD 1
                       1958    1975     400.0       INF     1975 HISTORICAL PERIOD
                       1
                       1976    2017    1020.0       INF     1981 HISTORICAL PERIOD
                       1
                 Interval Data                     =   None Specified



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

     WCF002J-CALCS COMPLETED.  RETURN CODE =  2
     EMA001W-VARIANCE OF ESTIMATE WARNING, HISTORIC PERIOD > 2* SYS
     EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                        Kendall's Tau Parameters

                                                          MEDIAN   No. of
                                        TAU    P-VALUE    SLOPE   PEAKS
                                   ---------------------------------------
              SYSTEMATIC RECORD     -0.022      1.000     -0.333    10



  1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.004.002
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

           Station - 06030500.00  Boulder River ab Rock Cr nr Basin MT


            ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                       LOGARITHMIC
                             -------------------------------
                                          STANDARD
                                MEAN     DEVIATION     SKEW
                             -------------------------------
   EMA W/O REG. INFO          2.1893      0.2793      0.813
   EMA W/REG. INFO            2.1947      0.3087      0.141

   EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.5091
   EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.5433
```

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	EMA W/ REG INFO ESTIMATE	EMA W/O REG INFO ESTIMATE	<------ FOR EMA ESTIMATES -------> VARIANCE OF EST.	95% CONFIDENCE INTERVALS LOWER	UPPER
0.9950	27.6	47.8	0.0398	4.9	51.9
0.9900	32.3	51.0	0.0319	7.0	57.5
0.9500	50.1	63.5	0.0179	17.7	80.7
0.9000	63.7	73.2	0.0138	27.9	99.7
0.8000	85.7	89.2	0.0106	45.4	130.2
0.6667	113.8	110.2	0.0089	66.5	167.7
0.5000	154.0	141.8	0.0077	94.7	220.0
0.4292	174.9	158.9	0.0073	108.7	247.2
0.2000	283.3	255.1	0.0066	179.8	394.5
0.1000	393.3	365.3	0.0071	251.3	565.8
0.0400	562.2	558.4	0.0091	358.1	899.4
0.0200	710.9	751.9	0.0118	444.9	1287.0
0.0100	880.5	998.3	0.0156	534.1	1857.0
0.0050	1073.	1312.	0.0205	625.2	2692.0
0.0020	1368.	1858.	0.0288	747.3	4424.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06030500.00 Boulder River ab Rock Cr nr Basin MT

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

WATER YEAR	PEAK VALUE	PEAKFQ CODES	<--- Intervals ---> LOW	HIGH	REMARKS
-1975	400.0	H			
-1981	1020.0	H			
1947	143.0				
1948	582.0				
1949	62.0				
1950	95.0				
1951	115.0				
1952	321.0				
1953	334.0				
1955	112.0				
1956	106.0				
1957	140.0				

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.004.004
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06030500.00 Boulder River ab Rock Cr nr Basin MT

EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	INTERVALS LOW	HIGH
-1981	1020.0	0.0070		
1948	582.0	0.0311		
-1975	400.0	0.0657		
1953	334.0	0.1747		
1952	321.0	0.2664		
1947	143.0	0.3582		
1957	140.0	0.4499		
1951	115.0	0.5417		
1955	112.0	0.6334		
1956	106.0	0.7252		
1950	95.0	0.8169		
1949	62.0	0.9087		

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.005
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06030500.00 Boulder River ab Rock Cr nr Basin MT

EMA REPRESENTATION OF DATA

WATER	<----- OBSERVED	----->	<-------- EMA	------->	<-PERCEPTION THRESHOLDS->	
YEAR	Q_LOWER	Q_UPPER	Q_LOWER	Q_UPPER	LOWER	UPPER
1947	143.0	143.0	143.0	143.0	0.0	INF
1948	582.0	582.0	582.0	582.0	0.0	INF
1949	62.0	62.0	62.0	62.0	0.0	INF
1950	95.0	95.0	95.0	95.0	0.0	INF
1951	115.0	115.0	115.0	115.0	0.0	INF
1952	321.0	321.0	321.0	321.0	0.0	INF
1953	334.0	334.0	334.0	334.0	0.0	INF
1954	0.0	582.0	0.0	582.0	582.0	INF
1955	112.0	112.0	112.0	112.0	0.0	INF
1956	106.0	106.0	106.0	106.0	0.0	INF
1957	140.0	140.0	140.0	140.0	0.0	INF
1958	0.0	400.0	0.0	400.0	400.0	INF
1959	0.0	400.0	0.0	400.0	400.0	INF
1960	0.0	400.0	0.0	400.0	400.0	INF
1961	0.0	400.0	0.0	400.0	400.0	INF
1962	0.0	400.0	0.0	400.0	400.0	INF
1963	0.0	400.0	0.0	400.0	400.0	INF
1964	0.0	400.0	0.0	400.0	400.0	INF
1965	0.0	400.0	0.0	400.0	400.0	INF
1966	0.0	400.0	0.0	400.0	400.0	INF
1967	0.0	400.0	0.0	400.0	400.0	INF
1968	0.0	400.0	0.0	400.0	400.0	INF
1969	0.0	400.0	0.0	400.0	400.0	INF
1970	0.0	400.0	0.0	400.0	400.0	INF

```
     1971        0.0      400.0        0.0      400.0        400.0        INF
     1972        0.0      400.0        0.0      400.0        400.0        INF
     1973        0.0      400.0        0.0      400.0        400.0        INF
     1974        0.0      400.0        0.0      400.0        400.0        INF
     1975      400.0      400.0      400.0      400.0        400.0        INF
     1976        0.0     1020.0        0.0     1020.0       1020.0        INF
     1977        0.0     1020.0        0.0     1020.0       1020.0        INF
     1978        0.0     1020.0        0.0     1020.0       1020.0        INF
     1979        0.0     1020.0        0.0     1020.0       1020.0        INF
     1980        0.0     1020.0        0.0     1020.0       1020.0        INF
     1981     1020.0     1020.0     1020.0     1020.0       1020.0        INF
     1982        0.0     1020.0        0.0     1020.0       1020.0        INF
     1983        0.0     1020.0        0.0     1020.0       1020.0        INF
     1984        0.0     1020.0        0.0     1020.0       1020.0        INF
     1985        0.0     1020.0        0.0     1020.0       1020.0        INF
     1986        0.0     1020.0        0.0     1020.0       1020.0        INF
     1987        0.0     1020.0        0.0     1020.0       1020.0        INF
     1988        0.0     1020.0        0.0     1020.0       1020.0        INF
     1989        0.0     1020.0        0.0     1020.0       1020.0        INF
     1990        0.0     1020.0        0.0     1020.0       1020.0        INF
     1991        0.0     1020.0        0.0     1020.0       1020.0        INF
     1992        0.0     1020.0        0.0     1020.0       1020.0        INF
     1993        0.0     1020.0        0.0     1020.0       1020.0        INF
     1994        0.0     1020.0        0.0     1020.0       1020.0        INF
     1995        0.0     1020.0        0.0     1020.0       1020.0        INF
     1996        0.0     1020.0        0.0     1020.0       1020.0        INF
     1997        0.0     1020.0        0.0     1020.0       1020.0        INF
     1998        0.0     1020.0        0.0     1020.0       1020.0        INF
     1999        0.0     1020.0        0.0     1020.0       1020.0        INF
     2000        0.0     1020.0        0.0     1020.0       1020.0        INF
     2001        0.0     1020.0        0.0     1020.0       1020.0        INF
     2002        0.0     1020.0        0.0     1020.0       1020.0        INF
     2003        0.0     1020.0        0.0     1020.0       1020.0        INF
     2004        0.0     1020.0        0.0     1020.0       1020.0        INF
     2005        0.0     1020.0        0.0     1020.0       1020.0        INF
     2006        0.0     1020.0        0.0     1020.0       1020.0        INF
     2007        0.0     1020.0        0.0     1020.0       1020.0        INF
     2008        0.0     1020.0        0.0     1020.0       1020.0        INF
     2009        0.0     1020.0        0.0     1020.0       1020.0        INF
     2010        0.0     1020.0        0.0     1020.0       1020.0        INF
     2011        0.0     1020.0        0.0     1020.0       1020.0        INF
     2012        0.0     1020.0        0.0     1020.0       1020.0        INF
     2013        0.0     1020.0        0.0     1020.0       1020.0        INF
     2014        0.0     1020.0        0.0     1020.0       1020.0        INF
     2015        0.0     1020.0        0.0     1020.0       1020.0        INF
     2016        0.0     1020.0        0.0     1020.0       1020.0        INF
     2017        0.0     1020.0        0.0     1020.0       1020.0        INF
1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.005.001
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

           Station - 06030500.01  Boulder River ab Rock Cr nr Basin MT


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

                 Number of peaks in record            =       78
                 Peaks not used in analysis           =        0
                 Systematic peaks in analysis         =       76
                 Historic peaks in analysis           =        2
                 Beginning Year                       =     1909
                 Ending Year                          =     2017
                 Historical Period Length             =      109
```

```
                 Generalized skew                      =    0.002
                      Standard error                   =    0.640
                      Mean Square error                =    0.410
                 Skew option                           = STATION SKEW
                 Gage base discharge                   =      0.0
                 User supplied high outlier threshold =   --
                 User supplied PILF (LO) criterion     =       49.0
                 Plotting position parameter           =     0.00
                 Type of analysis                            EMA
                 PILF (LO) Test Method                      FIXE
                 Perception Thresholds:
                      Begin     End       Low     High     Comment
                       1909    2017       0.0       INF
                       DEFAULT

                       1909    1928    1020.0       INF     1981 HISTORICAL PERIOD
                       1
                       1933    1933     400.0       INF     1975 HISTORICAL PERIOD
                       1
                       1973    1984     400.0       INF     1975 HISTORICAL PERIOD
                       2
                 Interval Data                     =   None Specified



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

    *WCF191I-USER LOW-OUTLIER CRITERION SUPERSEDES  LIMIT CALCULATED BY
             AUTOMATED LOW-OUTLIER DETECTION PROCEDURE.        49.0     13.7
    *WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.     0.452     0.535  -1
     EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                         Kendall's Tau Parameters

                                                          MEDIAN   No. of
                                          TAU    P-VALUE    SLOPE   PEAKS
                                     ---------------------------------------
              SYSTEMATIC RECORD      0.095      0.226      0.519    76


1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.005.002
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

           Station - 06030500.01  Boulder River ab Rock Cr nr Basin MT


            ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                       LOGARITHMIC
                             -------------------------------
                                          STANDARD
                                MEAN     DEVIATION     SKEW
                             -------------------------------
  EMA W/O REG. INFO           2.0945      0.3244      0.320
  EMA W/REG. INFO             2.0945      0.3244      0.320

  EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.1436
  EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.0873
```

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	EMA W/ REG INFO ESTIMATE	EMA W/O REG INFO ESTIMATE	<------ FOR EMA ESTIMATES -------> VARIANCE OF EST.	95% CONFIDENCE INTERVALS LOWER	UPPER
0.9950		19.1	--	--	--
0.9900		22.7	--	--	--
0.9500		36.3	--	--	--
0.9000	49.1	49.1	0.0028	33.1	58.7
0.8000	65.7	65.7	0.0017	51.7	77.9
0.6667	87.4	87.4	0.0015	72.9	104.5
0.5000	119.5	119.5	0.0016	99.4	143.7
0.4292	136.6	136.6	0.0017	113.0	165.0
0.2000	229.8	229.8	0.0021	187.8	286.6
0.1000	331.0	331.0	0.0028	265.4	439.2
0.0400	497.2	497.2	0.0050	381.2	777.0
0.0200	653.2	653.2	0.0078	478.7	1223.0
0.0100	840.4	840.4	0.0118	584.5	1950.0
0.0050	1064.	1064.	0.0170	698.5	3129.0
0.0020	1428.	1428.	0.0260	862.0	5874.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.005.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06030500.01 Boulder River ab Rock Cr nr Basin MT

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

WATER YEAR	PEAK VALUE	PEAKFQ CODES	<--- Intervals ---> LOW	HIGH	REMARKS
-1975	400.0	H			
-1981	1020.0	H			
1929	202.0				
1930	80.5				
1931	33.1				
1932	109.0				
1934	38.9				
1935	41.3				
1936	36.6				
1937	34.5				
1938	274.0				
1939	79.2				
1940	63.9				
1941	54.5				
1942	234.0				
1943	232.0				
1944	82.3				
1945	54.9				
1946	49.7				
1947	143.0				
1948	582.0				
1949	62.0				
1950	95.0				
1951	115.0				
1952	321.0				
1953	334.0				
1954	60.1				
1955	112.0				
1956	106.0				

1957	140.0
1958	164.0
1959	160.0
1960	146.0
1961	153.0
1962	89.7
1963	171.0
1964	689.0
1965	347.0
1966	105.0
1967	345.0
1968	238.0
1969	159.0
1970	259.0
1971	216.0
1972	257.0
1985	71.8
1986	132.0
1987	67.4
1988	71.8
1989	111.0
1990	115.0
1991	171.0
1992	52.2
1993	127.0
1994	102.0
1995	423.0
1996	206.0
1997	216.0
1998	124.0
1999	92.8
2000	17.4
2001	70.1
2002	67.5
2003	141.0
2004	49.5
2005	134.0
2006	104.0
2007	36.3
2008	136.0
2009	200.0
2010	342.0
2011	697.0
2012	146.0
2013	74.4
2014	220.0
2015	70.2
2016	83.5
2017	114.0

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.005.004
Version 7.1         Annual peak flow frequency analysis      Run Date / Time
3/14/2014                                                    11/06/2018 14:25

        Station - 06030500.01  Boulder River ab Rock Cr nr Basin MT


 EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

 WATER     RANKED      EMA         INTERVALS
  YEAR   DISCHARGE   ESTIMATE      LOW      HIGH
 -1981     1020.0     0.0046
  2011      697.0     0.0185
  1964      689.0     0.0279
  1948      582.0     0.0373
  1995      423.0     0.0467
 -1975      400.0     0.0561
  1965      347.0     0.0782
  1967      345.0     0.0910
  2010      342.0     0.1038
  1953      334.0     0.1166
  1952      321.0     0.1294
  1938      274.0     0.1422
  1970      259.0     0.1550
  1972      257.0     0.1678
  1968      238.0     0.1806
  1942      234.0     0.1934
  1943      232.0     0.2062
  2014      220.0     0.2191
  1971      216.0     0.2447
  1997      216.0     0.2319
  1996      206.0     0.2575
  1929      202.0     0.2703
  2009      200.0     0.2831
  1963      171.0     0.3087
  1991      171.0     0.2959
  1958      164.0     0.3215
  1959      160.0     0.3343
  1969      159.0     0.3471
  1961      153.0     0.3599
  1960      146.0     0.3855
  2012      146.0     0.3727
  1947      143.0     0.3983
  2003      141.0     0.4111
  1957      140.0     0.4239
  2008      136.0     0.4367
  2005      134.0     0.4495
  1986      132.0     0.4623
  1993      127.0     0.4751
  1998      124.0     0.4879
  1951      115.0     0.5135
  1990      115.0     0.5007
  2017      114.0     0.5263
  1955      112.0     0.5391
  1989      111.0     0.5519
  1932      109.0     0.5647
  1956      106.0     0.5775
  1966      105.0     0.5904
  2006      104.0     0.6032
  1994      102.0     0.6160
```

```
      1950       95.0     0.6288
      1999       92.8     0.6416
      1962       89.7     0.6544
      2016       83.5     0.6672
      1944       82.3     0.6800
      1930       80.5     0.6928
      1939       79.2     0.7056
      2013       74.4     0.7184
      1985       71.8     0.7440
      1988       71.8     0.7312
      2015       70.2     0.7568
      2001       70.1     0.7696
      2002       67.5     0.7824
      1987       67.4     0.7952
      1940       63.9     0.8080
      1949       62.0     0.8208
      1954       60.1     0.8336
      1945       54.9     0.8464
      1941       54.5     0.8592
      1992       52.2     0.8720
      1946       49.7     0.8848
      2004       49.5     0.8976
    * 1935       41.3     0.9104
    * 1934       38.9     0.9232
    * 1936       36.6     0.9360
    * 2007       36.3     0.9488
    * 1937       34.5     0.9616
    * 1931       33.1     0.9745
    * 2000       17.4     0.9873

      * DENOTES PILF (LO)

  1


    Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.005.005
    Version 7.1         Annual peak flow frequency analysis      Run Date / Time
    3/14/2014                                                    11/06/2018 14:25

            Station - 06030500.01  Boulder River ab Rock Cr nr Basin MT


                           EMA REPRESENTATION OF DATA

    WATER <----- OBSERVED-----><-------- EMA -------><-PERCEPTION THRESHOLDS->
     YEAR    Q_LOWER    Q_UPPER    Q_LOWER    Q_UPPER        LOWER        UPPER
     1909        0.0     1020.0        0.0     1020.0       1020.0          INF
     1910        0.0     1020.0        0.0     1020.0       1020.0          INF
     1911        0.0     1020.0        0.0     1020.0       1020.0          INF
     1912        0.0     1020.0        0.0     1020.0       1020.0          INF
     1913        0.0     1020.0        0.0     1020.0       1020.0          INF
     1914        0.0     1020.0        0.0     1020.0       1020.0          INF
     1915        0.0     1020.0        0.0     1020.0       1020.0          INF
     1916        0.0     1020.0        0.0     1020.0       1020.0          INF
     1917        0.0     1020.0        0.0     1020.0       1020.0          INF
     1918        0.0     1020.0        0.0     1020.0       1020.0          INF
     1919        0.0     1020.0        0.0     1020.0       1020.0          INF
     1920        0.0     1020.0        0.0     1020.0       1020.0          INF
     1921        0.0     1020.0        0.0     1020.0       1020.0          INF
     1922        0.0     1020.0        0.0     1020.0       1020.0          INF
     1923        0.0     1020.0        0.0     1020.0       1020.0          INF
     1924        0.0     1020.0        0.0     1020.0       1020.0          INF
     1925        0.0     1020.0        0.0     1020.0       1020.0          INF
     1926        0.0     1020.0        0.0     1020.0       1020.0          INF
     1927        0.0     1020.0        0.0     1020.0       1020.0          INF
     1928        0.0     1020.0        0.0     1020.0       1020.0          INF
```

1427	1929	202.0	202.0	202.0	202.0	49.0	INF
1428	1930	80.5	80.5	80.5	80.5	49.0	INF
1429	1931	33.1	33.1	0.0	49.0	49.0	INF
1430	1932	109.0	109.0	109.0	109.0	49.0	INF
1431	1933	0.0	400.0	0.0	400.0	400.0	INF
1432	1934	38.9	38.9	0.0	49.0	49.0	INF
1433	1935	41.3	41.3	0.0	49.0	49.0	INF
1434	1936	36.6	36.6	0.0	49.0	49.0	INF
1435	1937	34.5	34.5	0.0	49.0	49.0	INF
1436	1938	274.0	274.0	274.0	274.0	49.0	INF
1437	1939	79.2	79.2	79.2	79.2	49.0	INF
1438	1940	63.9	63.9	63.9	63.9	49.0	INF
1439	1941	54.5	54.5	54.5	54.5	49.0	INF
1440	1942	234.0	234.0	234.0	234.0	49.0	INF
1441	1943	232.0	232.0	232.0	232.0	49.0	INF
1442	1944	82.3	82.3	82.3	82.3	49.0	INF
1443	1945	54.9	54.9	54.9	54.9	49.0	INF
1444	1946	49.7	49.7	49.7	49.7	49.0	INF
1445	1947	143.0	143.0	143.0	143.0	49.0	INF
1446	1948	582.0	582.0	582.0	582.0	49.0	INF
1447	1949	62.0	62.0	62.0	62.0	49.0	INF
1448	1950	95.0	95.0	95.0	95.0	49.0	INF
1449	1951	115.0	115.0	115.0	115.0	49.0	INF
1450	1952	321.0	321.0	321.0	321.0	49.0	INF
1451	1953	334.0	334.0	334.0	334.0	49.0	INF
1452	1954	60.1	60.1	60.1	60.1	49.0	INF
1453	1955	112.0	112.0	112.0	112.0	49.0	INF
1454	1956	106.0	106.0	106.0	106.0	49.0	INF
1455	1957	140.0	140.0	140.0	140.0	49.0	INF
1456	1958	164.0	164.0	164.0	164.0	49.0	INF
1457	1959	160.0	160.0	160.0	160.0	49.0	INF
1458	1960	146.0	146.0	146.0	146.0	49.0	INF
1459	1961	153.0	153.0	153.0	153.0	49.0	INF
1460	1962	89.7	89.7	89.7	89.7	49.0	INF
1461	1963	171.0	171.0	171.0	171.0	49.0	INF
1462	1964	689.0	689.0	689.0	689.0	49.0	INF
1463	1965	347.0	347.0	347.0	347.0	49.0	INF
1464	1966	105.0	105.0	105.0	105.0	49.0	INF
1465	1967	345.0	345.0	345.0	345.0	49.0	INF
1466	1968	238.0	238.0	238.0	238.0	49.0	INF
1467	1969	159.0	159.0	159.0	159.0	49.0	INF
1468	1970	259.0	259.0	259.0	259.0	49.0	INF
1469	1971	216.0	216.0	216.0	216.0	49.0	INF
1470	1972	257.0	257.0	257.0	257.0	49.0	INF
1471	1973	0.0	400.0	0.0	400.0	400.0	INF
1472	1974	0.0	400.0	0.0	400.0	400.0	INF
1473	1975	400.0	400.0	400.0	400.0	400.0	INF
1474	1976	0.0	400.0	0.0	400.0	400.0	INF
1475	1977	0.0	400.0	0.0	400.0	400.0	INF
1476	1978	0.0	400.0	0.0	400.0	400.0	INF
1477	1979	0.0	400.0	0.0	400.0	400.0	INF
1478	1980	0.0	400.0	0.0	400.0	400.0	INF
1479	1981	1020.0	1020.0	1020.0	1020.0	400.0	INF
1480	1982	0.0	400.0	0.0	400.0	400.0	INF
1481	1983	0.0	400.0	0.0	400.0	400.0	INF
1482	1984	0.0	400.0	0.0	400.0	400.0	INF
1483	1985	71.8	71.8	71.8	71.8	49.0	INF
1484	1986	132.0	132.0	132.0	132.0	49.0	INF
1485	1987	67.4	67.4	67.4	67.4	49.0	INF
1486	1988	71.8	71.8	71.8	71.8	49.0	INF
1487	1989	111.0	111.0	111.0	111.0	49.0	INF
1488	1990	115.0	115.0	115.0	115.0	49.0	INF
1489	1991	171.0	171.0	171.0	171.0	49.0	INF
1490	1992	52.2	52.2	52.2	52.2	49.0	INF
1491	1993	127.0	127.0	127.0	127.0	49.0	INF
1492	1994	102.0	102.0	102.0	102.0	49.0	INF

```
     1995      423.0      423.0      423.0      423.0         49.0        INF
     1996      206.0      206.0      206.0      206.0         49.0        INF
     1997      216.0      216.0      216.0      216.0         49.0        INF
     1998      124.0      124.0      124.0      124.0         49.0        INF
     1999       92.8       92.8       92.8       92.8         49.0        INF
     2000       17.4       17.4        0.0       49.0         49.0        INF
     2001       70.1       70.1       70.1       70.1         49.0        INF
     2002       67.5       67.5       67.5       67.5         49.0        INF
     2003      141.0      141.0      141.0      141.0         49.0        INF
     2004       49.5       49.5       49.5       49.5         49.0        INF
     2005      134.0      134.0      134.0      134.0         49.0        INF
     2006      104.0      104.0      104.0      104.0         49.0        INF
     2007       36.3       36.3        0.0       49.0         49.0        INF
     2008      136.0      136.0      136.0      136.0         49.0        INF
     2009      200.0      200.0      200.0      200.0         49.0        INF
     2010      342.0      342.0      342.0      342.0         49.0        INF
     2011      697.0      697.0      697.0      697.0         49.0        INF
     2012      146.0      146.0      146.0      146.0         49.0        INF
     2013       74.4       74.4       74.4       74.4         49.0        INF
     2014      220.0      220.0      220.0      220.0         49.0        INF
     2015       70.2       70.2       70.2       70.2         49.0        INF
     2016       83.5       83.5       83.5       83.5         49.0        INF
     2017      114.0      114.0      114.0      114.0         49.0        INF
1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.006.001
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

               Station - 06031950.00  Cataract Creek near Basin MT


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

                Number of peaks in record            =       45
                Peaks not used in analysis           =        0
                Systematic peaks in analysis         =       45
                Historic peaks in analysis           =        0
                Beginning Year                       =     1909
                Ending Year                          =     2017
                Historical Period Length             =      109
                Generalized skew                     =    0.065
                     Standard error                  =    0.640
                     Mean Square error               =    0.410
                Skew option                          = STATION SKEW
                Gage base discharge                  =      0.0
                User supplied high outlier threshold =   --
                User supplied PILF (LO) criterion    =      146.0
                Plotting position parameter          =     0.00
                Type of analysis                           EMA
                PILF (LO) Test Method                     FIXE
                Perception Thresholds:
                     Begin     End       Low     High     Comment
                      1909    2017       0.0       INF
                      DEFAULT

                      1909    1972    3150.0       INF     1981 HISTORICAL SYSTEMATIC
                      PERIOD 1
                Interval Data                    =   None Specified



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

```
*WCF191I-USER LOW-OUTLIER CRITERION SUPERSEDES  LIMIT CALCULATED BY
         AUTOMATED LOW-OUTLIER DETECTION PROCEDURE.       146.0     57.0
*WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.     1.166     2.088  -1
 EMA001W-VARIANCE OF ESTIMATE WARNING, HISTORIC PERIOD > 2* SYS
 EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0
 EMA003W-SKEW VALUE OF 1.9601 IS OUTSIDE THE ACCEPTABLE RANGE (-1.4 - 1.4) FOR EMA
 ANALYSIS


                                    Kendall's Tau Parameters

                                                        MEDIAN   No. of
                                     TAU    P-VALUE    SLOPE   PEAKS
                                 ---------------------------------------
              SYSTEMATIC RECORD     -0.063      0.550     -0.821    45



1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.006.002
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

               Station - 06031950.00  Cataract Creek near Basin MT


            ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                     LOGARITHMIC
                           -------------------------------
                                        STANDARD
                              MEAN     DEVIATION     SKEW
                           -------------------------------
 EMA W/O REG. INFO          2.4389      0.2264      1.960
 EMA W/REG. INFO            2.4389      0.2264      1.960

 EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.8765
 EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.5114



     ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

    ANNUAL   EMA W/    EMA W/O     <------ FOR EMA ESTIMATES -------->
 EXCEEDANCE  REG INFO  REG INFO    VARIANCE  95% CONFIDENCE INTERVALS
 PROBABILITY ESTIMATE  ESTIMATE     OF EST.       LOWER       UPPER

    0.9950               151.3          --          --          --
    0.9900               151.9          --          --          --
    0.9500               156.2          --          --          --
    0.9000     171.4     171.4      0.0015       132.8        203.2
    0.8000     182.8     182.8      0.0007       158.2        208.1
    0.6667     201.6     201.6      0.0007       179.9        232.6
    0.5000     234.7     234.7      0.0014       202.3        293.1
    0.4292     254.3     254.3      0.0019       214.0        324.0
    0.2000     378.9     378.9      0.0032       298.3        515.1
    0.1000     542.8     542.8      0.0046       416.6        791.7
    0.0400     871.6     871.6      0.0090       601.6       1450.0
    0.0200    1246.     1246.       0.0157       758.6       2421.0
    0.0100    1781.     1781.       0.0263       940.2       4233.0
    0.0050    2544.     2544.       0.0412      1154.0       7678.0
    0.0020    4075.     4075.       0.0684      1497.0      17580.0
1
```

```
Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.006.003
Version 7.1         Annual peak flow frequency analysis      Run Date / Time
3/14/2014                                                    11/06/2018 14:25

            Station - 06031950.00  Cataract Creek near Basin MT


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


  WATER       PEAK   PEAKFQ   <--- Intervals --->
   YEAR      VALUE    CODES     LOW         HIGH   REMARKS
   1973      233.0
   1974      300.0
   1975      623.0
   1976      320.0
   1977      105.0
   1978      370.0
   1979      280.0
   1980      180.0
   1981     3150.0
   1982      200.0
   1983      200.0
   1984      250.0
   1985      185.0
   1986      245.0
   1987      210.0
   1988      222.0
   1989      256.0
   1990      260.0
   1991      274.0
   1992      256.0
   1993      274.0
   1994      198.0
   1995      934.0
   1996      605.0
   1997      409.0
   1998      260.0
   1999      256.0
   2000      105.0
   2001      251.0
   2002      260.0
   2003      330.0
   2004      165.0
   2005      330.0
   2006      242.0
   2007      201.0
   2008      346.0
   2009      330.0
   2010      335.0
   2011      820.0
   2012      207.0
   2013      178.0
   2014      318.0
   2015      158.0
   2016      152.0
   2017      146.0


      Explanation of peak discharge qualification codes

     PeakFQ    NWIS
      CODE     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
```

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```
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.006.004
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

               Station - 06031950.00  Cataract Creek near Basin MT


   EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

   WATER     RANKED      EMA         INTERVALS
    YEAR   DISCHARGE   ESTIMATE      LOW      HIGH
    1981     3150.0     0.0046
    1995      934.0     0.0311
    2011      820.0     0.0531
    1975      623.0     0.0751
    1996      605.0     0.0972
    1997      409.0     0.1192
    1978      370.0     0.1412
    2008      346.0     0.1632
    2010      335.0     0.1853
    2003      330.0     0.2513
    2005      330.0     0.2293
    2009      330.0     0.2073
    1976      320.0     0.2733
    2014      318.0     0.2954
    1974      300.0     0.3174
    1979      280.0     0.3394
    1991      274.0     0.3835
    1993      274.0     0.3614
    1990      260.0     0.4495
    1998      260.0     0.4275
    2002      260.0     0.4055
    1989      256.0     0.5156
    1992      256.0     0.4936
    1999      256.0     0.4716
    2001      251.0     0.5376
    1984      250.0     0.5596
    1986      245.0     0.5817
    2006      242.0     0.6037
    1973      233.0     0.6257
    1988      222.0     0.6477
    1987      210.0     0.6698
    2012      207.0     0.6918
    2007      201.0     0.7138
    1982      200.0     0.7579
    1983      200.0     0.7358
    1994      198.0     0.7799
    1985      185.0     0.8019
    1980      180.0     0.8239
    2013      178.0     0.8459
    2004      165.0     0.8680
    2015      158.0     0.8900
```

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      2016      152.0     0.9120
      2017      146.0     0.9340
    * 1977      105.0     0.9781
    * 2000      105.0     0.9561

      * DENOTES PILF (LO)

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    Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.006.005
    Version 7.1         Annual peak flow frequency analysis      Run Date / Time
    3/14/2014                                                    11/06/2018 14:25

                Station - 06031950.00  Cataract Creek near Basin MT


                           EMA REPRESENTATION OF DATA

    WATER <----- OBSERVED-----><-------- EMA -------><-PERCEPTION THRESHOLDS->
     YEAR    Q_LOWER    Q_UPPER    Q_LOWER    Q_UPPER        LOWER        UPPER
     1909        0.0     3150.0        0.0     3150.0       3150.0          INF
     1910        0.0     3150.0        0.0     3150.0       3150.0          INF
     1911        0.0     3150.0        0.0     3150.0       3150.0          INF
     1912        0.0     3150.0        0.0     3150.0       3150.0          INF
     1913        0.0     3150.0        0.0     3150.0       3150.0          INF
     1914        0.0     3150.0        0.0     3150.0       3150.0          INF
     1915        0.0     3150.0        0.0     3150.0       3150.0          INF
     1916        0.0     3150.0        0.0     3150.0       3150.0          INF
     1917        0.0     3150.0        0.0     3150.0       3150.0          INF
     1918        0.0     3150.0        0.0     3150.0       3150.0          INF
     1919        0.0     3150.0        0.0     3150.0       3150.0          INF
     1920        0.0     3150.0        0.0     3150.0       3150.0          INF
     1921        0.0     3150.0        0.0     3150.0       3150.0          INF
     1922        0.0     3150.0        0.0     3150.0       3150.0          INF
     1923        0.0     3150.0        0.0     3150.0       3150.0          INF
     1924        0.0     3150.0        0.0     3150.0       3150.0          INF
     1925        0.0     3150.0        0.0     3150.0       3150.0          INF
     1926        0.0     3150.0        0.0     3150.0       3150.0          INF
     1927        0.0     3150.0        0.0     3150.0       3150.0          INF
     1928        0.0     3150.0        0.0     3150.0       3150.0          INF
     1929        0.0     3150.0        0.0     3150.0       3150.0          INF
     1930        0.0     3150.0        0.0     3150.0       3150.0          INF
     1931        0.0     3150.0        0.0     3150.0       3150.0          INF
     1932        0.0     3150.0        0.0     3150.0       3150.0          INF
     1933        0.0     3150.0        0.0     3150.0       3150.0          INF
     1934        0.0     3150.0        0.0     3150.0       3150.0          INF
     1935        0.0     3150.0        0.0     3150.0       3150.0          INF
     1936        0.0     3150.0        0.0     3150.0       3150.0          INF
     1937        0.0     3150.0        0.0     3150.0       3150.0          INF
     1938        0.0     3150.0        0.0     3150.0       3150.0          INF
     1939        0.0     3150.0        0.0     3150.0       3150.0          INF
     1940        0.0     3150.0        0.0     3150.0       3150.0          INF
     1941        0.0     3150.0        0.0     3150.0       3150.0          INF
     1942        0.0     3150.0        0.0     3150.0       3150.0          INF
     1943        0.0     3150.0        0.0     3150.0       3150.0          INF
     1944        0.0     3150.0        0.0     3150.0       3150.0          INF
     1945        0.0     3150.0        0.0     3150.0       3150.0          INF
     1946        0.0     3150.0        0.0     3150.0       3150.0          INF
     1947        0.0     3150.0        0.0     3150.0       3150.0          INF
     1948        0.0     3150.0        0.0     3150.0       3150.0          INF
     1949        0.0     3150.0        0.0     3150.0       3150.0          INF
     1950        0.0     3150.0        0.0     3150.0       3150.0          INF
     1951        0.0     3150.0        0.0     3150.0       3150.0          INF
     1952        0.0     3150.0        0.0     3150.0       3150.0          INF
     1953        0.0     3150.0        0.0     3150.0       3150.0          INF
```

1954	0.0	3150.0	0.0	3150.0	3150.0	INF
1955	0.0	3150.0	0.0	3150.0	3150.0	INF
1956	0.0	3150.0	0.0	3150.0	3150.0	INF
1957	0.0	3150.0	0.0	3150.0	3150.0	INF
1958	0.0	3150.0	0.0	3150.0	3150.0	INF
1959	0.0	3150.0	0.0	3150.0	3150.0	INF
1960	0.0	3150.0	0.0	3150.0	3150.0	INF
1961	0.0	3150.0	0.0	3150.0	3150.0	INF
1962	0.0	3150.0	0.0	3150.0	3150.0	INF
1963	0.0	3150.0	0.0	3150.0	3150.0	INF
1964	0.0	3150.0	0.0	3150.0	3150.0	INF
1965	0.0	3150.0	0.0	3150.0	3150.0	INF
1966	0.0	3150.0	0.0	3150.0	3150.0	INF
1967	0.0	3150.0	0.0	3150.0	3150.0	INF
1968	0.0	3150.0	0.0	3150.0	3150.0	INF
1969	0.0	3150.0	0.0	3150.0	3150.0	INF
1970	0.0	3150.0	0.0	3150.0	3150.0	INF
1971	0.0	3150.0	0.0	3150.0	3150.0	INF
1972	0.0	3150.0	0.0	3150.0	3150.0	INF
1973	233.0	233.0	233.0	233.0	146.0	INF
1974	300.0	300.0	300.0	300.0	146.0	INF
1975	623.0	623.0	623.0	623.0	146.0	INF
1976	320.0	320.0	320.0	320.0	146.0	INF
1977	105.0	105.0	0.0	146.0	146.0	INF
1978	370.0	370.0	370.0	370.0	146.0	INF
1979	280.0	280.0	280.0	280.0	146.0	INF
1980	180.0	180.0	180.0	180.0	146.0	INF
1981	3150.0	3150.0	3150.0	3150.0	146.0	INF
1982	200.0	200.0	200.0	200.0	146.0	INF
1983	200.0	200.0	200.0	200.0	146.0	INF
1984	250.0	250.0	250.0	250.0	146.0	INF
1985	185.0	185.0	185.0	185.0	146.0	INF
1986	245.0	245.0	245.0	245.0	146.0	INF
1987	210.0	210.0	210.0	210.0	146.0	INF
1988	222.0	222.0	222.0	222.0	146.0	INF
1989	256.0	256.0	256.0	256.0	146.0	INF
1990	260.0	260.0	260.0	260.0	146.0	INF
1991	274.0	274.0	274.0	274.0	146.0	INF
1992	256.0	256.0	256.0	256.0	146.0	INF
1993	274.0	274.0	274.0	274.0	146.0	INF
1994	198.0	198.0	198.0	198.0	146.0	INF
1995	934.0	934.0	934.0	934.0	146.0	INF
1996	605.0	605.0	605.0	605.0	146.0	INF
1997	409.0	409.0	409.0	409.0	146.0	INF
1998	260.0	260.0	260.0	260.0	146.0	INF
1999	256.0	256.0	256.0	256.0	146.0	INF
2000	105.0	105.0	0.0	146.0	146.0	INF
2001	251.0	251.0	251.0	251.0	146.0	INF
2002	260.0	260.0	260.0	260.0	146.0	INF
2003	330.0	330.0	330.0	330.0	146.0	INF
2004	165.0	165.0	165.0	165.0	146.0	INF
2005	330.0	330.0	330.0	330.0	146.0	INF
2006	242.0	242.0	242.0	242.0	146.0	INF
2007	201.0	201.0	201.0	201.0	146.0	INF
2008	346.0	346.0	346.0	346.0	146.0	INF
2009	330.0	330.0	330.0	330.0	146.0	INF
2010	335.0	335.0	335.0	335.0	146.0	INF
2011	820.0	820.0	820.0	820.0	146.0	INF
2012	207.0	207.0	207.0	207.0	146.0	INF
2013	178.0	178.0	178.0	178.0	146.0	INF
2014	318.0	318.0	318.0	318.0	146.0	INF
2015	158.0	158.0	158.0	158.0	146.0	INF
2016	152.0	152.0	152.0	152.0	146.0	INF
2017	146.0	146.0	146.0	146.0	146.0	INF

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Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.007.001
Version 7.1         Annual peak flow frequency analysis      Run Date / Time
3/14/2014                                                    11/06/2018 14:25

            Station - 06033000.00  Boulder River near Boulder MT


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

              Number of peaks in record           =       78
              Peaks not used in analysis          =        0
              Systematic peaks in analysis        =       76
              Historic peaks in analysis          =        2
              Beginning Year                      =     1909
              Ending Year                         =     2017
              Historical Period Length            =      109
              Generalized skew                    =    0.079
                   Standard error                 =    0.640
                   Mean Square error              =    0.410
              Skew option                         = STATION SKEW
              Gage base discharge                 =      0.0
              User supplied high outlier threshold =   --
              User supplied PILF (LO) criterion   =      662.0
              Plotting position parameter         =     0.00
              Type of analysis                          EMA
              PILF (LO) Test Method                    FIXE
              Perception Thresholds:
                   Begin     End       Low     High     Comment
                    1909    2017       0.0       INF
                    DEFAULT

                    1909    1928    7000.0       INF     1981 HISTORICAL PERIOD
                    1
                    1933    1933    3500.0       INF     1975 HISTORICAL PERIOD
                    1
                    1973    1984    3500.0       INF     1975 HISTORICAL PERIOD
                    2
              Interval Data                    =   None Specified



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

 *WCF191I-USER LOW-OUTLIER CRITERION SUPERSEDES  LIMIT CALCULATED BY
          AUTOMATED LOW-OUTLIER DETECTION PROCEDURE.       662.0    233.0
 *WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.     0.733     0.896  -1
  EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                     Kendall's Tau Parameters

                                                        MEDIAN   No. of
                                       TAU    P-VALUE    SLOPE   PEAKS
                                 ----------------------------------------
            SYSTEMATIC RECORD      0.074      0.346      2.704    76


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Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.007.002
Version 7.1         Annual peak flow frequency analysis      Run Date / Time
3/14/2014                                                    11/06/2018 14:25
```

Station - 06033000.00 Boulder River near Boulder MT

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	LOGARITHMIC		
	MEAN	STANDARD DEVIATION	SKEW
EMA W/O REG. INFO	3.0386	0.2267	0.699
EMA W/REG. INFO	3.0386	0.2267	0.699

EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE) 0.2515
EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE) 0.1143

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	EMA W/ REG INFO ESTIMATE	EMA W/O REG INFO ESTIMATE	<------ FOR EMA ESTIMATES -------> VARIANCE OF EST.	95% CONFIDENCE INTERVALS LOWER	UPPER
0.9950		279.2	--	--	--
0.9900		316.9	--	--	--
0.9500		447.9	--	--	--
0.9000		538.8	--	--	--
0.8000	698.6	698.6	0.0008	559.1	770.8
0.6667	835.3	835.3	0.0007	741.1	946.9
0.5000	1029.	1029.	0.0008	906.6	1181.0
0.4292	1129.	1129.	0.0009	983.1	1303.0
0.2000	1651.	1651.	0.0013	1406.0	1975.0
0.1000	2192.	2192.	0.0019	1835.0	2781.0
0.0400	3051.	3051.	0.0037	2439.0	4588.0
0.0200	3839.	3839.	0.0062	2935.0	7157.0
0.0100	4771.	4771.	0.0099	3468.0	11760.0
0.0050	5876.	5876.	0.0149	4042.0	18520.0
0.0020	7654.	7654.	0.0237	4865.0	32160.0

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.007.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06033000.00 Boulder River near Boulder MT

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

WATER YEAR	PEAK VALUE	PEAKFQ CODES	<--- Intervals ---> LOW	HIGH	REMARKS
-1975	3500.0	H			
-1981	7000.0	H			
1929	1480.0				
1930	778.0				
1931	418.0				
1932	962.0				
1934	468.0				
1935	488.0				
1936	448.0				
1937	430.0				
1938	1830.0				
1939	769.0				

2012	1940	662.0
2013	1941	592.0
2014	1942	1640.0
2015	1943	1630.0
2016	1944	790.0
2017	1945	595.0
2018	1946	555.0
2019	1947	1620.0
2020	1948	2620.0
2021	1949	878.0
2022	1950	1040.0
2023	1951	1250.0
2024	1952	1060.0
2025	1953	1900.0
2026	1954	634.0
2027	1955	839.0
2028	1956	1760.0
2029	1957	1030.0
2030	1958	1280.0
2031	1959	1260.0
2032	1960	1180.0
2033	1961	1220.0
2034	1962	839.0
2035	1963	1320.0
2036	1964	3490.0
2037	1965	2160.0
2038	1966	936.0
2039	1967	2150.0
2040	1968	1660.0
2041	1969	1250.0
2042	1970	1760.0
2043	1971	1550.0
2044	1972	1750.0
2045	1985	718.0
2046	1986	1100.0
2047	1987	687.0
2048	1988	718.0
2049	1989	974.0
2050	1990	997.0
2051	1991	1320.0
2052	1992	575.0
2053	1993	1070.0
2054	1994	915.0
2055	1995	2480.0
2056	1996	1500.0
2057	1997	1550.0
2058	1998	1050.0
2059	1999	859.0
2060	2000	267.0
2061	2001	706.0
2062	2002	688.0
2063	2003	1150.0
2064	2004	554.0
2065	2005	1110.0
2066	2006	929.0
2067	2007	446.0
2068	2008	1120.0
2069	2009	1470.0
2070	2010	2140.0
2071	2011	3520.0
2072	2012	1180.0
2073	2013	736.0
2074	2014	1570.0
2075	2015	707.0
2076	2016	798.0
2077	2017	993.0

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.007.004
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06033000.00 Boulder River near Boulder MT

EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	INTERVALS LOW	HIGH
-1981	7000.0	0.0046		
2011	3520.0	0.0167		
-1975	3500.0	0.0242		
1964	3490.0	0.0444		
1948	2620.0	0.0571		
1995	2480.0	0.0699		
1965	2160.0	0.0826		
1967	2150.0	0.0953		
2010	2140.0	0.1081		
1953	1900.0	0.1208		
1938	1830.0	0.1336		
1956	1760.0	0.1591		
1970	1760.0	0.1463		
1972	1750.0	0.1718		
1968	1660.0	0.1845		
1942	1640.0	0.1973		
1943	1630.0	0.2100		
1947	1620.0	0.2228		
2014	1570.0	0.2355		
1971	1550.0	0.2610		
1997	1550.0	0.2483		
1996	1500.0	0.2737		
1929	1480.0	0.2865		
2009	1470.0	0.2992		
1963	1320.0	0.3247		
1991	1320.0	0.3120		
1958	1280.0	0.3375		
1959	1260.0	0.3502		
1951	1250.0	0.3757		
1969	1250.0	0.3629		
1961	1220.0	0.3884		
1960	1180.0	0.4139		

```
      2012     1180.0     0.4012
      2003     1150.0     0.4266
      2008     1120.0     0.4394
      2005     1110.0     0.4521
      1986     1100.0     0.4649
      1993     1070.0     0.4776
      1952     1060.0     0.4904
      1998     1050.0     0.5031
      1950     1040.0     0.5158
      1957     1030.0     0.5286
      1990      997.0     0.5413
      2017      993.0     0.5541
      1989      974.0     0.5668
      1932      962.0     0.5796
      1966      936.0     0.5923
      2006      929.0     0.6050
      1994      915.0     0.6178
      1949      878.0     0.6305
      1999      859.0     0.6433
      1955      839.0     0.6688
      1962      839.0     0.6560
      2016      798.0     0.6815
      1944      790.0     0.6942
      1930      778.0     0.7070
      1939      769.0     0.7197
      2013      736.0     0.7325
      1985      718.0     0.7580
      1988      718.0     0.7452
      2015      707.0     0.7707
      2001      706.0     0.7834
      2002      688.0     0.7962
      1987      687.0     0.8089
      1940      662.0     0.8217
    * 1954      634.0     0.8344
    * 1945      595.0     0.8472
    * 1941      592.0     0.8599
    * 1992      575.0     0.8726
    * 1946      555.0     0.8854
    * 2004      554.0     0.8981
    * 1935      488.0     0.9109
    * 1934      468.0     0.9236
    * 1936      448.0     0.9363
    * 2007      446.0     0.9491
    * 1937      430.0     0.9618
    * 1931      418.0     0.9746
    * 2000      267.0     0.9873

      * DENOTES PILF (LO)

1


    Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.007.005
    Version 7.1         Annual peak flow frequency analysis      Run Date / Time
    3/14/2014                                                    11/06/2018 14:25

                Station - 06033000.00  Boulder River near Boulder MT


                           EMA REPRESENTATION OF DATA

    WATER <----- OBSERVED-----><-------- EMA -------><-PERCEPTION THRESHOLDS->
     YEAR    Q_LOWER    Q_UPPER    Q_LOWER    Q_UPPER        LOWER       UPPER
     1909        0.0     7000.0        0.0     7000.0       7000.0         INF
     1910        0.0     7000.0        0.0     7000.0       7000.0         INF
     1911        0.0     7000.0        0.0     7000.0       7000.0         INF
```

1912	0.0	7000.0	0.0	7000.0	7000.0	INF
1913	0.0	7000.0	0.0	7000.0	7000.0	INF
1914	0.0	7000.0	0.0	7000.0	7000.0	INF
1915	0.0	7000.0	0.0	7000.0	7000.0	INF
1916	0.0	7000.0	0.0	7000.0	7000.0	INF
1917	0.0	7000.0	0.0	7000.0	7000.0	INF
1918	0.0	7000.0	0.0	7000.0	7000.0	INF
1919	0.0	7000.0	0.0	7000.0	7000.0	INF
1920	0.0	7000.0	0.0	7000.0	7000.0	INF
1921	0.0	7000.0	0.0	7000.0	7000.0	INF
1922	0.0	7000.0	0.0	7000.0	7000.0	INF
1923	0.0	7000.0	0.0	7000.0	7000.0	INF
1924	0.0	7000.0	0.0	7000.0	7000.0	INF
1925	0.0	7000.0	0.0	7000.0	7000.0	INF
1926	0.0	7000.0	0.0	7000.0	7000.0	INF
1927	0.0	7000.0	0.0	7000.0	7000.0	INF
1928	0.0	7000.0	0.0	7000.0	7000.0	INF
1929	1480.0	1480.0	1480.0	1480.0	662.0	INF
1930	778.0	778.0	778.0	778.0	662.0	INF
1931	418.0	418.0	0.0	662.0	662.0	INF
1932	962.0	962.0	962.0	962.0	662.0	INF
1933	0.0	3500.0	0.0	3500.0	3500.0	INF
1934	468.0	468.0	0.0	662.0	662.0	INF
1935	488.0	488.0	0.0	662.0	662.0	INF
1936	448.0	448.0	0.0	662.0	662.0	INF
1937	430.0	430.0	0.0	662.0	662.0	INF
1938	1830.0	1830.0	1830.0	1830.0	662.0	INF
1939	769.0	769.0	769.0	769.0	662.0	INF
1940	662.0	662.0	662.0	662.0	662.0	INF
1941	592.0	592.0	0.0	662.0	662.0	INF
1942	1640.0	1640.0	1640.0	1640.0	662.0	INF
1943	1630.0	1630.0	1630.0	1630.0	662.0	INF
1944	790.0	790.0	790.0	790.0	662.0	INF
1945	595.0	595.0	0.0	662.0	662.0	INF
1946	555.0	555.0	0.0	662.0	662.0	INF
1947	1620.0	1620.0	1620.0	1620.0	662.0	INF
1948	2620.0	2620.0	2620.0	2620.0	662.0	INF
1949	878.0	878.0	878.0	878.0	662.0	INF
1950	1040.0	1040.0	1040.0	1040.0	662.0	INF
1951	1250.0	1250.0	1250.0	1250.0	662.0	INF
1952	1060.0	1060.0	1060.0	1060.0	662.0	INF
1953	1900.0	1900.0	1900.0	1900.0	662.0	INF
1954	634.0	634.0	0.0	662.0	662.0	INF
1955	839.0	839.0	839.0	839.0	662.0	INF
1956	1760.0	1760.0	1760.0	1760.0	662.0	INF
1957	1030.0	1030.0	1030.0	1030.0	662.0	INF
1958	1280.0	1280.0	1280.0	1280.0	662.0	INF
1959	1260.0	1260.0	1260.0	1260.0	662.0	INF
1960	1180.0	1180.0	1180.0	1180.0	662.0	INF
1961	1220.0	1220.0	1220.0	1220.0	662.0	INF
1962	839.0	839.0	839.0	839.0	662.0	INF
1963	1320.0	1320.0	1320.0	1320.0	662.0	INF
1964	3490.0	3490.0	3490.0	3490.0	662.0	INF
1965	2160.0	2160.0	2160.0	2160.0	662.0	INF
1966	936.0	936.0	936.0	936.0	662.0	INF
1967	2150.0	2150.0	2150.0	2150.0	662.0	INF
1968	1660.0	1660.0	1660.0	1660.0	662.0	INF
1969	1250.0	1250.0	1250.0	1250.0	662.0	INF
1970	1760.0	1760.0	1760.0	1760.0	662.0	INF
1971	1550.0	1550.0	1550.0	1550.0	662.0	INF
1972	1750.0	1750.0	1750.0	1750.0	662.0	INF
1973	0.0	3500.0	0.0	3500.0	3500.0	INF
1974	0.0	3500.0	0.0	3500.0	3500.0	INF
1975	3500.0	3500.0	3500.0	3500.0	3500.0	INF
1976	0.0	3500.0	0.0	3500.0	3500.0	INF
1977	0.0	3500.0	0.0	3500.0	3500.0	INF

```
     1978        0.0     3500.0        0.0     3500.0       3500.0        INF
     1979        0.0     3500.0        0.0     3500.0       3500.0        INF
     1980        0.0     3500.0        0.0     3500.0       3500.0        INF
     1981     7000.0     7000.0     7000.0     7000.0       3500.0        INF
     1982        0.0     3500.0        0.0     3500.0       3500.0        INF
     1983        0.0     3500.0        0.0     3500.0       3500.0        INF
     1984        0.0     3500.0        0.0     3500.0       3500.0        INF
     1985      718.0      718.0      718.0      718.0        662.0        INF
     1986     1100.0     1100.0     1100.0     1100.0        662.0        INF
     1987      687.0      687.0      687.0      687.0        662.0        INF
     1988      718.0      718.0      718.0      718.0        662.0        INF
     1989      974.0      974.0      974.0      974.0        662.0        INF
     1990      997.0      997.0      997.0      997.0        662.0        INF
     1991     1320.0     1320.0     1320.0     1320.0        662.0        INF
     1992      575.0      575.0        0.0      662.0        662.0        INF
     1993     1070.0     1070.0     1070.0     1070.0        662.0        INF
     1994      915.0      915.0      915.0      915.0        662.0        INF
     1995     2480.0     2480.0     2480.0     2480.0        662.0        INF
     1996     1500.0     1500.0     1500.0     1500.0        662.0        INF
     1997     1550.0     1550.0     1550.0     1550.0        662.0        INF
     1998     1050.0     1050.0     1050.0     1050.0        662.0        INF
     1999      859.0      859.0      859.0      859.0        662.0        INF
     2000      267.0      267.0        0.0      662.0        662.0        INF
     2001      706.0      706.0      706.0      706.0        662.0        INF
     2002      688.0      688.0      688.0      688.0        662.0        INF
     2003     1150.0     1150.0     1150.0     1150.0        662.0        INF
     2004      554.0      554.0        0.0      662.0        662.0        INF
     2005     1110.0     1110.0     1110.0     1110.0        662.0        INF
     2006      929.0      929.0      929.0      929.0        662.0        INF
     2007      446.0      446.0        0.0      662.0        662.0        INF
     2008     1120.0     1120.0     1120.0     1120.0        662.0        INF
     2009     1470.0     1470.0     1470.0     1470.0        662.0        INF
     2010     2140.0     2140.0     2140.0     2140.0        662.0        INF
     2011     3520.0     3520.0     3520.0     3520.0        662.0        INF
     2012     1180.0     1180.0     1180.0     1180.0        662.0        INF
     2013      736.0      736.0      736.0      736.0        662.0        INF
     2014     1570.0     1570.0     1570.0     1570.0        662.0        INF
     2015      707.0      707.0      707.0      707.0        662.0        INF
     2016      798.0      798.0      798.0      798.0        662.0        INF
     2017      993.0      993.0      993.0      993.0        662.0        INF
1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.008.001
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

            Station - 06058700.00  Mitchell Gulch near East Helena MT


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

                 Number of peaks in record            =       45
                 Peaks not used in analysis           =        0
                 Systematic peaks in analysis         =       45
                 Historic peaks in analysis           =        0
                 Beginning Year                       =     1959
                 Ending Year                          =     2003
                 Historical Period Length             =       45
                 Generalized skew                     =    0.188
                      Standard error                  =    0.640
                      Mean Square error               =    0.410
                 Skew option                          = STATION SKEW
                 Gage base discharge                  =      0.0
                 User supplied high outlier threshold =   --
                 User supplied PILF (LO) criterion    =        2.0
```

```
                  Plotting position parameter          =     0.00
                  Type of analysis                           EMA
                  PILF (LO) Test Method                     FIXE
                  Perception Thresholds:
                       Begin     End       Low     High     Comment
                        1959    2003       0.0       INF
                        DEFAULT

                  Interval Data                    =   None Specified



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

     *WCF191I-USER LOW-OUTLIER CRITERION SUPERSEDES  LIMIT CALCULATED BY
              AUTOMATED LOW-OUTLIER DETECTION PROCEDURE.         2.0      0.4
     *WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.    -0.479    -0.767  -1
      WCF002J-CALCS COMPLETED.  RETURN CODE =  2
      EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                          Kendall's Tau Parameters

                                                          MEDIAN   No. of
                                        TAU    P-VALUE    SLOPE   PEAKS
                                   ---------------------------------------
               SYSTEMATIC RECORD      0.018      0.887      0.048    35


  1


    Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.008.002
    Version 7.1         Annual peak flow frequency analysis      Run Date / Time
    3/14/2014                                                    11/06/2018 14:25

             Station - 06058700.00  Mitchell Gulch near East Helena MT


             ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                       LOGARITHMIC
                            -------------------------------
                                         STANDARD
                               MEAN     DEVIATION     SKEW
                            -------------------------------
   EMA W/O REG. INFO          0.9139      1.0859     -0.949
   EMA W/REG. INFO            0.9139      1.0859     -0.949

   EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.0765
   EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.2051



      ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

     ANNUAL   EMA W/    EMA W/O     <------ FOR EMA ESTIMATES -------->
  EXCEEDANCE  REG INFO  REG INFO    VARIANCE  95% CONFIDENCE INTERVALS
  PROBABILITY ESTIMATE  ESTIMATE     OF EST.       LOWER       UPPER

     0.6667                 5.9          --          --          --
     0.5000      12.1      12.1      0.0315         3.5         25.1
     0.4292      18.3      18.3      0.0269         6.9         37.5
     0.2000      69.2      69.2      0.0201        35.3        138.4
     0.1000     141.0     141.0      0.0202        74.9        319.2
```

```
     0.0400     263.0     263.0      0.0245       142.0        798.3
     0.0200     367.5     367.5      0.0304       192.7       1358.0
     0.0100     476.4     476.4      0.0385       236.7       2088.0
     0.0050     585.3     585.3      0.0484       272.5       3068.0
     0.0020     723.7     723.7      0.0636       309.1       4948.0
1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.008.003
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

            Station - 06058700.00  Mitchell Gulch near East Helena MT


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


      WATER       PEAK   PEAKFQ   <--- Intervals --->
       YEAR      VALUE    CODES     LOW         HIGH   REMARKS
       1959       53.0
       1960        6.0
       1961        2.0
       1962       12.0
       1963      107.0
       1964        0.0
       1965       28.0
       1966       50.0
       1967       52.0
       1968        0.0
       1969       90.0
       1970        2.0
       1971        4.0
       1972        0.0
       1973      139.0
       1974       53.0
       1975       90.0
       1976        2.0
       1977        0.0
       1978       82.0
       1979       43.0
       1980       25.0
       1981      105.0
       1982        9.0
       1983        9.0
       1984        2.0
       1985       24.0
       1986      195.0
       1987        1.0
       1988        0.0
       1989       31.0
       1990      127.0
       1991        0.0
       1992        0.0
       1993       62.0
       1994       22.0
       1995       14.0
       1996      120.0
       1997        5.0
       1998       15.0
       1999        0.0
       2000        0.0
       2001        4.0
       2002        0.0
       2003      255.0
```

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.008.004
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06058700.00 Mitchell Gulch near East Helena MT

EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	INTERVALS LOW	HIGH
2003	255.0	0.0216		
1986	195.0	0.0434		
1973	139.0	0.0651		
1990	127.0	0.0869		
1996	120.0	0.1086		
1963	107.0	0.1304		
1981	105.0	0.1521		
1969	90.0	0.1956		
1975	90.0	0.1738		
1978	82.0	0.2173		
1993	62.0	0.2391		
1959	53.0	0.2826		
1974	53.0	0.2608		
1967	52.0	0.3043		
1966	50.0	0.3261		
1979	43.0	0.3478		
1989	31.0	0.3695		
1965	28.0	0.3913		
1980	25.0	0.4130		
1985	24.0	0.4348		
1994	22.0	0.4565		
1998	15.0	0.4783		
1995	14.0	0.5000		
1962	12.0	0.5217		
1982	9.0	0.5652		
1983	9.0	0.5435		
1960	6.0	0.5870		
1997	5.0	0.6087		
1971	4.0	0.6522		
2001	4.0	0.6305		
1961	2.0	0.7392		
1970	2.0	0.7174		
1976	2.0	0.6957		

```
      1984        2.0     0.6739
    * 1987        1.0     0.7609

      * DENOTES PILF (LO)

  1


    Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.008.005
    Version 7.1         Annual peak flow frequency analysis      Run Date / Time
    3/14/2014                                                    11/06/2018 14:25

             Station - 06058700.00  Mitchell Gulch near East Helena MT


                           EMA REPRESENTATION OF DATA

    WATER <----- OBSERVED-----><-------- EMA -------><-PERCEPTION THRESHOLDS->
     YEAR    Q_LOWER    Q_UPPER    Q_LOWER    Q_UPPER         LOWER        UPPER
     1959       53.0       53.0       53.0       53.0           2.0          INF
     1960        6.0        6.0        6.0        6.0           2.0          INF
     1961        2.0        2.0        2.0        2.0           2.0          INF
     1962       12.0       12.0       12.0       12.0           2.0          INF
     1963      107.0      107.0      107.0      107.0           2.0          INF
     1964        0.0        0.0        0.0        2.0           2.0          INF
     1965       28.0       28.0       28.0       28.0           2.0          INF
     1966       50.0       50.0       50.0       50.0           2.0          INF
     1967       52.0       52.0       52.0       52.0           2.0          INF
     1968        0.0        0.0        0.0        2.0           2.0          INF
     1969       90.0       90.0       90.0       90.0           2.0          INF
     1970        2.0        2.0        2.0        2.0           2.0          INF
     1971        4.0        4.0        4.0        4.0           2.0          INF
     1972        0.0        0.0        0.0        2.0           2.0          INF
     1973      139.0      139.0      139.0      139.0           2.0          INF
     1974       53.0       53.0       53.0       53.0           2.0          INF
     1975       90.0       90.0       90.0       90.0           2.0          INF
     1976        2.0        2.0        2.0        2.0           2.0          INF
     1977        0.0        0.0        0.0        2.0           2.0          INF
     1978       82.0       82.0       82.0       82.0           2.0          INF
     1979       43.0       43.0       43.0       43.0           2.0          INF
     1980       25.0       25.0       25.0       25.0           2.0          INF
     1981      105.0      105.0      105.0      105.0           2.0          INF
     1982        9.0        9.0        9.0        9.0           2.0          INF
     1983        9.0        9.0        9.0        9.0           2.0          INF
     1984        2.0        2.0        2.0        2.0           2.0          INF
     1985       24.0       24.0       24.0       24.0           2.0          INF
     1986      195.0      195.0      195.0      195.0           2.0          INF
     1987        1.0        1.0        0.0        2.0           2.0          INF
     1988        0.0        0.0        0.0        2.0           2.0          INF
     1989       31.0       31.0       31.0       31.0           2.0          INF
     1990      127.0      127.0      127.0      127.0           2.0          INF
     1991        0.0        0.0        0.0        2.0           2.0          INF
     1992        0.0        0.0        0.0        2.0           2.0          INF
     1993       62.0       62.0       62.0       62.0           2.0          INF
     1994       22.0       22.0       22.0       22.0           2.0          INF
     1995       14.0       14.0       14.0       14.0           2.0          INF
     1996      120.0      120.0      120.0      120.0           2.0          INF
     1997        5.0        5.0        5.0        5.0           2.0          INF
     1998       15.0       15.0       15.0       15.0           2.0          INF
     1999        0.0        0.0        0.0        2.0           2.0          INF
     2000        0.0        0.0        0.0        2.0           2.0          INF
     2001        4.0        4.0        4.0        4.0           2.0          INF
     2002        0.0        0.0        0.0        2.0           2.0          INF
     2003      255.0      255.0      255.0      255.0           2.0          INF
  1
```

```
Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.009.001
Version 7.1         Annual peak flow frequency analysis      Run Date / Time
3/14/2014                                                    11/06/2018 14:25

          Station - 06061500.00  Prickly Pear Creek near Clancy MT


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

            Number of peaks in record           =       77
            Peaks not used in analysis          =        0
            Systematic peaks in analysis        =       76
            Historic peaks in analysis          =        1
            Beginning Year                      =     1909
            Ending Year                         =     2017
            Historical Period Length            =      109
            Generalized skew                    =    0.172
                 Standard error                 =    0.640
                 Mean Square error              =    0.410
            Skew option                         = STATION SKEW
            Gage base discharge                 =      0.0
            User supplied high outlier threshold =   --
            User supplied PILF (LO) criterion   =      100.0
            Plotting position parameter         =     0.00
            Type of analysis                          EMA
            PILF (LO) Test Method                    FIXE
            Perception Thresholds:
                 Begin     End       Low     High     Comment
                  1909    2017       0.0       INF
                  DEFAULT

                  1909    1910    1200.0       INF     1975 HISTORICAL PERIOD
                  1
                  1917    1922    1200.0       INF     1975 HISTORICAL PERIOD
                  2
                  1934    1945    1200.0       INF     1975 HISTORICAL PERIOD
                  3
                  1954    1954    1200.0       INF     1975 HISTORICAL PERIOD
                  4
                  1970    1978    1200.0       INF     1975 HISTORICAL PERIOD
                  5
                  2003    2005    1200.0       INF     1975 HISTORICAL PERIOD
                  6
            Interval Data                   =   None Specified



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

 *WCF191I-USER LOW-OUTLIER CRITERION SUPERSEDES  LIMIT CALCULATED BY
          AUTOMATED LOW-OUTLIER DETECTION PROCEDURE.       100.0     41.2
 *WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.     0.801     0.979  -1
  EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                     Kendall's Tau Parameters

                                                      MEDIAN   No. of
                                     TAU    P-VALUE    SLOPE   PEAKS
                                 ----------------------------------------
          SYSTEMATIC RECORD     -0.044      0.581     -0.368    76


1
```

```
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.009.002
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06061500.00  Prickly Pear Creek near Clancy MT


           ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                     LOGARITHMIC
                          -------------------------------
                                       STANDARD
                             MEAN     DEVIATION     SKEW
                          -------------------------------
 EMA W/O REG. INFO          2.4181      0.2503      0.837
 EMA W/REG. INFO            2.4181      0.2503      0.837

 EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.1395
 EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.1261



     ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

    ANNUAL   EMA W/    EMA W/O     <------ FOR EMA ESTIMATES ------->
 EXCEEDANCE  REG INFO  REG INFO    VARIANCE  95% CONFIDENCE INTERVALS
 PROBABILITY ESTIMATE  ESTIMATE     OF EST.       LOWER       UPPER

    0.9950                72.2          --          --          --
    0.9900                79.2          --          --          --
    0.9500     118.5     118.5      0.0014        96.6        137.8
    0.9000     134.3     134.3      0.0008       114.3        149.9
    0.8000     159.9     159.9      0.0006       142.1        181.3
    0.6667     193.1     193.1      0.0008       170.1        221.5
    0.5000     241.9     241.9      0.0011       206.4        280.5
    0.4292     267.8     267.8      0.0012       226.5        312.7
    0.2000     409.5     409.5      0.0016       343.4        499.7
    0.1000     566.0     566.0      0.0024       464.2        741.3
    0.0400     830.4     830.4      0.0048       643.1       1305.0
    0.0200    1087.     1087.       0.0080       798.8       2102.0
    0.0100    1405.     1405.       0.0125       974.9       3511.0
    0.0050    1800.     1800.       0.0184      1174.0       6031.0
    0.0020    2470.     2470.       0.0286      1478.0      11810.0
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.009.003
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06061500.00  Prickly Pear Creek near Clancy MT


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


     WATER       PEAK   PEAKFQ   <--- Intervals --->
      YEAR      VALUE    CODES     LOW         HIGH   REMARKS
     -1975     1200.0  H
      1911      310.0
      1912      358.0
      1913      420.0
      1914      306.0
      1915      465.0
```

2728	1916	441.0
2729	1923	196.0
2730	1924	161.0
2731	1925	164.0
2732	1926	213.0
2733	1927	900.0
2734	1928	174.0
2735	1929	273.0
2736	1930	189.0
2737	1931	63.0
2738	1932	260.0
2739	1933	142.0
2740	1946	135.0
2741	1947	333.0
2742	1948	778.0
2743	1949	168.0
2744	1950	246.0
2745	1951	247.0
2746	1952	193.0
2747	1953	476.0
2748	1955	220.0
2749	1956	180.0
2750	1957	154.0
2751	1958	251.0
2752	1959	210.0
2753	1960	256.0
2754	1961	120.0
2755	1962	235.0
2756	1963	486.0
2757	1964	700.0
2758	1965	418.0
2759	1966	156.0
2760	1967	377.0
2761	1968	446.0
2762	1969	296.0
2763	1979	204.0
2764	1980	349.0
2765	1981	2300.0
2766	1982	328.0
2767	1983	439.0
2768	1984	270.0
2769	1985	100.0
2770	1986	220.0
2771	1987	226.0
2772	1988	124.0
2773	1989	267.0
2774	1990	148.0
2775	1991	248.0
2776	1992	304.0
2777	1993	385.0
2778	1994	183.0
2779	1995	545.0
2780	1996	271.0
2781	1997	354.0
2782	1998	307.0
2783	1999	234.0
2784	2000	49.0
2785	2001	110.0
2786	2002	163.0
2787	2006	374.0
2788	2007	155.0
2789	2008	285.0
2790	2009	261.0
2791	2010	464.0
2792	2011	1030.0
2793	2012	123.0

2013	166.0
2014	278.0
2015	291.0
2016	187.0
2017	135.0

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

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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.009.004
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06061500.00 Prickly Pear Creek near Clancy MT

EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	INTERVALS LOW	HIGH
1981	2300.0	0.0061		
-1975	1200.0	0.0122		
2011	1030.0	0.0312		
1927	900.0	0.0441		
1948	778.0	0.0570		
1964	700.0	0.0700		
1995	545.0	0.0829		
1963	486.0	0.0958		
1953	476.0	0.1087		
1915	465.0	0.1216		
2010	464.0	0.1346		
1968	446.0	0.1475		
1916	441.0	0.1604		
1983	439.0	0.1733		
1913	420.0	0.1862		
1965	418.0	0.1991		
1993	385.0	0.2121		
1967	377.0	0.2250		
2006	374.0	0.2379		
1912	358.0	0.2508		
1997	354.0	0.2637		
1980	349.0	0.2766		
1947	333.0	0.2896		
1982	328.0	0.3025		
1911	310.0	0.3154		
1998	307.0	0.3283		
1914	306.0	0.3412		

```
      1992      304.0     0.3542
      1969      296.0     0.3671
      2015      291.0     0.3800
      2008      285.0     0.3929
      2014      278.0     0.4058
      1929      273.0     0.4187
      1996      271.0     0.4317
      1984      270.0     0.4446
      1989      267.0     0.4575
      2009      261.0     0.4704
      1932      260.0     0.4833
      1960      256.0     0.4963
      1958      251.0     0.5092
      1991      248.0     0.5221
      1951      247.0     0.5350
      1950      246.0     0.5479
      1962      235.0     0.5608
      1999      234.0     0.5738
      1987      226.0     0.5867
      1955      220.0     0.6125
      1986      220.0     0.5996
      1926      213.0     0.6254
      1959      210.0     0.6384
      1979      204.0     0.6513
      1923      196.0     0.6642
      1952      193.0     0.6771
      1930      189.0     0.6900
      2016      187.0     0.7029
      1994      183.0     0.7159
      1956      180.0     0.7288
      1928      174.0     0.7417
      1949      168.0     0.7546
      2013      166.0     0.7675
      1925      164.0     0.7805
      2002      163.0     0.7934
      1924      161.0     0.8063
      1966      156.0     0.8192
      2007      155.0     0.8321
      1957      154.0     0.8450
      1990      148.0     0.8580
      1933      142.0     0.8709
      1946      135.0     0.8967
      2017      135.0     0.8838
      1988      124.0     0.9096
      2012      123.0     0.9226
      1961      120.0     0.9355
      2001      110.0     0.9484
      1985      100.0     0.9613
    * 1931       63.0     0.9742
    * 2000       49.0     0.9871

      * DENOTES PILF (LO)

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    Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.009.005
    Version 7.1         Annual peak flow frequency analysis      Run Date / Time
    3/14/2014                                                    11/06/2018 14:25

              Station - 06061500.00  Prickly Pear Creek near Clancy MT


                           EMA REPRESENTATION OF DATA

    WATER <----- OBSERVED-----><-------- EMA -------><-PERCEPTION THRESHOLDS->
```

YEAR	Q_LOWER	Q_UPPER	Q_LOWER	Q_UPPER	LOWER	UPPER
1909	0.0	1200.0	0.0	1200.0	1200.0	INF
1910	0.0	1200.0	0.0	1200.0	1200.0	INF
1911	310.0	310.0	310.0	310.0	100.0	INF
1912	358.0	358.0	358.0	358.0	100.0	INF
1913	420.0	420.0	420.0	420.0	100.0	INF
1914	306.0	306.0	306.0	306.0	100.0	INF
1915	465.0	465.0	465.0	465.0	100.0	INF
1916	441.0	441.0	441.0	441.0	100.0	INF
1917	0.0	1200.0	0.0	1200.0	1200.0	INF
1918	0.0	1200.0	0.0	1200.0	1200.0	INF
1919	0.0	1200.0	0.0	1200.0	1200.0	INF
1920	0.0	1200.0	0.0	1200.0	1200.0	INF
1921	0.0	1200.0	0.0	1200.0	1200.0	INF
1922	0.0	1200.0	0.0	1200.0	1200.0	INF
1923	196.0	196.0	196.0	196.0	100.0	INF
1924	161.0	161.0	161.0	161.0	100.0	INF
1925	164.0	164.0	164.0	164.0	100.0	INF
1926	213.0	213.0	213.0	213.0	100.0	INF
1927	900.0	900.0	900.0	900.0	100.0	INF
1928	174.0	174.0	174.0	174.0	100.0	INF
1929	273.0	273.0	273.0	273.0	100.0	INF
1930	189.0	189.0	189.0	189.0	100.0	INF
1931	63.0	63.0	0.0	100.0	100.0	INF
1932	260.0	260.0	260.0	260.0	100.0	INF
1933	142.0	142.0	142.0	142.0	100.0	INF
1934	0.0	1200.0	0.0	1200.0	1200.0	INF
1935	0.0	1200.0	0.0	1200.0	1200.0	INF
1936	0.0	1200.0	0.0	1200.0	1200.0	INF
1937	0.0	1200.0	0.0	1200.0	1200.0	INF
1938	0.0	1200.0	0.0	1200.0	1200.0	INF
1939	0.0	1200.0	0.0	1200.0	1200.0	INF
1940	0.0	1200.0	0.0	1200.0	1200.0	INF
1941	0.0	1200.0	0.0	1200.0	1200.0	INF
1942	0.0	1200.0	0.0	1200.0	1200.0	INF
1943	0.0	1200.0	0.0	1200.0	1200.0	INF
1944	0.0	1200.0	0.0	1200.0	1200.0	INF
1945	0.0	1200.0	0.0	1200.0	1200.0	INF
1946	135.0	135.0	135.0	135.0	100.0	INF
1947	333.0	333.0	333.0	333.0	100.0	INF
1948	778.0	778.0	778.0	778.0	100.0	INF
1949	168.0	168.0	168.0	168.0	100.0	INF
1950	246.0	246.0	246.0	246.0	100.0	INF
1951	247.0	247.0	247.0	247.0	100.0	INF
1952	193.0	193.0	193.0	193.0	100.0	INF
1953	476.0	476.0	476.0	476.0	100.0	INF
1954	0.0	1200.0	0.0	1200.0	1200.0	INF
1955	220.0	220.0	220.0	220.0	100.0	INF
1956	180.0	180.0	180.0	180.0	100.0	INF
1957	154.0	154.0	154.0	154.0	100.0	INF
1958	251.0	251.0	251.0	251.0	100.0	INF
1959	210.0	210.0	210.0	210.0	100.0	INF
1960	256.0	256.0	256.0	256.0	100.0	INF
1961	120.0	120.0	120.0	120.0	100.0	INF
1962	235.0	235.0	235.0	235.0	100.0	INF
1963	486.0	486.0	486.0	486.0	100.0	INF
1964	700.0	700.0	700.0	700.0	100.0	INF
1965	418.0	418.0	418.0	418.0	100.0	INF
1966	156.0	156.0	156.0	156.0	100.0	INF
1967	377.0	377.0	377.0	377.0	100.0	INF
1968	446.0	446.0	446.0	446.0	100.0	INF
1969	296.0	296.0	296.0	296.0	100.0	INF
1970	0.0	1200.0	0.0	1200.0	1200.0	INF
1971	0.0	1200.0	0.0	1200.0	1200.0	INF
1972	0.0	1200.0	0.0	1200.0	1200.0	INF
1973	0.0	1200.0	0.0	1200.0	1200.0	INF

```
     1974        0.0     1200.0        0.0     1200.0       1200.0        INF
     1975     1200.0     1200.0     1200.0     1200.0       1200.0        INF
     1976        0.0     1200.0        0.0     1200.0       1200.0        INF
     1977        0.0     1200.0        0.0     1200.0       1200.0        INF
     1978        0.0     1200.0        0.0     1200.0       1200.0        INF
     1979      204.0      204.0      204.0      204.0        100.0        INF
     1980      349.0      349.0      349.0      349.0        100.0        INF
     1981     2300.0     2300.0     2300.0     2300.0        100.0        INF
     1982      328.0      328.0      328.0      328.0        100.0        INF
     1983      439.0      439.0      439.0      439.0        100.0        INF
     1984      270.0      270.0      270.0      270.0        100.0        INF
     1985      100.0      100.0      100.0      100.0        100.0        INF
     1986      220.0      220.0      220.0      220.0        100.0        INF
     1987      226.0      226.0      226.0      226.0        100.0        INF
     1988      124.0      124.0      124.0      124.0        100.0        INF
     1989      267.0      267.0      267.0      267.0        100.0        INF
     1990      148.0      148.0      148.0      148.0        100.0        INF
     1991      248.0      248.0      248.0      248.0        100.0        INF
     1992      304.0      304.0      304.0      304.0        100.0        INF
     1993      385.0      385.0      385.0      385.0        100.0        INF
     1994      183.0      183.0      183.0      183.0        100.0        INF
     1995      545.0      545.0      545.0      545.0        100.0        INF
     1996      271.0      271.0      271.0      271.0        100.0        INF
     1997      354.0      354.0      354.0      354.0        100.0        INF
     1998      307.0      307.0      307.0      307.0        100.0        INF
     1999      234.0      234.0      234.0      234.0        100.0        INF
     2000       49.0       49.0        0.0      100.0        100.0        INF
     2001      110.0      110.0      110.0      110.0        100.0        INF
     2002      163.0      163.0      163.0      163.0        100.0        INF
     2003        0.0     1200.0        0.0     1200.0       1200.0        INF
     2004        0.0     1200.0        0.0     1200.0       1200.0        INF
     2005        0.0     1200.0        0.0     1200.0       1200.0        INF
     2006      374.0      374.0      374.0      374.0        100.0        INF
     2007      155.0      155.0      155.0      155.0        100.0        INF
     2008      285.0      285.0      285.0      285.0        100.0        INF
     2009      261.0      261.0      261.0      261.0        100.0        INF
     2010      464.0      464.0      464.0      464.0        100.0        INF
     2011     1030.0     1030.0     1030.0     1030.0        100.0        INF
     2012      123.0      123.0      123.0      123.0        100.0        INF
     2013      166.0      166.0      166.0      166.0        100.0        INF
     2014      278.0      278.0      278.0      278.0        100.0        INF
     2015      291.0      291.0      291.0      291.0        100.0        INF
     2016      187.0      187.0      187.0      187.0        100.0        INF
     2017      135.0      135.0      135.0      135.0        100.0        INF
1


   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.010.001
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

             Station - 06061700.00  Jackson Creek near East Helena MT


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

                  Number of peaks in record            =       18
                  Peaks not used in analysis           =        0
                  Systematic peaks in analysis         =       17
                  Historic peaks in analysis           =        1
                  Beginning Year                       =     1961
                  Ending Year                          =     2011
                  Historical Period Length             =       51
                  Generalized skew                     =    0.167
                       Standard error                  =    0.640
                       Mean Square error               =    0.410
```

```
                 Skew option                          = STATION SKEW
                 Gage base discharge                  =      0.0
                 User supplied high outlier threshold =   --
                 User supplied PILF (LO) criterion    =   --
                 Plotting position parameter          =     0.00
                 Type of analysis                           EMA
                 PILF (LO) Test Method                      MGBT
                 Perception Thresholds:
                      Begin     End       Low     High     Comment
                       1961    2011       0.0       INF
                       DEFAULT

                       1976    1988     111.0       INF     1981 HISTORICAL PERIOD
                       1
                       1991    2011     380.0       INF     1990 HISTORICAL SYSTEMATIC
                       PERIOD 1
                 Interval Data                    =   None Specified



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

    *WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.     0.822     1.235  -1
     WCF002J-CALCS COMPLETED.  RETURN CODE =  2
     EMA001W-VARIANCE OF ESTIMATE WARNING, HISTORIC PERIOD > 2* SYS
     EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                        Kendall's Tau Parameters

                                                        MEDIAN   No. of
                                        TAU    P-VALUE    SLOPE   PEAKS
                                  ---------------------------------------
              SYSTEMATIC RECORD      0.279      0.127      1.000    17


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   Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.010.002
   Version 7.1         Annual peak flow frequency analysis      Run Date / Time
   3/14/2014                                                    11/06/2018 14:25

             Station - 06061700.00  Jackson Creek near East Helena MT


            ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                     LOGARITHMIC
                          -------------------------------
                                       STANDARD
                             MEAN     DEVIATION     SKEW
                          -------------------------------
  EMA W/O REG. INFO         1.1946      0.4074      1.279
  EMA W/REG. INFO           1.1946      0.4074      1.279

  EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.6908
  EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.5292



     ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

    ANNUAL   EMA W/    EMA W/O     <------ FOR EMA ESTIMATES -------->
 EXCEEDANCE  REG INFO  REG INFO    VARIANCE  95% CONFIDENCE INTERVALS
```

PROBABILITY	ESTIMATE	ESTIMATE	OF EST.	LOWER	UPPER
0.9950	4.1	4.1	0.0697	0.6	8.5
0.9900	4.2	4.2	0.0508	0.9	8.5
0.9500	5.0	5.0	0.0163	2.2	8.5
0.9000	5.7	5.7	0.0077	3.1	8.6
0.8000	7.1	7.1	0.0052	4.8	11.2
0.6667	9.2	9.2	0.0084	6.3	16.2
0.5000	12.9	12.9	0.0141	7.7	23.8
0.4292	15.1	15.1	0.0163	8.4	28.4
0.2000	30.8	30.8	0.0209	15.0	62.1
0.1000	55.0	55.0	0.0240	27.3	125.1
0.0400	112.6	112.6	0.0394	51.9	376.5
0.0200	189.4	189.4	0.0654	75.7	1086.0
0.0100	314.3	314.3	0.1072	104.5	3843.0
0.0050	516.4	516.4	0.1671	139.2	16240.0
0.0020	983.4	983.4	0.2769	195.4	128100.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.010.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06061700.00 Jackson Creek near East Helena MT

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

WATER YEAR	PEAK VALUE	PEAKFQ CODES	<--- Intervals ---> LOW	HIGH	REMARKS
-1981	111.0	H			
1961	4.0				
1962	16.0				
1963	12.0				
1964	19.0				
1965	14.0				
1966	7.0				
1967	20.0				
1968	17.0				
1969	15.0				
1970	10.0				
1971	9.0				
1972	9.0				
1973	4.0				
1974	24.0				
1975	33.0				
1989	30.0				
1990	380.0				

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.010.004
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

             Station - 06061700.00  Jackson Creek near East Helena MT


   EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

   WATER     RANKED      EMA         INTERVALS
    YEAR   DISCHARGE   ESTIMATE      LOW      HIGH
    1990      380.0     0.0098
   -1981      111.0     0.0365
    1975       33.0     0.1089
    1989       30.0     0.1646
    1974       24.0     0.2203
    1967       20.0     0.2760
    1964       19.0     0.3317
    1968       17.0     0.3874
    1962       16.0     0.4431
    1969       15.0     0.4989
    1965       14.0     0.5546
    1963       12.0     0.6103
    1970       10.0     0.6660
    1971        9.0     0.7774
    1972        9.0     0.7217
    1966        7.0     0.8331
    1961        4.0     0.9445
    1973        4.0     0.8888
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.010.005
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

             Station - 06061700.00  Jackson Creek near East Helena MT


                         EMA REPRESENTATION OF DATA

  WATER <----- OBSERVED-----><-------- EMA -------><-PERCEPTION THRESHOLDS->
   YEAR    Q_LOWER    Q_UPPER    Q_LOWER    Q_UPPER        LOWER       UPPER
   1961        4.0        4.0        4.0        4.0          0.0         INF
   1962       16.0       16.0       16.0       16.0          0.0         INF
   1963       12.0       12.0       12.0       12.0          0.0         INF
   1964       19.0       19.0       19.0       19.0          0.0         INF
   1965       14.0       14.0       14.0       14.0          0.0         INF
   1966        7.0        7.0        7.0        7.0          0.0         INF
   1967       20.0       20.0       20.0       20.0          0.0         INF
   1968       17.0       17.0       17.0       17.0          0.0         INF
   1969       15.0       15.0       15.0       15.0          0.0         INF
   1970       10.0       10.0       10.0       10.0          0.0         INF
   1971        9.0        9.0        9.0        9.0          0.0         INF
   1972        9.0        9.0        9.0        9.0          0.0         INF
   1973        4.0        4.0        4.0        4.0          0.0         INF
   1974       24.0       24.0       24.0       24.0          0.0         INF
   1975       33.0       33.0       33.0       33.0          0.0         INF
   1976        0.0      111.0        0.0      111.0        111.0         INF
```

```
    1977        0.0      111.0        0.0      111.0        111.0        INF
    1978        0.0      111.0        0.0      111.0        111.0        INF
    1979        0.0      111.0        0.0      111.0        111.0        INF
    1980        0.0      111.0        0.0      111.0        111.0        INF
    1981      111.0      111.0      111.0      111.0        111.0        INF
    1982        0.0      111.0        0.0      111.0        111.0        INF
    1983        0.0      111.0        0.0      111.0        111.0        INF
    1984        0.0      111.0        0.0      111.0        111.0        INF
    1985        0.0      111.0        0.0      111.0        111.0        INF
    1986        0.0      111.0        0.0      111.0        111.0        INF
    1987        0.0      111.0        0.0      111.0        111.0        INF
    1988        0.0      111.0        0.0      111.0        111.0        INF
    1989       30.0       30.0       30.0       30.0          0.0        INF
    1990      380.0      380.0      380.0      380.0          0.0        INF
    1991        0.0      380.0        0.0      380.0        380.0        INF
    1992        0.0      380.0        0.0      380.0        380.0        INF
    1993        0.0      380.0        0.0      380.0        380.0        INF
    1994        0.0      380.0        0.0      380.0        380.0        INF
    1995        0.0      380.0        0.0      380.0        380.0        INF
    1996        0.0      380.0        0.0      380.0        380.0        INF
    1997        0.0      380.0        0.0      380.0        380.0        INF
    1998        0.0      380.0        0.0      380.0        380.0        INF
    1999        0.0      380.0        0.0      380.0        380.0        INF
    2000        0.0      380.0        0.0      380.0        380.0        INF
    2001        0.0      380.0        0.0      380.0        380.0        INF
    2002        0.0      380.0        0.0      380.0        380.0        INF
    2003        0.0      380.0        0.0      380.0        380.0        INF
    2004        0.0      380.0        0.0      380.0        380.0        INF
    2005        0.0      380.0        0.0      380.0        380.0        INF
    2006        0.0      380.0        0.0      380.0        380.0        INF
    2007        0.0      380.0        0.0      380.0        380.0        INF
    2008        0.0      380.0        0.0      380.0        380.0        INF
    2009        0.0      380.0        0.0      380.0        380.0        INF
    2010        0.0      380.0        0.0      380.0        380.0        INF
    2011        0.0      380.0        0.0      380.0        380.0        INF
1


  Program PeakFq          U. S. GEOLOGICAL SURVEY            Seq.011.001
  Version 7.1         Annual peak flow frequency analysis    Run Date / Time
  3/14/2014                                                  11/06/2018 14:25

            Station - 06061800.00  Crystal Creek near East Helena MT


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

                Number of peaks in record            =       18
                Peaks not used in analysis           =        0
                Systematic peaks in analysis         =       17
                Historic peaks in analysis           =        1
                Beginning Year                       =     1961
                Ending Year                          =     1990
                Historical Period Length             =       30
                Generalized skew                     =    0.168
                     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                            EMA
                PILF (LO) Test Method                      MGBT
                Perception Thresholds:
                     Begin     End       Low     High     Comment
```

```
                        1961    1990       0.0       INF
                        DEFAULT

                        1976    1988      72.0       INF     1981 HISTORICAL PERIOD
                        1
                  Interval Data                    =   None Specified



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

      WCF002J-CALCS COMPLETED.  RETURN CODE =  2
      EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                          Kendall's Tau Parameters

                                                            MEDIAN   No. of
                                        TAU    P-VALUE    SLOPE   PEAKS
                                  ---------------------------------------
               SYSTEMATIC RECORD      0.206      0.265      0.815    17


  1


    Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.011.002
    Version 7.1         Annual peak flow frequency analysis      Run Date / Time
    3/14/2014                                                    11/06/2018 14:25

              Station - 06061800.00  Crystal Creek near East Helena MT


            ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                                       LOGARITHMIC
                           -------------------------------
                                         STANDARD
                              MEAN     DEVIATION     SKEW
                           -------------------------------
   EMA W/O REG. INFO         1.1217      0.4251     -0.211
   EMA W/REG. INFO           1.1186      0.4217     -0.042

   EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE)      0.2306
   EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE)  0.3040



      ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

     ANNUAL   EMA W/    EMA W/O     <------ FOR EMA ESTIMATES -------->
  EXCEEDANCE  REG INFO  REG INFO    VARIANCE  95% CONFIDENCE INTERVALS
  PROBABILITY ESTIMATE  ESTIMATE     OF EST.       LOWER       UPPER

     0.9950       1.0       0.9      0.0583         0.1          2.3
     0.9900       1.3       1.2      0.0453         0.2          2.8
     0.9500       2.6       2.5      0.0234         0.8          4.7
     0.9000       3.8       3.7      0.0174         1.5          6.4
     0.8000       5.8       5.9      0.0134         2.9          9.6
     0.6667       8.7       8.9      0.0115         4.9         14.0
     0.5000      13.2      13.7      0.0106         7.9         21.0
     0.4292      15.7      16.3      0.0105         9.5         25.0
     0.2000      29.8      30.4      0.0113        18.2         49.0
     0.1000      45.4      45.3      0.0140        27.3         82.8
     0.0400      70.9      68.2      0.0203        41.2        164.6
```

```
  0.0200      94.5      88.3      0.0275        52.6        277.6
  0.0100     122.1     110.7      0.0368        64.5        463.8
  0.0050     154.3     135.6      0.0483        76.5        768.1
  0.0020     204.6     172.5      0.0671        92.3       1480.0
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.011.003
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06061800.00  Crystal Creek near East Helena MT


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


    WATER       PEAK   PEAKFQ   <--- Intervals --->
     YEAR      VALUE    CODES     LOW         HIGH   REMARKS
    -1981       72.0  H
     1961        5.0
     1962       11.0
     1963        4.0
     1964       21.0
     1965       14.0
     1966        9.0
     1967       28.0
     1968       12.0
     1969       30.0
     1970       12.0
     1971       27.0
     1972        3.0
     1973        2.0
     1974        9.0
     1975       80.0
     1989       35.0
     1990       18.0


        Explanation of peak discharge qualification codes

       PeakFQ    NWIS
        CODE     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.011.004
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06061800.00  Crystal Creek near East Helena MT

```

EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	EMA ESTIMATE	INTERVALS LOW	HIGH
1975	80.0	0.0222		
-1981	72.0	0.0445		
1989	35.0	0.1213		
1969	30.0	0.1763		
1967	28.0	0.2312		
1971	27.0	0.2861		
1964	21.0	0.3411		
1990	18.0	0.3960		
1965	14.0	0.4509		
1968	12.0	0.5608		
1970	12.0	0.5059		
1962	11.0	0.6157		
1966	9.0	0.7256		
1974	9.0	0.6707		
1961	5.0	0.7805		
1963	4.0	0.8355		
1972	3.0	0.8904		
1973	2.0	0.9453		

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.011.005
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06061800.00 Crystal Creek near East Helena MT

EMA REPRESENTATION OF DATA

WATER YEAR	OBSERVED Q_LOWER	OBSERVED Q_UPPER	EMA Q_LOWER	EMA Q_UPPER	PERCEPTION THRESHOLDS LOWER	PERCEPTION THRESHOLDS UPPER
1961	5.0	5.0	5.0	5.0	0.0	INF
1962	11.0	11.0	11.0	11.0	0.0	INF
1963	4.0	4.0	4.0	4.0	0.0	INF
1964	21.0	21.0	21.0	21.0	0.0	INF
1965	14.0	14.0	14.0	14.0	0.0	INF
1966	9.0	9.0	9.0	9.0	0.0	INF
1967	28.0	28.0	28.0	28.0	0.0	INF
1968	12.0	12.0	12.0	12.0	0.0	INF
1969	30.0	30.0	30.0	30.0	0.0	INF
1970	12.0	12.0	12.0	12.0	0.0	INF
1971	27.0	27.0	27.0	27.0	0.0	INF
1972	3.0	3.0	3.0	3.0	0.0	INF
1973	2.0	2.0	2.0	2.0	0.0	INF
1974	9.0	9.0	9.0	9.0	0.0	INF
1975	80.0	80.0	80.0	80.0	0.0	INF
1976	0.0	72.0	0.0	72.0	72.0	INF
1977	0.0	72.0	0.0	72.0	72.0	INF
1978	0.0	72.0	0.0	72.0	72.0	INF
1979	0.0	72.0	0.0	72.0	72.0	INF
1980	0.0	72.0	0.0	72.0	72.0	INF
1981	72.0	72.0	72.0	72.0	72.0	INF
1982	0.0	72.0	0.0	72.0	72.0	INF
1983	0.0	72.0	0.0	72.0	72.0	INF
1984	0.0	72.0	0.0	72.0	72.0	INF
1985	0.0	72.0	0.0	72.0	72.0	INF
1986	0.0	72.0	0.0	72.0	72.0	INF
1987	0.0	72.0	0.0	72.0	72.0	INF
1988	0.0	72.0	0.0	72.0	72.0	INF
1989	35.0	35.0	35.0	35.0	0.0	INF

```
   1990       18.0       18.0       18.0       18.0          0.0        INF
1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.012.001
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06061900.00  Mcclellan Creek nr East Helena MT


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

                Number of peaks in record            =       19
                Peaks not used in analysis           =        0
                Systematic peaks in analysis         =       18
                Historic peaks in analysis           =        1
                Beginning Year                       =     1960
                Ending Year                          =     2017
                Historical Period Length             =       58
                Generalized skew                     =    0.178
                     Standard error                  =    0.640
                     Mean Square error               =    0.410
                Skew option                          = STATION SKEW
                Gage base discharge                  =      0.0
                User supplied high outlier threshold =   --
                User supplied PILF (LO) criterion    =       72.0
                Plotting position parameter          =     0.00
                Type of analysis                           EMA
                PILF (LO) Test Method                     FIXE
                Perception Thresholds:
                     Begin     End       Low     High     Comment
                      1960    2017       0.0       INF
                      DEFAULT

                      1976    1988    1730.0       INF     1981 HISTORICAL PERIOD
                      1
                      1991    2017    1730.0       INF     1981 HISTORICAL PERIOD
                      2
                Interval Data                    =   None Specified



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

   *WCF191I-USER LOW-OUTLIER CRITERION SUPERSEDES  LIMIT CALCULATED BY
            AUTOMATED LOW-OUTLIER DETECTION PROCEDURE.        72.0     34.4
   *WCF151I-17B WEIGHTED SKEW REPLACED BY USER OPTION.     0.756     1.019  -1
    EMA001W-VARIANCE OF ESTIMATE WARNING, HISTORIC PERIOD > 2* SYS
    EMA002W-CONFIDENCE INTERVALS ARE NOT EXACT IF HISTORIC PERIOD > 0


                                        Kendall's Tau Parameters

                                                        MEDIAN   No. of
                                        TAU    P-VALUE    SLOPE   PEAKS
                                   ----------------------------------------
             SYSTEMATIC RECORD      0.092      0.622      3.000    18


1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.012.002
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
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3/14/2014 11/06/2018 14:25

Station - 06061900.00 Mcclellan Creek nr East Helena MT

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	LOGARITHMIC		
	MEAN	STANDARD DEVIATION	SKEW
EMA W/O REG. INFO	2.2268	0.3122	0.957
EMA W/REG. INFO	2.2268	0.3122	0.957

EMA ESTIMATE OF MSE OF SKEW W/O REG. INFO (AT-SITE) 0.5734
EMA ESTIMATE OF MSE OF SKEW W/SYSTEMATIC ONLY (AT-SITE) 0.3895

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	EMA W/ REG INFO ESTIMATE	EMA W/O REG INFO ESTIMATE	<------ FOR EMA ESTIMATES -------> VARIANCE OF EST.	95% CONFIDENCE INTERVALS LOWER	UPPER
0.9950		22.6	--	--	--
0.9900		28.2	--	--	--
0.9500		49.4	--	--	--
0.9000		65.3	--	--	--
0.8000	91.3	91.3	0.0042	46.9	119.3
0.6667	114.4	114.4	0.0047	84.7	180.4
0.5000	150.6	150.6	0.0069	106.6	241.9
0.4292	170.8	170.8	0.0079	116.1	276.8
0.2000	291.7	291.7	0.0107	182.3	502.8
0.1000	441.7	441.7	0.0129	271.5	813.0
0.0400	726.6	726.6	0.0200	414.3	1650.0
0.0200	1034.	1034.	0.0305	544.5	3336.0
0.0100	1451.	1451.	0.0468	698.0	8165.0
0.0050	2014.	2014.	0.0696	875.2	24470.0
0.0020	3069.	3069.	0.1109	1147.0	70350.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.012.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06061900.00 Mcclellan Creek nr East Helena MT

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

WATER YEAR	PEAK VALUE	PEAKFQ CODES	<--- Intervals ---> LOW	HIGH	REMARKS
-1981	1730.0	H			
1960	120.0				
1961	48.0				
1962	175.0				
1963	87.0				
1964	390.0				
1965	220.0				
1966	85.0				
1967	235.0				
1968	222.0				

```
      1969      275.0
      1970      150.0
      1971      130.0
      1972       72.0
      1973       47.0
      1974      275.0
      1975      340.0
      1989      182.0
      1990      145.0


         Explanation of peak discharge qualification codes

        PeakFQ    NWIS
         CODE     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.012.004
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    11/06/2018 14:25

            Station - 06061900.00  Mcclellan Creek nr East Helena MT


   EMPIRICAL FREQUENCY CURVES -- HIRSCH-STEDINGER PLOTTING POSITIONS

   WATER     RANKED      EMA         INTERVALS
    YEAR   DISCHARGE   ESTIMATE      LOW      HIGH
   -1981     1730.0     0.0086
    1964      390.0     0.0687
    1975      340.0     0.1205
    1969      275.0     0.2240
    1974      275.0     0.1722
    1967      235.0     0.2757
    1968      222.0     0.3275
    1965      220.0     0.3792
    1989      182.0     0.4310
    1962      175.0     0.4827
    1970      150.0     0.5345
    1990      145.0     0.5862
    1971      130.0     0.6380
    1960      120.0     0.6897
    1963       87.0     0.7415
    1966       85.0     0.7932
    1972       72.0     0.8450
  * 1961       48.0     0.8967
  * 1973       47.0     0.9485

    * DENOTES PILF (LO)

1
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Program PeakFq U. S. GEOLOGICAL SURVEY Seq.012.005
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 11/06/2018 14:25

Station - 06061900.00 Mcclellan Creek nr East Helena MT

EMA REPRESENTATION OF DATA

WATER	<----- OBSERVED----->		<-------- EMA ------->		<-PERCEPTION THRESHOLDS->	
YEAR	Q_LOWER	Q_UPPER	Q_LOWER	Q_UPPER	LOWER	UPPER
1960	120.0	120.0	120.0	120.0	72.0	INF
1961	48.0	48.0	0.0	72.0	72.0	INF
1962	175.0	175.0	175.0	175.0	72.0	INF
1963	87.0	87.0	87.0	87.0	72.0	INF
1964	390.0	390.0	390.0	390.0	72.0	INF
1965	220.0	220.0	220.0	220.0	72.0	INF
1966	85.0	85.0	85.0	85.0	72.0	INF
1967	235.0	235.0	235.0	235.0	72.0	INF
1968	222.0	222.0	222.0	222.0	72.0	INF
1969	275.0	275.0	275.0	275.0	72.0	INF
1970	150.0	150.0	150.0	150.0	72.0	INF
1971	130.0	130.0	130.0	130.0	72.0	INF
1972	72.0	72.0	72.0	72.0	72.0	INF
1973	47.0	47.0	0.0	72.0	72.0	INF
1974	275.0	275.0	275.0	275.0	72.0	INF
1975	340.0	340.0	340.0	340.0	72.0	INF
1976	0.0	1730.0	0.0	1730.0	1730.0	INF
1977	0.0	1730.0	0.0	1730.0	1730.0	INF
1978	0.0	1730.0	0.0	1730.0	1730.0	INF
1979	0.0	1730.0	0.0	1730.0	1730.0	INF
1980	0.0	1730.0	0.0	1730.0	1730.0	INF
1981	1730.0	1730.0	1730.0	1730.0	1730.0	INF
1982	0.0	1730.0	0.0	1730.0	1730.0	INF
1983	0.0	1730.0	0.0	1730.0	1730.0	INF
1984	0.0	1730.0	0.0	1730.0	1730.0	INF
1985	0.0	1730.0	0.0	1730.0	1730.0	INF
1986	0.0	1730.0	0.0	1730.0	1730.0	INF
1987	0.0	1730.0	0.0	1730.0	1730.0	INF
1988	0.0	1730.0	0.0	1730.0	1730.0	INF
1989	182.0	182.0	182.0	182.0	72.0	INF
1990	145.0	145.0	145.0	145.0	72.0	INF
1991	0.0	1730.0	0.0	1730.0	1730.0	INF
1992	0.0	1730.0	0.0	1730.0	1730.0	INF
1993	0.0	1730.0	0.0	1730.0	1730.0	INF
1994	0.0	1730.0	0.0	1730.0	1730.0	INF
1995	0.0	1730.0	0.0	1730.0	1730.0	INF
1996	0.0	1730.0	0.0	1730.0	1730.0	INF
1997	0.0	1730.0	0.0	1730.0	1730.0	INF
1998	0.0	1730.0	0.0	1730.0	1730.0	INF
1999	0.0	1730.0	0.0	1730.0	1730.0	INF
2000	0.0	1730.0	0.0	1730.0	1730.0	INF
2001	0.0	1730.0	0.0	1730.0	1730.0	INF
2002	0.0	1730.0	0.0	1730.0	1730.0	INF
2003	0.0	1730.0	0.0	1730.0	1730.0	INF
2004	0.0	1730.0	0.0	1730.0	1730.0	INF
2005	0.0	1730.0	0.0	1730.0	1730.0	INF
2006	0.0	1730.0	0.0	1730.0	1730.0	INF
2007	0.0	1730.0	0.0	1730.0	1730.0	INF
2008	0.0	1730.0	0.0	1730.0	1730.0	INF
2009	0.0	1730.0	0.0	1730.0	1730.0	INF
2010	0.0	1730.0	0.0	1730.0	1730.0	INF
2011	0.0	1730.0	0.0	1730.0	1730.0	INF
2012	0.0	1730.0	0.0	1730.0	1730.0	INF

```
    2013        0.0     1730.0        0.0     1730.0       1730.0        INF
    2014        0.0     1730.0        0.0     1730.0       1730.0        INF
    2015        0.0     1730.0        0.0     1730.0       1730.0        INF
    2016        0.0     1730.0        0.0     1730.0       1730.0        INF
    2017        0.0     1730.0        0.0     1730.0       1730.0        INF
  1



  End PeakFQ analysis.
    Stations processed :      12
    Number of errors   :       0
    Stations skipped   :       0
    Station years      :     497


  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:  06027700.00    USGS Fish Creek near Silver Star M


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06029000.10    USGS Whitetail Creek near Whitehal


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06030300.00    USGS Jefferson River trib no. 2 nr


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06030500.00    USGS Boulder River ab Rock Cr nr B


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06030500.01    USGS Boulder River ab Rock Cr nr B


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06031950.00    USGS Cataract Creek near Basin MT


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06033000.00    USGS Boulder River near Boulder MT


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06058700.00    USGS Mitchell Gulch near East Hele


  For the station below, the following records were ignored:

  FINISHED PROCESSING STATION:  06061500.00    USGS Prickly Pear Creek near Clanc


  For the station below, the following records were ignored:
```

```
FINISHED PROCESSING STATION:  06061700.00    USGS Jackson Creek near East Helen


For the station below, the following records were ignored:

FINISHED PROCESSING STATION:  06061800.00    USGS Crystal Creek near East Helen


For the station below, the following records were ignored:

FINISHED PROCESSING STATION:  06061900.00    USGS Mcclellan Creek nr East Helen


For the station below, the following records were ignored:

FINISHED PROCESSING STATION:
```

Appendix B

Logarithmic Interpolation, Gage Transfer, and Regional Regression Calculations

Boulder River Mainstem Drainage Area Gage Transfer Calculations										
				Drainage Area Gage Transfer Estimated Discharge (cfs)						
				Estimated Discharge (cfs)						
				50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% + Annual Chance
Node/USGS Station ID	Location Description	Cumulative Basin Area (mi^2)	DA_U/DA_G	2-year	10-year	25-year	50-year	100-year	500-year	100-year +
1400	Headwaters Boulder River	19	0.8	95	275	419	556	722	1,250	2,790
06030500	**Boulder River above Rock Creek, near Basin, Montana**	**24**	**-**	**120**	**331**	**497**	**653**	**840**	**1,430**	**3,250**
6033000	**Boulder River at USGS Gage Station 06033000 Boulder River near Boulder, Montana**	**381**	**-**	**1,030**	**2,190**	**3,050**	**3,840**	**4,770**	**7,650**	**7,860**
700	McCarthy Creek	466	1.2	1,240	2,550	3,500	4,370	5,390	8,510	8,880
600	Dry Creek	526	1.4	1,390	2,790	3,810	4,730	5,810	9,090	9,570
500	Quinn Creek	582	1.5	1,530	3,020	4,090	5,050	6,180	9,590	10,200
400	Cabin Gulch	640	1.7	1,680	3,240	4,360	5,370	6,540	10,100	10,800
300	Dunn Creek	682	1.8	1,780	3,400	4,560	5,590	6,800	10,400	11,200
200	Conrow Creek	745	2.0	1,930	3,630	4,840	5,920	7,170	10,900	11,800
100	Boulder River at junction with Jefferson River	769	2.0	1,990	3,720	4,950	6,050	7,320	11,100	12,100
		Regression Coefficient expAEP =		0.939	0.755	0.69	0.647	0.609	0.533	0.609

For an ungaged site that is not located between two gaged locations
Recommended that the drainage ratio be within 0.5 to 1.5
Equation recommended by SIR 2015-5019-F

*** Recommended ratio be within 0.5 to 1.5
*Southwest Region for regression coefficient

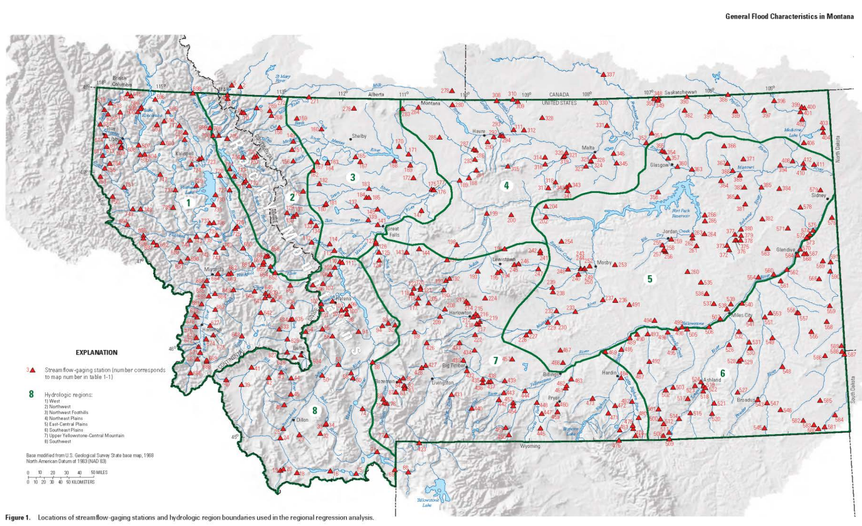


Figure 1. Locations of streamflow-gaging stations and hydrologic region boundaries used in the regional regression analysis.

$$Q_{AEP,U} = Q_{AEP,G}\left(\frac{DA_U}{DA_G}\right)^{exp_{AEP}} \qquad (6)$$

where

$Q_{AEP,G}$ is the AEP-percent peak flow for gaging station G, in cubic feet per second;

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

DA_G is the drainage area at gaging station G, in square miles; and

exp_{AEP} is the regression coefficient for an OLS regression relating the log of the AEP-percent peak flow to the log of the drainage area within each region (table 5).

Table 5. Regression coefficients for ordinary least squares regressions relating annual exceedance probability percent peak flow to contributing drainage area for use with ungaged sites on gaged streams.

	Regression coefficient relating Q_{AEP} to drainage area for indicated region							
AEP-percent peak flow (Q_{AEP})	West Region	Northwest Region	Northwest Foothills Region	Northeast Plains Region	East-Central Plains Region	Southeast Plains Region	Upper Yellowstone-Central Mountain Region	Southwest Region
$Q_{66.7}$	0.858	0.922	0.606	0.684	0.500	0.541	0.942	0.999
Q_{50}	0.843	0.904	0.575	0.690	0.488	0.527	0.896	0.939
$Q_{42.9}$	0.836	0.890	0.564	0.681	0.483	0.523	0.866	0.911
Q_{20}	0.813	0.832	0.534	0.639	0.463	0.502	0.761	0.818
Q_{10}	0.794	0.790	0.522	0.611	0.449	0.487	0.697	0.755
Q_4	0.777	0.741	0.516	0.579	0.434	0.471	0.634	0.690
Q_2	0.766	0.707	0.517	0.557	0.423	0.460	0.595	0.647
Q_1	0.755	0.675	0.521	0.537	0.414	0.450	0.561	0.609
$Q_{0.5}$	0.746	0.644	0.526	0.519	0.404	0.441	0.532	0.576
$Q_{0.2}$	0.735	0.605	0.536	0.496	0.393	0.430	0.498	0.533

Boulder River Mainstem Log Interpolation Calculations									
			Log Interpolation of At-Site and Extended Record Gaged Analysis						
			Estimated Discharge (cfs)						
		Cumulative Basin	50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% + Annual Chance
Node/USGS Station ID	Location Description	Area (mi^2)	2-year	10-year	25-year	50-year	100-year	500-year	100-year +
06030500*	**Boulder River above Rock Creek, near Basin, Montana**	**24**	**120**	**331**	**497**	**653**	**840**	**1,430**	**3,250**
1300	Lower Bison Creek	112	395	944	1,360	1,740	2,200	3,620	5,300
1200	Red Rock Creek	190	599	1,360	1,930	2,460	3,080	5,010	6,290
1100	Basin Creek	220	670	1,500	2,120	2,700	3,370	5,470	6,590
1000	Cataract Creek	263	771	1,700	2,390	3,030	3,780	6,110	6,980
900	High Ore Creek	323	905	1,950	2,730	3,450	4,300	6,920	7,450
800	Boulder, MT	334	929	2,000	2,800	3,530	4,390	7,060	7,530
06033000**	**USGS Gage Station 06033000 Boulder River near Boulder, Montana**	**381**	**1,030**	**2,190**	**3,050**	**3,840**	**4,770**	**7,650**	**7,860**

For locations that are ungaged and located between two gaged locations with reliable period of record (10 yrs)
Equation utilizes drainage areas and flows.
* Values are weighted w/ RRE

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

where

$Q_{AEP,U}$ is the AEP-percent peak flow at ungaged site U, in cubic feet per second; (7)

$Q_{AEP,G1}$ is the AEP-percent peak flow for the upstream gaging station $G1$, in cubic feet per second;

$Q_{AEP,G2}$ is the AEP-percent peak flow at the downstream gaging station $G2$, in cubic feet per second;

DA_{G2} is the drainage area at the downstream gaging station $G2$, in square miles;

DA_{G1} is the drainage area at the upstream gaging station $G1$, in square miles; and

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

Boulder River Mainstem Regional Regression Calculations

Node/USGS Station ID	Location Description	Basin Area (mi^2)	E_{6000}	Southwest Region Regression Estimated Discharge (cfs)						
				50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
				2-year	10-year	25-year	50-year	100-year	500-year	100-year
1400	Headwaters Boulder River	19	100	60	147	205	252	304	439	530
1300	Lower Bison Creek	112	95	309	608	787	921	1,070	1,430	1,860
1200	Red Rock Creek	190	95	506	928	1,170	1,350	1,540	2,010	2,680
1100	Basin Creek	220	94	578	1,040	1,310	1,500	1,720	2,220	2,990
1000	Cataract Creek	263	94	683	1,200	1,500	1,710	1,940	2,500	3,370
900	High Ore Creek	323	92	825	1,420	1,760	2,000	2,260	2,880	3,930
800	Boulder, MT	334	89	849	1,470	1,820	2,070	2,340	2,990	4,070
6033000	**Boulder River at USGS Gage Station 06033000 Boulder River near Boulder, Montana**	**381**	**81**	**952**	**1,660**	**2,060**	**2,350**	**2,660**	**3,410**	**4,620**
700*	McCarthy Creek	466	77	1,140	1,960	2,430	2,760	3,120	3,990	5,420
600*	Dry Creek	526	74	1,270	2,180	2,680	3,050	3,440	4,390	5,980
500*	Quinn Creek	582	71	1,390	2,380	2,930	3,320	3,750	4,780	6,520
400*	Cabin Gulch	640	66	1,510	2,600	3,210	3,650	4,130	5,290	7,180
300	Dunn Creek	682	63	1,600	2,750	3,400	3,870	4,390	5,620	7,630
200	Conrow Creek	745	59	1,720	2,990	3,710	4,220	4,790	6,160	8,330
100	Boulder River at junction with Jefferson River	769	57	1,770	3,080	3,830	4,370	4,960	6,380	8,620

Equation recommended by SIR 2015-5019-F

* Denotes hand calculated discharge with Regional Regression Equation

Southwest hydrologic region

$$Q_{66.7} = 1.04\ A^{0.971}\ (E_{6000} + 1)^{0.195}$$
$$Q_{50} = 2.49\ A^{0.930}\ (E_{6000} + 1)^{0.095}$$
$$Q_{42.9} = 3.61\ A^{0.910}\ (E_{6000} + 1)^{0.053}$$
$$Q_{20} = 13.4\ A^{0.842}\ (E_{6000} + 1)^{-0.088}$$
$$Q_{10} = 31.9\ A^{0.796}\ (E_{6000} + 1)^{-0.177}$$
$$Q_{4} = 79.8\ A^{0.750}\ (E_{6000} + 1)^{-0.274}$$
$$Q_{2} = 142\ A^{0.721}\ (E_{6000} + 1)^{-0.336}$$
$$Q_{1} = 238\ A^{0.696}\ (E_{6000} + 1)^{-0.391}$$
$$Q_{0.5} = 377\ A^{0.675}\ (E_{6000} + 1)^{-0.442}$$
$$Q_{0.2} = 655\ A^{0.649}\ (E_{6000} + 1)^{-0.501}$$

[Q_{AEP}, peak-flow magnitude, in cubic feet per second, for annual exceedance probability (AEP) in percent; n, number of streamflow-gaging stations used in developing regression equations for indicated hydrologic region; σ_{δ}^{2}, model error variance; MVP, mean variance of prediction; SEP, mean standard error of prediction; SEM, mean standard error of model; Pseudo R^2, pseudo coefficient of determination; A, contributing drainage area, in square miles; P, mean annual precipitation, in inches; F, percentage of basin that is forest; E_{5000}, percentage of basin above 5,000 feet elevation; SLP_{30}, percentage of basin with slope greater than 30 percent; ET_{SPR}, Mean spring (March–June) evapotranspiration, in inches per month; E_{6000}, percent of basin above 6,000 feet elevation]

Boulder River Tributaries Regional Regression Calculations

Node/USGS Station ID	Location Description	Tributary	Cumulative Basin Area	E_{6000} (%)	Streamstats/Southwest Regression Region						
					Estimated Discharge (cfs)						
					50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
					2-year	10-year	25-year	50-year	100-year	500-year	100-year-plus
1200	Cottonwood Lake	Cottonwood Lake	2	100	5.6	19	31	40	52	84	90
1100	Bear Gulch	Bear Gulch	1	100	5.3	18	29	38	49	81	85
1000	Upper Bison Creek HUC 12 Basin Boundary	Bison Creek	35	100	106	240	326	393	467	654	812
900	Upper Bison Creek end of reach	Bison Creek	56	100	162	345	458	545	641	879	1,110
800	Bison Creek	Bison Creek	78	96	220	454	596	704	823	1,120	1,430
700	Red Rock Creek	Red Rock Creek	21	89	64	161	226	279	339	492	589
600	Basin Creek	Basin Creek	42	96	123	277	374	450	535	747	930
500	Muskrat Creek	Muskrat Creek	40	25	105	338	520	679	868	1,400	1,510
400	McGinley Gulch upstream of junction with North Fork Little Boulder River	McGinely Gulch	1	100	4.9	17	27	36	47	77	82
300	North Fork Little Boulder River upstream of junction with McGinley Gulch	North Fork Little Boulder River	4	100	14	43	64	82	103	160	179
200	North Fork Little Boulder River	North Fork Little Boulder River	7	100	25	69	101	128	158	238	275
100	Little Boulder River	Little Boulder River	59	75	165	378	516	624	745	1,050	1,300

All discharges calculated in StreamStats
Equation recommended by SIR 2015-5019-F

Southwest hydrologic region

$$Q_{66.7} = 1.04\ A^{0.971}\ (E_{6000} + 1)^{0.195}$$
$$Q_{50} = 2.49\ A^{0.930}\ (E_{6000} + 1)^{0.095}$$
$$Q_{42.9} = 3.61\ A^{0.910}\ (E_{6000} + 1)^{0.053}$$
$$Q_{20} = 13.4\ A^{0.842}\ (E_{6000} + 1)^{-0.088}$$
$$Q_{10} = 31.9\ A^{0.796}\ (E_{6000} + 1)^{-0.177}$$
$$Q_{4} = 79.8\ A^{0.750}\ (E_{6000} + 1)^{-0.274}$$
$$Q_{2} = 142\ A^{0.721}\ (E_{6000} + 1)^{-0.336}$$
$$Q_{1} = 238\ A^{0.696}\ (E_{6000} + 1)^{-0.391}$$
$$Q_{0.5} = 377\ A^{0.675}\ (E_{6000} + 1)^{-0.442}$$
$$Q_{0.2} = 655\ A^{0.649}\ (E_{6000} + 1)^{-0.501}$$

[Q_{AEP}, peak-flow magnitude, in cubic feet per second, for annual exceedance probability (AEP) in percent; n, number of streamflow-gaging stations used in developing regression equations for indicated hydrologic region; σ_{δ}^{2}, model error variance; MVP, mean variance of prediction; SEP, mean standard error of prediction; SEM, mean standard error of model; Pseudo R^2, pseudo coefficient of determination; A, contributing drainage area, in square miles; P, mean annual precipitation, in inches; F, percentage of basin that is forest; E_{5000}, percentage of basin above 5,000 feet elevation; SLP_{30}, percentage of basin with slope greater than 30 percent; ET_{SPR}, Mean spring (March–June) evapotranspiration, in inches per month; E_{6000}, percent of basin above 6,000 feet elevation]

Jefferson River Tributaries Drainage Area Gage Transfer Calculations										
				Drainage Area Gage Transfer Estimated Discharge (cfs)						
				Estimated Discharge (cfs)						
				50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% + Annual Chance
Node/USGS Station ID	Location Description	Cumulative Basin Area (mi^2)	DA_U/DA_G	2-year	10-year	25-year	50-year	100-year	500-year	100-year +
06027700	USGS Gage Fish Creek near Silver Star, MT	39	-	125	212	252	282	311	380	358
1300	Fish Creek upstream of Jefferson Slough recharge	43	1.1	137	228	269	300	329	400	379
1200	Fish Creek at junction with Jefferson River	52	1.3	165	265	309	341	372	445	428
06029000	Whitetail Creek near Whitehall, MT	30	-	67	116	140	158	174	212	240
100	Whitetail Creek at Junction with Jefferson River	184	6.1	364	453	486	507	522	554	719
For an ungaged site that is not located between two gaged locations										
Recommended that the drainage ratio be within 0.5 to 1.5		**Southwest Region Regression Coefficient expAEP =**		0.939	0.7558	0.69	0.647	0.609	0.533	0.609
Equation recommended by SIR 2015-5019-F										

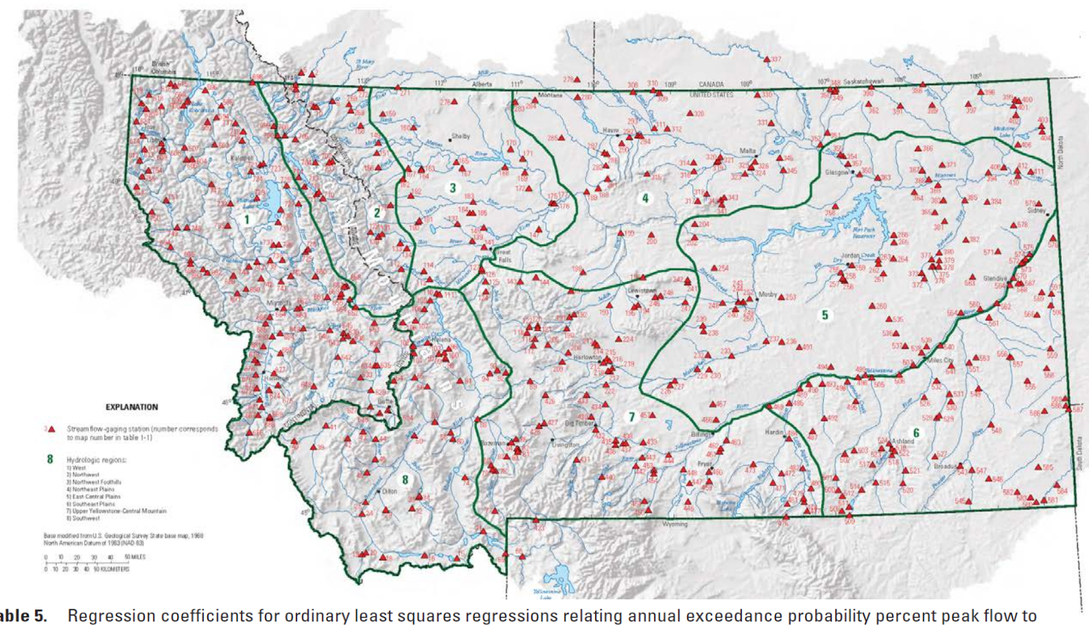


Table 5. Regression coefficients for ordinary least squares regressions relating annual exceedance probability percent peak flow to contributing drainage area for use with ungaged sites on gaged streams.

AEP-percent peak flow (Q_{AEP})	Regression coefficient relating Q_{AEP} to drainage area for indicated region							
	West Region	Northwest Region	Northwest Foothills Region	Northeast Plains Region	East-Central Plains Region	Southeast Plains Region	Upper Yellowstone-Central Mountain Region	Southwest Region
$Q_{66.7}$	0.858	0.922	0.606	0.684	0.500	0.541	0.942	0.999
Q_{50}	0.843	0.904	0.575	0.690	0.488	0.527	0.896	0.939
$Q_{42.9}$	0.836	0.890	0.564	0.681	0.483	0.523	0.866	0.911
Q_{20}	0.813	0.832	0.534	0.639	0.463	0.502	0.761	0.818
Q_{10}	0.794	0.790	0.522	0.611	0.449	0.487	0.697	0.755
Q_4	0.777	0.741	0.516	0.579	0.434	0.471	0.634	0.690
Q_2	0.766	0.707	0.517	0.557	0.423	0.460	0.595	0.647
Q_1	0.755	0.675	0.521	0.537	0.414	0.450	0.561	0.609
$Q_{0.5}$	0.746	0.644	0.526	0.519	0.404	0.441	0.532	0.576
$Q_{0.2}$	0.735	0.605	0.536	0.496	0.393	0.430	0.498	0.533

$$Q_{AEP,U} = Q_{AEP,G}\left(\frac{DA_U}{DA_G}\right)^{exp_{AEP}} \qquad (6)$$

where

$Q_{AEP,G}$ is the AEP-percent peak flow for gaging station G, in cubic feet per second;

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

DA_G is the drainage area at gaging station G, in square miles; and

exp_{AEP} is the regression coefficient for an OLS regression relating the log of the AEP-percent peak flow to the log of the drainage area within each region (table 5).

Jefferson River Tributaries Regional Regression Calculations										
				Streamstats/Southwest Regression Region						
				Estimated Discharge (cfs)						
				50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
Node/USGS Station ID	Location Description	Basin Area (mi^2)	E_{6000}	2-year	10-year	25-year	50-year	100-year	500-year	100-year-plus
06027700	USGS Gage Station Number 06027700: Fish Creek near Silver Star, Montana	39	76	113	273	379	464	558	803	970
1300*	Fish Creek upstream of Jefferson Slough recharge	43	69	123	300	418	512	619	895	1,080
1200*	Fish Creek at junction with Jefferson River	52	56	145	364	512	632	768	1,120	1,340
1100	Pappas Creek	3	100	11	35	53	68	86	135	150
1000	Little Pipestone Creek south of Montana Highway 2	41	51	114	304	438	548	674	1,010	1,170
900	Little Pipestone Creek upstream of junction with Big Pipestone Creek	46	46	125	337	488	612	755	1,140	1,310
800	Delmoe Lake Outlet	24	100	73	174	241	293	352	503	612
700	Big Pipestone Creek Downstream of Hot Springs Road	95	70	258	563	755	904	1,070	1,490	1,860
600	Big Pipestone Creek upstream of junction with Little Pipestone Creek	114	59	301	672	909	1,090	1,300	1,830	2,260
500	Big Pipestone Creek upstream of Pleasant Valley Ditch.	169	52	429	938	1,260	1,510	1,790	2,500	3,110
400	Big Pipestone Creek at junction with Jefferson River	187	47	466	1,030	1,390	1,680	1,990	2,800	3,460
300	Little Whitetail Creek at junction with Whitetail Creek	101	39	258	651	921	1,140	1,390	2,050	2,420
200	Whitetail Reservoir Outlet	19	100	61	149	208	255	308	444	535
100*	Whitetail Creek at junction with Jefferson River	184	44	457	1,040	1,410	1,700	2,030	2,880	3,530

Equation recommended by SIR 2015-5019-F

* Denotes hand calculated discharge with Regional Regression Equation

Southwest hydrologic region

$$Q_{66.7} = 1.04\ A^{0.971}\ (E_{6000} + 1)^{0.195}$$
$$Q_{50} = 2.49\ A^{0.930}\ (E_{6000} + 1)^{0.095}$$
$$Q_{42.9} = 3.61\ A^{0.910}\ (E_{6000} + 1)^{0.053}$$
$$Q_{20} = 13.4\ A^{0.842}\ (E_{6000} + 1)^{-0.088}$$
$$Q_{10} = 31.9\ A^{0.796}\ (E_{6000} + 1)^{-0.177}$$
$$Q_{4} = 79.8\ A^{0.750}\ (E_{6000} + 1)^{-0.274}$$
$$Q_{2} = 142\ A^{0.721}\ (E_{6000} + 1)^{-0.336}$$
$$Q_{1} = 238\ A^{0.696}\ (E_{6000} + 1)^{-0.391}$$
$$Q_{0.5} = 377\ A^{0.675}\ (E_{6000} + 1)^{-0.442}$$
$$Q_{0.2} = 655\ A^{0.649}\ (E_{6000} + 1)^{-0.501}$$

[Q_{AEP}, peak-flow magnitude, in cubic feet per second, for annual exceedance probability (AEP) in percent; n, number of streamflow-gaging stations used in developing regression equations for indicated hydrologic region; σ_{δ}^{2}, model error variance; MVP, mean variance of prediction; SEP, mean standard error of prediction; SEM, mean standard error of model; Pseudo R^2, pseudo coefficient of determination; A, contributing drainage area, in square miles; P, mean annual precipitation, in inches; F, percentage of basin that is forest; E_{5000}, percentage of basin above 5,000 feet elevation; SLP_{30}, percentage of basin with slope greater than 30 percent; ET_{SPR},

Prickly Pear Creek Mainstem Drainage Area Gage Transfer Calculations										
				Drainage Area Gage Transfer Estimated Discharge (cfs)						
				Estimated Discharge (cfs)						
Node/USGS Station ID	Location Description	Cumulative Basin Area (mi^2)	DA_U/DA_G	50% Annual Chance 2-year	10% Annual Chance 10-year	4% Annual Chance 25-year	2% Annual Chance 50-year	1% Annual Chance 100-year	0.2% Annual Chance 500-year	1% + Annual Chance 100-year +
600	Headwaters Prickly Pear Creek	21	0.1	30	107	185	271	390	824	495
500	Jefferson City, MT	52	0.3	71	215	351	493	685	1,350	870
400	Warm Springs Creek	74	0.4	100	282	449	622	853	1,630	1,080
300	Buffalo Creek	130	0.7	169	431	662	894	1,200	2,200	1,520
06061500	**Prickly Pear Creek Near Clancy, Montana**	**192**	**-**	**243**	**578**	**865**	**1,150**	**1,520**	**2,710**	**1,930**
200	Middle Prickly Pear Creek	205	1.1	258	607	905	1,200	1,580	2,810	2,010
100	Reach origin	248	1.3	308	700	1,030	1,360	1,770	3,100	2,250
			Southwest Region Regression Coefficient expAEP =	0.939	0.755	0.69	0.647	0.609	0.533	0.609

For an ungaged site that is not located between two gaged locations
Recommended that the drainage ratio be within 0.5 to 1.5
Equation recommended by SIR 2015-5019-F

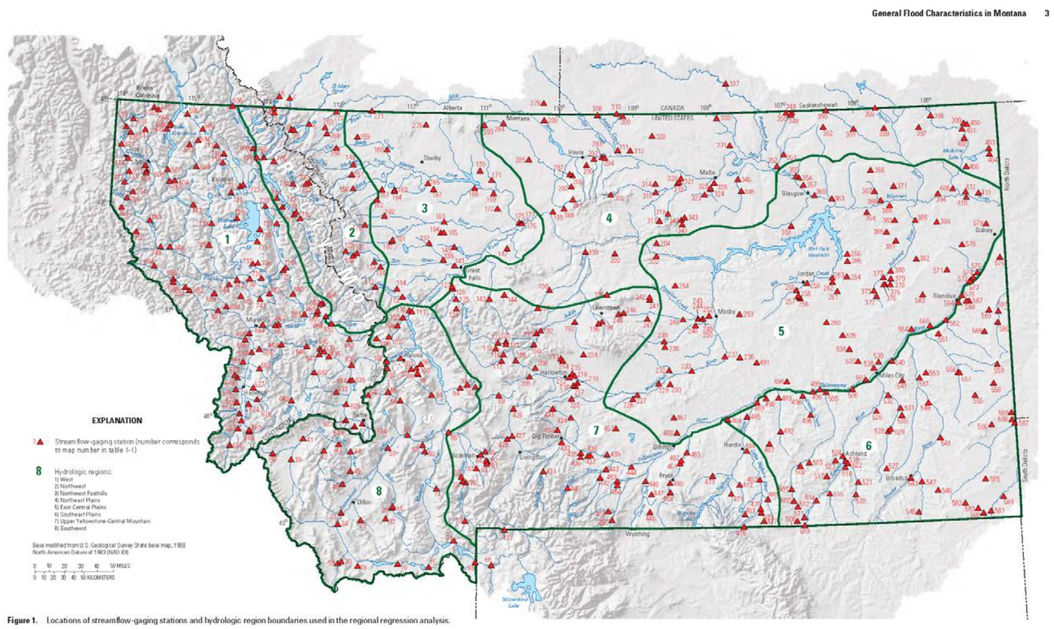


Figure 1. Locations of streamflow-gaging stations and hydrologic region boundaries used in the regional regression analysis.

Table 5. Regression coefficients for ordinary least squares regressions relating annual exceedance probability percent peak flow to contributing drainage area for use with ungaged sites on gaged streams.

AEP-percent peak flow (Q_{AEP})	Regression coefficient relating Q_{AEP} to drainage area for indicated region							
	West Region	Northwest Region	Northwest Foothills Region	Northeast Plains Region	East-Central Plains Region	Southeast Plains Region	Upper Yellowstone-Central Mountain Region	Southwest Region
$Q_{66.7}$	0.858	0.922	0.606	0.684	0.500	0.541	0.942	0.999
Q_{50}	0.843	0.904	0.575	0.690	0.488	0.527	0.896	0.939
$Q_{42.9}$	0.836	0.890	0.564	0.681	0.483	0.523	0.866	0.911
Q_{20}	0.813	0.832	0.534	0.639	0.463	0.502	0.761	0.818
Q_{10}	0.794	0.790	0.522	0.611	0.449	0.487	0.697	0.755
Q_4	0.777	0.741	0.516	0.579	0.434	0.471	0.634	0.690
Q_2	0.766	0.707	0.517	0.557	0.423	0.460	0.595	0.647
Q_1	0.755	0.675	0.521	0.537	0.414	0.450	0.561	0.609
$Q_{0.5}$	0.746	0.644	0.526	0.519	0.404	0.441	0.532	0.576
$Q_{0.2}$	0.735	0.605	0.536	0.496	0.393	0.430	0.498	0.533

$$Q_{AEP,U} = Q_{AEP,G}\left(\frac{DA_U}{DA_G}\right)^{exp_{AEP}} \qquad (6)$$

where

$Q_{AEP,G}$ is the AEP-percent peak flow for gaging station G, in cubic feet per second;

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

DA_G is the drainage area at gaging station G, in square miles; and

exp_{AEP} is the regression coefficient for an OLS regression relating the log of the AEP-percent peak flow to the log of the drainage area within each region (table 5).

Prickly Pear Creek Mainstem Regional Regression Calculations										
				Southwest Region Regression						
				Estimated Discharge (cfs)						
Node/USGS Station ID	Location Description	Basin Area (mi^2)	E_{6000}	50% Annual Chance 2-year	10% Annual Chance 10-year	4% Annual Chance 25-year	2% Annual Chance 50-year	1% Annual Chance 100-year	0.2% Annual Chance 500-year	1% + 100-year
600	Headwaters Prickly Pear Creek	21	61	61	171	249	314	389	591	676
500	Jefferson City, MT	52	39	139	385	562	710	881	1,340	1,530
400	Warm Springs Creek	74	31	191	532	779	987	1,230	1,880	2,140
300	Buffalo Creek	130	32	321	830	1,180	1,470	1,800	2,690	3,130
06061500	**Prickly Pear Creek Near Clancy, Montana**	**192**	**29**	**457**	**1,150**	**1,630**	**2,020**	**2,460**	**3,640**	**4,280**
200	Middle Prickly Pear Creek	205	27	483	1,230	1,740	2,160	2,630	3,910	4,570
100	Reach origin	248	27	575	1,430	2,000	2,470	3,010	4,430	5,230

Southwest hydrologic region SEP f

Precent	Decimal
73.84	0.7384

Equation recommended by SIR 2015-5019-F

Southwest hydrologic region
$Q_{66.7} = 1.04\ A^{0.971}\ (E_{6000} + 1)^{0.195}$
$Q_{50} = 2.49\ A^{0.930}\ (E_{6000} + 1)^{0.095}$
$Q_{42.9} = 3.61\ A^{0.910}\ (E_{6000} + 1)^{0.053}$
$Q_{20} = 13.4\ A^{0.842}\ (E_{6000} + 1)^{-0.088}$
$Q_{10} = 31.9\ A^{0.796}\ (E_{6000} + 1)^{-0.177}$
$Q_{4} = 79.8\ A^{0.750}\ (E_{6000} + 1)^{-0.274}$
$Q_{2} = 142\ A^{0.721}\ (E_{6000} + 1)^{-0.336}$
$Q_{1} = 238\ A^{0.696}\ (E_{6000} + 1)^{-0.391}$
$Q_{0.5} = 377\ A^{0.675}\ (E_{6000} + 1)^{-0.442}$
$Q_{0.2} = 655\ A^{0.649}\ (E_{6000} + 1)^{-0.501}$

[Q_{AEP}, peak-flow magnitude, in cubic feet per second, for annual exceedance probability (AEP) in percent; n, number of streamflow-gaging stations used in developing regression equations for indicated hydrologic region; σ_{δ}^{2}, model error variance; MVP, mean variance of prediction; SEP, mean standard error of prediction; SEM, mean standard error of model; Pseudo R^2, pseudo coefficient of determination; A, contributing drainage area, in square miles; P, mean annual precipitation, in inches; F, percentage of basin that is forest; E_{5000}, percentage of basin above 5,000 feet elevation; SLP_{30}, percentage of basin with slope greater than 30 percent; ET_{SPR}, Mean spring (March–June) evapotranspiration, in inches per month; E_{6000}, percent of basin above 6,000 feet elevation]

or 100-year flows

Prickly Pear Creek Tributaries Regional Regression Calculations

Node/USGS Station ID	Location Description	Cumulative Basin Area (mi^2)	E_{6000}	Southwest Region Regression Estimated Discharge (cfs)						
				50% Annual Chance	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	1% +
				2-year	10-year	25-year	50-year	100-year	500-year	100-year
500	Warm Springs Creek at Badger Creek	17	36.9	48	158	243	319	408	659	709
400	Warm Springs Creek junction with Prickly Pear Creek	21	29.7	58	194	303	399	514	842	894
300	Clancy Creek	33	35.9	90	271	407	523	659	1040	1150
200	Buffalo Creek	44	30.2	116	350	527	680	858	1350	1490
100	Unnamed Tributary	1	0	1.6	21	54	98	167	470	290

Equation recommended by SIR 2015-5019-F

Southwest hydrologic region

$$Q_{66.7} = 1.04\ A^{0.971}\ (E_{6000} + 1)^{0.195}$$
$$Q_{50} = 2.49\ A^{0.930}\ (E_{6000} + 1)^{0.095}$$
$$Q_{42.9} = 3.61\ A^{0.910}\ (E_{6000} + 1)^{0.053}$$
$$Q_{20} = 13.4\ A^{0.842}\ (E_{6000} + 1)^{-0.088}$$
$$Q_{10} = 31.9\ A^{0.796}\ (E_{6000} + 1)^{-0.177}$$
$$Q_{4} = 79.8\ A^{0.750}\ (E_{6000} + 1)^{-0.274}$$
$$Q_{2} = 142\ A^{0.721}\ (E_{6000} + 1)^{-0.336}$$
$$Q_{1} = 238\ A^{0.696}\ (E_{6000} + 1)^{-0.391}$$
$$Q_{0.5} = 377\ A^{0.675}\ (E_{6000} + 1)^{-0.442}$$
$$Q_{0.2} = 655\ A^{0.649}\ (E_{6000} + 1)^{-0.501}$$

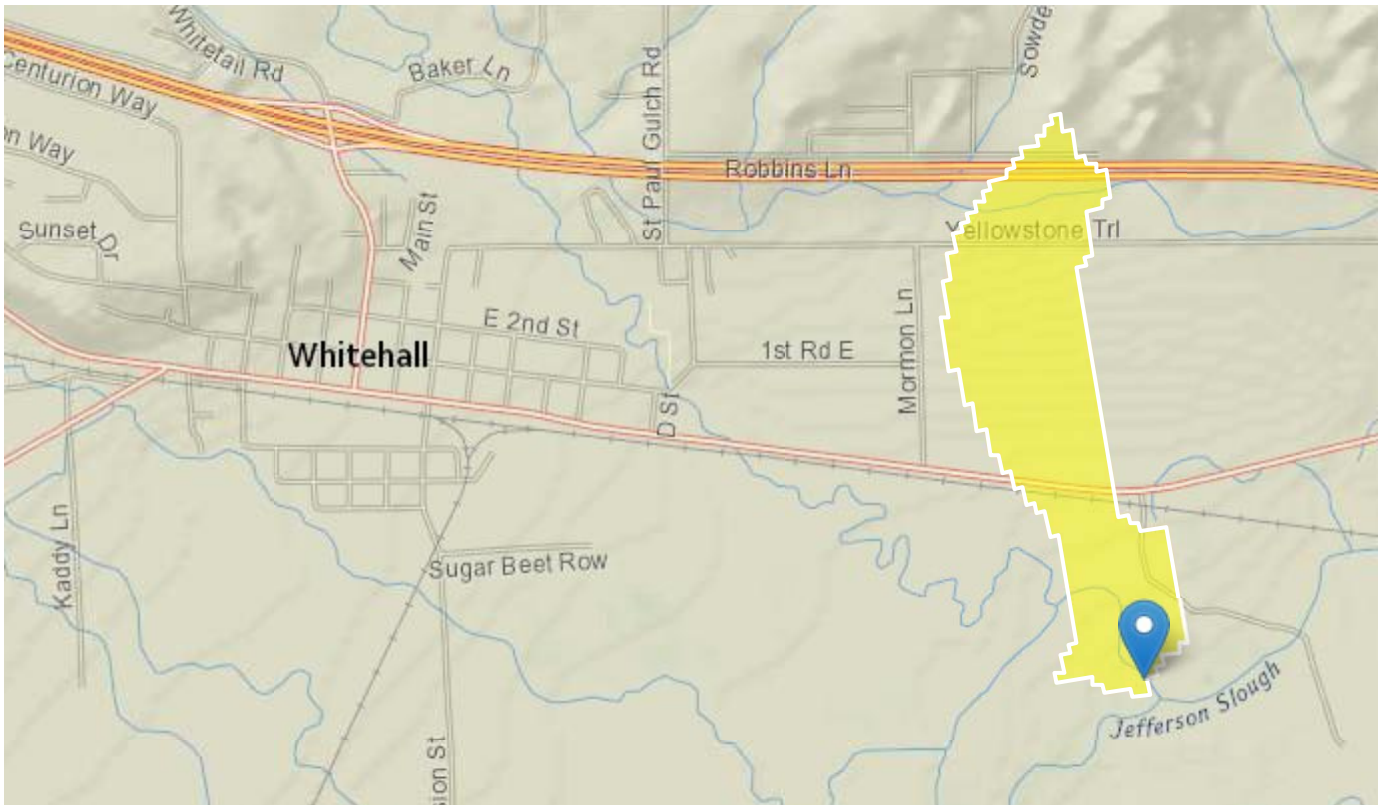
[Q_{AEP}, peak flow magnitude, in cubic feet per second, for annual exceedance probability (AEP) in percent; n, number of streamflow-gaging stations used in developing regression equations for indicated hydrologic region; σ_δ^2, model error variance; MVP, mean variance of prediction; SEP, mean standard error of prediction; SEM, mean standard error of model; Pseudo R^2, pseudo coefficient of determination; A, contributing drainage area, in square miles; P, mean annual precipitation, in inches; F, percentage of basin that is forest; E_{5000}, percentage of basin above 5,000 feet elevation; SLP_{30}, percentage of basin with slope greater than 30 percent; ET_{SPR}, Mean spring

Appendix C

Streamstats Results

StreamStats Report - Node 100A Jefferson Tributaries (Combined with Basin 100B)

Region ID: MT
Workspace ID: MT20190228193831270000
Clicked Point (Latitude, Longitude): 45.86119, -112.06707
Time: 2019-02-28 12:38:46 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.3	square miles
EL6000	Percent of area above 6000 ft	0	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.3	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	0	percent	0	100

Peak-Flow Statistics Disclaimers [SW Region BasinC 2015 5019F]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

Statistic	Value	Unit
1.5 Year Peak Flood	0.323	ft^3/s
2 Year Peak Flood	0.813	ft^3/s
2 33 Year Peak Flood	1.21	ft^3/s
5 Year Peak Flood	4.86	ft^3/s
10 Year Peak Flood	12.2	ft^3/s
25 Year Peak Flood	32.3	ft^3/s
50 Year Peak Flood	59.6	ft^3/s
100 Year Peak Flood	103	ft^3/s
200 Year Peak Flood	167	ft^3/s
500 Year Peak Flood	300	ft^3/s

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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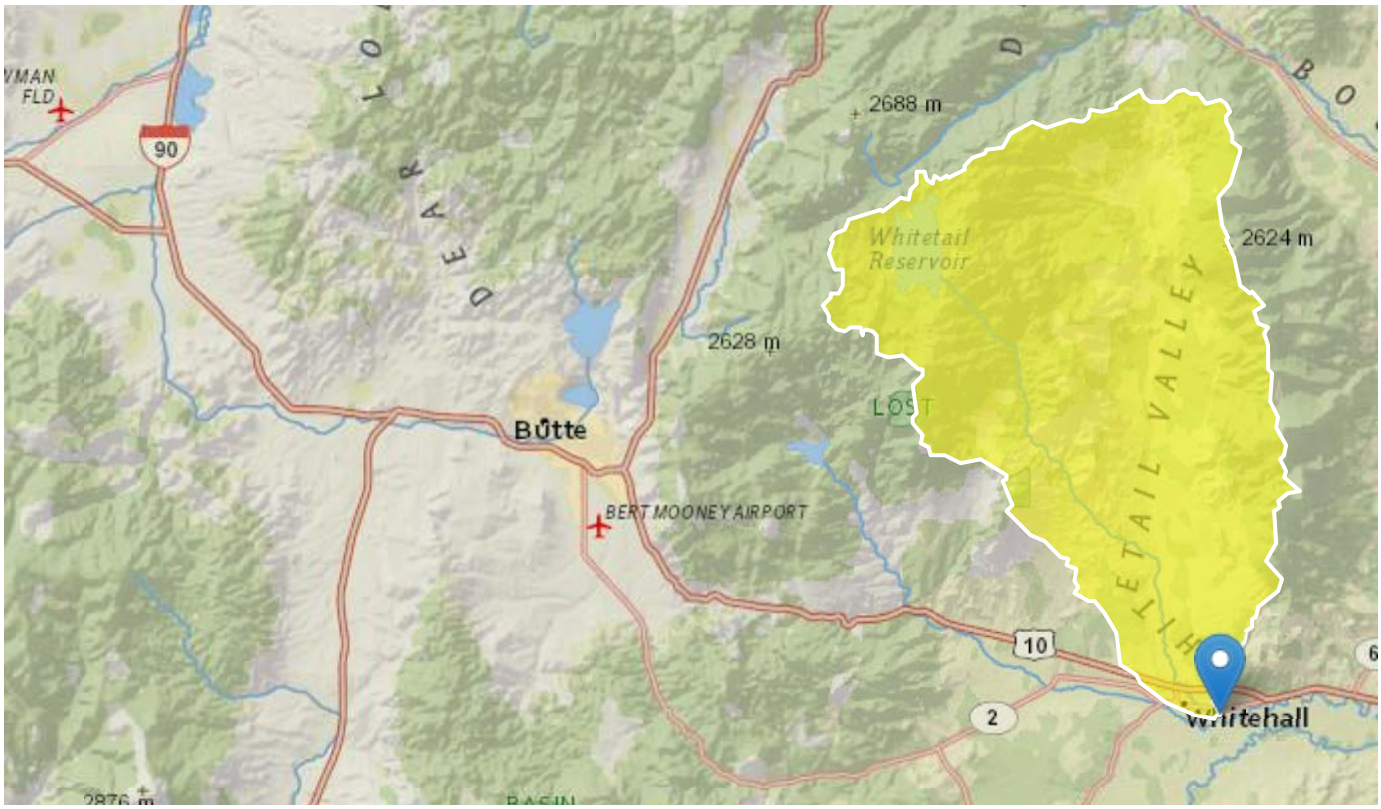
Application Version: 4.3.0

StreamStats Report - Node 100B Jefferson Tributaries (Combined with Basin 100A)

Region ID: MT
Workspace ID: MT20190228194246449000
Clicked Point (Latitude, Longitude): 45.86409, -112.07087
Time: 2019-02-28 12:43:01 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	184.1	square miles
EL6000	Percent of area above 6000 ft	43.8	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	184.1	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	43.8	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	345	ft^3/s	74.1	1610	118
2 Year Peak Flood	457	ft^3/s	121	1720	96
2 33 Year Peak Flood	508	ft^3/s	143	1810	90.1
5 Year Peak Flood	774	ft^3/s	254	2360	76.9
10 Year Peak Flood	1030	ft^3/s	359	2980	72.1
25 Year Peak Flood	1410	ft^3/s	495	4000	71.3
50 Year Peak Flood	1700	ft^3/s	597	4840	72
100 Year Peak Flood	2030	ft^3/s	697	5910	73.8
200 Year Peak Flood	2370	ft^3/s	791	7120	76.5
500 Year Peak Flood	2880	ft^3/s	919	9010	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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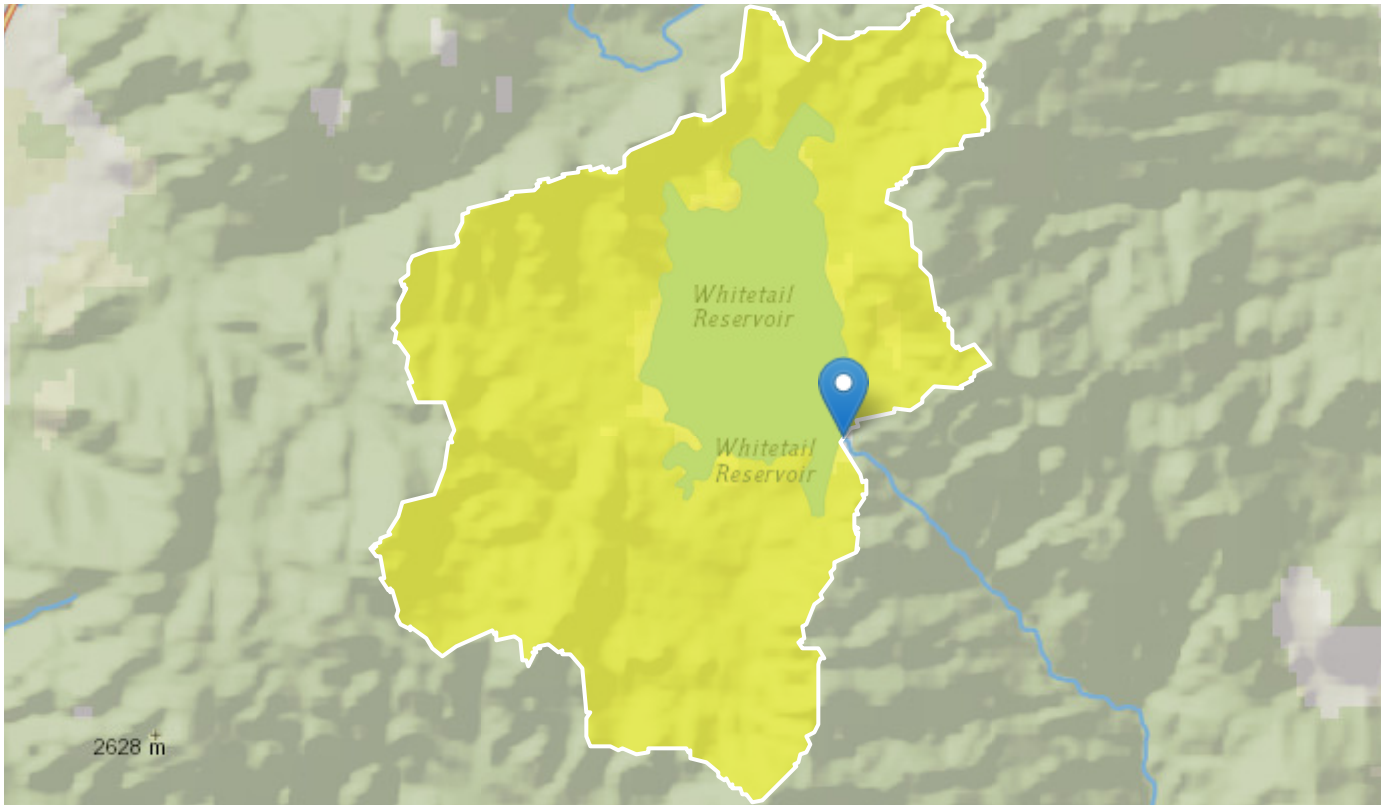
Application Version: 4.3.0

StreamStats Report - Node 200 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190117194230488000
Clicked Point (Latitude, Longitude): 46.07308, -112.26180
Time: 2019-01-17 12:42:45 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	19.4	square miles
EL6000	Percent of area above 6000 ft	100	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	19.4	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	45.5	ft^3/s	9.69	214	118
2 Year Peak Flood	60.9	ft^3/s	16	232	96
2 33 Year Peak Flood	68.5	ft^3/s	19.1	246	90.1
5 Year Peak Flood	108	ft^3/s	35.3	333	76.9
10 Year Peak Flood	149	ft^3/s	51.3	435	72.1
25 Year Peak Flood	208	ft^3/s	72.4	599	71.3
50 Year Peak Flood	255	ft^3/s	88.6	737	72
100 Year Peak Flood	308	ft^3/s	104	911	73.8
200 Year Peak Flood	363	ft^3/s	119	1110	76.5
500 Year Peak Flood	444	ft^3/s	140	1410	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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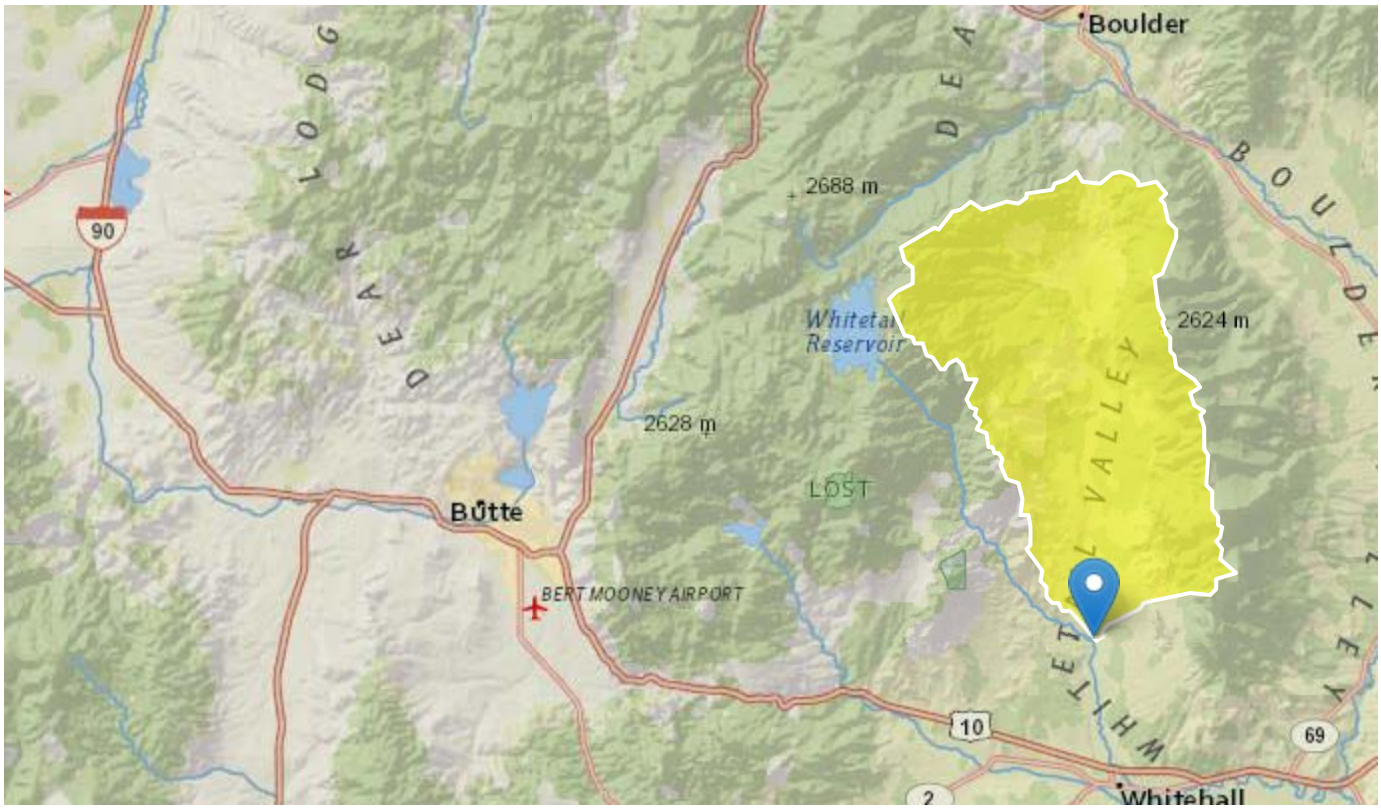
Application Version: 4.3.0

StreamStats Report - Node 300 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190211174554236000
Clicked Point (Latitude, Longitude): 45.93933, -112.11402
Time: 2019-02-11 10:46:09 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	100.6	square miles
EL6000	Percent of area above 6000 ft	39.3	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	100.6	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	39.3	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	188	ft^3/s	40.6	873	118
2 Year Peak Flood	258	ft^3/s	68.6	968	96
2 33 Year Peak Flood	292	ft^3/s	82.3	1030	90.1
5 Year Peak Flood	470	ft^3/s	155	1430	76.9
10 Year Peak Flood	651	ft^3/s	227	1870	72.1
25 Year Peak Flood	921	ft^3/s	325	2610	71.3
50 Year Peak Flood	1140	ft^3/s	401	3240	72
100 Year Peak Flood	1390	ft^3/s	478	4040	73.8
200 Year Peak Flood	1650	ft^3/s	553	4950	76.5
500 Year Peak Flood	2050	ft^3/s	656	6400	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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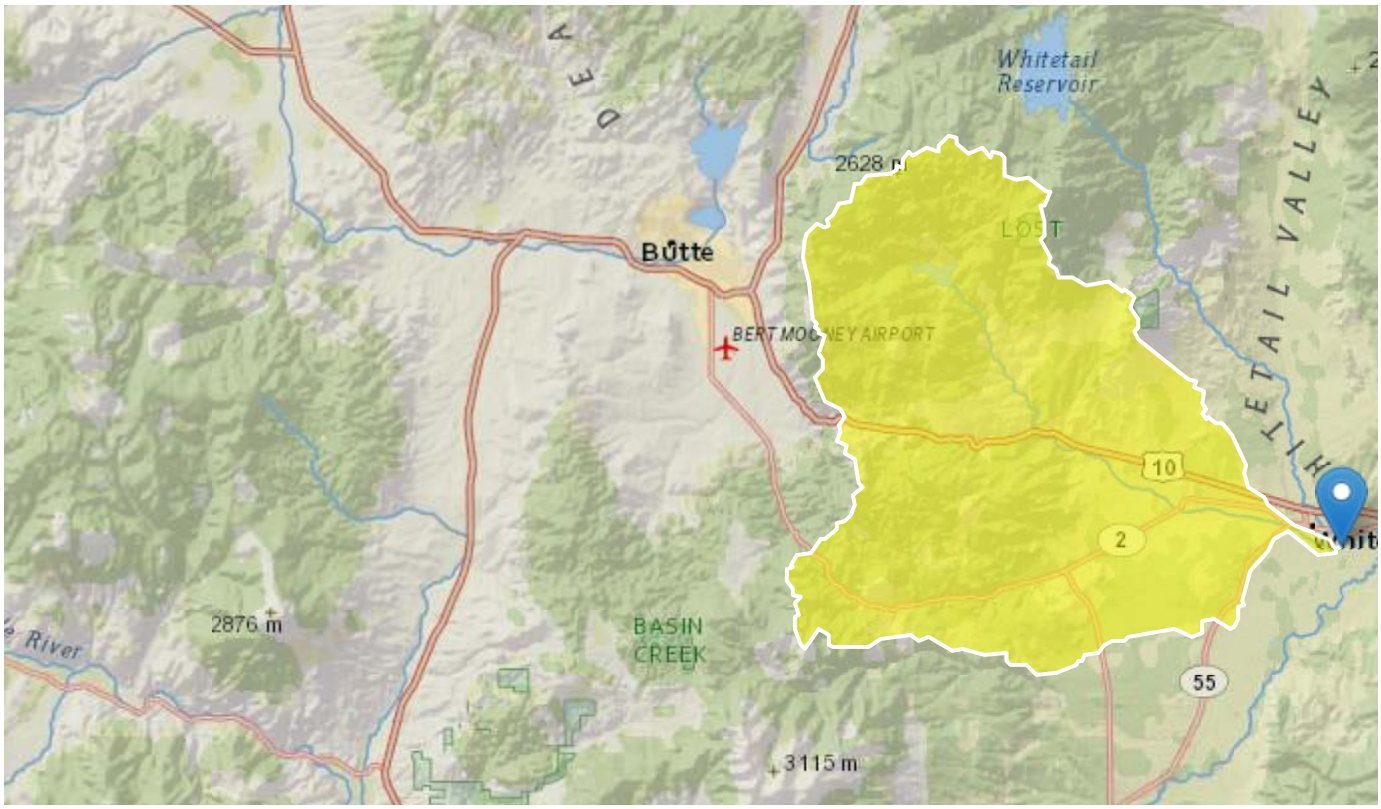
Application Version: 4.3.0

StreamStats Report - Node 400 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190211175216504000
Clicked Point (Latitude, Longitude): 45.85926, -112.07615
Time: 2019-02-11 10:52:31 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	186.6	square miles
EL6000	Percent of area above 6000 ft	47.1	percent
PRECIP	Mean Annual Precipitation	15.17	inches
FOREST	Percentage of area covered by forest	54.7	percent

Peak-Flow Statistics Parameters [95 Percent (178 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	186.6	square miles	0.42	2480
EL6000	Percent above 6000 ft	47.1	percent	0	100

Peak-Flow Statistics Parameters [5 Percent (8.84 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	186.6	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	15.17	inches	14.6	62.1
FOREST	Percent Forest	54.7	percent	20.4	99.1

Peak-Flow Statistics Flow Report [95 Percent (178 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	355	ft^3/s	76.1	1650	118
2 Year Peak Flood	466	ft^3/s	123	1760	96
2 33 Year Peak Flood	517	ft^3/s	145	1840	90.1
5 Year Peak Flood	778	ft^3/s	256	2370	76.9
10 Year Peak Flood	1030	ft^3/s	358	2970	72.1
25 Year Peak Flood	1390	ft^3/s	491	3960	71.3
50 Year Peak Flood	1680	ft^3/s	589	4770	72
100 Year Peak Flood	1990	ft^3/s	685	5800	73.8
200 Year Peak Flood	2320	ft^3/s	774	6960	76.5
500 Year Peak Flood	2800	ft^3/s	896	8760	80.3

Peak-Flow Statistics Flow Report [5 Percent (8.84 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	169	ft^3/s	67.3	426	59.4
2 Year Peak Flood	238	ft^3/s	98.1	578	56.5
2 33 Year Peak Flood	274	ft^3/s	114	659	55.7
5 Year Peak Flood	455	ft^3/s	196	1060	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	655	ft^3/s	284	1510	52.8
25 Year Peak Flood	913	ft^3/s	394	2110	53.2
50 Year Peak Flood	1140	ft^3/s	482	2690	54.2
100 Year Peak Flood	1390	ft^3/s	577	3350	56
200 Year Peak Flood	1670	ft^3/s	672	4130	58
500 Year Peak Flood	2020	ft^3/s	780	5250	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	346	ft^3/s	75.7	1600
2 Year Peak Flood	455	ft^3/s	122	1700
2 33 Year Peak Flood	505	ft^3/s	144	1780
5 Year Peak Flood	763	ft^3/s	253	2310
10 Year Peak Flood	1010	ft^3/s	355	2900
25 Year Peak Flood	1370	ft^3/s	486	3870
50 Year Peak Flood	1650	ft^3/s	584	4670
100 Year Peak Flood	1960	ft^3/s	680	5680
200 Year Peak Flood	2290	ft^3/s	770	6820
500 Year Peak Flood	2760	ft^3/s	890	8590

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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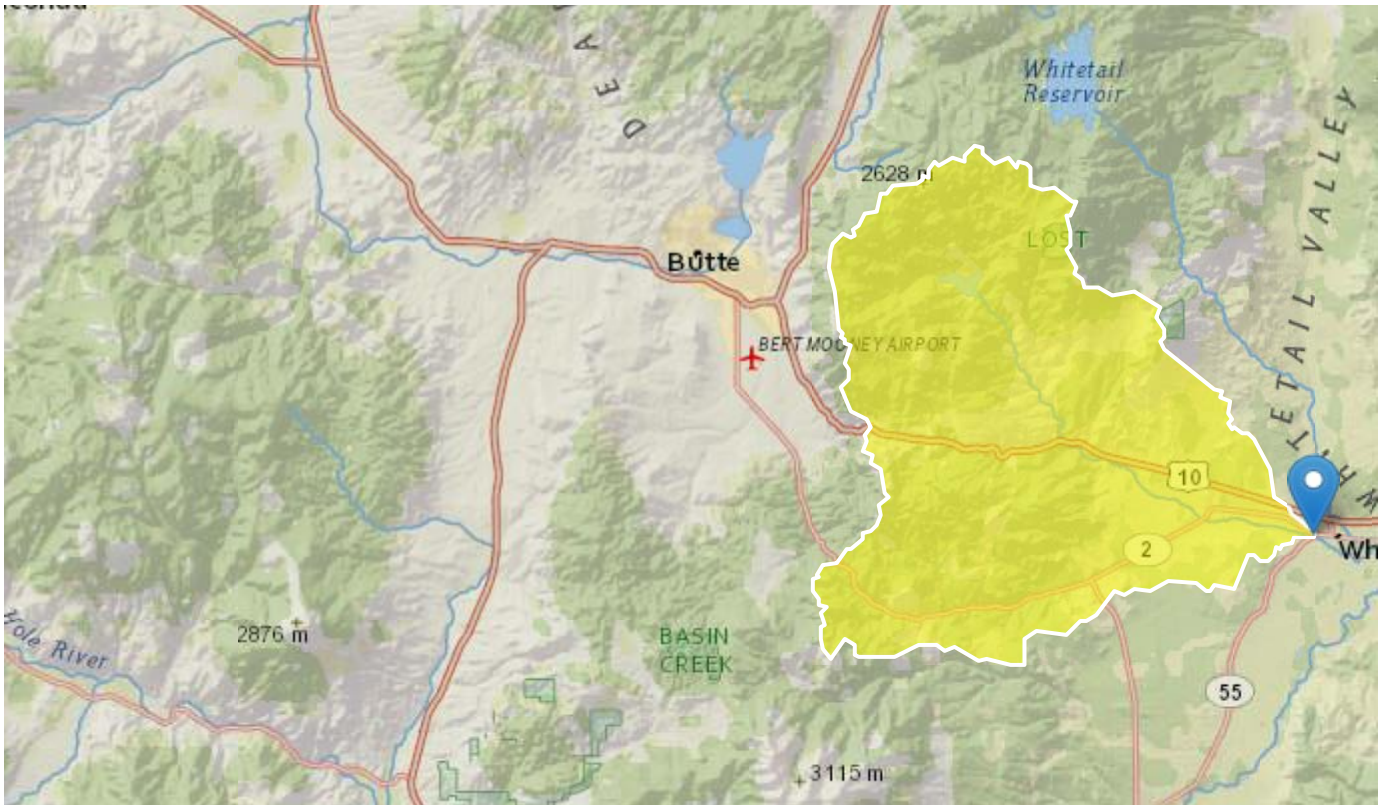
Application Version: 4.3.0

StreamStats Report - Node 500 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190211175943138000
Clicked Point (Latitude, Longitude): 45.86981, -112.11226
Time: 2019-02-11 10:59:58 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	169.2	square miles
EL6000	Percent of area above 6000 ft	52	percent
PRECIP	Mean Annual Precipitation	15.68	inches
FOREST	Percentage of area covered by forest	60.1	percent

Peak-Flow Statistics Parameters [95 Percent (160 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	169.2	square miles	0.42	2480
EL6000	Percent above 6000 ft	52	percent	0	100

Peak-Flow Statistics Parameters [5 Percent (8.81 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	169.2	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	15.68	inches	14.6	62.1
FOREST	Percent Forest	60.1	percent	20.4	99.1

Peak-Flow Statistics Flow Report [95 Percent (160 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	329	ft^3/s	70.7	1530	118
2 Year Peak Flood	429	ft^3/s	114	1620	96
2 33 Year Peak Flood	475	ft^3/s	134	1690	90.1
5 Year Peak Flood	711	ft^3/s	234	2160	76.9
10 Year Peak Flood	938	ft^3/s	326	2700	72.1
25 Year Peak Flood	1260	ft^3/s	444	3580	71.3
50 Year Peak Flood	1510	ft^3/s	532	4300	72
100 Year Peak Flood	1790	ft^3/s	617	5210	73.8
200 Year Peak Flood	2080	ft^3/s	696	6230	76.5
500 Year Peak Flood	2500	ft^3/s	802	7820	80.3

Peak-Flow Statistics Flow Report [5 Percent (8.81 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	155	ft^3/s	61.7	388	59.4
2 Year Peak Flood	217	ft^3/s	89.5	525	56.5
2 33 Year Peak Flood	249	ft^3/s	104	597	55.7
5 Year Peak Flood	411	ft^3/s	177	952	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	588	ft^3/s	256	1350	52.8
25 Year Peak Flood	815	ft^3/s	353	1880	53.2
50 Year Peak Flood	1010	ft^3/s	431	2390	54.2
100 Year Peak Flood	1240	ft^3/s	514	2970	56
200 Year Peak Flood	1480	ft^3/s	597	3650	58
500 Year Peak Flood	1790	ft^3/s	691	4620	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	320	ft^3/s	70.2	1470
2 Year Peak Flood	418	ft^3/s	113	1560
2 33 Year Peak Flood	463	ft^3/s	132	1630
5 Year Peak Flood	695	ft^3/s	231	2100
10 Year Peak Flood	920	ft^3/s	323	2630
25 Year Peak Flood	1240	ft^3/s	440	3490
50 Year Peak Flood	1490	ft^3/s	527	4200
100 Year Peak Flood	1760	ft^3/s	611	5090
200 Year Peak Flood	2050	ft^3/s	690	6090
500 Year Peak Flood	2470	ft^3/s	796	7650

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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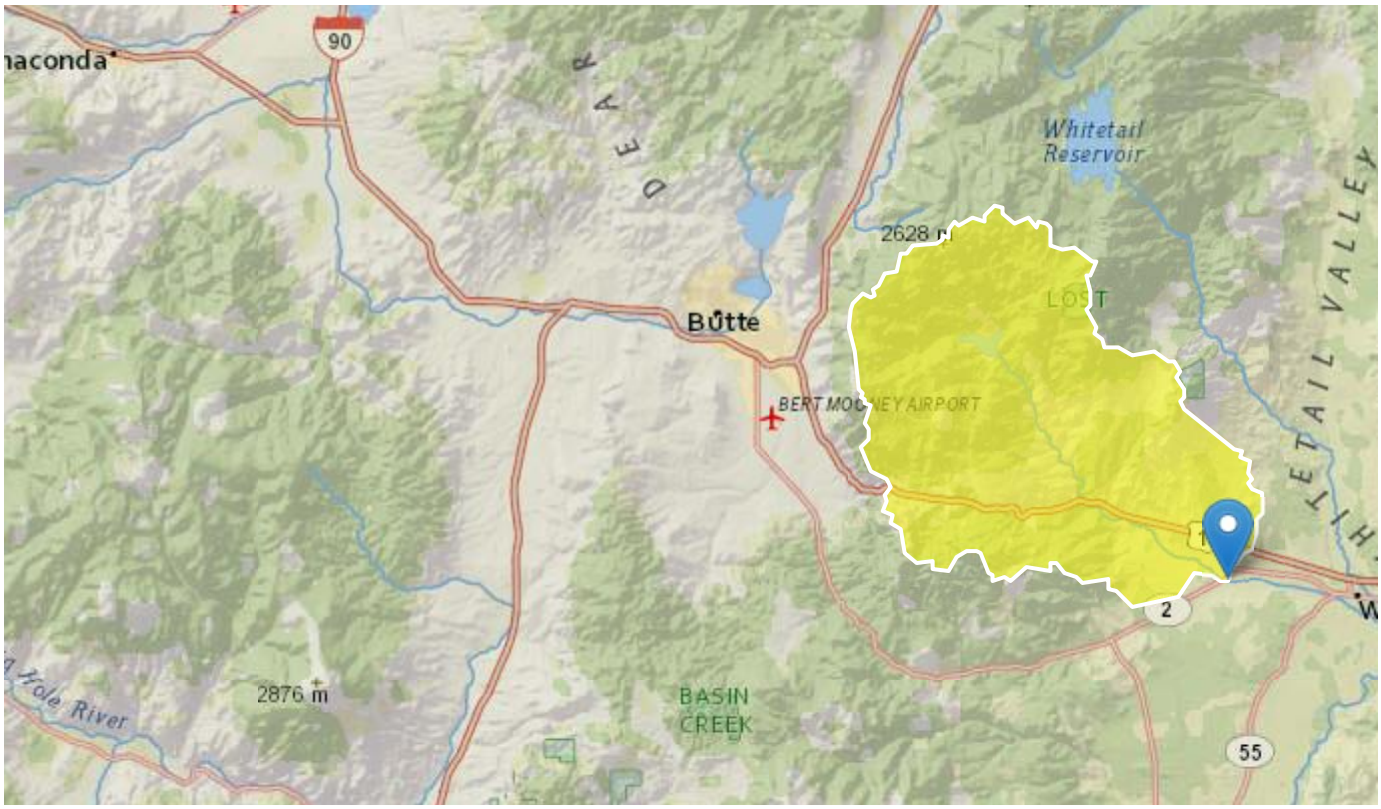
USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.3.0

StreamStats Report - Node 600 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190416165230608000
Clicked Point (Latitude, Longitude): 45.87715, -112.18537
Time: 2019-04-16 10:52:46 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	114.2	square miles
EL6000	Percent of area above 6000 ft	58.8	percent
PRECIP	Mean Annual Precipitation	16.35	inches
FOREST	Percentage of area covered by forest	66.4	percent

General Disclaimers

Upstream regulation was checked for this watershed.

This watershed is 20.61 percent regulated, computed flows may not apply.

Peak-Flow Statistics Parameters [97 Percent (111 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	114.2	square miles	0.42	2480
EL6000	Percent above 6000 ft	58.8	percent	0	100

Peak-Flow Statistics Parameters [3 Percent (3.3 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	114.2	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	16.35	inches	14.6	62.1
FOREST	Percent Forest	66.4	percent	20.4	99.1

Peak-Flow Statistics Flow Report [97 Percent (111 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	230	ft^3/s	49.6	1070	118
2 Year Peak Flood	301	ft^3/s	80.1	1130	96
2 33 Year Peak Flood	334	ft^3/s	94.4	1180	90.1
5 Year Peak Flood	505	ft^3/s	166	1530	76.9
10 Year Peak Flood	672	ft^3/s	234	1930	72.1
25 Year Peak Flood	909	ft^3/s	321	2570	71.3
50 Year Peak Flood	1090	ft^3/s	386	3100	72
100 Year Peak Flood	1300	ft^3/s	449	3770	73.8
200 Year Peak Flood	1510	ft^3/s	507	4520	76.5
500 Year Peak Flood	1830	ft^3/s	586	5690	80.3

Peak-Flow Statistics Flow Report [3 Percent (3.3 square miles) W Region BasinC 2015 5019F]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
1.5 Year Peak Flood	109	ft^3/s	43.5	273	59.4
2 Year Peak Flood	153	ft^3/s	63	369	56.5
2 33 Year Peak Flood	175	ft^3/s	73.1	420	55.7
5 Year Peak Flood	289	ft^3/s	125	670	53.4
10 Year Peak Flood	415	ft^3/s	180	953	52.8
25 Year Peak Flood	575	ft^3/s	249	1320	53.2
50 Year Peak Flood	715	ft^3/s	304	1680	54.2
100 Year Peak Flood	870	ft^3/s	363	2090	56
200 Year Peak Flood	1040	ft^3/s	421	2560	58
500 Year Peak Flood	1260	ft^3/s	488	3250	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu
1.5 Year Peak Flood	226	ft^3/s	49.4	1040
2 Year Peak Flood	297	ft^3/s	79.6	1110
2 33 Year Peak Flood	330	ft^3/s	93.8	1160
5 Year Peak Flood	499	ft^3/s	165	1510
10 Year Peak Flood	664	ft^3/s	233	1900
25 Year Peak Flood	899	ft^3/s	319	2540
50 Year Peak Flood	1080	ft^3/s	384	3060
100 Year Peak Flood	1290	ft^3/s	446	3720
200 Year Peak Flood	1500	ft^3/s	505	4460
500 Year Peak Flood	1810	ft^3/s	584	5620

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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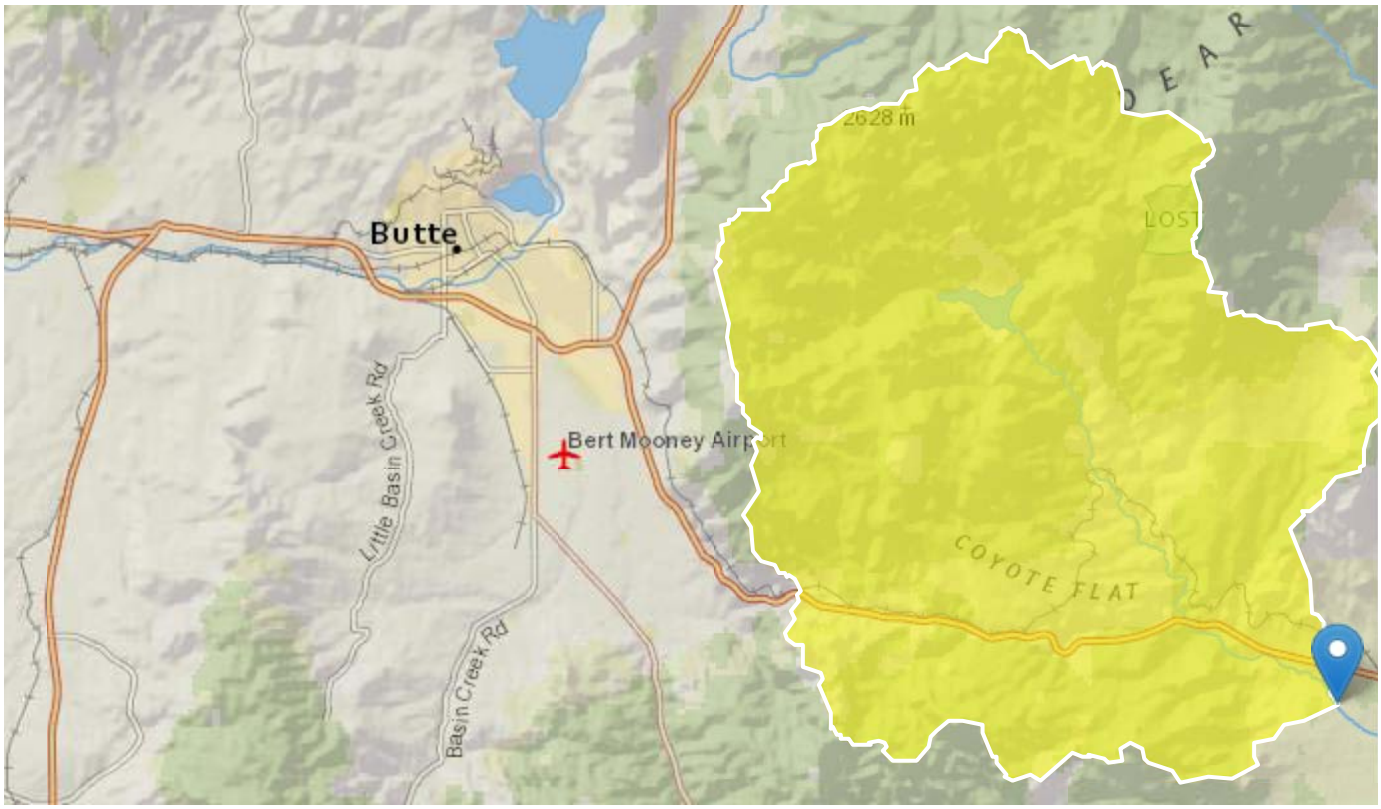
Application Version: 4.3.0

StreamStats Report - Node 700 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190416164835467000
Clicked Point (Latitude, Longitude): 45.89455, -112.23199
Time: 2019-04-16 10:48:50 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	95.1	square miles
EL6000	Percent of area above 6000 ft	70.1	percent
PRECIP	Mean Annual Precipitation	17.59	inches
FOREST	Percentage of area covered by forest	79	percent

General Disclaimers

Upstream regulation was checked for this watershed.

This watershed is 24.76 percent regulated, computed flows may not apply.

Peak-Flow Statistics Parameters [97 Percent (91.8 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	95.1	square miles	0.42	2480
EL6000	Percent above 6000 ft	70.1	percent	0	100

Peak-Flow Statistics Parameters [3 Percent (3.31 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	95.1	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	17.59	inches	14.6	62.1
FOREST	Percent Forest	79	percent	20.4	99.1

Peak-Flow Statistics Flow Report [97 Percent (91.8 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	199	ft^3/s	42.9	923	118
2 Year Peak Flood	258	ft^3/s	68.7	969	96
2 33 Year Peak Flood	286	ft^3/s	80.7	1010	90.1
5 Year Peak Flood	426	ft^3/s	141	1290	76.9
10 Year Peak Flood	563	ft^3/s	196	1620	72.1
25 Year Peak Flood	755	ft^3/s	267	2140	71.3
50 Year Peak Flood	904	ft^3/s	319	2560	72
100 Year Peak Flood	1070	ft^3/s	369	3100	73.8
200 Year Peak Flood	1240	ft^3/s	415	3700	76.5
500 Year Peak Flood	1490	ft^3/s	478	4630	80.3

Peak-Flow Statistics Flow Report [3 Percent (3.31 square miles) W Region BasinC 2015 5019F]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
1.5 Year Peak Flood	94.9	ft^3/s	37.8	238	59.4
2 Year Peak Flood	131	ft^3/s	54.2	318	56.5
2 33 Year Peak Flood	150	ft^3/s	62.6	361	55.7
5 Year Peak Flood	244	ft^3/s	105	565	53.4
10 Year Peak Flood	346	ft^3/s	150	796	52.8
25 Year Peak Flood	474	ft^3/s	205	1090	53.2
50 Year Peak Flood	586	ft^3/s	249	1380	54.2
100 Year Peak Flood	708	ft^3/s	295	1700	56
200 Year Peak Flood	841	ft^3/s	341	2080	58
500 Year Peak Flood	1010	ft^3/s	392	2610	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu
1.5 Year Peak Flood	195	ft^3/s	42.8	899
2 Year Peak Flood	254	ft^3/s	68.2	947
2 33 Year Peak Flood	281	ft^3/s	80.1	988
5 Year Peak Flood	420	ft^3/s	139	1270
10 Year Peak Flood	556	ft^3/s	195	1590
25 Year Peak Flood	746	ft^3/s	265	2100
50 Year Peak Flood	893	ft^3/s	317	2520
100 Year Peak Flood	1060	ft^3/s	366	3050
200 Year Peak Flood	1230	ft^3/s	413	3640
500 Year Peak Flood	1470	ft^3/s	475	4560

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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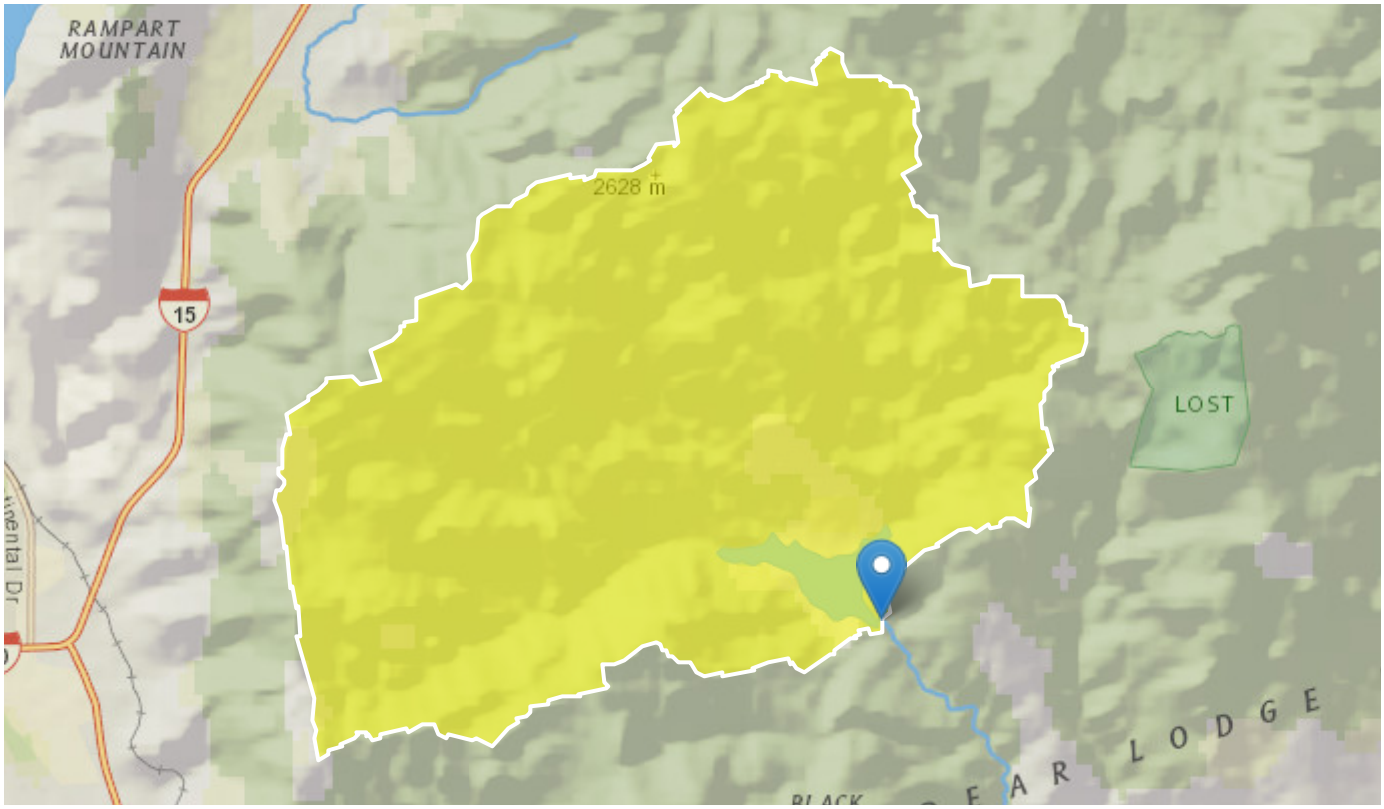
Application Version: 4.3.0

StreamStats Report - Node 800 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190117200926638000
Clicked Point (Latitude, Longitude): 45.98447, -112.34128
Time: 2019-01-17 13:10:44 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	23.5	square miles
EL6000	Percent of area above 6000 ft	100	percent
PRECIP	Mean Annual Precipitation	23.7	inches
FOREST	Percentage of area covered by forest	96	percent

Peak-Flow Statistics Parameters [93 Percent (21.9 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	23.5	square miles	0.42	2480
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Parameters [7 Percent (1.56 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	23.5	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	23.7	inches	14.6	62.1
FOREST	Percent Forest	96	percent	20.4	99.1

Peak-Flow Statistics Flow Report [93 Percent (21.9 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	54.9	ft^3/s	11.7	257	118
2 Year Peak Flood	72.7	ft^3/s	19.2	276	96
2 33 Year Peak Flood	81.5	ft^3/s	22.8	292	90.1
5 Year Peak Flood	127	ft^3/s	41.5	391	76.9
10 Year Peak Flood	174	ft^3/s	59.9	505	72.1
25 Year Peak Flood	241	ft^3/s	83.8	690	71.3
50 Year Peak Flood	293	ft^3/s	102	843	72
100 Year Peak Flood	352	ft^3/s	120	1040	73.8
200 Year Peak Flood	413	ft^3/s	136	1250	76.5
500 Year Peak Flood	503	ft^3/s	159	1600	80.3

Peak-Flow Statistics Flow Report [7 Percent (1.56 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	44.7	ft^3/s	17.9	112	59.4
2 Year Peak Flood	60.2	ft^3/s	24.9	145	56.5
2 33 Year Peak Flood	68.1	ft^3/s	28.5	163	55.7
5 Year Peak Flood	106	ft^3/s	45.9	246	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	148	ft^3/s	64.4	339	52.8
25 Year Peak Flood	197	ft^3/s	85.7	453	53.2
50 Year Peak Flood	240	ft^3/s	102	563	54.2
100 Year Peak Flood	286	ft^3/s	119	684	56
200 Year Peak Flood	335	ft^3/s	136	823	58
500 Year Peak Flood	396	ft^3/s	154	1020	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	54.2	ft^3/s	12.1	247
2 Year Peak Flood	71.9	ft^3/s	19.5	267
2 33 Year Peak Flood	80.7	ft^3/s	23.2	283
5 Year Peak Flood	126	ft^3/s	41.8	381
10 Year Peak Flood	172	ft^3/s	60.2	494
25 Year Peak Flood	238	ft^3/s	84	674
50 Year Peak Flood	290	ft^3/s	102	825
100 Year Peak Flood	348	ft^3/s	120	1010
200 Year Peak Flood	408	ft^3/s	136	1220
500 Year Peak Flood	496	ft^3/s	158	1560

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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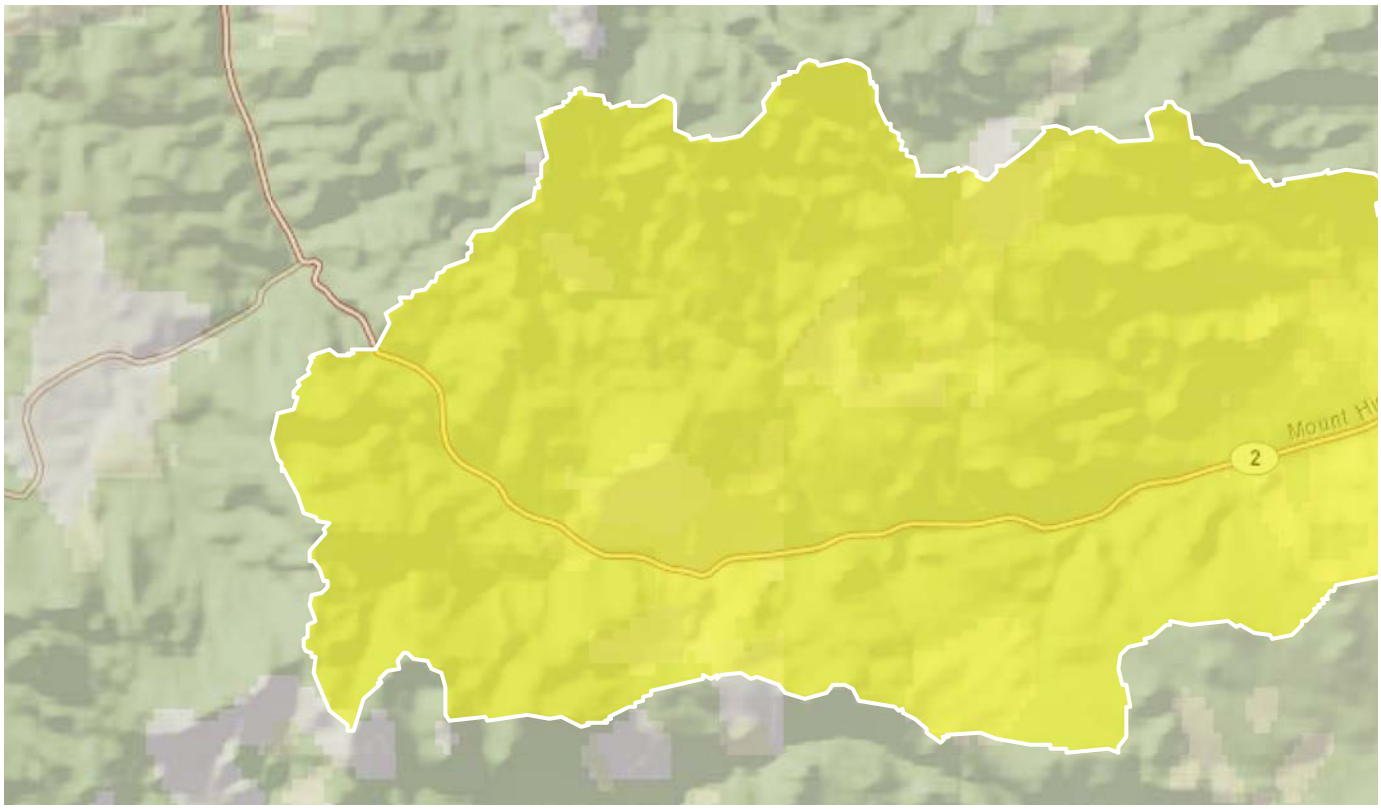
Application Version: 4.3.0

StreamStats Report - Node 900 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190328193058857000
Clicked Point (Latitude, Longitude): 45.87598, -112.18627
Time: 2019-03-28 13:31:14 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	45.5	square miles
EL6000	Percent of area above 6000 ft	45.7	percent
PRECIP	Mean Annual Precipitation	15.12	inches
FOREST	Percentage of area covered by forest	57	percent

Peak-Flow Statistics Parameters [88 Percent (40 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	45.5	square miles	0.42	2480
EL6000	Percent above 6000 ft	45.7	percent	0	100

Peak-Flow Statistics Parameters [12 Percent (5.52 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	45.5	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	15.12	inches	14.6	62.1
FOREST	Percent Forest	57	percent	20.4	99.1

Peak-Flow Statistics Flow Report [88 Percent (40 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	89.6	ft^3/s	19.4	415	118
2 Year Peak Flood	125	ft^3/s	33.3	469	96
2 33 Year Peak Flood	143	ft^3/s	40.4	505	90.1
5 Year Peak Flood	238	ft^3/s	78.3	722	76.9
10 Year Peak Flood	337	ft^3/s	117	969	72.1
25 Year Peak Flood	488	ft^3/s	172	1380	71.3
50 Year Peak Flood	612	ft^3/s	215	1740	72
100 Year Peak Flood	755	ft^3/s	260	2190	73.8
200 Year Peak Flood	907	ft^3/s	303	2720	76.5
500 Year Peak Flood	1140	ft^3/s	364	3550	80.3

Peak-Flow Statistics Flow Report [12 Percent (5.52 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	42.9	ft^3/s	17	108	59.4
2 Year Peak Flood	62.3	ft^3/s	25.6	152	56.5
2 33 Year Peak Flood	72.8	ft^3/s	30.2	175	55.7
5 Year Peak Flood	127	ft^3/s	54.5	296	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	189	ft^3/s	81.5	437	52.8
25 Year Peak Flood	271	ft^3/s	117	630	53.2
50 Year Peak Flood	345	ft^3/s	145	817	54.2
100 Year Peak Flood	428	ft^3/s	177	1040	56
200 Year Peak Flood	520	ft^3/s	209	1300	58
500 Year Peak Flood	644	ft^3/s	247	1680	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	84	ft^3/s	19.1	378
2 Year Peak Flood	117	ft^3/s	32.4	430
2 33 Year Peak Flood	134	ft^3/s	39.1	465
5 Year Peak Flood	224	ft^3/s	75.4	670
10 Year Peak Flood	319	ft^3/s	113	905
25 Year Peak Flood	461	ft^3/s	165	1290
50 Year Peak Flood	580	ft^3/s	207	1630
100 Year Peak Flood	715	ft^3/s	250	2050
200 Year Peak Flood	860	ft^3/s	292	2540
500 Year Peak Flood	1080	ft^3/s	350	3330

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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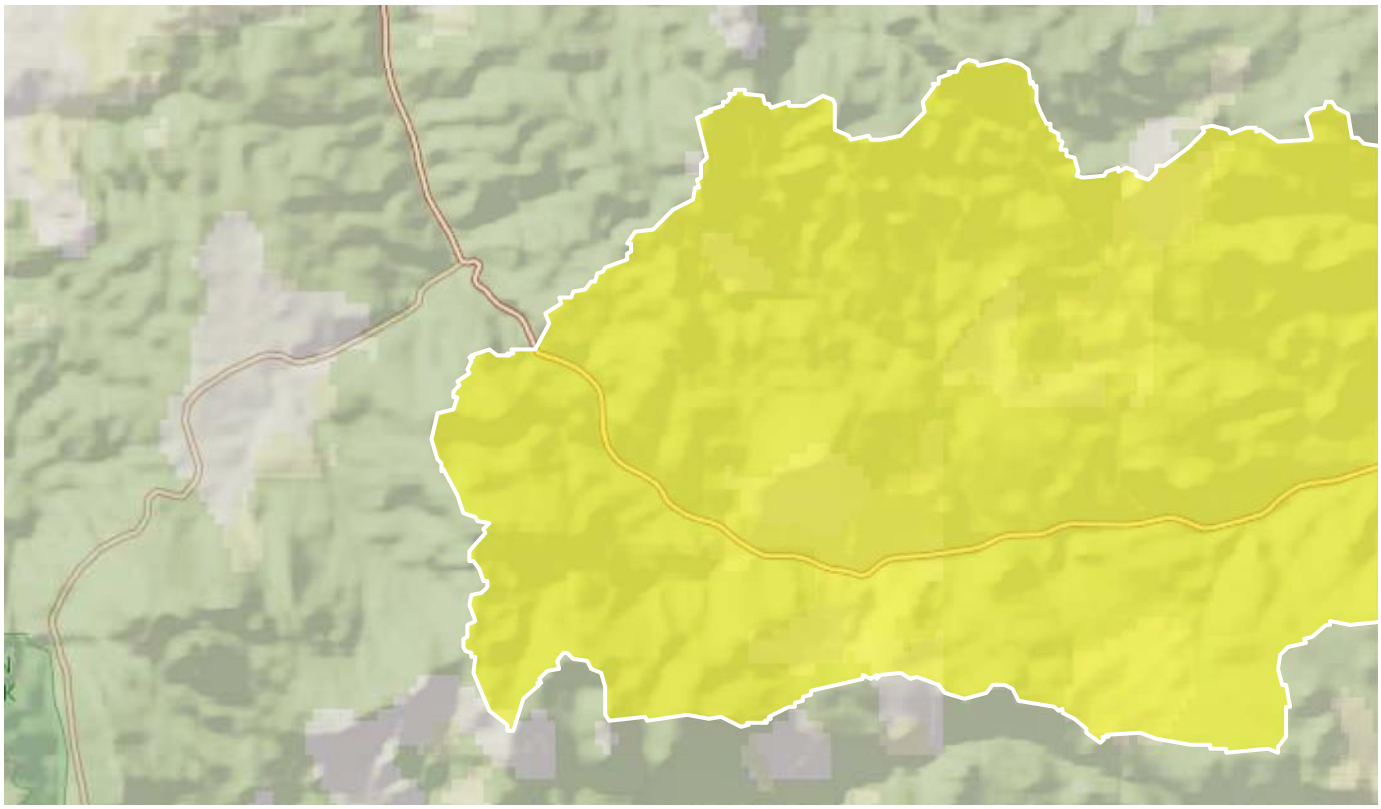
Application Version: 4.3.0

StreamStats Report - Node 1000 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190225220921979000
Clicked Point (Latitude, Longitude): 45.85399, -112.24075
Time: 2019-02-25 15:09:37 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	40.9	square miles
EL6000	Percent of area above 6000 ft	50.7	percent
PRECIP	Mean Annual Precipitation	15.71	inches
FOREST	Percentage of area covered by forest	63.3	percent

Peak-Flow Statistics Parameters [87 Percent (35.4 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	40.9	square miles	0.42	2480
EL6000	Percent above 6000 ft	50.7	percent	0	100

Peak-Flow Statistics Parameters [13 Percent (5.51 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	40.9	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	15.71	inches	14.6	62.1
FOREST	Percent Forest	63.3	percent	20.4	99.1

Peak-Flow Statistics Flow Report [87 Percent (35.4 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	82.4	ft^3/s	17.8	382	118
2 Year Peak Flood	114	ft^3/s	30.4	429	96
2 33 Year Peak Flood	130	ft^3/s	36.8	461	90.1
5 Year Peak Flood	215	ft^3/s	71	654	76.9
10 Year Peak Flood	304	ft^3/s	106	875	72.1
25 Year Peak Flood	438	ft^3/s	154	1240	71.3
50 Year Peak Flood	548	ft^3/s	193	1560	72
100 Year Peak Flood	674	ft^3/s	232	1960	73.8
200 Year Peak Flood	807	ft^3/s	269	2420	76.5
500 Year Peak Flood	1010	ft^3/s	323	3150	80.3

Peak-Flow Statistics Flow Report [13 Percent (5.51 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	39.1	ft^3/s	15.5	98.4	59.4
2 Year Peak Flood	56.4	ft^3/s	23.2	137	56.5
2 33 Year Peak Flood	65.7	ft^3/s	27.3	158	55.7
5 Year Peak Flood	114	ft^3/s	48.8	264	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	168	ft^3/s	72.7	388	52.8
25 Year Peak Flood	240	ft^3/s	104	557	53.2
50 Year Peak Flood	304	ft^3/s	129	720	54.2
100 Year Peak Flood	377	ft^3/s	156	910	56
200 Year Peak Flood	456	ft^3/s	183	1130	58
500 Year Peak Flood	562	ft^3/s	216	1460	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	76.6	ft^3/s	17.5	344
2 Year Peak Flood	106	ft^3/s	29.5	390
2 33 Year Peak Flood	122	ft^3/s	35.5	420
5 Year Peak Flood	202	ft^3/s	68	602
10 Year Peak Flood	286	ft^3/s	101	809
25 Year Peak Flood	411	ft^3/s	147	1150
50 Year Peak Flood	515	ft^3/s	184	1440
100 Year Peak Flood	634	ft^3/s	221	1820
200 Year Peak Flood	760	ft^3/s	258	2240
500 Year Peak Flood	949	ft^3/s	308	2930

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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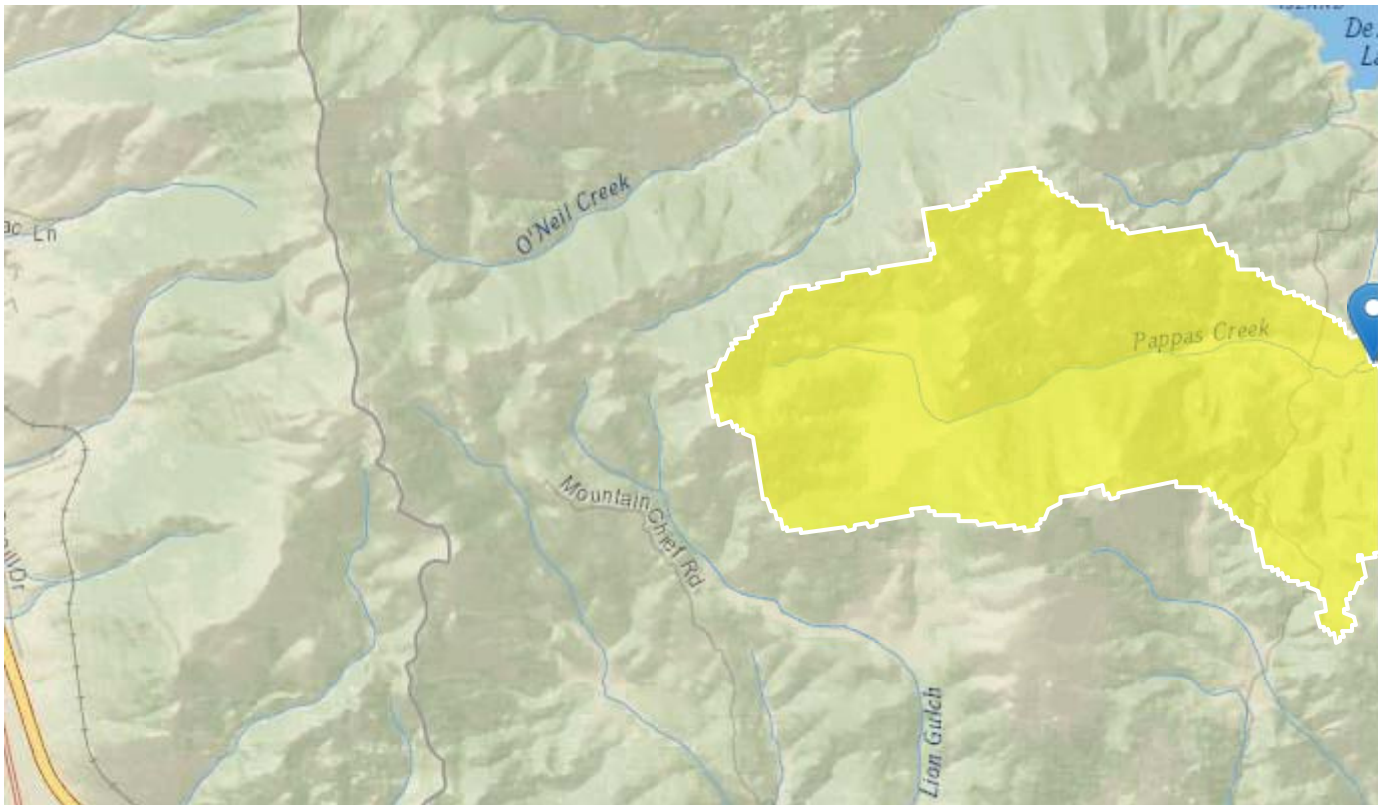
Application Version: 4.3.0

StreamStats Report - Node 1100 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190225222232290000
Clicked Point (Latitude, Longitude): 45.97017, -112.35063
Time: 2019-02-25 15:22:47 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	3.1	square miles
EL6000	Percent of area above 6000 ft	100	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	3.1	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	7.67	ft^3/s	1.56	37.8	118
2 Year Peak Flood	11.1	ft^3/s	2.78	43.9	96
2 33 Year Peak Flood	12.9	ft^3/s	3.46	48.2	90.1
5 Year Peak Flood	23.1	ft^3/s	7.23	74.1	76.9
10 Year Peak Flood	34.7	ft^3/s	11.4	105	72.1
25 Year Peak Flood	52.6	ft^3/s	17.5	158	71.3
50 Year Peak Flood	68.1	ft^3/s	22.5	206	72
100 Year Peak Flood	86.1	ft^3/s	27.7	267	73.8
200 Year Peak Flood	105	ft^3/s	32.8	337	76.5
500 Year Peak Flood	135	ft^3/s	40.2	455	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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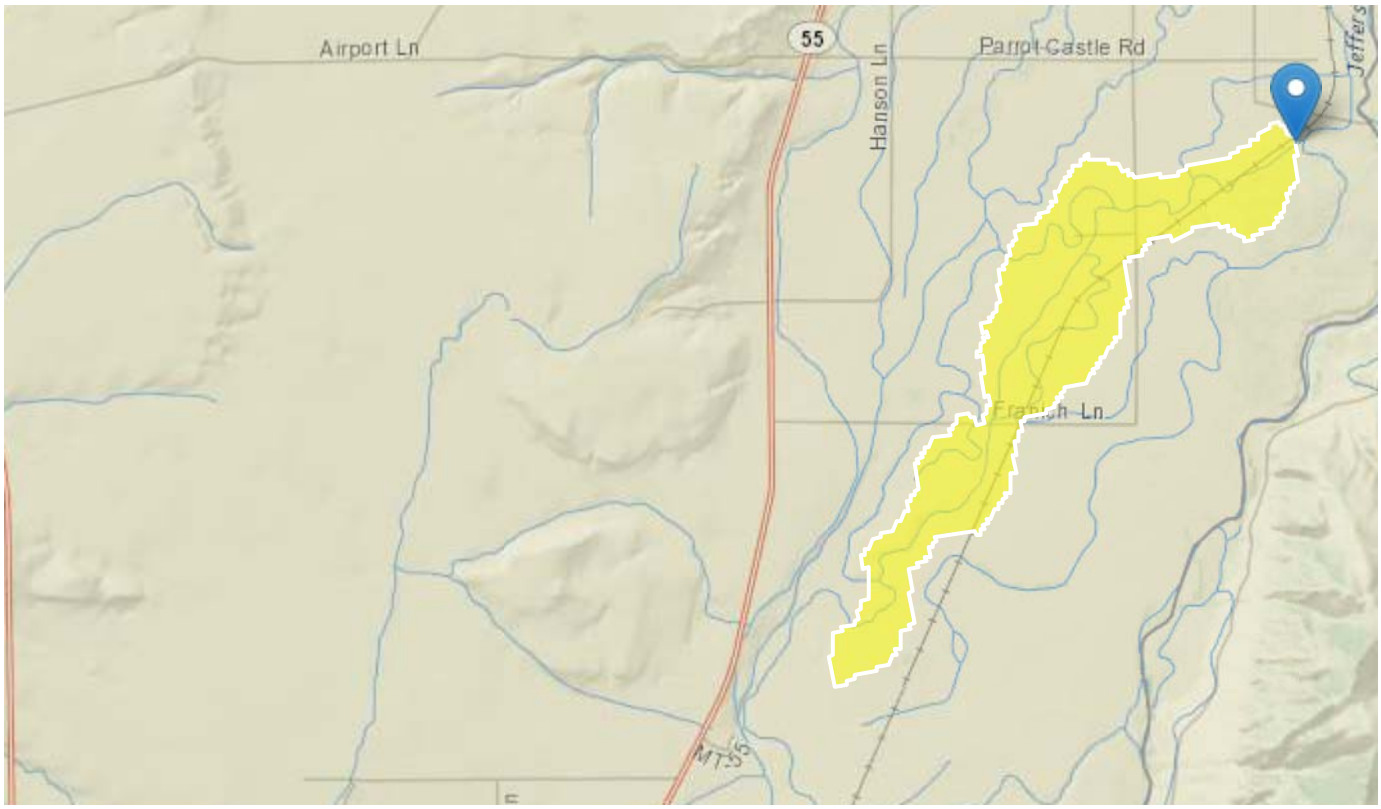
Application Version: 4.3.0

StreamStats Report - Node 1200 Jefferson Tributaries (Basin delineated with ESRI ArcGIS)

Region ID: MT
Workspace ID: MT20190422143019527000
Clicked Point (Latitude, Longitude): 45.81047, -112.12430
Time: 2019-04-22 08:30:33 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1	square miles
EL6000	Percent of area above 6000 ft	0	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	0	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1.04	ft^3/s	0.199	5.43	118
2 Year Peak Flood	2.49	ft^3/s	0.594	10.4	96
2 33 Year Peak Flood	3.61	ft^3/s	0.915	14.2	90.1
5 Year Peak Flood	13.4	ft^3/s	3.95	45.4	76.9
10 Year Peak Flood	31.9	ft^3/s	9.88	103	72.1
25 Year Peak Flood	79.8	ft^3/s	24.8	257	71.3
50 Year Peak Flood	142	ft^3/s	43.6	462	72
100 Year Peak Flood	238	ft^3/s	70.9	799	73.8
200 Year Peak Flood	377	ft^3/s	108	1320	76.5
500 Year Peak Flood	655	ft^3/s	178	2410	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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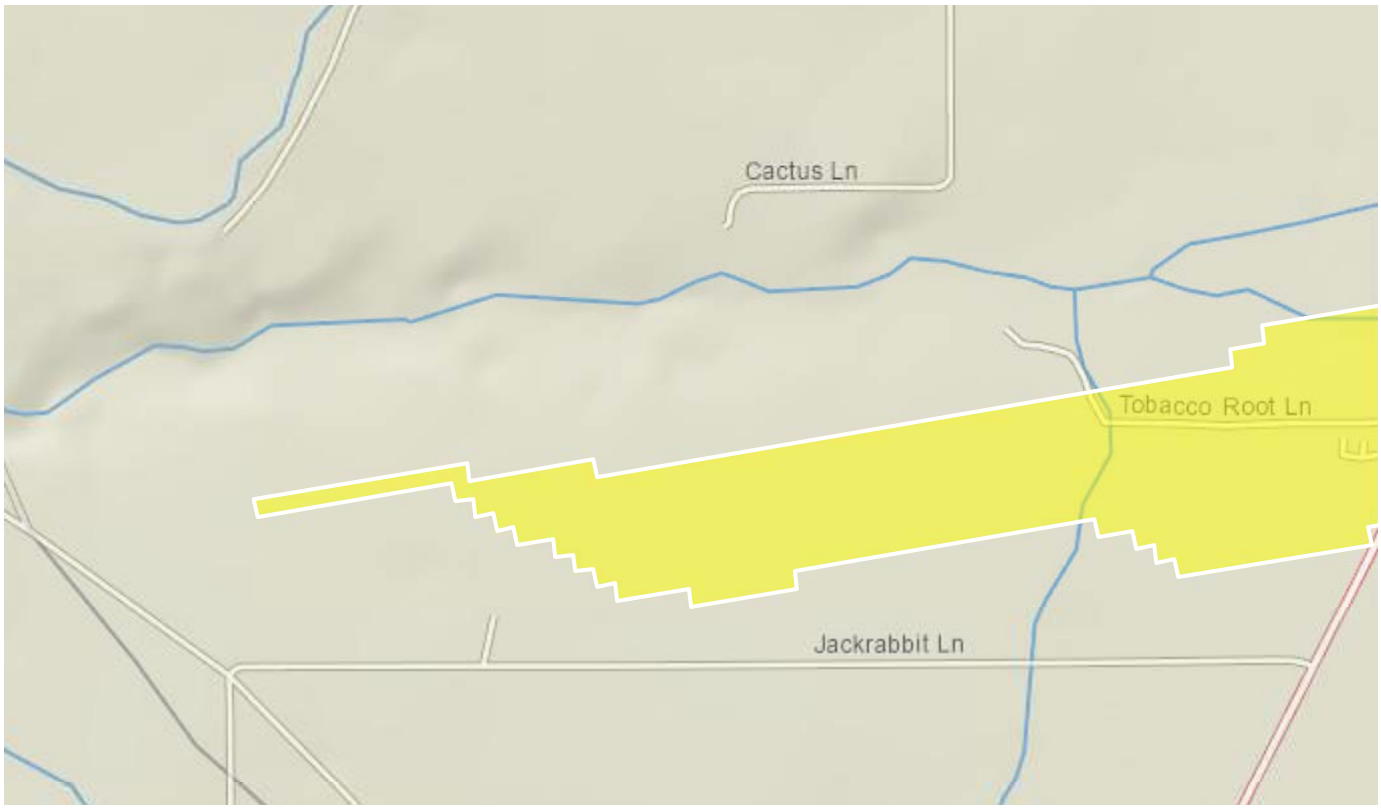
Application Version: 4.3.0

StreamStats Report - Node 1300A Jefferson Tributaries (Combined with Basin 1300B)

Region ID: MT
Workspace ID: MT20190225165516073000
Clicked Point (Latitude, Longitude): 45.76591, -112.17339
Time: 2019-02-25 09:55:30 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.3	square miles
EL6000	Percent of area above 6000 ft	0	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.3	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	0	percent	0	100

Peak-Flow Statistics Disclaimers [SW Region BasinC 2015 5019F]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

Statistic	Value	Unit
1.5 Year Peak Flood	0.323	ft^3/s
2 Year Peak Flood	0.813	ft^3/s
2 33 Year Peak Flood	1.21	ft^3/s
5 Year Peak Flood	4.86	ft^3/s
10 Year Peak Flood	12.2	ft^3/s
25 Year Peak Flood	32.3	ft^3/s
50 Year Peak Flood	59.6	ft^3/s
100 Year Peak Flood	103	ft^3/s
200 Year Peak Flood	167	ft^3/s
500 Year Peak Flood	300	ft^3/s

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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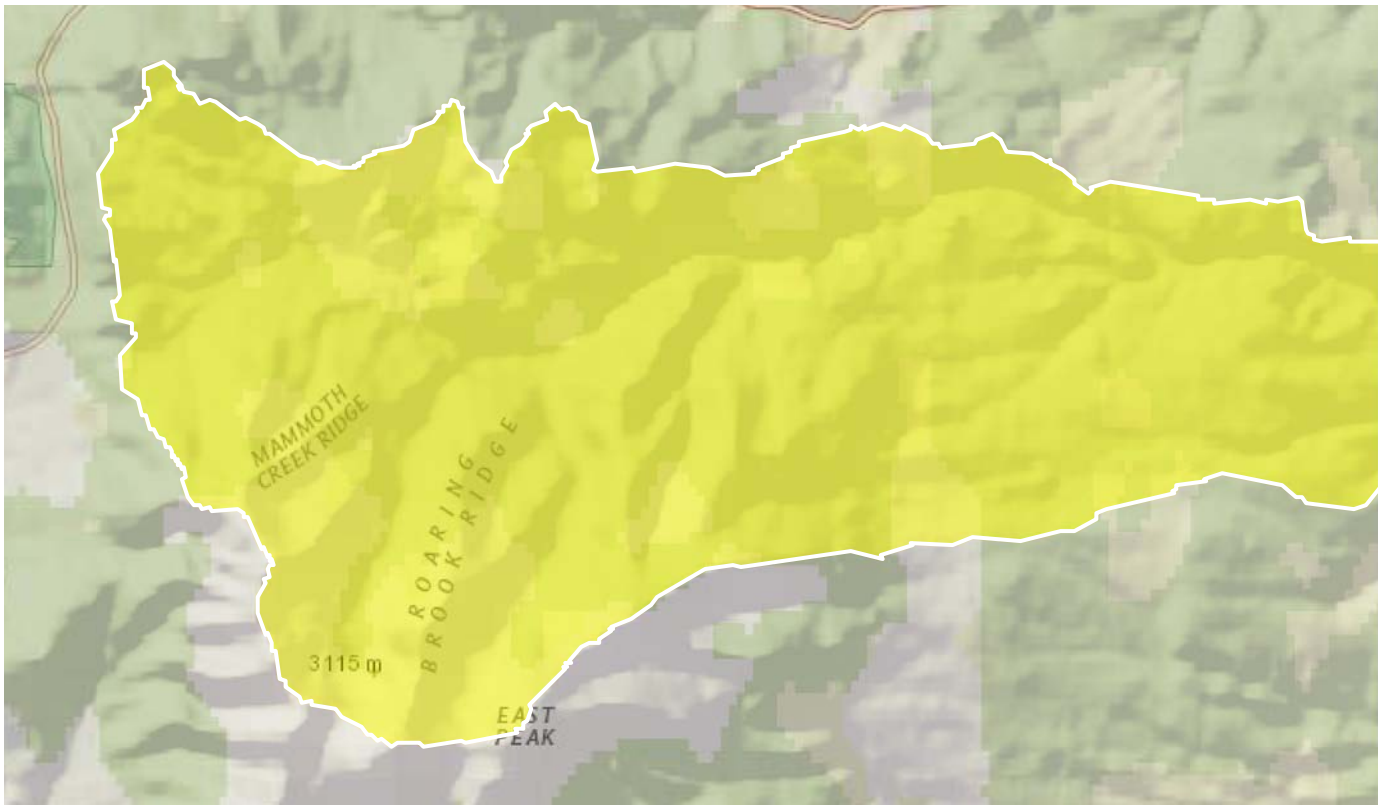
Application Version: 4.3.0

StreamStats Report - Node 1300B Jefferson Tributaries (Combined with Basin 1300A)

Region ID: MT
Workspace ID: MT20190225165812661000
Clicked Point (Latitude, Longitude): 45.76962, -112.18157
Time: 2019-02-25 09:58:27 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	42.6	square miles
EL6000	Percent of area above 6000 ft	69.2	percent
PRECIP	Mean Annual Precipitation	20.21	inches
FOREST	Percentage of area covered by forest	65.5	percent

Peak-Flow Statistics Parameters [97 Percent (41.2 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	42.6	square miles	0.42	2480
EL6000	Percent above 6000 ft	69.2	percent	0	100

Peak-Flow Statistics Parameters [3 Percent (1.39 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	42.6	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	20.21	inches	14.6	62.1
FOREST	Percent Forest	65.5	percent	20.4	99.1

Peak-Flow Statistics Flow Report [97 Percent (41.2 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	91	ft^3/s	19.6	422	118
2 Year Peak Flood	122	ft^3/s	32.5	459	96
2 33 Year Peak Flood	137	ft^3/s	38.8	487	90.1
5 Year Peak Flood	217	ft^3/s	71.4	660	76.9
10 Year Peak Flood	298	ft^3/s	104	856	72.1
25 Year Peak Flood	415	ft^3/s	146	1180	71.3
50 Year Peak Flood	509	ft^3/s	179	1450	72
100 Year Peak Flood	615	ft^3/s	211	1790	73.8
200 Year Peak Flood	725	ft^3/s	242	2170	76.5
500 Year Peak Flood	889	ft^3/s	284	2780	80.3

Peak-Flow Statistics Flow Report [3 Percent (1.39 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	73	ft^3/s	29.4	181	59.4
2 Year Peak Flood	100	ft^3/s	41.8	240	56.5
2 33 Year Peak Flood	114	ft^3/s	48.1	271	55.7
5 Year Peak Flood	184	ft^3/s	80	421	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	260	ft^3/s	114	592	52.8
25 Year Peak Flood	354	ft^3/s	155	809	53.2
50 Year Peak Flood	436	ft^3/s	188	1020	54.2
100 Year Peak Flood	526	ft^3/s	222	1250	56
200 Year Peak Flood	623	ft^3/s	255	1520	58
500 Year Peak Flood	746	ft^3/s	293	1900	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	90.4	ft^3/s	20	414
2 Year Peak Flood	121	ft^3/s	32.8	452
2 33 Year Peak Flood	137	ft^3/s	39.1	480
5 Year Peak Flood	216	ft^3/s	71.7	652
10 Year Peak Flood	297	ft^3/s	104	848
25 Year Peak Flood	413	ft^3/s	147	1170
50 Year Peak Flood	507	ft^3/s	179	1430
100 Year Peak Flood	612	ft^3/s	212	1770
200 Year Peak Flood	721	ft^3/s	242	2150
500 Year Peak Flood	884	ft^3/s	285	2750

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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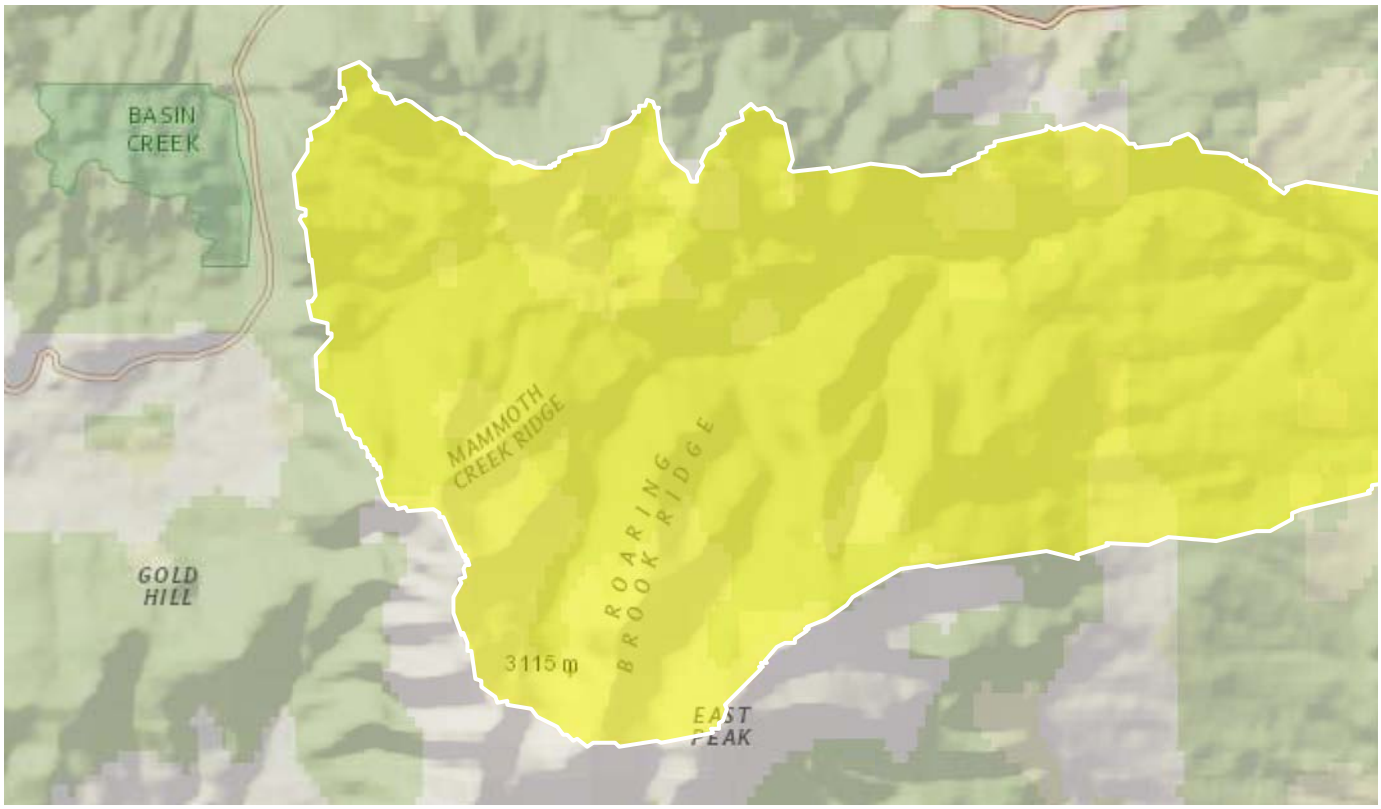
Application Version: 4.3.0

StreamStats Report - USGS Gage 06027700 Jefferson Tributaries

Region ID: MT
Workspace ID: MT20190225214022853000
Clicked Point (Latitude, Longitude): 45.77092, -112.25021
Time: 2019-02-25 14:40:37 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	39	square miles
EL6000	Percent of area above 6000 ft	75.7	percent
PRECIP	Mean Annual Precipitation	21.18	inches
FOREST	Percentage of area covered by forest	71.7	percent

Peak-Flow Statistics Parameters [96 Percent (37.6 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	39	square miles	0.42	2480
EL6000	Percent above 6000 ft	75.7	percent	0	100

Peak-Flow Statistics Parameters [4 Percent (1.4 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	39	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	21.18	inches	14.6	62.1
FOREST	Percent Forest	71.7	percent	20.4	99.1

Peak-Flow Statistics Flow Report [96 Percent (37.6 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	85	ft^3/s	18.3	395	118
2 Year Peak Flood	113	ft^3/s	30.2	427	96
2 33 Year Peak Flood	127	ft^3/s	35.9	452	90.1
5 Year Peak Flood	200	ft^3/s	65.7	608	76.9
10 Year Peak Flood	273	ft^3/s	95	787	72.1
25 Year Peak Flood	379	ft^3/s	133	1080	71.3
50 Year Peak Flood	464	ft^3/s	163	1320	72
100 Year Peak Flood	558	ft^3/s	192	1630	73.8
200 Year Peak Flood	656	ft^3/s	219	1970	76.5
500 Year Peak Flood	803	ft^3/s	256	2510	80.3

Peak-Flow Statistics Flow Report [4 Percent (1.4 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	69.8	ft^3/s	28.2	173	59.4
2 Year Peak Flood	95.1	ft^3/s	39.7	228	56.5
2 33 Year Peak Flood	108	ft^3/s	45.6	257	55.7
5 Year Peak Flood	172	ft^3/s	75	394	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	242	ft^3/s	106	550	52.8
25 Year Peak Flood	327	ft^3/s	143	745	53.2
50 Year Peak Flood	401	ft^3/s	172	931	54.2
100 Year Peak Flood	481	ft^3/s	203	1140	56
200 Year Peak Flood	567	ft^3/s	233	1380	58
500 Year Peak Flood	677	ft^3/s	266	1720	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	84.5	ft^3/s	18.7	387
2 Year Peak Flood	113	ft^3/s	30.5	420
2 33 Year Peak Flood	127	ft^3/s	36.3	445
5 Year Peak Flood	199	ft^3/s	66.1	601
10 Year Peak Flood	272	ft^3/s	95.4	778
25 Year Peak Flood	377	ft^3/s	134	1070
50 Year Peak Flood	461	ft^3/s	163	1310
100 Year Peak Flood	556	ft^3/s	192	1610
200 Year Peak Flood	653	ft^3/s	219	1950
500 Year Peak Flood	798	ft^3/s	257	2490

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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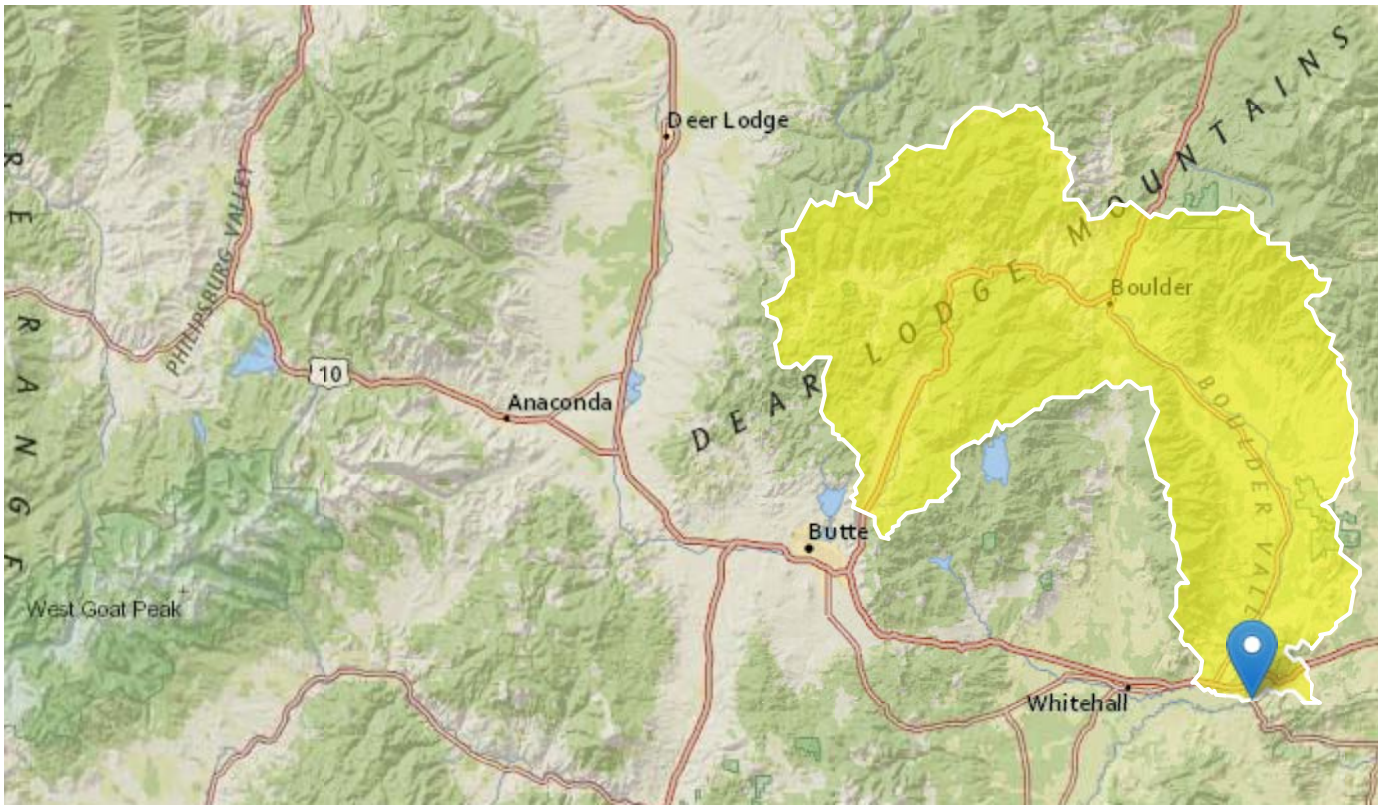
Application Version: 4.3.0

StreamStats Report - Node 100 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190211203011987000
Clicked Point (Latitude, Longitude): 45.85771, -111.92998
Time: 2019-02-11 13:30:27 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	769.3	square miles
EL6000	Percent of area above 6000 ft	57.2	percent
PRECIP	Mean Annual Precipitation	19.25	inches
FOREST	Percentage of area covered by forest	57.4	percent

Peak-Flow Statistics Parameters [97 Percent (744 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	769.3	square miles	0.42	2480
EL6000	Percent above 6000 ft	57.2	percent	0	100

Peak-Flow Statistics Parameters [3 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	769.3	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	19.25	inches	14.6	62.1
FOREST	Percent Forest	57.4	percent	20.4	99.1

Peak-Flow Statistics Flow Report [97 Percent (744 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1460	ft^3/s	304	6990	118
2 Year Peak Flood	1770	ft^3/s	458	6850	96
2 33 Year Peak Flood	1890	ft^3/s	520	6890	90.1
5 Year Peak Flood	2520	ft^3/s	811	7850	76.9
10 Year Peak Flood	3080	ft^3/s	1050	9050	72.1
25 Year Peak Flood	3830	ft^3/s	1320	11100	71.3
50 Year Peak Flood	4370	ft^3/s	1500	12700	72
100 Year Peak Flood	4960	ft^3/s	1670	14700	73.8
200 Year Peak Flood	5550	ft^3/s	1810	17000	76.5
500 Year Peak Flood	6380	ft^3/s	2000	20400	80.3

Peak-Flow Statistics Flow Report [3 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1110	ft^3/s	444	2760	59.4
2 Year Peak Flood	1440	ft^3/s	596	3450	56.5
2 33 Year Peak Flood	1600	ft^3/s	670	3810	55.7
5 Year Peak Flood	2370	ft^3/s	1030	5450	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	3160	ft^3/s	1380	7230	52.8
25 Year Peak Flood	4090	ft^3/s	1790	9370	53.2
50 Year Peak Flood	4880	ft^3/s	2090	11400	54.2
100 Year Peak Flood	5720	ft^3/s	2400	13600	56
200 Year Peak Flood	6610	ft^3/s	2700	16200	58
500 Year Peak Flood	7670	ft^3/s	3000	19600	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	1450	ft^3/s	308	6860
2 Year Peak Flood	1760	ft^3/s	462	6740
2 33 Year Peak Flood	1880	ft^3/s	525	6800
5 Year Peak Flood	2520	ft^3/s	818	7770
10 Year Peak Flood	3080	ft^3/s	1060	8990
25 Year Peak Flood	3840	ft^3/s	1340	11000
50 Year Peak Flood	4380	ft^3/s	1520	12600
100 Year Peak Flood	4980	ft^3/s	1690	14700
200 Year Peak Flood	5580	ft^3/s	1840	17000
500 Year Peak Flood	6430	ft^3/s	2030	20400

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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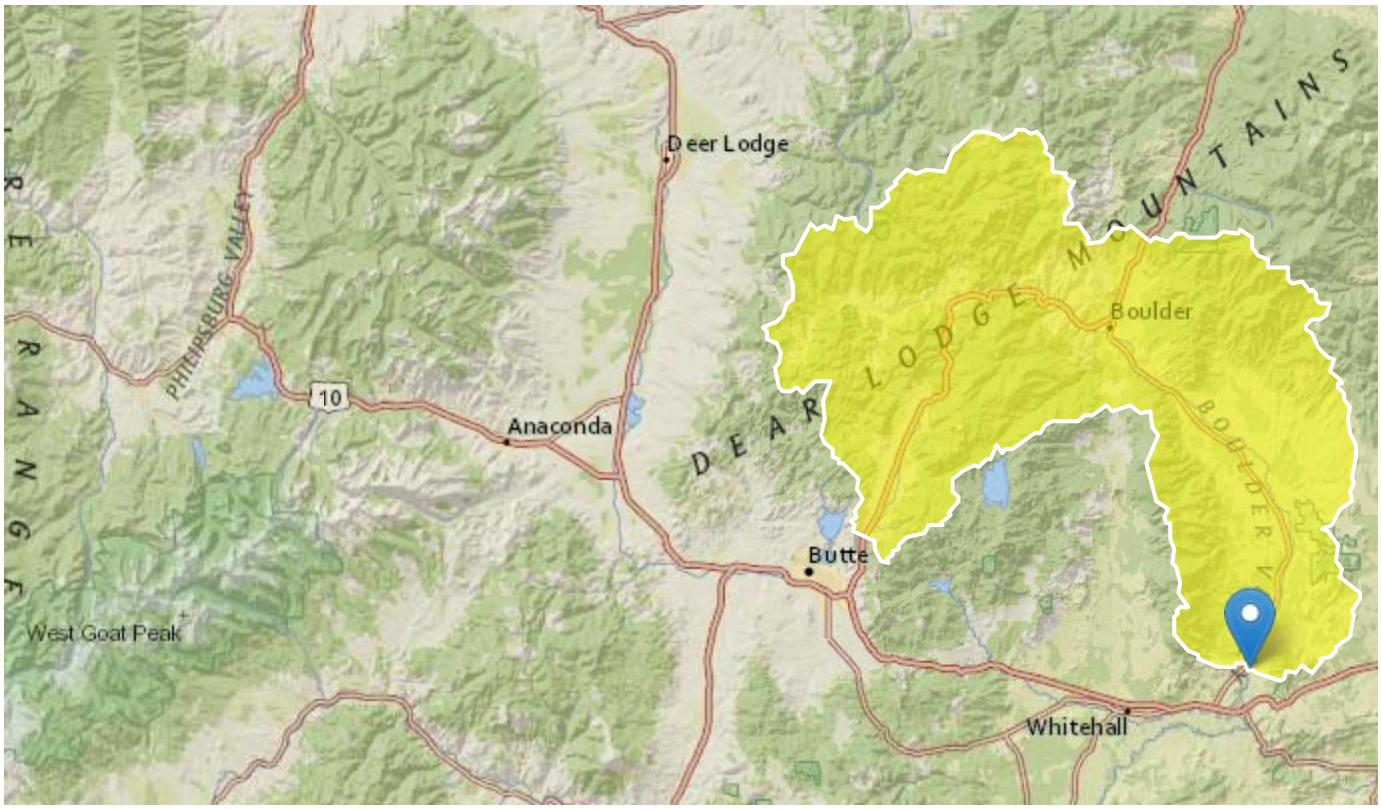
Application Version: 4.3.0

StreamStats Report - Node 200 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190402173511586000
Clicked Point (Latitude, Longitude): 45.91020, -111.93103
Time: 2019-04-02 11:35:26 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	744.8	square miles
EL6000	Percent of area above 6000 ft	58.9	percent
PRECIP	Mean Annual Precipitation	19.42	inches
FOREST	Percentage of area covered by forest	59.1	percent

Peak-Flow Statistics Parameters [97 Percent (720 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	744.8	square miles	0.42	2480
EL6000	Percent above 6000 ft	58.9	percent	0	100

Peak-Flow Statistics Parameters [3 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	744.8	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	19.42	inches	14.6	62.1
FOREST	Percent Forest	59.1	percent	20.4	99.1

Peak-Flow Statistics Flow Report [97 Percent (720 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1420	ft^3/s	296	6810	118
2 Year Peak Flood	1720	ft^3/s	446	6650	96
2 33 Year Peak Flood	1840	ft^3/s	506	6700	90.1
5 Year Peak Flood	2450	ft^3/s	788	7610	76.9
10 Year Peak Flood	2990	ft^3/s	1020	8770	72.1
25 Year Peak Flood	3710	ft^3/s	1280	10700	71.3
50 Year Peak Flood	4220	ft^3/s	1460	12200	72
100 Year Peak Flood	4790	ft^3/s	1620	14200	73.8
200 Year Peak Flood	5360	ft^3/s	1750	16400	76.5
500 Year Peak Flood	6160	ft^3/s	1930	19700	80.3

Peak-Flow Statistics Flow Report [3 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1070	ft^3/s	430	2660	59.4
2 Year Peak Flood	1390	ft^3/s	577	3340	56.5
2 33 Year Peak Flood	1540	ft^3/s	647	3680	55.7
5 Year Peak Flood	2280	ft^3/s	991	5250	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	3050	ft^3/s	1330	6950	52.8
25 Year Peak Flood	3930	ft^3/s	1720	9000	53.2
50 Year Peak Flood	4690	ft^3/s	2010	10900	54.2
100 Year Peak Flood	5490	ft^3/s	2310	13100	56
200 Year Peak Flood	6340	ft^3/s	2590	15500	58
500 Year Peak Flood	7360	ft^3/s	2880	18800	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	1410	ft^3/s	301	6670
2 Year Peak Flood	1710	ft^3/s	450	6540
2 33 Year Peak Flood	1830	ft^3/s	511	6600
5 Year Peak Flood	2440	ft^3/s	795	7530
10 Year Peak Flood	2990	ft^3/s	1030	8710
25 Year Peak Flood	3710	ft^3/s	1290	10700
50 Year Peak Flood	4240	ft^3/s	1480	12200
100 Year Peak Flood	4820	ft^3/s	1640	14200
200 Year Peak Flood	5390	ft^3/s	1780	16400
500 Year Peak Flood	6200	ft^3/s	1960	19600

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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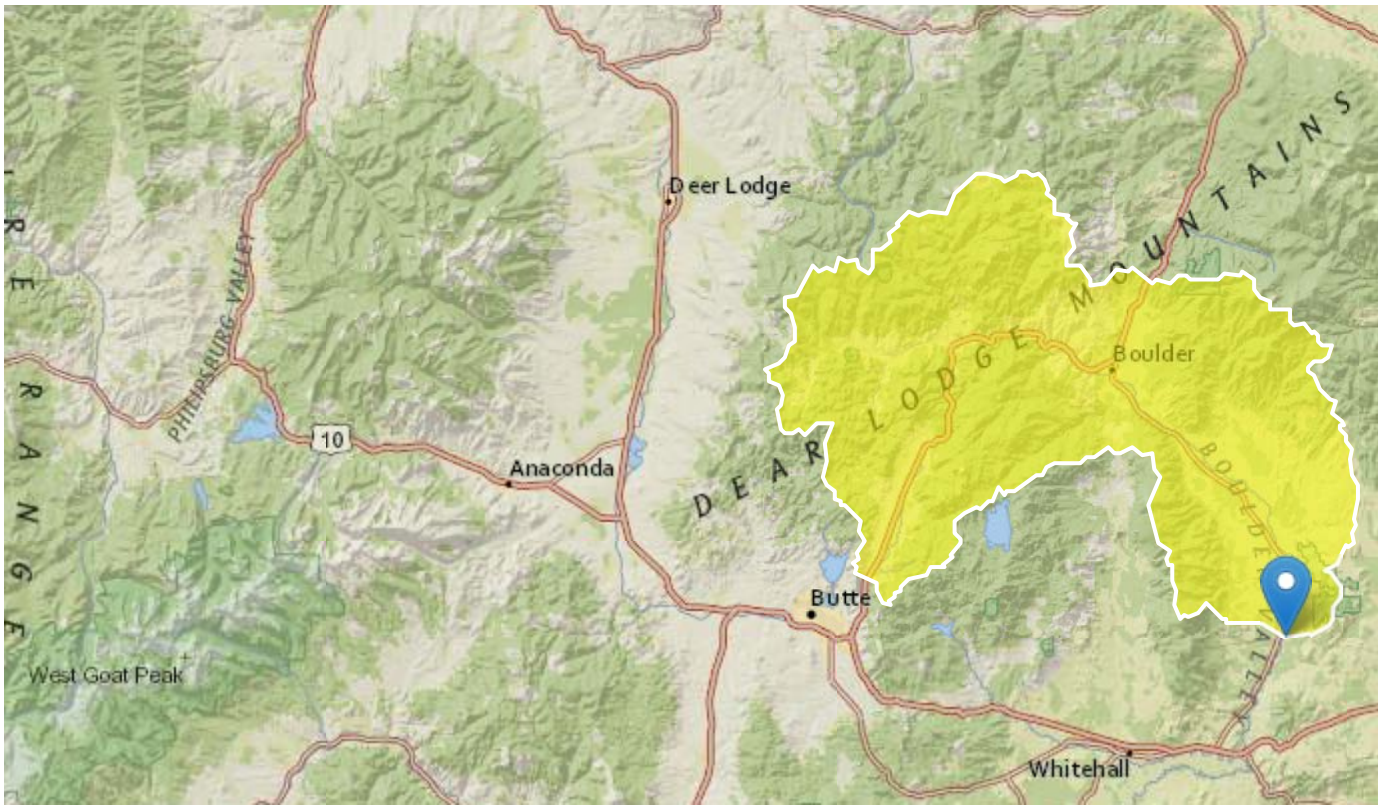
Application Version: 4.3.0

StreamStats Report - Node 300 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190226153532378000
Clicked Point (Latitude, Longitude): 45.98249, -111.88571
Time: 2019-02-26 08:35:47 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	681.6	square miles
EL6000	Percent of area above 6000 ft	63.1	percent
PRECIP	Mean Annual Precipitation	19.9	inches
FOREST	Percentage of area covered by forest	62.9	percent

Peak-Flow Statistics Parameters [96 Percent (656 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	681.6	square miles	0.42	2480
EL6000	Percent above 6000 ft	63.1	percent	0	100

Peak-Flow Statistics Parameters [4 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	681.6	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	19.9	inches	14.6	62.1
FOREST	Percent Forest	62.9	percent	20.4	99.1

Peak-Flow Statistics Flow Report [96 Percent (656 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1320	ft^3/s	276	6310	118
2 Year Peak Flood	1600	ft^3/s	414	6150	96
2 33 Year Peak Flood	1710	ft^3/s	470	6190	90.1
5 Year Peak Flood	2260	ft^3/s	728	7010	76.9
10 Year Peak Flood	2750	ft^3/s	939	8060	72.1
25 Year Peak Flood	3400	ft^3/s	1180	9840	71.3
50 Year Peak Flood	3870	ft^3/s	1340	11200	72
100 Year Peak Flood	4390	ft^3/s	1480	13000	73.8
200 Year Peak Flood	4900	ft^3/s	1610	15000	76.5
500 Year Peak Flood	5620	ft^3/s	1770	17900	80.3

Peak-Flow Statistics Flow Report [4 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	992	ft^3/s	399	2470	59.4
2 Year Peak Flood	1280	ft^3/s	534	3080	56.5
2 33 Year Peak Flood	1420	ft^3/s	599	3390	55.7
5 Year Peak Flood	2100	ft^3/s	912	4810	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	2790	ft^3/s	1220	6360	52.8
25 Year Peak Flood	3590	ft^3/s	1570	8200	53.2
50 Year Peak Flood	4270	ft^3/s	1840	9950	54.2
100 Year Peak Flood	5000	ft^3/s	2100	11900	56
200 Year Peak Flood	5760	ft^3/s	2360	14000	58
500 Year Peak Flood	6670	ft^3/s	2620	17000	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	1310	ft^3/s	281	6170
2 Year Peak Flood	1580	ft^3/s	418	6040
2 33 Year Peak Flood	1700	ft^3/s	475	6090
5 Year Peak Flood	2250	ft^3/s	735	6930
10 Year Peak Flood	2750	ft^3/s	950	7990
25 Year Peak Flood	3410	ft^3/s	1190	9780
50 Year Peak Flood	3890	ft^3/s	1360	11200
100 Year Peak Flood	4410	ft^3/s	1500	12900
200 Year Peak Flood	4930	ft^3/s	1630	14900
500 Year Peak Flood	5660	ft^3/s	1800	17900

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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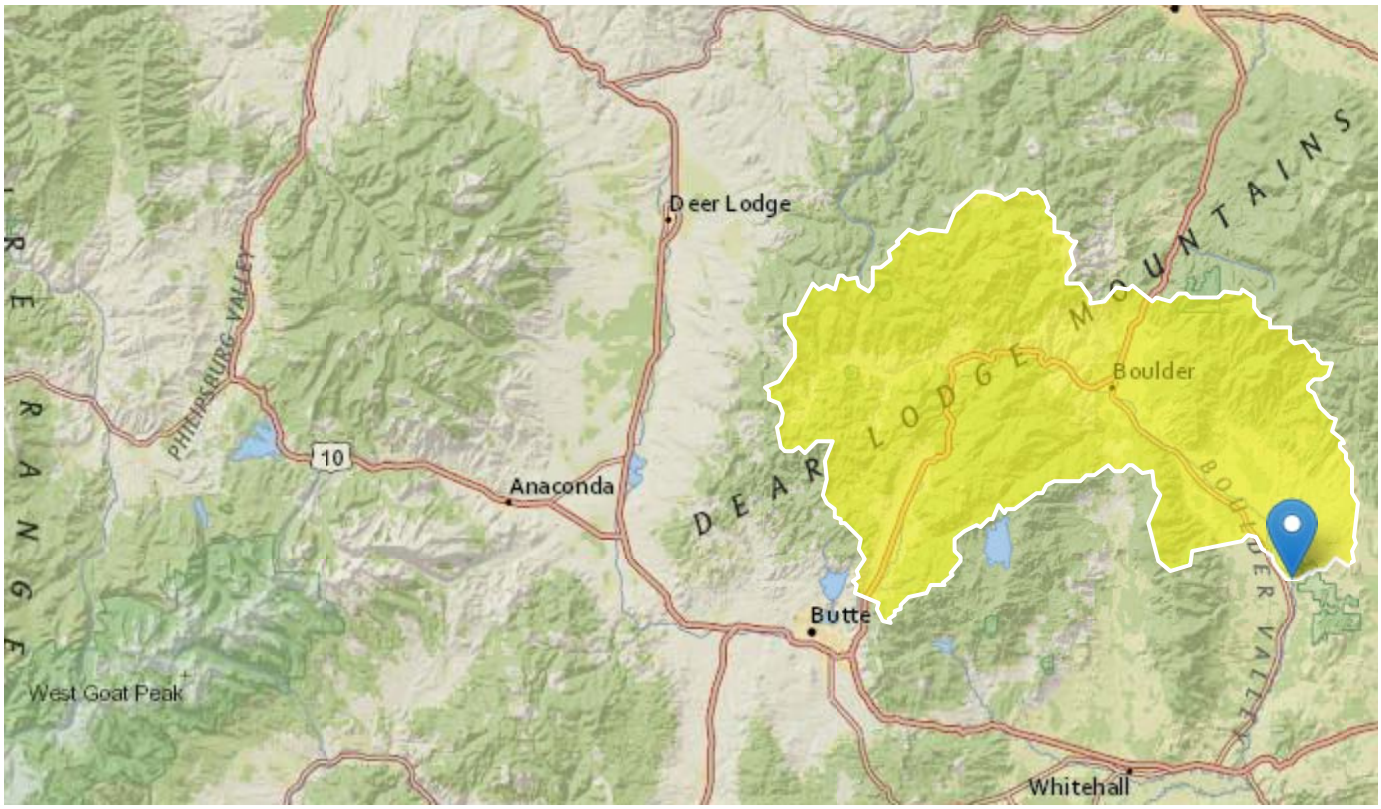
Application Version: 4.3.0

StreamStats Report - Node 400 Boulder Mainstem (Expanded to HUC-12 Boundary)

Region ID: MT
Workspace ID: MT20190325150720582000
Clicked Point (Latitude, Longitude): 46.05368, -111.87627
Time: 2019-03-25 09:07:35 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	621.8	square miles
EL6000	Percent of area above 6000 ft	67	percent
PRECIP	Mean Annual Precipitation	20.37	inches
FOREST	Percentage of area covered by forest	67.2	percent

Peak-Flow Statistics Parameters [96 Percent (597 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	621.8	square miles	0.42	2480
EL6000	Percent above 6000 ft	67	percent	0	100

Peak-Flow Statistics Parameters [4 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	621.8	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	20.37	inches	14.6	62.1
FOREST	Percent Forest	67.2	percent	20.4	99.1

Peak-Flow Statistics Flow Report [96 Percent (597 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1220	ft^3/s	256	5830	118
2 Year Peak Flood	1470	ft^3/s	383	5670	96
2 33 Year Peak Flood	1570	ft^3/s	434	5700	90.1
5 Year Peak Flood	2080	ft^3/s	672	6440	76.9
10 Year Peak Flood	2530	ft^3/s	866	7400	72.1
25 Year Peak Flood	3130	ft^3/s	1080	9020	71.3
50 Year Peak Flood	3550	ft^3/s	1230	10300	72
100 Year Peak Flood	4020	ft^3/s	1360	11900	73.8
200 Year Peak Flood	4490	ft^3/s	1470	13700	76.5
500 Year Peak Flood	5140	ft^3/s	1620	16300	80.3

Peak-Flow Statistics Flow Report [4 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	912	ft^3/s	367	2260	59.4
2 Year Peak Flood	1170	ft^3/s	490	2820	56.5
2 33 Year Peak Flood	1300	ft^3/s	549	3100	55.7
5 Year Peak Flood	1910	ft^3/s	832	4380	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	2540	ft^3/s	1110	5770	52.8
25 Year Peak Flood	3250	ft^3/s	1430	7420	53.2
50 Year Peak Flood	3870	ft^3/s	1660	8990	54.2
100 Year Peak Flood	4510	ft^3/s	1900	10700	56
200 Year Peak Flood	5190	ft^3/s	2130	12600	58
500 Year Peak Flood	6000	ft^3/s	2360	15300	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	1210	ft^3/s	261	5680
2 Year Peak Flood	1460	ft^3/s	387	5560
2 33 Year Peak Flood	1560	ft^3/s	439	5590
5 Year Peak Flood	2070	ft^3/s	678	6360
10 Year Peak Flood	2530	ft^3/s	876	7330
25 Year Peak Flood	3130	ft^3/s	1100	8950
50 Year Peak Flood	3570	ft^3/s	1250	10200
100 Year Peak Flood	4040	ft^3/s	1380	11800
200 Year Peak Flood	4520	ft^3/s	1500	13600
500 Year Peak Flood	5180	ft^3/s	1650	16300

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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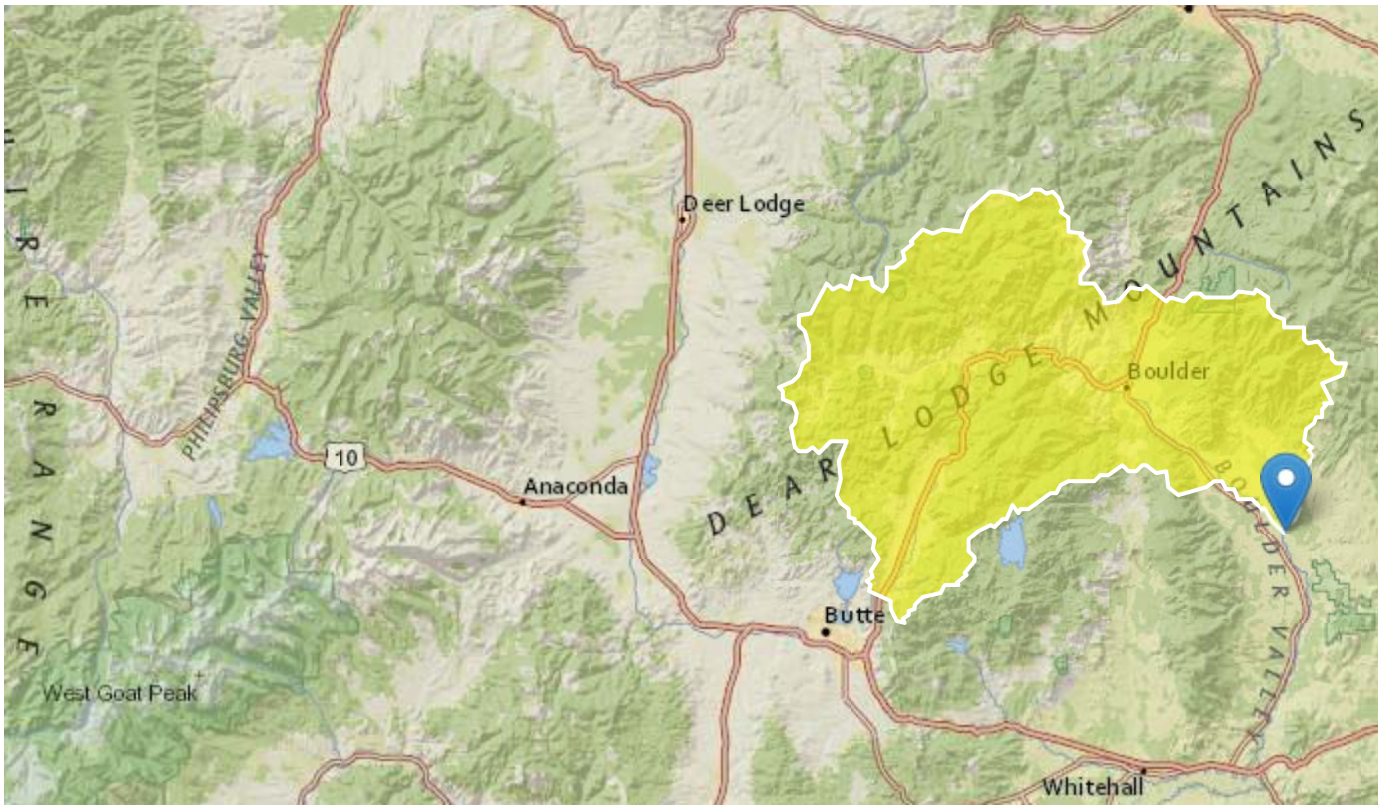
Application Version: 4.3.0

StreamStats Report - Node 500 Boulder Mainstem (Expanded to HUC-12 Boundary)

Region ID: MT
Workspace ID: MT20190226154829517000
Clicked Point (Latitude, Longitude): 46.09892, -111.90491
Time: 2019-02-26 08:48:44 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	550.5	square miles
EL6000	Percent of area above 6000 ft	72.8	percent
PRECIP	Mean Annual Precipitation	21.04	inches
FOREST	Percentage of area covered by forest	73	percent

Peak-Flow Statistics Parameters [95 Percent (525 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	550.5	square miles	0.42	2480
EL6000	Percent above 6000 ft	72.8	percent	0	100

Peak-Flow Statistics Parameters [5 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	550.5	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	21.04	inches	14.6	62.1
FOREST	Percent Forest	73	percent	20.4	99.1

Peak-Flow Statistics Flow Report [95 Percent (525 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1100	ft^3/s	232	5240	118
2 Year Peak Flood	1330	ft^3/s	346	5090	96
2 33 Year Peak Flood	1410	ft^3/s	392	5110	90.1
5 Year Peak Flood	1860	ft^3/s	604	5760	76.9
10 Year Peak Flood	2260	ft^3/s	776	6600	72.1
25 Year Peak Flood	2790	ft^3/s	970	8030	71.3
50 Year Peak Flood	3170	ft^3/s	1100	9120	72
100 Year Peak Flood	3580	ft^3/s	1210	10500	73.8
200 Year Peak Flood	3990	ft^3/s	1310	12100	76.5
500 Year Peak Flood	4560	ft^3/s	1440	14500	80.3

Peak-Flow Statistics Flow Report [5 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	822	ft^3/s	331	2040	59.4
2 Year Peak Flood	1050	ft^3/s	440	2530	56.5
2 33 Year Peak Flood	1170	ft^3/s	492	2770	55.7
5 Year Peak Flood	1700	ft^3/s	741	3900	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	2250	ft^3/s	989	5120	52.8
25 Year Peak Flood	2870	ft^3/s	1260	6550	53.2
50 Year Peak Flood	3410	ft^3/s	1470	7910	54.2
100 Year Peak Flood	3960	ft^3/s	1670	9380	56
200 Year Peak Flood	4550	ft^3/s	1870	11100	58
500 Year Peak Flood	5250	ft^3/s	2070	13300	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	1090	ft^3/s	236	5100
2 Year Peak Flood	1310	ft^3/s	350	4970
2 33 Year Peak Flood	1400	ft^3/s	396	5000
5 Year Peak Flood	1860	ft^3/s	610	5670
10 Year Peak Flood	2260	ft^3/s	786	6540
25 Year Peak Flood	2790	ft^3/s	983	7960
50 Year Peak Flood	3180	ft^3/s	1120	9070
100 Year Peak Flood	3600	ft^3/s	1240	10500
200 Year Peak Flood	4010	ft^3/s	1340	12100
500 Year Peak Flood	4590	ft^3/s	1470	14400

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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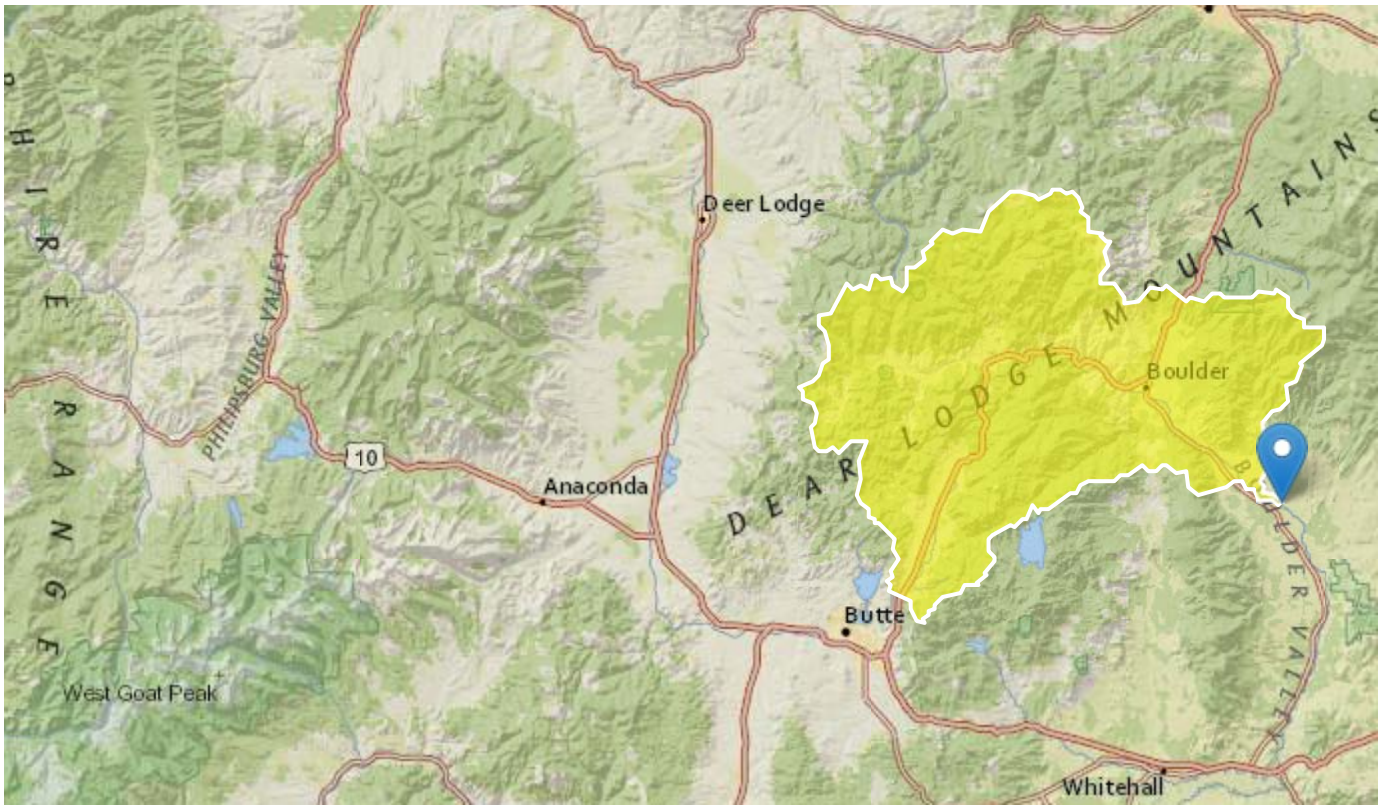
Application Version: 4.3.0

StreamStats Report - Node 600A Boulder Mainstem (Combined with Basins 600B and 600C)

Region ID: MT
Workspace ID: MT20190220002008263000
Clicked Point (Latitude, Longitude): 46.12653, -111.93611
Time: 2019-02-19 17:20:23 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	507.3	square miles
EL6000	Percent of area above 6000 ft	76	percent
PRECIP	Mean Annual Precipitation	21.41	inches
FOREST	Percentage of area covered by forest	76.2	percent

Peak-Flow Statistics Parameters [95 Percent (482 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	507.3	square miles	0.42	2480
EL6000	Percent above 6000 ft	76	percent	0	100

Peak-Flow Statistics Parameters [5 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	507.3	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	21.41	inches	14.6	62.1
FOREST	Percent Forest	76.2	percent	20.4	99.1

Peak-Flow Statistics Flow Report [95 Percent (482 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	1030	ft^3/s	217	4870	118
2 Year Peak Flood	1230	ft^3/s	322	4730	96
2 33 Year Peak Flood	1320	ft^3/s	365	4750	90.1
5 Year Peak Flood	1730	ft^3/s	562	5350	76.9
10 Year Peak Flood	2110	ft^3/s	723	6130	72.1
25 Year Peak Flood	2590	ft^3/s	903	7450	71.3
50 Year Peak Flood	2940	ft^3/s	1020	8470	72
100 Year Peak Flood	3330	ft^3/s	1130	9780	73.8
200 Year Peak Flood	3700	ft^3/s	1220	11200	76.5
500 Year Peak Flood	4230	ft^3/s	1340	13400	80.3

Peak-Flow Statistics Flow Report [5 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	766	ft^3/s	309	1900	59.4
2 Year Peak Flood	981	ft^3/s	409	2350	56.5
2 33 Year Peak Flood	1090	ft^3/s	457	2580	55.7
5 Year Peak Flood	1580	ft^3/s	687	3610	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	2080	ft^3/s	916	4740	52.8
25 Year Peak Flood	2660	ft^3/s	1170	6050	53.2
50 Year Peak Flood	3140	ft^3/s	1350	7300	54.2
100 Year Peak Flood	3660	ft^3/s	1540	8650	56
200 Year Peak Flood	4190	ft^3/s	1720	10200	58
500 Year Peak Flood	4830	ft^3/s	1900	12300	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	1010	ft^3/s	221	4730
2 Year Peak Flood	1220	ft^3/s	326	4610
2 33 Year Peak Flood	1300	ft^3/s	369	4640
5 Year Peak Flood	1730	ft^3/s	568	5260
10 Year Peak Flood	2100	ft^3/s	732	6060
25 Year Peak Flood	2600	ft^3/s	916	7390
50 Year Peak Flood	2950	ft^3/s	1040	8410
100 Year Peak Flood	3340	ft^3/s	1150	9730
200 Year Peak Flood	3730	ft^3/s	1250	11200
500 Year Peak Flood	4260	ft^3/s	1370	13300

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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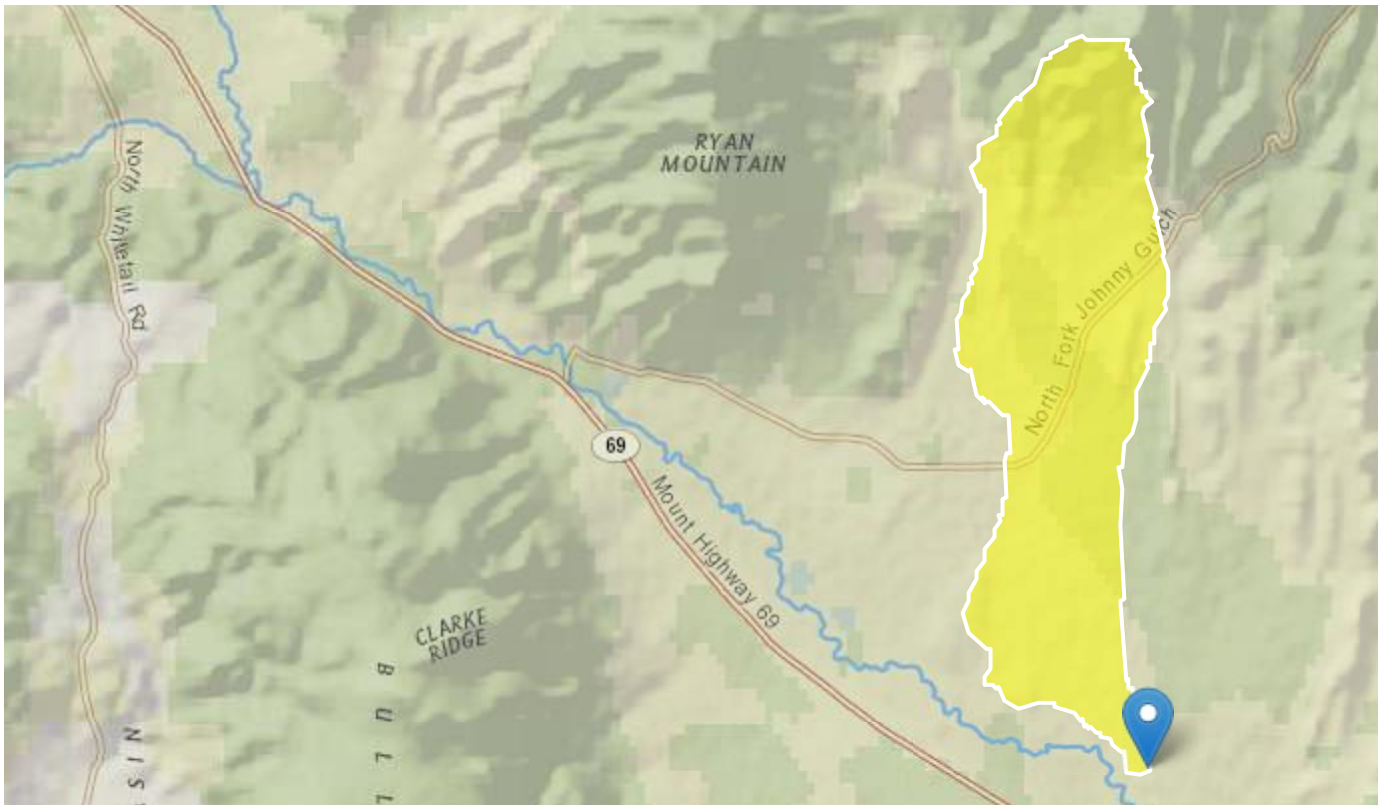
Application Version: 4.3.0

StreamStats Report - Node 600B Boulder Mainstem (Combined with Basins 600A and 600C)

Region ID: MT
Workspace ID: MT20190220002422734000
Clicked Point (Latitude, Longitude): 46.12861, -111.93249
Time: 2019-02-19 17:24:37 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	6.9	square miles
EL6000	Percent of area above 6000 ft	0.5	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	6.9	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	0.5	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	7.34	ft^3/s	1.49	36.2	118
2 Year Peak Flood	15.6	ft^3/s	3.92	62	96
2 33 Year Peak Flood	21.4	ft^3/s	5.71	80.2	90.1
5 Year Peak Flood	65.8	ft^3/s	20.4	212	76.9
10 Year Peak Flood	138	ft^3/s	45	424	72.1
25 Year Peak Flood	304	ft^3/s	99.4	930	71.3
50 Year Peak Flood	499	ft^3/s	162	1540	72
100 Year Peak Flood	779	ft^3/s	245	2470	73.8
200 Year Peak Flood	1160	ft^3/s	353	3820	76.5
500 Year Peak Flood	1870	ft^3/s	541	6480	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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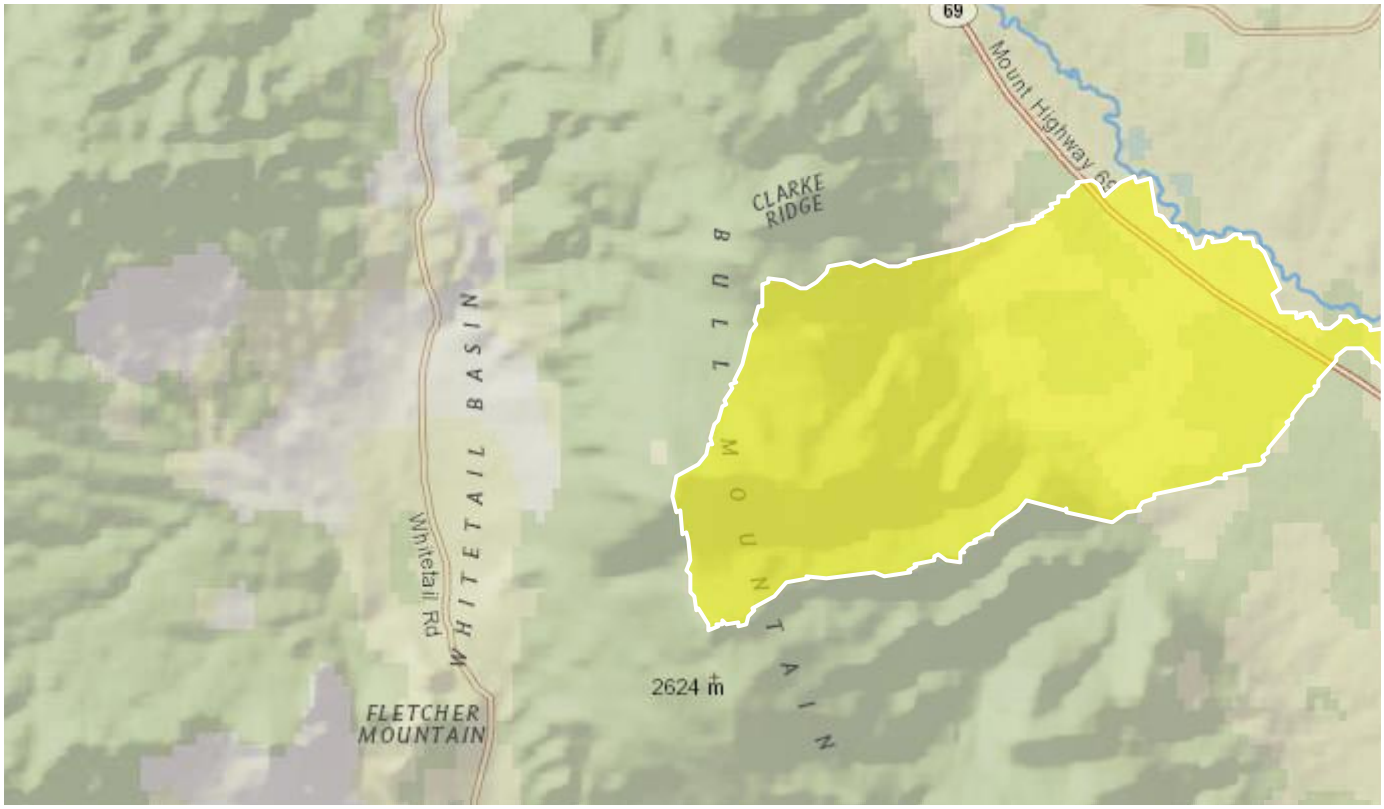
Application Version: 4.3.0

StreamStats Report - Node 600C Boulder Mainstem (Combined with Basins 600A and 600B)

Region ID: MT
Workspace ID: MT20190506161746546000
Clicked Point (Latitude, Longitude): 46.12201, -111.93993
Time: 2019-05-06 10:18:03 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	12	square miles
EL6000	Percent of area above 6000 ft	40.3	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	12	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	40.3	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	24	ft^3/s	5.11	113	118
2 Year Peak Flood	35.8	ft^3/s	9.4	136	96
2 33 Year Peak Flood	42.2	ft^3/s	11.8	151	90.1
5 Year Peak Flood	78.3	ft^3/s	25.4	241	76.9
10 Year Peak Flood	119	ft^3/s	40.9	348	72.1
25 Year Peak Flood	186	ft^3/s	64.4	535	71.3
50 Year Peak Flood	244	ft^3/s	84.4	705	72
100 Year Peak Flood	313	ft^3/s	106	927	73.8
200 Year Peak Flood	390	ft^3/s	128	1190	76.5
500 Year Peak Flood	509	ft^3/s	160	1630	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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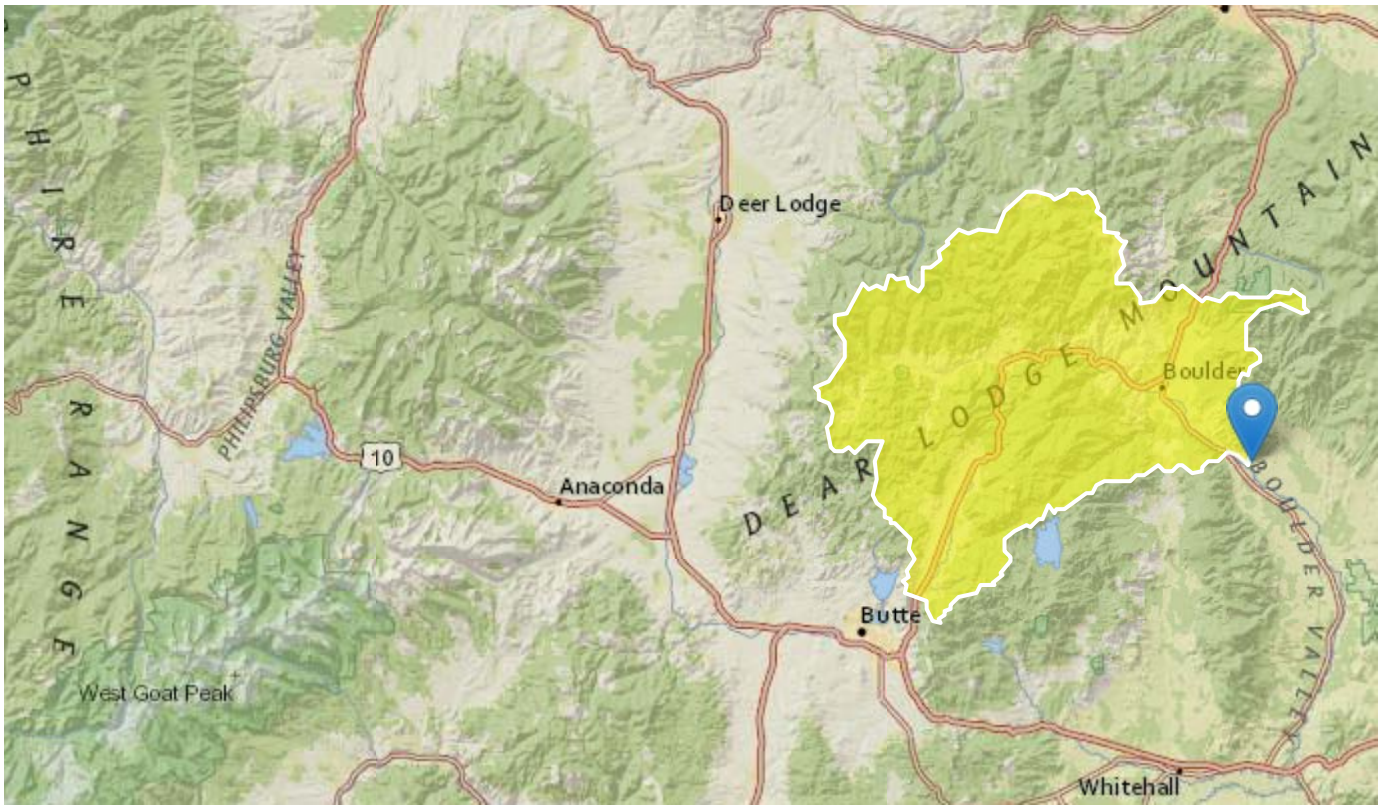
Application Version: 4.3.0

StreamStats Report - Node 700 Boulder Mainstem (Expanded to HUC-12 Boundary)

Region ID: MT
Workspace ID: MT20190226155943108000
Clicked Point (Latitude, Longitude): 46.16442, -112.00053
Time: 2019-02-26 08:59:57 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	458.7	square miles
EL6000	Percent of area above 6000 ft	77.6	percent
PRECIP	Mean Annual Precipitation	21.53	inches
FOREST	Percentage of area covered by forest	77.6	percent

Peak-Flow Statistics Parameters [95 Percent (434 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	458.7	square miles	0.42	2480
EL6000	Percent above 6000 ft	77.6	percent	0	100

Peak-Flow Statistics Parameters [5 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	458.7	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	21.53	inches	14.6	62.1
FOREST	Percent Forest	77.6	percent	20.4	99.1

Peak-Flow Statistics Flow Report [95 Percent (434 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	935	ft^3/s	198	4430	118
2 Year Peak Flood	1130	ft^3/s	294	4300	96
2 33 Year Peak Flood	1200	ft^3/s	334	4330	90.1
5 Year Peak Flood	1590	ft^3/s	516	4890	76.9
10 Year Peak Flood	1940	ft^3/s	666	5630	72.1
25 Year Peak Flood	2390	ft^3/s	834	6860	71.3
50 Year Peak Flood	2720	ft^3/s	947	7810	72
100 Year Peak Flood	3080	ft^3/s	1050	9030	73.8
200 Year Peak Flood	3430	ft^3/s	1130	10400	76.5
500 Year Peak Flood	3930	ft^3/s	1240	12400	80.3

Peak-Flow Statistics Flow Report [5 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	696	ft^3/s	280	1730	59.4
2 Year Peak Flood	892	ft^3/s	372	2140	56.5
2 33 Year Peak Flood	988	ft^3/s	416	2350	55.7
5 Year Peak Flood	1440	ft^3/s	626	3290	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	1900	ft^3/s	835	4320	52.8
25 Year Peak Flood	2420	ft^3/s	1060	5520	53.2
50 Year Peak Flood	2870	ft^3/s	1240	6670	54.2
100 Year Peak Flood	3340	ft^3/s	1410	7900	56
200 Year Peak Flood	3830	ft^3/s	1580	9320	58
500 Year Peak Flood	4420	ft^3/s	1740	11200	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	922	ft^3/s	202	4280
2 Year Peak Flood	1110	ft^3/s	299	4190
2 33 Year Peak Flood	1190	ft^3/s	338	4220
5 Year Peak Flood	1580	ft^3/s	522	4810
10 Year Peak Flood	1930	ft^3/s	675	5560
25 Year Peak Flood	2390	ft^3/s	846	6790
50 Year Peak Flood	2730	ft^3/s	963	7750
100 Year Peak Flood	3090	ft^3/s	1070	8970
200 Year Peak Flood	3450	ft^3/s	1160	10300
500 Year Peak Flood	3950	ft^3/s	1270	12300

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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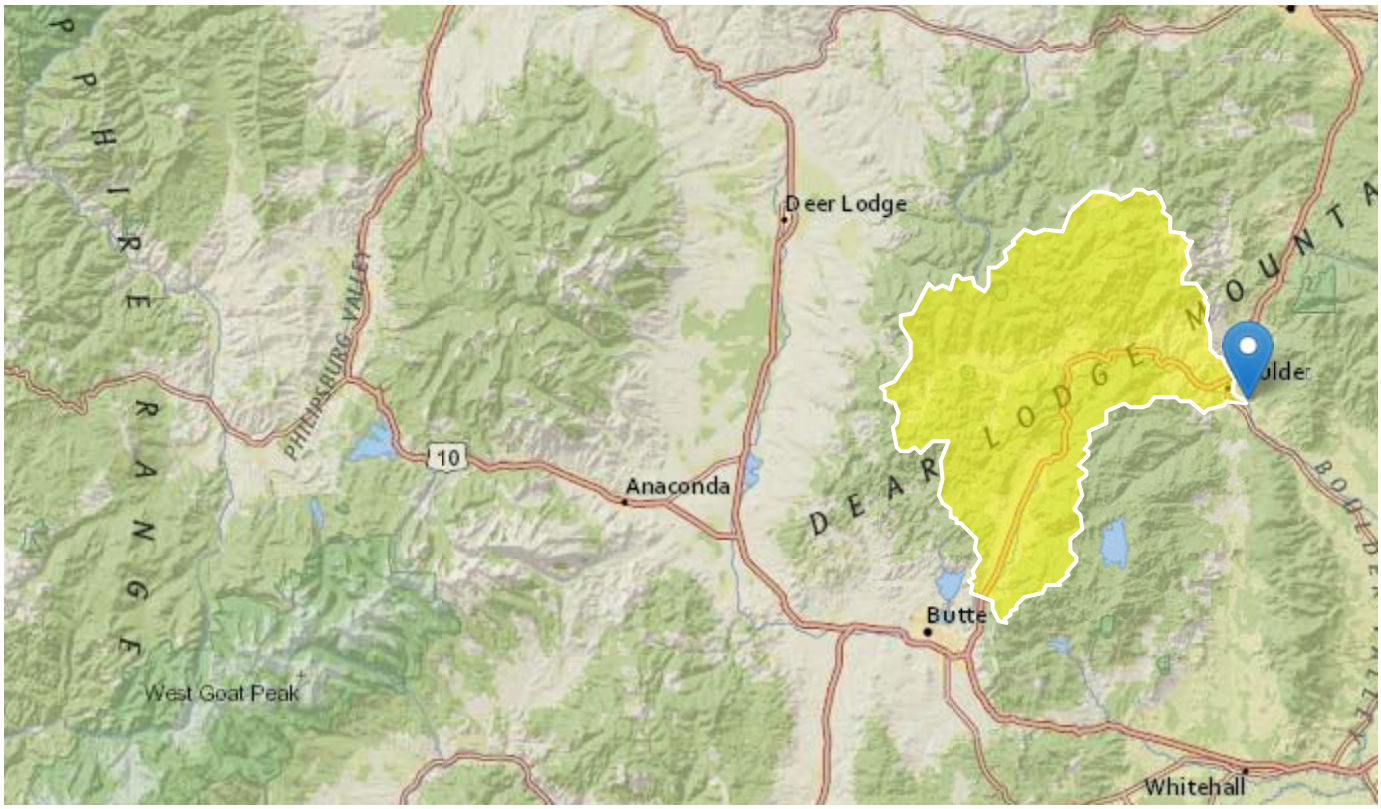
Application Version: 4.3.0

StreamStats Report - Node 800 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190410151244506000
Clicked Point (Latitude, Longitude): 46.22283, -112.09744
Time: 2019-04-10 09:12:59 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	333.9	square miles
EL6000	Percent of area above 6000 ft	88.8	percent
PRECIP	Mean Annual Precipitation	22.86	inches
FOREST	Percentage of area covered by forest	81	percent

Peak-Flow Statistics Parameters [93 Percent (309 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	333.9	square miles	0.42	2480
EL6000	Percent above 6000 ft	88.8	percent	0	100

Peak-Flow Statistics Parameters [7 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	333.9	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	22.86	inches	14.6	62.1
FOREST	Percent Forest	81	percent	20.4	99.1

Peak-Flow Statistics Flow Report [93 Percent (309 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	705	ft^3/s	150	3320	118
2 Year Peak Flood	849	ft^3/s	223	3230	96
2 33 Year Peak Flood	907	ft^3/s	253	3250	90.1
5 Year Peak Flood	1200	ft^3/s	392	3690	76.9
10 Year Peak Flood	1470	ft^3/s	507	4250	72.1
25 Year Peak Flood	1820	ft^3/s	636	5190	71.3
50 Year Peak Flood	2070	ft^3/s	723	5920	72
100 Year Peak Flood	2340	ft^3/s	800	6850	73.8
200 Year Peak Flood	2610	ft^3/s	866	7860	76.5
500 Year Peak Flood	2990	ft^3/s	950	9400	80.3

Peak-Flow Statistics Flow Report [7 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	576	ft^3/s	233	1430	59.4
2 Year Peak Flood	735	ft^3/s	307	1760	56.5
2 33 Year Peak Flood	813	ft^3/s	343	1930	55.7
5 Year Peak Flood	1170	ft^3/s	513	2690	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	1550	ft^3/s	682	3510	52.8
25 Year Peak Flood	1970	ft^3/s	865	4470	53.2
50 Year Peak Flood	2320	ft^3/s	1000	5380	54.2
100 Year Peak Flood	2690	ft^3/s	1140	6360	56
200 Year Peak Flood	3080	ft^3/s	1270	7480	58
500 Year Peak Flood	3550	ft^3/s	1400	8980	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	696	ft^3/s	156	3180
2 Year Peak Flood	840	ft^3/s	229	3120
2 33 Year Peak Flood	900	ft^3/s	260	3150
5 Year Peak Flood	1200	ft^3/s	401	3610
10 Year Peak Flood	1470	ft^3/s	520	4200
25 Year Peak Flood	1830	ft^3/s	653	5140
50 Year Peak Flood	2090	ft^3/s	744	5880
100 Year Peak Flood	2370	ft^3/s	825	6810
200 Year Peak Flood	2640	ft^3/s	896	7830
500 Year Peak Flood	3030	ft^3/s	984	9370

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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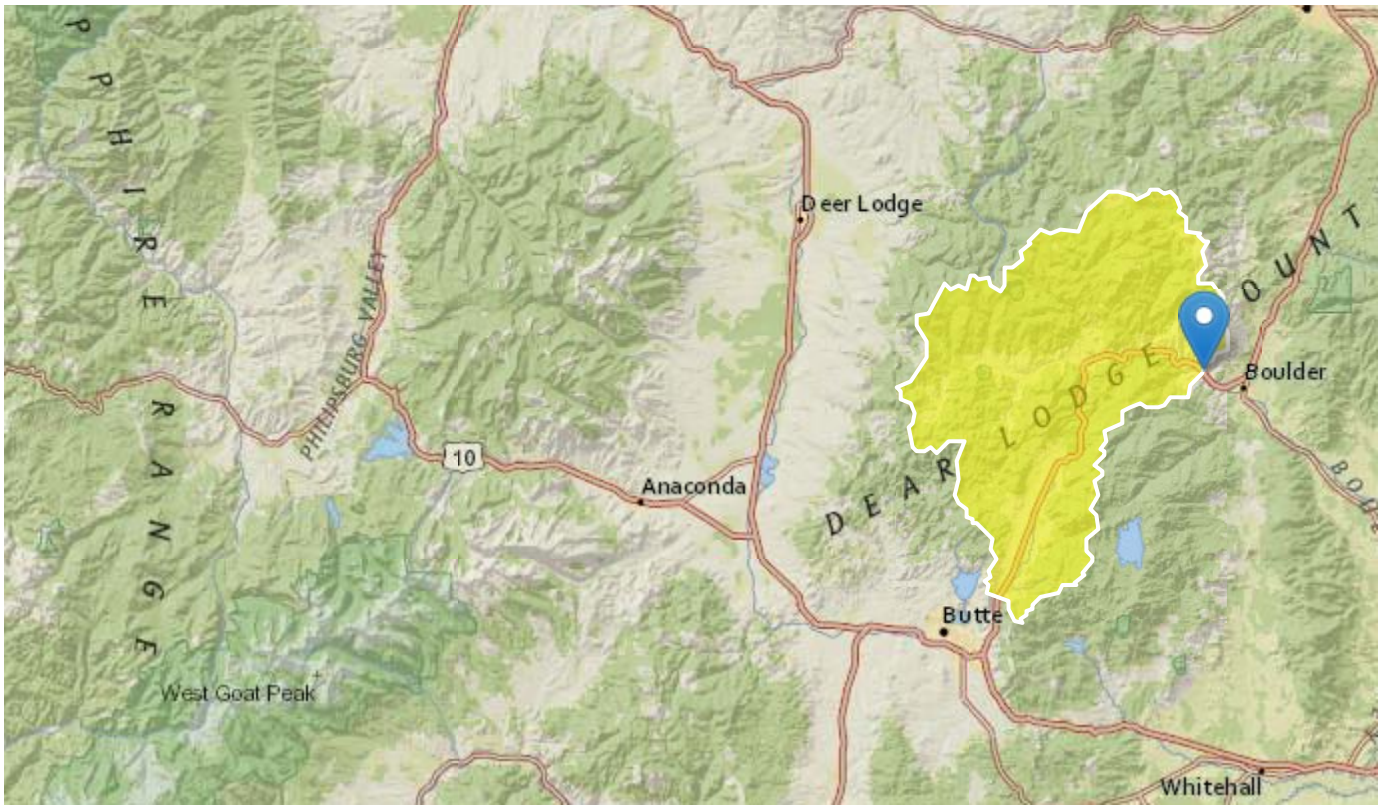
Application Version: 4.3.0

StreamStats Report - Node 900 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190325191659621000
Clicked Point (Latitude, Longitude): 46.25235, -112.17923
Time: 2019-03-25 13:17:16 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	322.9	square miles
EL6000	Percent of area above 6000 ft	91.6	percent
PRECIP	Mean Annual Precipitation	23.17	inches
FOREST	Percentage of area covered by forest	82.5	percent

Peak-Flow Statistics Parameters [92 Percent (298 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	322.9	square miles	0.42	2480
EL6000	Percent above 6000 ft	91.6	percent	0	100

Peak-Flow Statistics Parameters [8 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	322.9	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	23.17	inches	14.6	62.1
FOREST	Percent Forest	82.5	percent	20.4	99.1

Peak-Flow Statistics Flow Report [92 Percent (298 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	687	ft^3/s	146	3230	118
2 Year Peak Flood	825	ft^3/s	217	3140	96
2 33 Year Peak Flood	881	ft^3/s	246	3160	90.1
5 Year Peak Flood	1170	ft^3/s	380	3570	76.9
10 Year Peak Flood	1420	ft^3/s	491	4120	72.1
25 Year Peak Flood	1760	ft^3/s	615	5020	71.3
50 Year Peak Flood	2000	ft^3/s	698	5710	72
100 Year Peak Flood	2260	ft^3/s	772	6610	73.8
200 Year Peak Flood	2520	ft^3/s	835	7580	76.5
500 Year Peak Flood	2880	ft^3/s	916	9060	80.3

Peak-Flow Statistics Flow Report [8 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	568	ft^3/s	229	1410	59.4
2 Year Peak Flood	723	ft^3/s	302	1730	56.5
2 33 Year Peak Flood	799	ft^3/s	337	1890	55.7
5 Year Peak Flood	1150	ft^3/s	503	2630	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	1510	ft^3/s	667	3440	52.8
25 Year Peak Flood	1920	ft^3/s	845	4360	53.2
50 Year Peak Flood	2270	ft^3/s	978	5250	54.2
100 Year Peak Flood	2630	ft^3/s	1110	6200	56
200 Year Peak Flood	3000	ft^3/s	1240	7280	58
500 Year Peak Flood	3450	ft^3/s	1360	8730	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	678	ft^3/s	152	3090
2 Year Peak Flood	817	ft^3/s	223	3030
2 33 Year Peak Flood	875	ft^3/s	253	3060
5 Year Peak Flood	1160	ft^3/s	390	3500
10 Year Peak Flood	1430	ft^3/s	504	4070
25 Year Peak Flood	1770	ft^3/s	633	4970
50 Year Peak Flood	2020	ft^3/s	720	5680
100 Year Peak Flood	2290	ft^3/s	798	6580
200 Year Peak Flood	2550	ft^3/s	866	7560
500 Year Peak Flood	2920	ft^3/s	950	9030

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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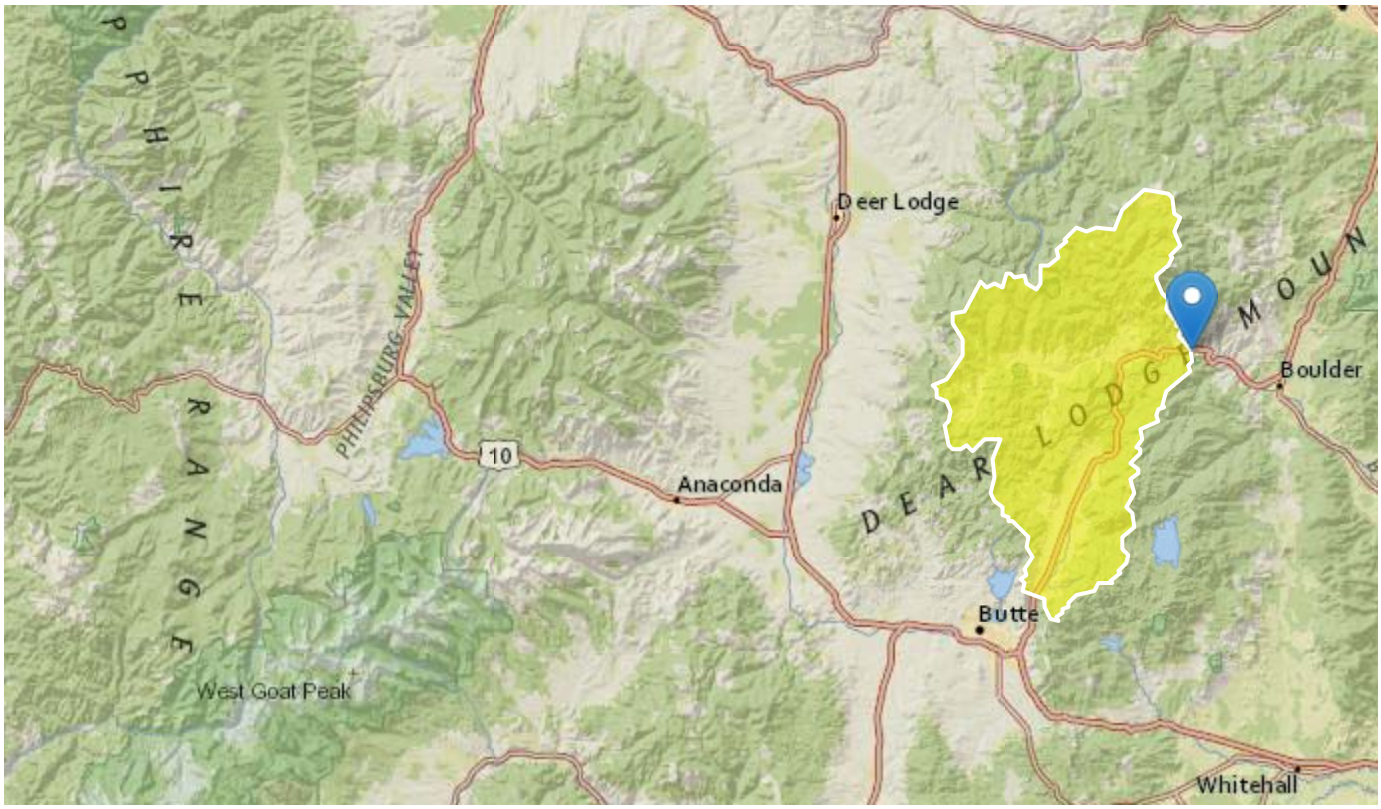
Application Version: 4.3.0

StreamStats Report - Node 1000 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190226162721201000
Clicked Point (Latitude, Longitude): 46.26975, -112.24459
Time: 2019-02-26 09:27:36 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	263.2	square miles
EL6000	Percent of area above 6000 ft	93.5	percent
PRECIP	Mean Annual Precipitation	23.09	inches
FOREST	Percentage of area covered by forest	82.7	percent

Peak-Flow Statistics Parameters [91 Percent (238 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	263.2	square miles	0.42	2480
EL6000	Percent above 6000 ft	93.5	percent	0	100

Peak-Flow Statistics Parameters [9 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	263.2	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	23.09	inches	14.6	62.1
FOREST	Percent Forest	82.7	percent	20.4	99.1

Peak-Flow Statistics Flow Report [91 Percent (238 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	565	ft^3/s	120	2650	118
2 Year Peak Flood	683	ft^3/s	180	2590	96
2 33 Year Peak Flood	732	ft^3/s	205	2620	90.1
5 Year Peak Flood	980	ft^3/s	320	3000	76.9
10 Year Peak Flood	1200	ft^3/s	417	3480	72.1
25 Year Peak Flood	1500	ft^3/s	526	4280	71.3
50 Year Peak Flood	1710	ft^3/s	600	4890	72
100 Year Peak Flood	1940	ft^3/s	666	5680	73.8
200 Year Peak Flood	2170	ft^3/s	722	6530	76.5
500 Year Peak Flood	2500	ft^3/s	796	7830	80.3

Peak-Flow Statistics Flow Report [9 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	464	ft^3/s	187	1150	59.4
2 Year Peak Flood	593	ft^3/s	248	1420	56.5
2 33 Year Peak Flood	657	ft^3/s	277	1560	55.7
5 Year Peak Flood	953	ft^3/s	417	2180	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	1260	ft^3/s	556	2860	52.8
25 Year Peak Flood	1610	ft^3/s	708	3650	53.2
50 Year Peak Flood	1900	ft^3/s	822	4410	54.2
100 Year Peak Flood	2210	ft^3/s	937	5220	56
200 Year Peak Flood	2540	ft^3/s	1050	6150	58
500 Year Peak Flood	2920	ft^3/s	1150	7400	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	556	ft^3/s	127	2510
2 Year Peak Flood	675	ft^3/s	187	2480
2 33 Year Peak Flood	725	ft^3/s	212	2520
5 Year Peak Flood	977	ft^3/s	329	2920
10 Year Peak Flood	1210	ft^3/s	430	3420
25 Year Peak Flood	1510	ft^3/s	543	4220
50 Year Peak Flood	1730	ft^3/s	621	4840
100 Year Peak Flood	1970	ft^3/s	691	5630
200 Year Peak Flood	2210	ft^3/s	753	6500
500 Year Peak Flood	2540	ft^3/s	829	7790

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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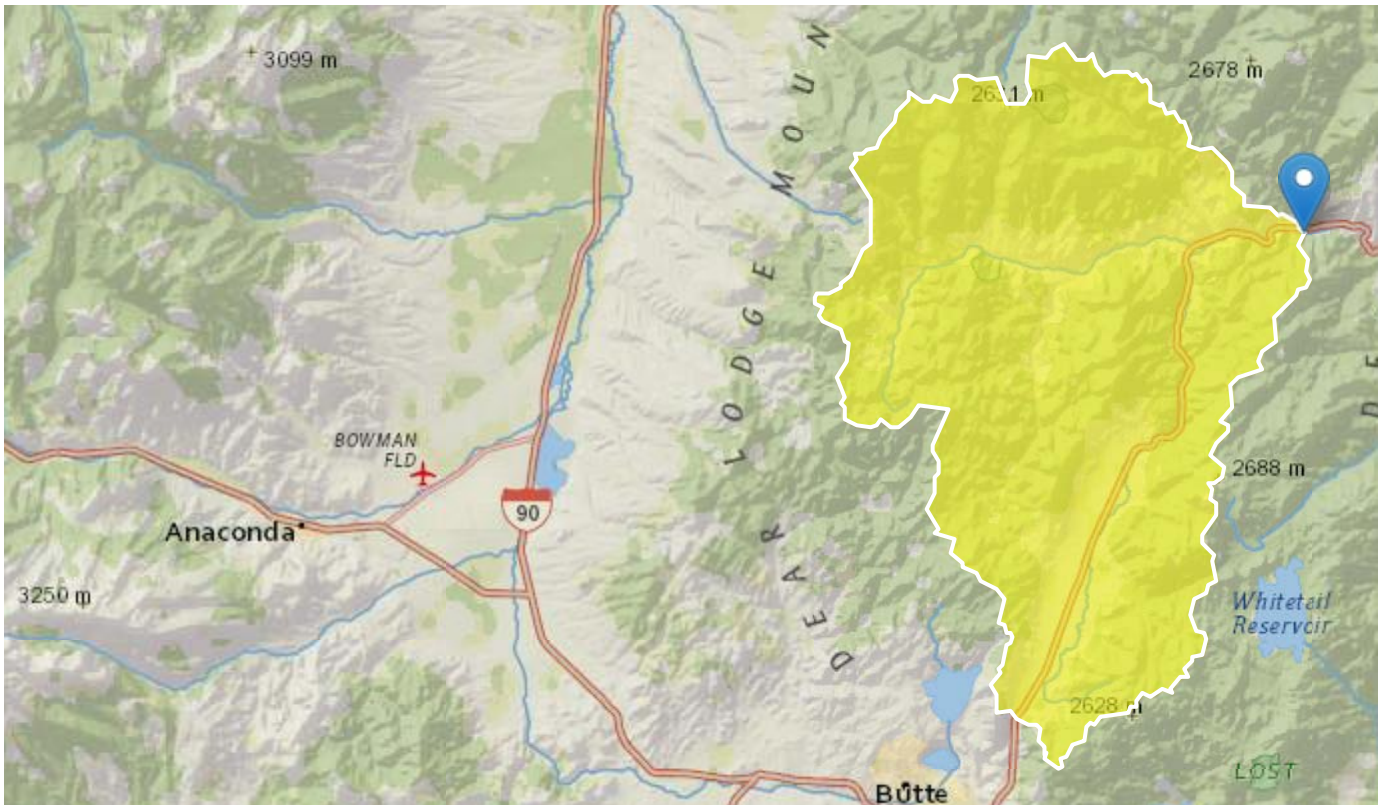
Application Version: 4.3.0

StreamStats Report - Node 1100 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190226163043842000
Clicked Point (Latitude, Longitude): 46.26680, -112.26214
Time: 2019-02-26 09:30:58 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	219.9	square miles
EL6000	Percent of area above 6000 ft	93.5	percent
PRECIP	Mean Annual Precipitation	22.36	inches
FOREST	Percentage of area covered by forest	80.8	percent

Peak-Flow Statistics Parameters [91 Percent (200 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	219.9	square miles	0.42	2480
EL6000	Percent above 6000 ft	93.5	percent	0	100

Peak-Flow Statistics Parameters [9 Percent (19.6 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	219.9	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	22.36	inches	14.6	62.1
FOREST	Percent Forest	80.8	percent	20.4	99.1

Peak-Flow Statistics Flow Report [91 Percent (200 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	475	ft^3/s	101	2220	118
2 Year Peak Flood	578	ft^3/s	153	2190	96
2 33 Year Peak Flood	622	ft^3/s	174	2220	90.1
5 Year Peak Flood	842	ft^3/s	276	2570	76.9
10 Year Peak Flood	1040	ft^3/s	362	3010	72.1
25 Year Peak Flood	1310	ft^3/s	460	3730	71.3
50 Year Peak Flood	1500	ft^3/s	528	4290	72
100 Year Peak Flood	1720	ft^3/s	588	5000	73.8
200 Year Peak Flood	1920	ft^3/s	641	5780	76.5
500 Year Peak Flood	2220	ft^3/s	709	6960	80.3

Peak-Flow Statistics Flow Report [9 Percent (19.6 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	369	ft^3/s	149	913	59.4
2 Year Peak Flood	477	ft^3/s	200	1140	56.5
2 33 Year Peak Flood	531	ft^3/s	224	1260	55.7
5 Year Peak Flood	782	ft^3/s	342	1790	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	1050	ft^3/s	460	2370	52.8
25 Year Peak Flood	1350	ft^3/s	592	3060	53.2
50 Year Peak Flood	1600	ft^3/s	691	3710	54.2
100 Year Peak Flood	1870	ft^3/s	793	4420	56
200 Year Peak Flood	2160	ft^3/s	889	5230	58
500 Year Peak Flood	2500	ft^3/s	987	6330	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	465	ft^3/s	106	2110
2 Year Peak Flood	569	ft^3/s	157	2100
2 33 Year Peak Flood	614	ft^3/s	179	2130
5 Year Peak Flood	837	ft^3/s	282	2500
10 Year Peak Flood	1040	ft^3/s	370	2960
25 Year Peak Flood	1310	ft^3/s	472	3670
50 Year Peak Flood	1510	ft^3/s	542	4240
100 Year Peak Flood	1730	ft^3/s	607	4950
200 Year Peak Flood	1940	ft^3/s	663	5730
500 Year Peak Flood	2250	ft^3/s	734	6900

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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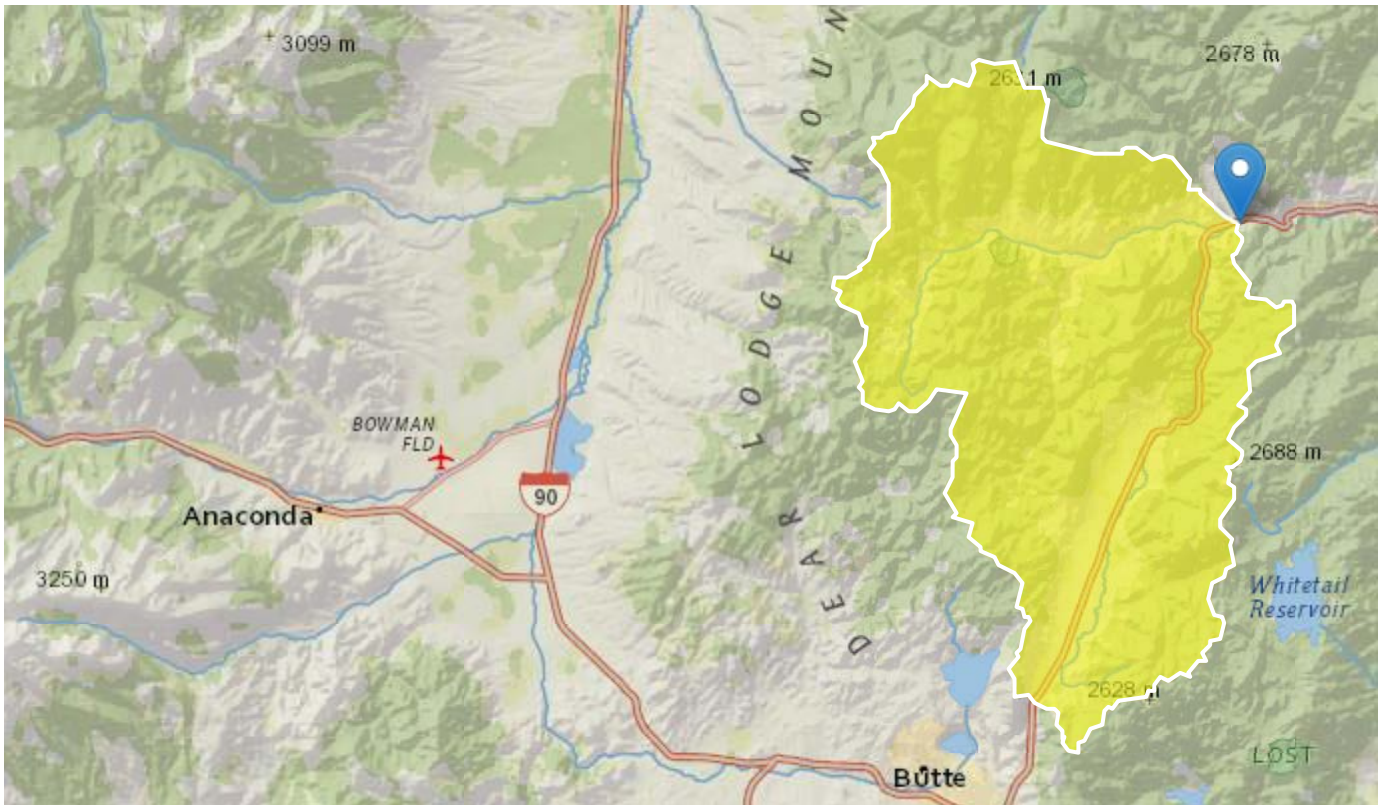
Application Version: 4.3.0

StreamStats Report - Node 1200 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190226163326537000
Clicked Point (Latitude, Longitude): 46.26421, -112.31922
Time: 2019-02-26 09:33:41 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	190.3	square miles
EL6000	Percent of area above 6000 ft	94.9	percent
PRECIP	Mean Annual Precipitation	22.28	inches
FOREST	Percentage of area covered by forest	79.6	percent

Peak-Flow Statistics Parameters [90 Percent (172 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	190.3	square miles	0.42	2480
EL6000	Percent above 6000 ft	94.9	percent	0	100

Peak-Flow Statistics Parameters [10 Percent (18.3 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	190.3	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	22.28	inches	14.6	62.1
FOREST	Percent Forest	79.6	percent	20.4	99.1

Peak-Flow Statistics Flow Report [90 Percent (172 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	414	ft^3/s	88.6	1930	118
2 Year Peak Flood	506	ft^3/s	134	1910	96
2 33 Year Peak Flood	546	ft^3/s	153	1940	90.1
5 Year Peak Flood	745	ft^3/s	244	2270	76.9
10 Year Peak Flood	928	ft^3/s	322	2680	72.1
25 Year Peak Flood	1170	ft^3/s	412	3330	71.3
50 Year Peak Flood	1350	ft^3/s	474	3840	72
100 Year Peak Flood	1540	ft^3/s	530	4490	73.8
200 Year Peak Flood	1730	ft^3/s	578	5200	76.5
500 Year Peak Flood	2010	ft^3/s	641	6280	80.3

Peak-Flow Statistics Flow Report [10 Percent (18.3 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	323	ft^3/s	131	799	59.4
2 Year Peak Flood	420	ft^3/s	176	1000	56.5
2 33 Year Peak Flood	468	ft^3/s	197	1110	55.7
5 Year Peak Flood	693	ft^3/s	303	1590	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	930	ft^3/s	410	2110	52.8
25 Year Peak Flood	1200	ft^3/s	529	2730	53.2
50 Year Peak Flood	1440	ft^3/s	620	3320	54.2
100 Year Peak Flood	1680	ft^3/s	712	3970	56
200 Year Peak Flood	1940	ft^3/s	800	4710	58
500 Year Peak Flood	2250	ft^3/s	890	5710	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	405	ft^3/s	92.6	1820
2 Year Peak Flood	498	ft^3/s	138	1830
2 33 Year Peak Flood	538	ft^3/s	157	1860
5 Year Peak Flood	740	ft^3/s	250	2210
10 Year Peak Flood	928	ft^3/s	330	2620
25 Year Peak Flood	1170	ft^3/s	423	3270
50 Year Peak Flood	1360	ft^3/s	488	3790
100 Year Peak Flood	1560	ft^3/s	547	4440
200 Year Peak Flood	1750	ft^3/s	599	5150
500 Year Peak Flood	2030	ft^3/s	665	6230

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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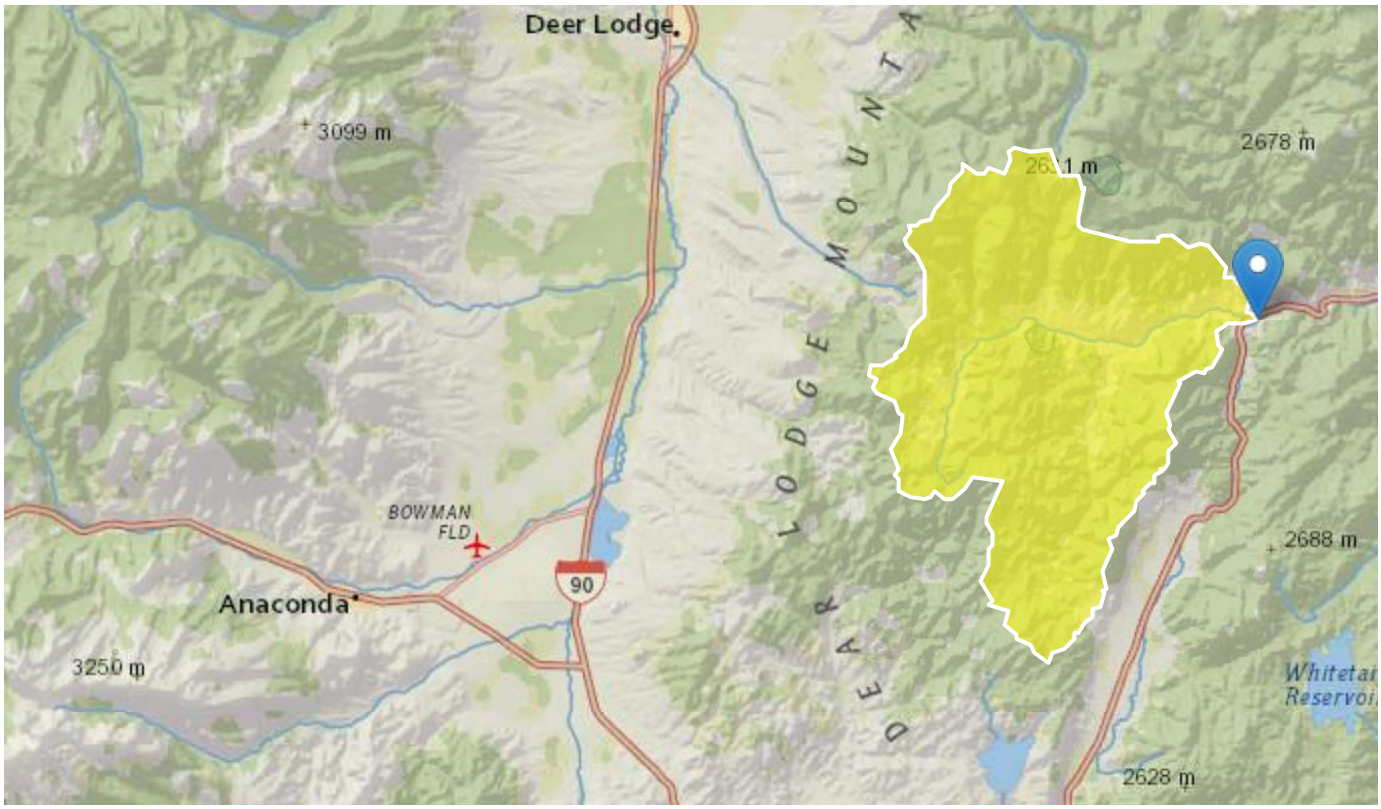
Application Version: 4.3.0

StreamStats Report - Node 1300 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190226163520583000
Clicked Point (Latitude, Longitude): 46.26064, -112.33134
Time: 2019-02-26 09:35:34 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	111.9	square miles
EL6000	Percent of area above 6000 ft	94.5	percent
PRECIP	Mean Annual Precipitation	22.9	inches
FOREST	Percentage of area covered by forest	84.5	percent

Peak-Flow Statistics Parameters [86 Percent (95.9 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	111.9	square miles	0.42	2480
EL6000	Percent above 6000 ft	94.5	percent	0	100

Peak-Flow Statistics Parameters [14 Percent (16.1 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	111.9	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	22.9	inches	14.6	62.1
FOREST	Percent Forest	84.5	percent	20.4	99.1

Peak-Flow Statistics Flow Report [86 Percent (95.9 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	247	ft^3/s	53.1	1150	118
2 Year Peak Flood	309	ft^3/s	82	1160	96
2 33 Year Peak Flood	336	ft^3/s	94.8	1190	90.1
5 Year Peak Flood	476	ft^3/s	157	1450	76.9
10 Year Peak Flood	608	ft^3/s	212	1750	72.1
25 Year Peak Flood	787	ft^3/s	277	2230	71.3
50 Year Peak Flood	921	ft^3/s	324	2620	72
100 Year Peak Flood	1070	ft^3/s	367	3100	73.8
200 Year Peak Flood	1210	ft^3/s	405	3630	76.5
500 Year Peak Flood	1430	ft^3/s	456	4450	80.3

Peak-Flow Statistics Flow Report [14 Percent (16.1 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	199	ft^3/s	80.4	493	59.4
2 Year Peak Flood	260	ft^3/s	109	623	56.5
2 33 Year Peak Flood	291	ft^3/s	123	691	55.7
5 Year Peak Flood	436	ft^3/s	190	998	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	589	ft^3/s	259	1340	52.8
25 Year Peak Flood	765	ft^3/s	336	1740	53.2
50 Year Peak Flood	917	ft^3/s	395	2130	54.2
100 Year Peak Flood	1080	ft^3/s	456	2550	56
200 Year Peak Flood	1250	ft^3/s	513	3030	58
500 Year Peak Flood	1450	ft^3/s	573	3680	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	240	ft^3/s	57	1050
2 Year Peak Flood	302	ft^3/s	85.8	1090
2 33 Year Peak Flood	330	ft^3/s	98.8	1120
5 Year Peak Flood	471	ft^3/s	161	1380
10 Year Peak Flood	606	ft^3/s	218	1690
25 Year Peak Flood	784	ft^3/s	286	2160
50 Year Peak Flood	920	ft^3/s	334	2550
100 Year Peak Flood	1070	ft^3/s	380	3020
200 Year Peak Flood	1220	ft^3/s	421	3550
500 Year Peak Flood	1430	ft^3/s	473	4340

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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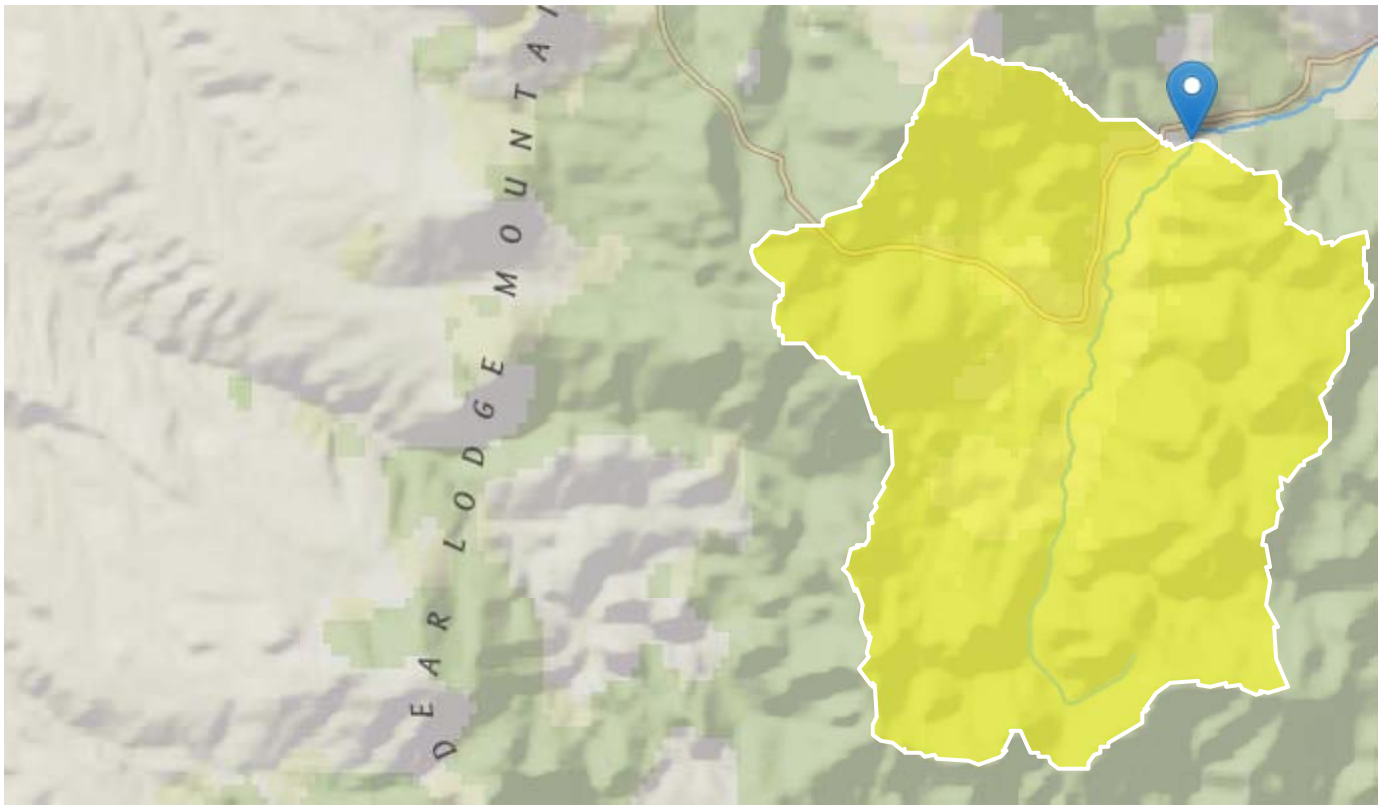
Application Version: 4.3.0

StreamStats Report - Node 1400 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190226163824778000
Clicked Point (Latitude, Longitude): 46.24933, -112.52279
Time: 2019-02-26 09:38:39 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	19	square miles
EL6000	Percent of area above 6000 ft	100	percent
PRECIP	Mean Annual Precipitation	23.33	inches
FOREST	Percentage of area covered by forest	83.7	percent

Peak-Flow Statistics Parameters [70 Percent (13.4 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	19	square miles	0.42	2480
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Parameters [30 Percent (5.62 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	19	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	23.33	inches	14.6	62.1
FOREST	Percent Forest	83.7	percent	20.4	99.1

Peak-Flow Statistics Flow Report [70 Percent (13.4 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	44.6	ft^3/s	9.49	210	118
2 Year Peak Flood	59.7	ft^3/s	15.7	227	96
2 33 Year Peak Flood	67.2	ft^3/s	18.7	241	90.1
5 Year Peak Flood	107	ft^3/s	34.6	328	76.9
10 Year Peak Flood	147	ft^3/s	50.5	428	72.1
25 Year Peak Flood	205	ft^3/s	71.3	590	71.3
50 Year Peak Flood	252	ft^3/s	87.2	726	72
100 Year Peak Flood	304	ft^3/s	103	898	73.8
200 Year Peak Flood	358	ft^3/s	117	1090	76.5
500 Year Peak Flood	439	ft^3/s	138	1400	80.3

Peak-Flow Statistics Flow Report [30 Percent (5.62 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	39.5	ft^3/s	15.9	98.1	59.4
2 Year Peak Flood	53.6	ft^3/s	22.3	129	56.5
2 33 Year Peak Flood	60.9	ft^3/s	25.6	145	55.7
5 Year Peak Flood	96.2	ft^3/s	41.8	221	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	135	ft^3/s	59.1	308	52.8
25 Year Peak Flood	182	ft^3/s	79.5	416	53.2
50 Year Peak Flood	223	ft^3/s	95.4	519	54.2
100 Year Peak Flood	267	ft^3/s	112	635	56
200 Year Peak Flood	314	ft^3/s	128	767	58
500 Year Peak Flood	373	ft^3/s	146	954	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	43.1	ft^3/s	11.4	177
2 Year Peak Flood	57.9	ft^3/s	17.6	198
2 33 Year Peak Flood	65.3	ft^3/s	20.8	213
5 Year Peak Flood	103	ft^3/s	36.8	296
10 Year Peak Flood	143	ft^3/s	53	392
25 Year Peak Flood	198	ft^3/s	73.7	539
50 Year Peak Flood	243	ft^3/s	89.6	665
100 Year Peak Flood	293	ft^3/s	106	820
200 Year Peak Flood	345	ft^3/s	121	994
500 Year Peak Flood	419	ft^3/s	140	1270

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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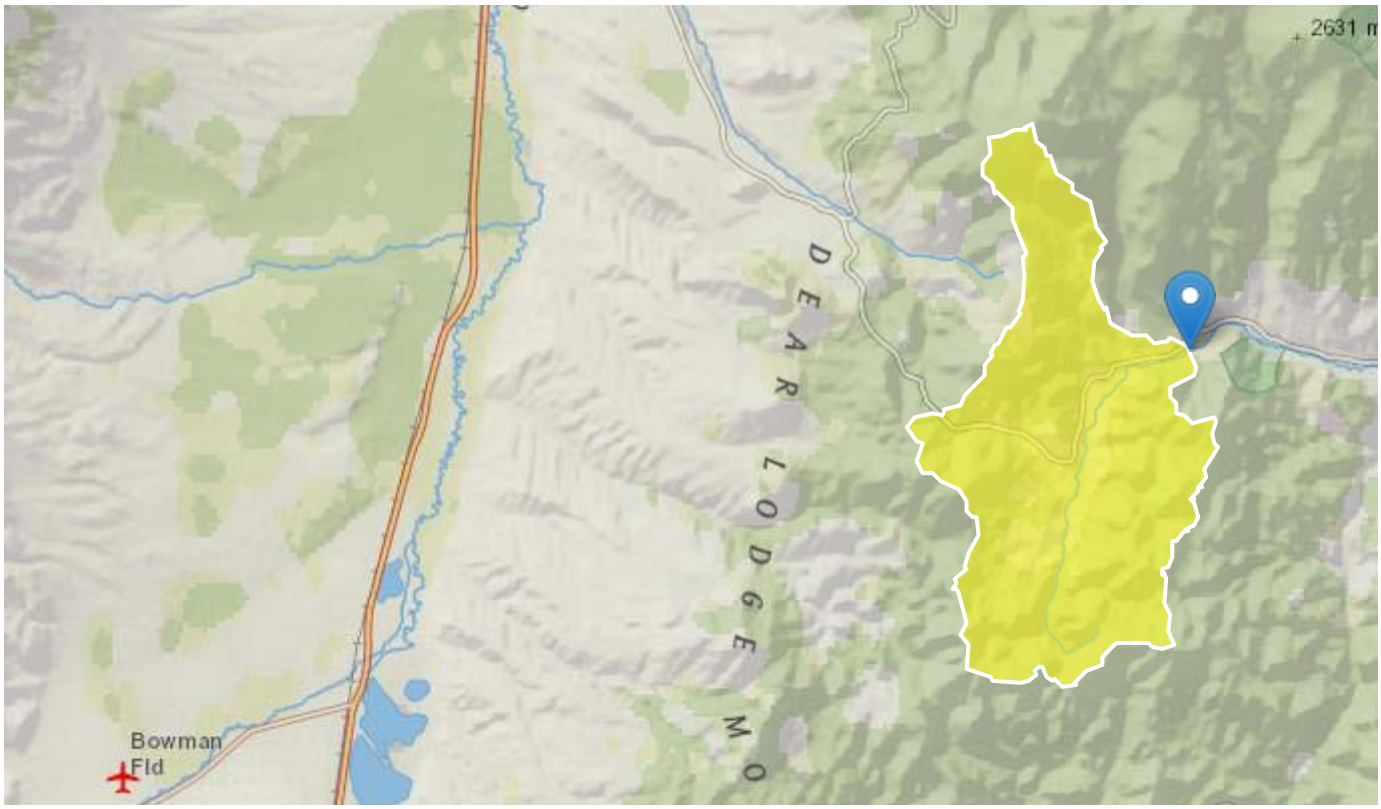
Application Version: 4.3.0

StreamStats Report - USGS Gage 06030500 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190227210422379000
Clicked Point (Latitude, Longitude): 46.25426, -112.50122
Time: 2019-02-27 14:04:36 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	24.4	square miles
EL6000	Percent of area above 6000 ft	100	percent
PRECIP	Mean Annual Precipitation	24.26	inches
FOREST	Percentage of area covered by forest	84.9	percent

Peak-Flow Statistics Parameters [68 Percent (16.6 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	24.4	square miles	0.42	2480
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Parameters [32 Percent (7.84 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	24.4	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	24.26	inches	14.6	62.1
FOREST	Percent Forest	84.9	percent	20.4	99.1

Peak-Flow Statistics Flow Report [68 Percent (16.6 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	56.9	ft^3/s	12.1	267	118
2 Year Peak Flood	75.3	ft^3/s	19.9	286	96
2 33 Year Peak Flood	84.4	ft^3/s	23.6	302	90.1
5 Year Peak Flood	131	ft^3/s	42.9	403	76.9
10 Year Peak Flood	179	ft^3/s	61.8	520	72.1
25 Year Peak Flood	247	ft^3/s	86.3	709	71.3
50 Year Peak Flood	301	ft^3/s	105	866	72
100 Year Peak Flood	362	ft^3/s	123	1060	73.8
200 Year Peak Flood	424	ft^3/s	140	1280	76.5
500 Year Peak Flood	516	ft^3/s	163	1630	80.3

Peak-Flow Statistics Flow Report [32 Percent (7.84 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	54.3	ft^3/s	21.9	135	59.4
2 Year Peak Flood	72.7	ft^3/s	30.3	174	56.5
2 33 Year Peak Flood	82.2	ft^3/s	34.6	195	55.7
5 Year Peak Flood	127	ft^3/s	55.5	292	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	177	ft^3/s	77.5	402	52.8
25 Year Peak Flood	235	ft^3/s	103	536	53.2
50 Year Peak Flood	285	ft^3/s	123	663	54.2
100 Year Peak Flood	339	ft^3/s	143	804	56
200 Year Peak Flood	396	ft^3/s	163	966	58
500 Year Peak Flood	468	ft^3/s	184	1190	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	56.1	ft^3/s	15.3	224
2 Year Peak Flood	74.5	ft^3/s	23.2	250
2 33 Year Peak Flood	83.7	ft^3/s	27.1	267
5 Year Peak Flood	130	ft^3/s	47	367
10 Year Peak Flood	178	ft^3/s	66.8	482
25 Year Peak Flood	243	ft^3/s	91.6	654
50 Year Peak Flood	296	ft^3/s	111	801
100 Year Peak Flood	355	ft^3/s	129	981
200 Year Peak Flood	415	ft^3/s	147	1180
500 Year Peak Flood	501	ft^3/s	170	1490

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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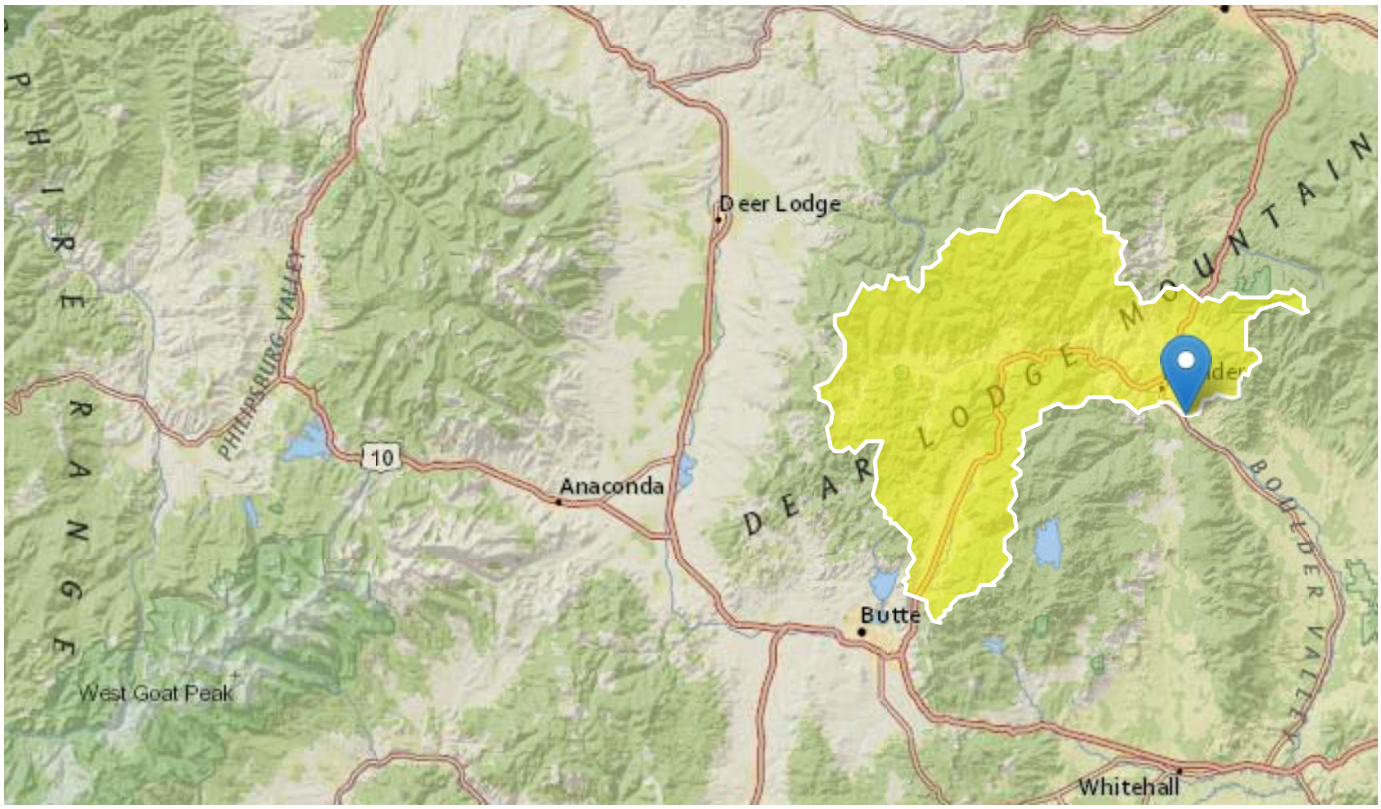
Application Version: 4.3.0

StreamStats Report - USGS Gage 06033000 Boulder Mainstem

Region ID: MT
Workspace ID: MT20190226160449810000
Clicked Point (Latitude, Longitude): 46.21084, -112.09177
Time: 2019-02-26 09:05:05 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	381.3	square miles
EL6000	Percent of area above 6000 ft	81.1	percent
PRECIP	Mean Annual Precipitation	22	inches
FOREST	Percentage of area covered by forest	77.7	percent

Peak-Flow Statistics Parameters [93 Percent (356 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	381.3	square miles	0.42	2480
EL6000	Percent above 6000 ft	81.1	percent	0	100

Peak-Flow Statistics Parameters [7 Percent (24.8 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	381.3	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	22	inches	14.6	62.1
FOREST	Percent Forest	77.7	percent	20.4	99.1

Peak-Flow Statistics Flow Report [93 Percent (356 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	788	ft^3/s	167	3720	118
2 Year Peak Flood	952	ft^3/s	250	3630	96
2 33 Year Peak Flood	1020	ft^3/s	284	3660	90.1
5 Year Peak Flood	1360	ft^3/s	441	4160	76.9
10 Year Peak Flood	1660	ft^3/s	572	4810	72.1
25 Year Peak Flood	2060	ft^3/s	719	5890	71.3
50 Year Peak Flood	2350	ft^3/s	819	6720	72
100 Year Peak Flood	2660	ft^3/s	907	7790	73.8
200 Year Peak Flood	2970	ft^3/s	984	8960	76.5
500 Year Peak Flood	3410	ft^3/s	1080	10700	80.3

Peak-Flow Statistics Flow Report [7 Percent (24.8 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	615	ft^3/s	248	1520	59.4
2 Year Peak Flood	789	ft^3/s	330	1890	56.5
2 33 Year Peak Flood	874	ft^3/s	369	2070	55.7
5 Year Peak Flood	1270	ft^3/s	555	2910	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	1680	ft^3/s	741	3820	52.8
25 Year Peak Flood	2150	ft^3/s	944	4880	53.2
50 Year Peak Flood	2540	ft^3/s	1100	5890	54.2
100 Year Peak Flood	2960	ft^3/s	1250	6990	56
200 Year Peak Flood	3390	ft^3/s	1400	8240	58
500 Year Peak Flood	3910	ft^3/s	1540	9920	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	777	ft^3/s	172	3580
2 Year Peak Flood	941	ft^3/s	255	3520
2 33 Year Peak Flood	1010	ft^3/s	289	3550
5 Year Peak Flood	1350	ft^3/s	449	4080
10 Year Peak Flood	1660	ft^3/s	583	4750
25 Year Peak Flood	2060	ft^3/s	734	5820
50 Year Peak Flood	2360	ft^3/s	837	6660
100 Year Peak Flood	2680	ft^3/s	930	7740
200 Year Peak Flood	3000	ft^3/s	1010	8910
500 Year Peak Flood	3440	ft^3/s	1110	10700

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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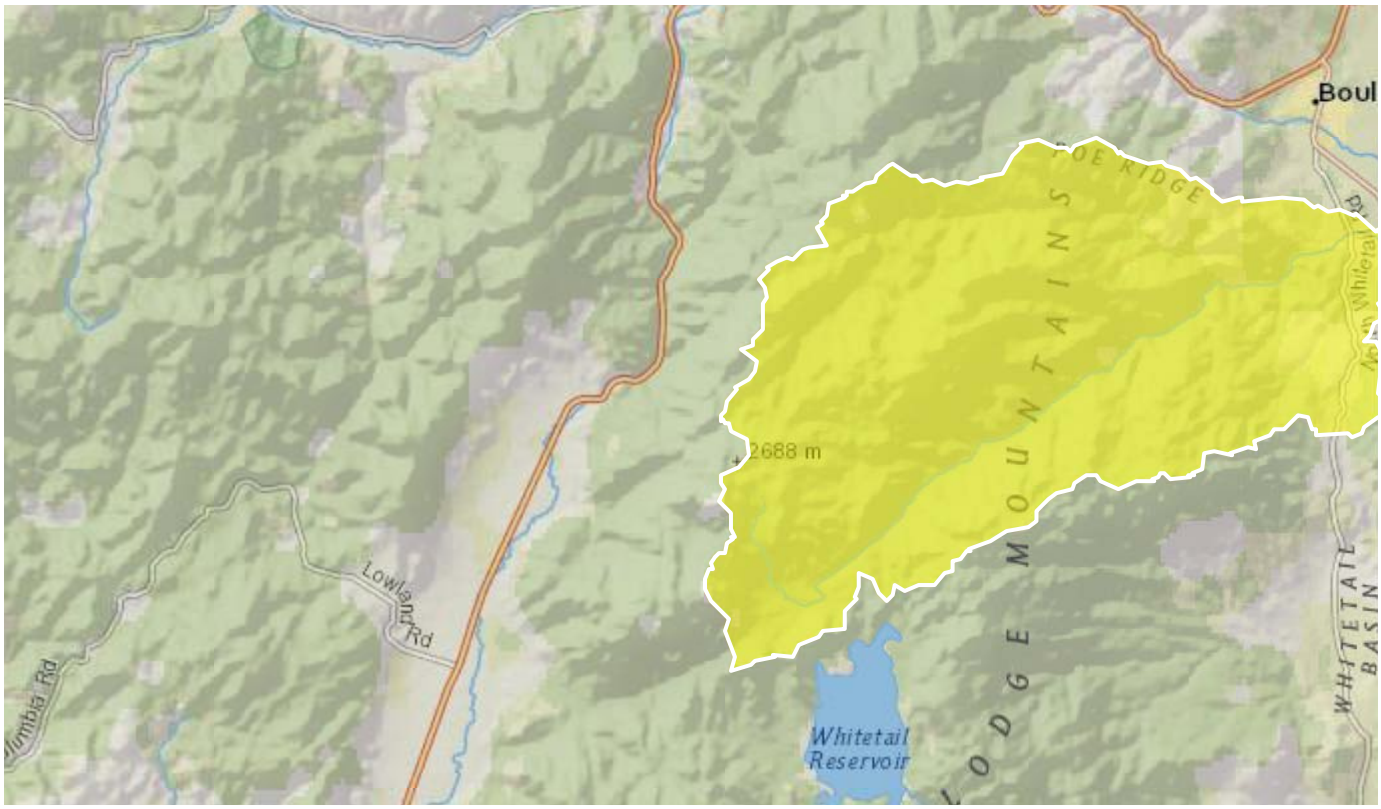
Application Version: 4.3.0

StreamStats Report - Node 100 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190211224707013000
Clicked Point (Latitude, Longitude): 46.19736, -112.08574
Time: 2019-02-11 15:47:24 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	58.5	square miles
EL6000	Percent of area above 6000 ft	74.5	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	58.5	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	74.5	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	126	ft^3/s	27.1	582	118
2 Year Peak Flood	165	ft^3/s	44	621	96
2 33 Year Peak Flood	184	ft^3/s	52	652	90.1
5 Year Peak Flood	282	ft^3/s	92.8	855	76.9
10 Year Peak Flood	378	ft^3/s	132	1090	72.1
25 Year Peak Flood	516	ft^3/s	182	1460	71.3
50 Year Peak Flood	624	ft^3/s	220	1770	72
100 Year Peak Flood	745	ft^3/s	257	2160	73.8
200 Year Peak Flood	869	ft^3/s	291	2600	76.5
500 Year Peak Flood	1050	ft^3/s	337	3280	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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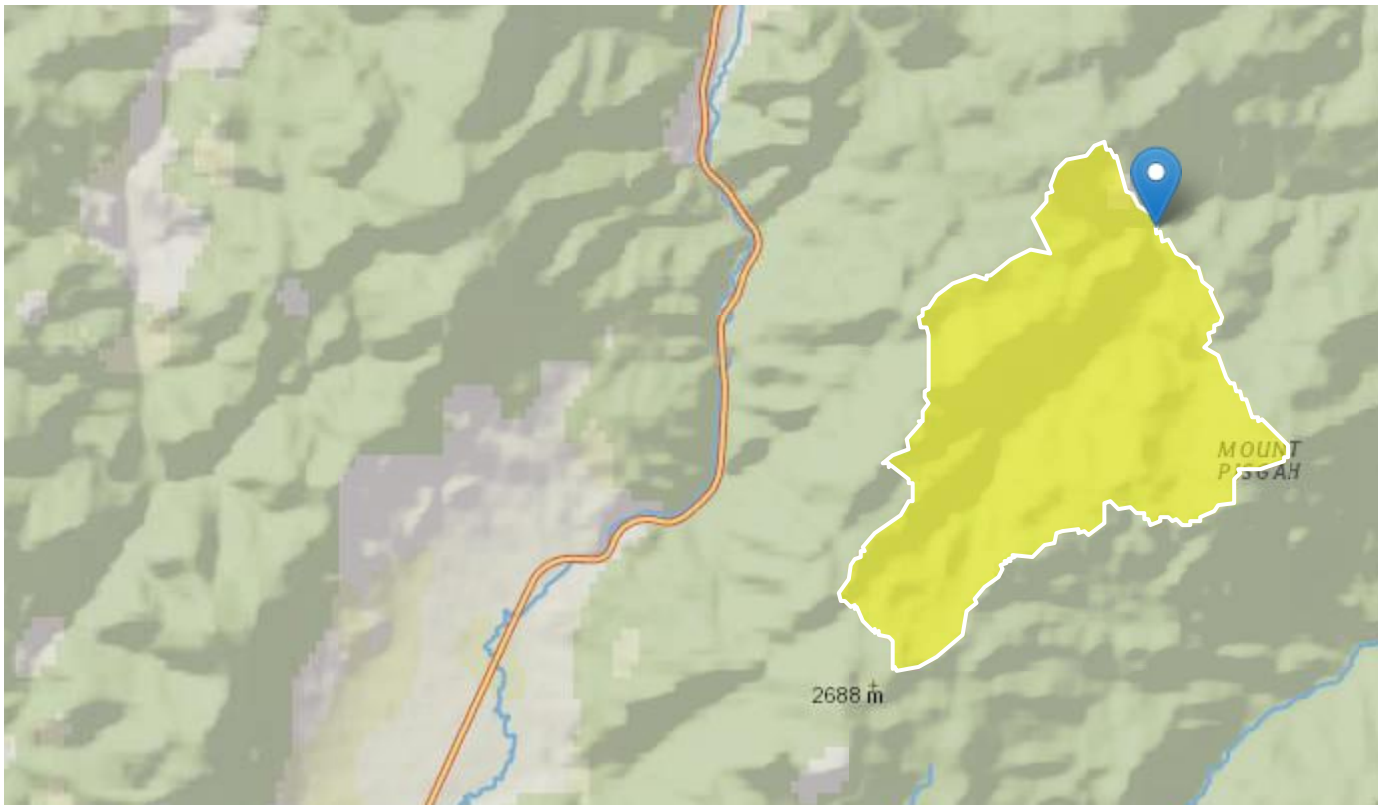
Application Version: 4.3.0

StreamStats Report - Node 200 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190211225352307000
Clicked Point (Latitude, Longitude): 46.20556, -112.27143
Time: 2019-02-11 15:54:07 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	7.4	square miles
EL6000	Percent of area above 6000 ft	100	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	7.4	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	17.9	ft^3/s	3.72	85.7	118
2 Year Peak Flood	24.8	ft^3/s	6.41	96.2	96
2 33 Year Peak Flood	28.5	ft^3/s	7.81	104	90.1
5 Year Peak Flood	48.2	ft^3/s	15.4	151	76.9
10 Year Peak Flood	69.3	ft^3/s	23.4	205	72.1
25 Year Peak Flood	101	ft^3/s	34.5	297	71.3
50 Year Peak Flood	128	ft^3/s	43.3	375	72
100 Year Peak Flood	158	ft^3/s	52.2	476	73.8
200 Year Peak Flood	189	ft^3/s	60.7	590	76.5
500 Year Peak Flood	238	ft^3/s	72.9	776	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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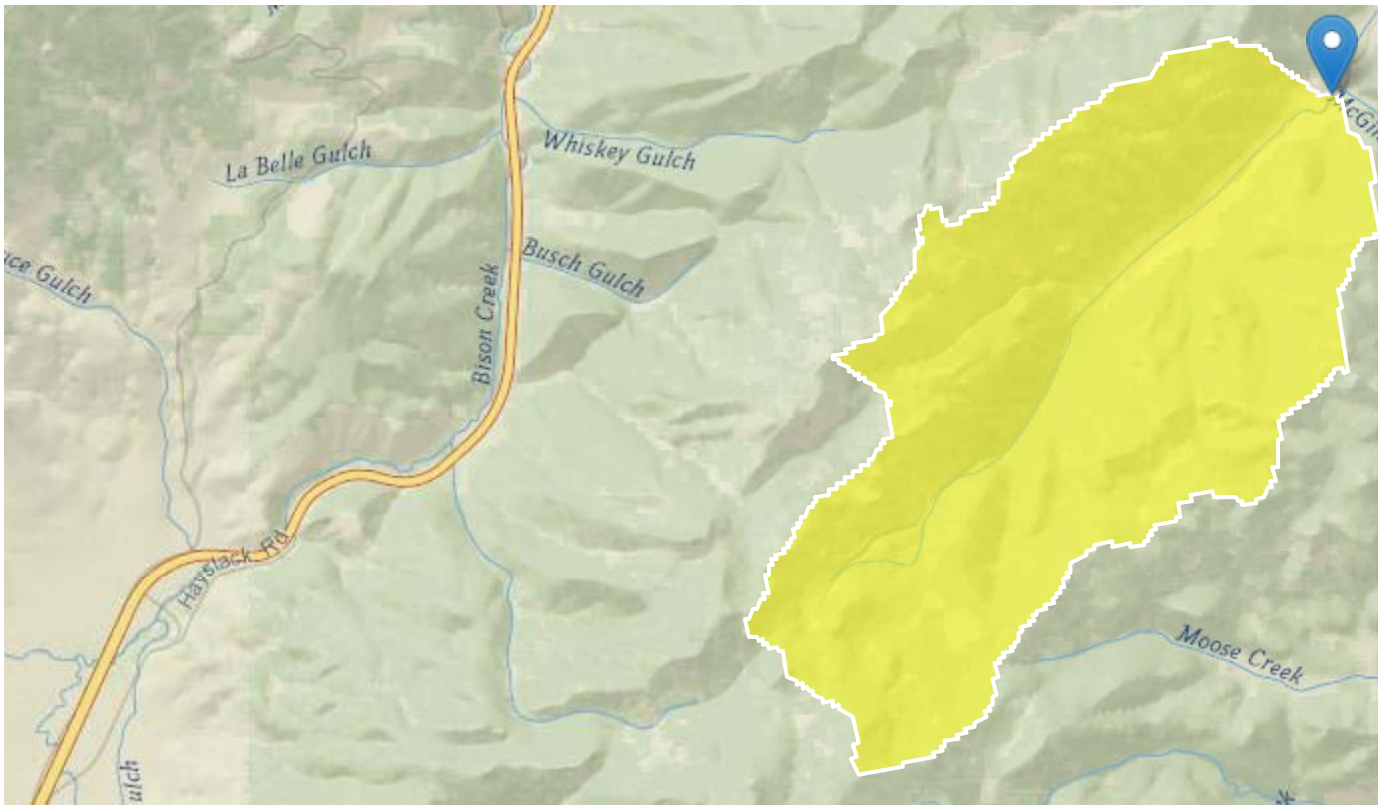
Application Version: 4.3.0

StreamStats Report - Node 300 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190211225622807000
Clicked Point (Latitude, Longitude): 46.19326, -112.27557
Time: 2019-02-11 15:56:37 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	4	square miles
EL6000	Percent of area above 6000 ft	100	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	4	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	9.83	ft^3/s	2.01	48	118
2 Year Peak Flood	14	ft^3/s	3.56	55.2	96
2 33 Year Peak Flood	16.3	ft^3/s	4.39	60.4	90.1
5 Year Peak Flood	28.7	ft^3/s	9.03	91.1	76.9
10 Year Peak Flood	42.5	ft^3/s	14.1	128	72.1
25 Year Peak Flood	63.7	ft^3/s	21.4	190	71.3
50 Year Peak Flood	81.8	ft^3/s	27.3	245	72
100 Year Peak Flood	103	ft^3/s	33.4	316	73.8
200 Year Peak Flood	125	ft^3/s	39.3	397	76.5
500 Year Peak Flood	160	ft^3/s	47.9	531	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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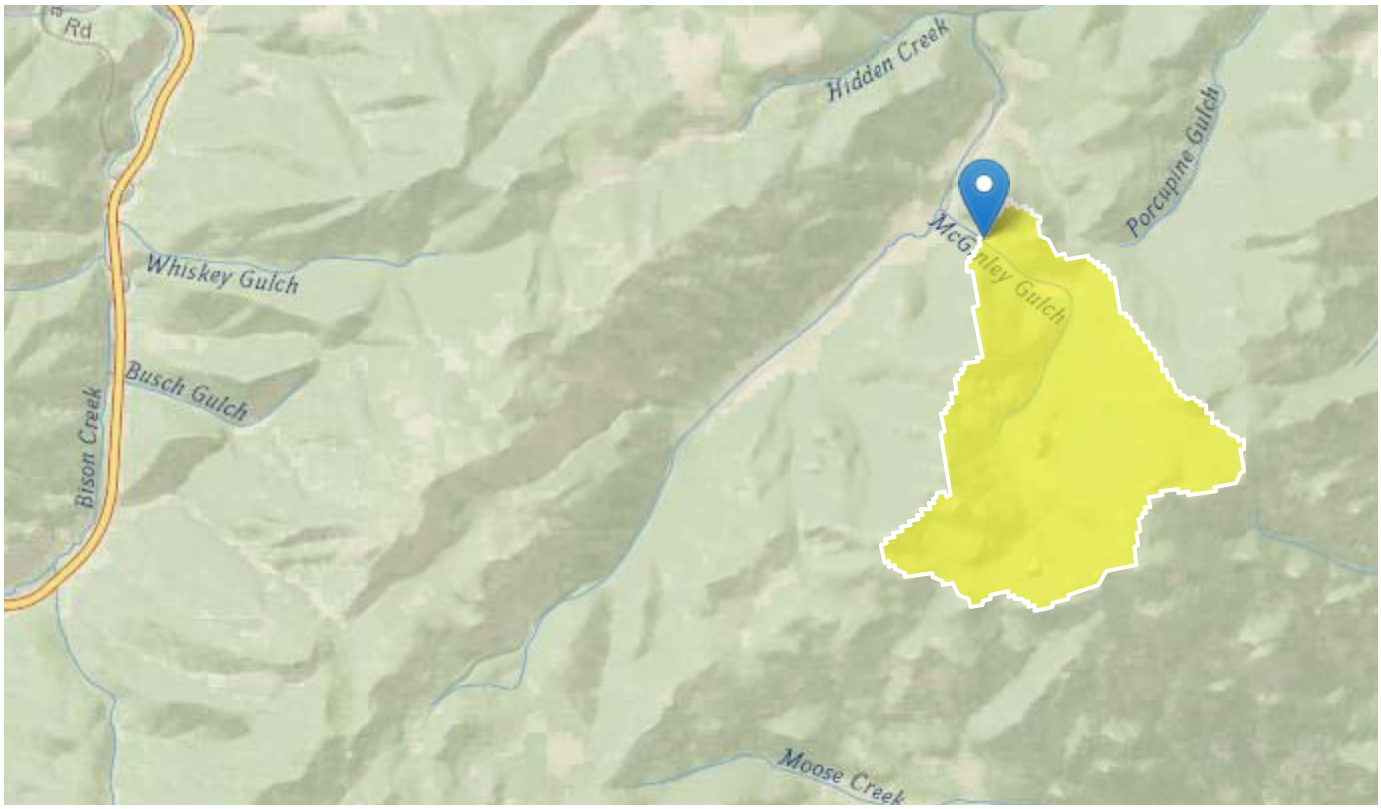
Application Version: 4.3.0

StreamStats Report - Node 400 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190211225758703000
Clicked Point (Latitude, Longitude): 46.19210, -112.27135
Time: 2019-02-11 15:58:13 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.3	square miles
EL6000	Percent of area above 6000 ft	100	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.3	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	3.3	ft^3/s	0.646	16.9	118
2 Year Peak Flood	4.93	ft^3/s	1.2	20.2	96
2 33 Year Peak Flood	5.85	ft^3/s	1.52	22.5	90.1
5 Year Peak Flood	11.1	ft^3/s	3.38	36.7	76.9
10 Year Peak Flood	17.4	ft^3/s	5.56	54.2	72.1
25 Year Peak Flood	27.4	ft^3/s	8.85	85	71.3
50 Year Peak Flood	36.4	ft^3/s	11.7	114	72
100 Year Peak Flood	47	ft^3/s	14.6	151	73.8
200 Year Peak Flood	58.5	ft^3/s	17.6	195	76.5
500 Year Peak Flood	76.9	ft^3/s	22	269	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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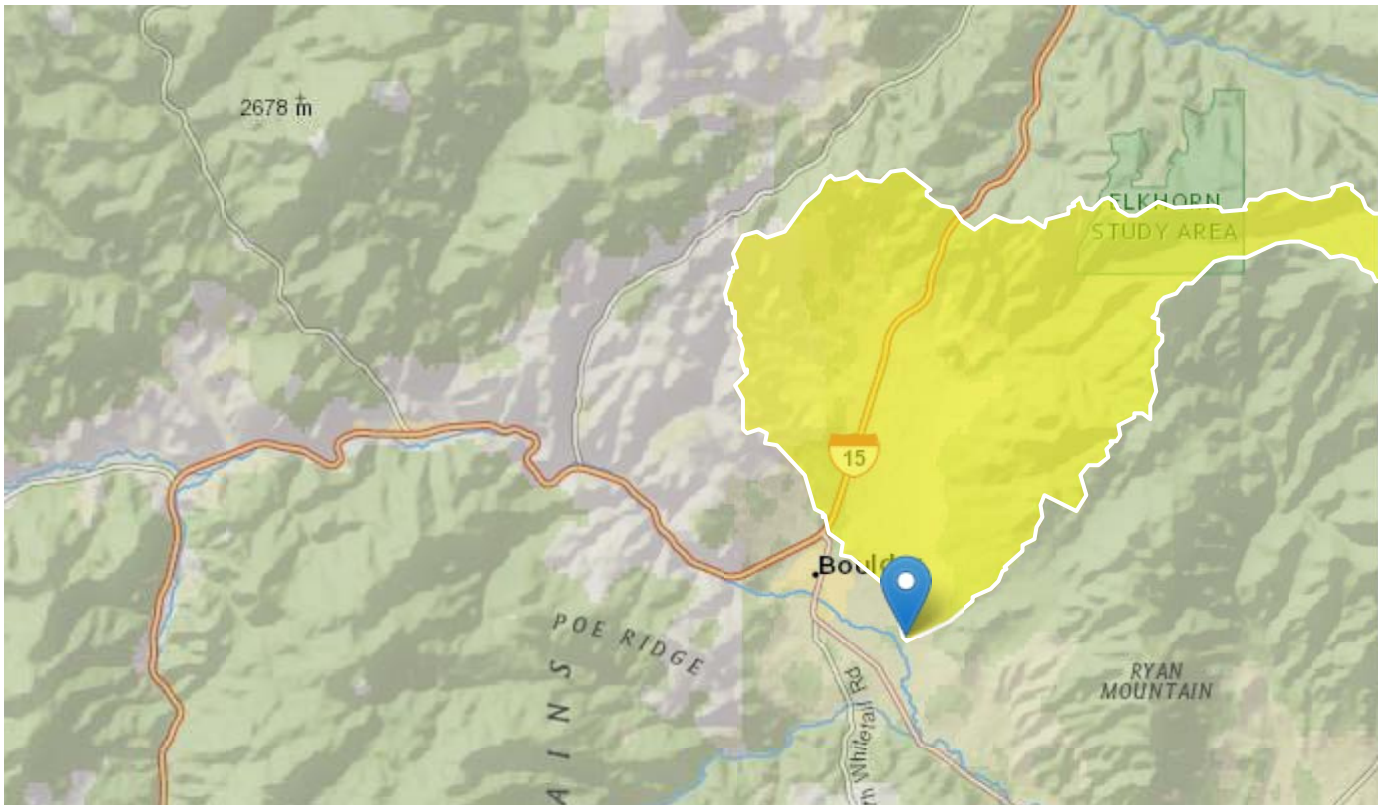
Application Version: 4.3.0

StreamStats Report - Node 500 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190221171435884000
Clicked Point (Latitude, Longitude): 46.22143, -112.09082
Time: 2019-02-21 10:14:51 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	40	square miles
EL6000	Percent of area above 6000 ft	25	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	40	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	25	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	70.6	ft^3/s	15.2	328	118
2 Year Peak Flood	105	ft^3/s	27.8	395	96
2 33 Year Peak Flood	123	ft^3/s	34.6	438	90.1
5 Year Peak Flood	225	ft^3/s	73.6	686	76.9
10 Year Peak Flood	338	ft^3/s	117	976	72.1
25 Year Peak Flood	520	ft^3/s	182	1490	71.3
50 Year Peak Flood	679	ft^3/s	237	1940	72
100 Year Peak Flood	868	ft^3/s	296	2540	73.8
200 Year Peak Flood	1080	ft^3/s	356	3260	76.5
500 Year Peak Flood	1400	ft^3/s	444	4430	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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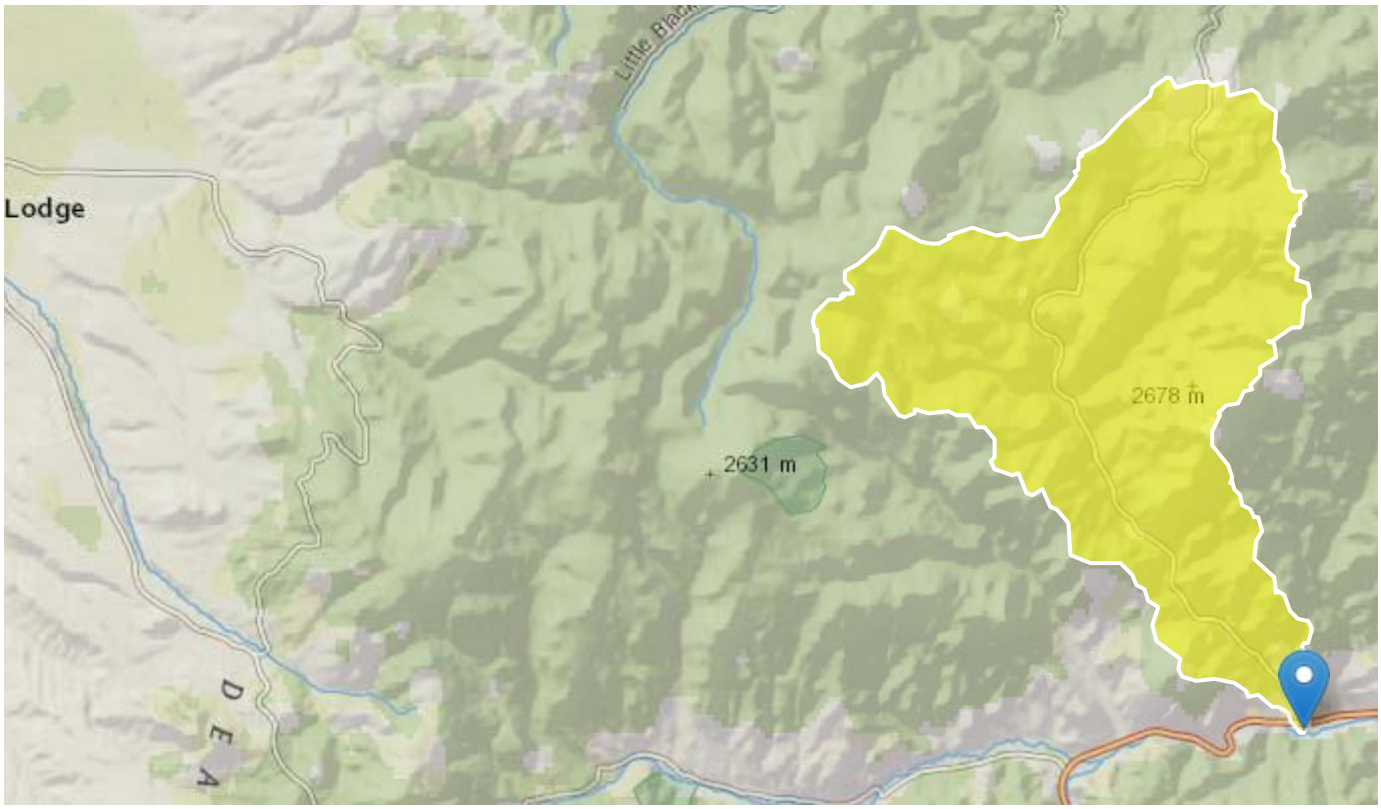
Application Version: 4.3.0

StreamStats Report - Node 600 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190221171846620000
Clicked Point (Latitude, Longitude): 46.26745, -112.26052
Time: 2019-02-21 10:19:01 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	41.7	square miles
EL6000	Percent of area above 6000 ft	95.6	percent
PRECIP	Mean Annual Precipitation	27.21	inches
FOREST	Percentage of area covered by forest	93.3	percent

Peak-Flow Statistics Parameters [87 Percent (36.4 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	41.7	square miles	0.42	2480
EL6000	Percent above 6000 ft	95.6	percent	0	100

Peak-Flow Statistics Parameters [13 Percent (5.27 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	41.7	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	27.21	inches	14.6	62.1
FOREST	Percent Forest	93.3	percent	20.4	99.1

Peak-Flow Statistics Flow Report [87 Percent (36.4 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	94.9	ft^3/s	20.4	442	118
2 Year Peak Flood	123	ft^3/s	32.7	466	96
2 33 Year Peak Flood	137	ft^3/s	38.6	487	90.1
5 Year Peak Flood	207	ft^3/s	68	632	76.9
10 Year Peak Flood	277	ft^3/s	96	798	72.1
25 Year Peak Flood	374	ft^3/s	131	1070	71.3
50 Year Peak Flood	450	ft^3/s	158	1280	72
100 Year Peak Flood	535	ft^3/s	183	1560	73.8
200 Year Peak Flood	620	ft^3/s	206	1870	76.5
500 Year Peak Flood	747	ft^3/s	238	2350	80.3

Peak-Flow Statistics Flow Report [13 Percent (5.27 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	110	ft^3/s	44.5	273	59.4
2 Year Peak Flood	142	ft^3/s	59.5	340	56.5
2 33 Year Peak Flood	158	ft^3/s	66.8	375	55.7
5 Year Peak Flood	233	ft^3/s	102	534	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	313	ft^3/s	138	710	52.8
25 Year Peak Flood	402	ft^3/s	177	915	53.2
50 Year Peak Flood	478	ft^3/s	206	1110	54.2
100 Year Peak Flood	559	ft^3/s	236	1320	56
200 Year Peak Flood	642	ft^3/s	265	1560	58
500 Year Peak Flood	744	ft^3/s	293	1890	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	96.8	ft^3/s	23.4	421
2 Year Peak Flood	126	ft^3/s	36.1	450
2 33 Year Peak Flood	140	ft^3/s	42.1	473
5 Year Peak Flood	211	ft^3/s	72.3	619
10 Year Peak Flood	281	ft^3/s	101	787
25 Year Peak Flood	378	ft^3/s	137	1050
50 Year Peak Flood	454	ft^3/s	164	1260
100 Year Peak Flood	538	ft^3/s	190	1530
200 Year Peak Flood	623	ft^3/s	214	1830
500 Year Peak Flood	746	ft^3/s	245	2290

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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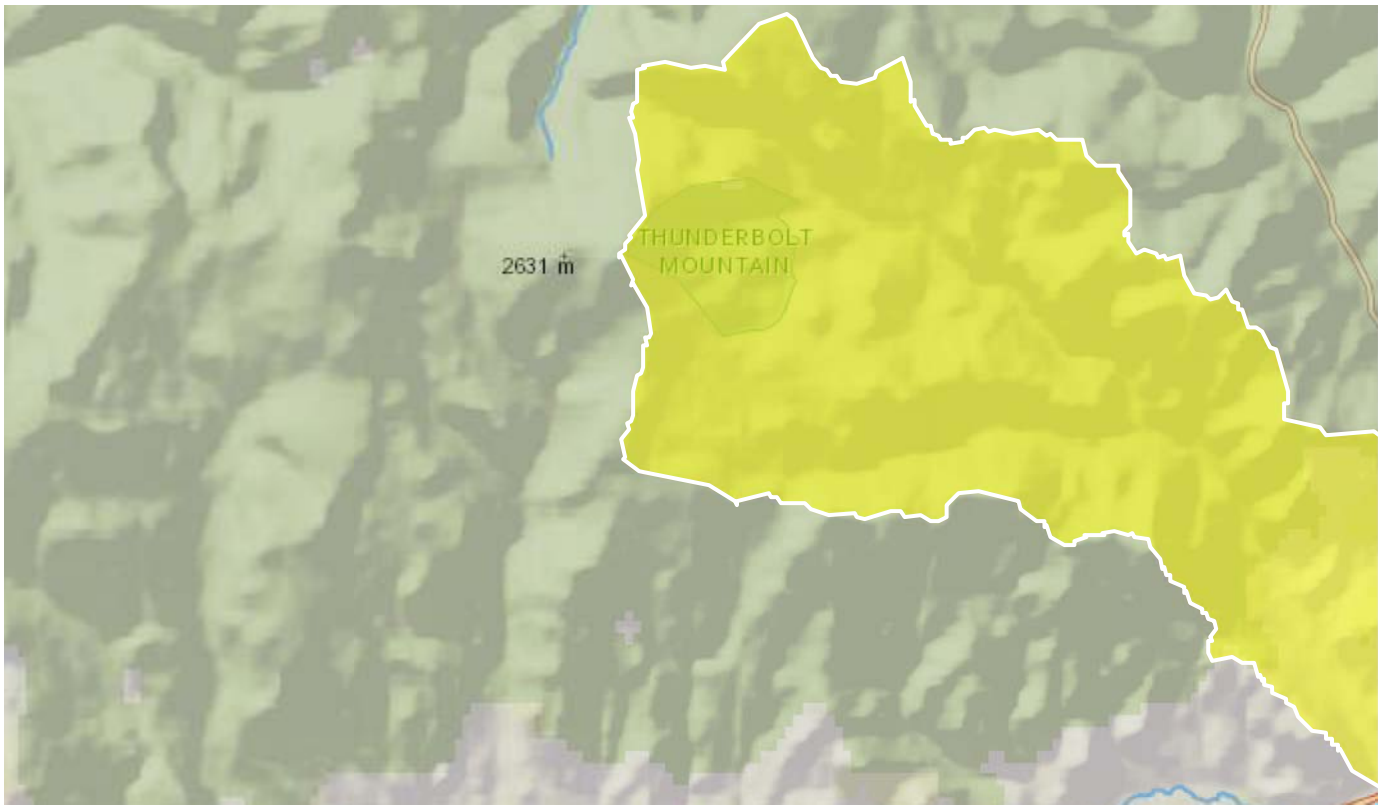
Application Version: 4.3.0

StreamStats Report - Node 700 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190212152544277000
Clicked Point (Latitude, Longitude): 46.26478, -112.31774
Time: 2019-02-12 08:25:58 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	20.8	square miles
EL6000	Percent of area above 6000 ft	89.1	percent
PRECIP	Mean Annual Precipitation	24.67	inches
FOREST	Percentage of area covered by forest	88.9	percent

Peak-Flow Statistics Parameters [94 Percent (19.6 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	20.8	square miles	0.42	2480
EL6000	Percent above 6000 ft	89.1	percent	0	100

Peak-Flow Statistics Parameters [6 Percent (1.17 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	20.8	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	24.67	inches	14.6	62.1
FOREST	Percent Forest	88.9	percent	20.4	99.1

Peak-Flow Statistics Flow Report [94 Percent (19.6 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	47.6	ft^3/s	10.2	223	118
2 Year Peak Flood	64.2	ft^3/s	16.9	244	96
2 33 Year Peak Flood	72.5	ft^3/s	20.3	259	90.1
5 Year Peak Flood	116	ft^3/s	37.9	356	76.9
10 Year Peak Flood	161	ft^3/s	55.5	467	72.1
25 Year Peak Flood	226	ft^3/s	79	649	71.3
50 Year Peak Flood	279	ft^3/s	97.1	802	72
100 Year Peak Flood	339	ft^3/s	115	997	73.8
200 Year Peak Flood	400	ft^3/s	132	1210	76.5
500 Year Peak Flood	492	ft^3/s	155	1560	80.3

Peak-Flow Statistics Flow Report [6 Percent (1.17 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	46.9	ft^3/s	18.9	116	59.4
2 Year Peak Flood	62.7	ft^3/s	26.1	151	56.5
2 33 Year Peak Flood	70.9	ft^3/s	29.8	169	55.7
5 Year Peak Flood	110	ft^3/s	47.8	253	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	152	ft^3/s	66.8	348	52.8
25 Year Peak Flood	203	ft^3/s	88.6	463	53.2
50 Year Peak Flood	246	ft^3/s	105	574	54.2
100 Year Peak Flood	293	ft^3/s	123	696	56
200 Year Peak Flood	342	ft^3/s	140	835	58
500 Year Peak Flood	404	ft^3/s	158	1030	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	47.6	ft^3/s	10.7	217
2 Year Peak Flood	64.1	ft^3/s	17.4	238
2 33 Year Peak Flood	72.4	ft^3/s	20.8	254
5 Year Peak Flood	116	ft^3/s	38.4	350
10 Year Peak Flood	161	ft^3/s	56.1	461
25 Year Peak Flood	225	ft^3/s	79.5	639
50 Year Peak Flood	277	ft^3/s	97.6	789
100 Year Peak Flood	336	ft^3/s	115	980
200 Year Peak Flood	397	ft^3/s	132	1190
500 Year Peak Flood	487	ft^3/s	156	1530

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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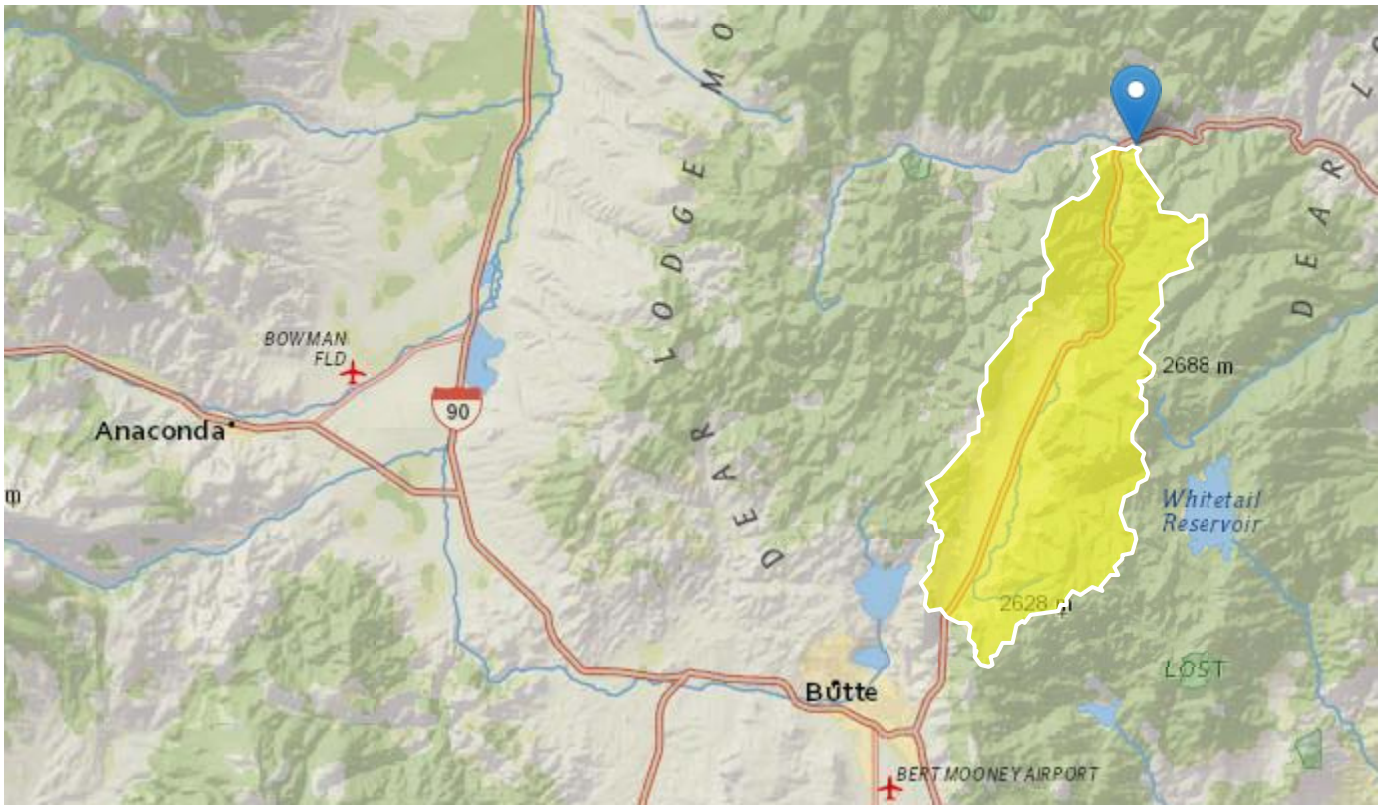
Application Version: 4.3.0

StreamStats Report - Node 800 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190402160217306000
Clicked Point (Latitude, Longitude): 46.26028, -112.32963
Time: 2019-04-02 10:02:31 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	77.7	square miles
EL6000	Percent of area above 6000 ft	96	percent
PRECIP	Mean Annual Precipitation	21.44	inches
FOREST	Percentage of area covered by forest	72.8	percent

Peak-Flow Statistics Parameters [97 Percent (75.4 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	77.7	square miles	0.42	2480
EL6000	Percent above 6000 ft	96	percent	0	100

Peak-Flow Statistics Parameters [3 Percent (2.27 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	77.7	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	21.44	inches	14.6	62.1
FOREST	Percent Forest	72.8	percent	20.4	99.1

Peak-Flow Statistics Flow Report [97 Percent (75.4 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	174	ft^3/s	37.4	808	118
2 Year Peak Flood	220	ft^3/s	58.5	830	96
2 33 Year Peak Flood	242	ft^3/s	68.1	857	90.1
5 Year Peak Flood	350	ft^3/s	115	1060	76.9
10 Year Peak Flood	454	ft^3/s	158	1310	72.1
25 Year Peak Flood	596	ft^3/s	210	1690	71.3
50 Year Peak Flood	704	ft^3/s	248	2000	72
100 Year Peak Flood	823	ft^3/s	283	2390	73.8
200 Year Peak Flood	942	ft^3/s	315	2820	76.5
500 Year Peak Flood	1120	ft^3/s	357	3490	80.3

Peak-Flow Statistics Flow Report [3 Percent (2.27 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	136	ft^3/s	55	337	59.4
2 Year Peak Flood	182	ft^3/s	76.1	435	56.5
2 33 Year Peak Flood	205	ft^3/s	86.7	486	55.7
5 Year Peak Flood	318	ft^3/s	139	727	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	438	ft^3/s	193	995	52.8
25 Year Peak Flood	583	ft^3/s	256	1320	53.2
50 Year Peak Flood	707	ft^3/s	305	1640	54.2
100 Year Peak Flood	841	ft^3/s	356	1990	56
200 Year Peak Flood	983	ft^3/s	405	2390	58
500 Year Peak Flood	1160	ft^3/s	458	2940	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	173	ft^3/s	37.9	794
2 Year Peak Flood	219	ft^3/s	59	818
2 33 Year Peak Flood	241	ft^3/s	68.6	846
5 Year Peak Flood	349	ft^3/s	116	1050
10 Year Peak Flood	453	ft^3/s	159	1300
25 Year Peak Flood	596	ft^3/s	211	1680
50 Year Peak Flood	704	ft^3/s	249	1990
100 Year Peak Flood	824	ft^3/s	285	2380
200 Year Peak Flood	944	ft^3/s	317	2810
500 Year Peak Flood	1120	ft^3/s	360	3470

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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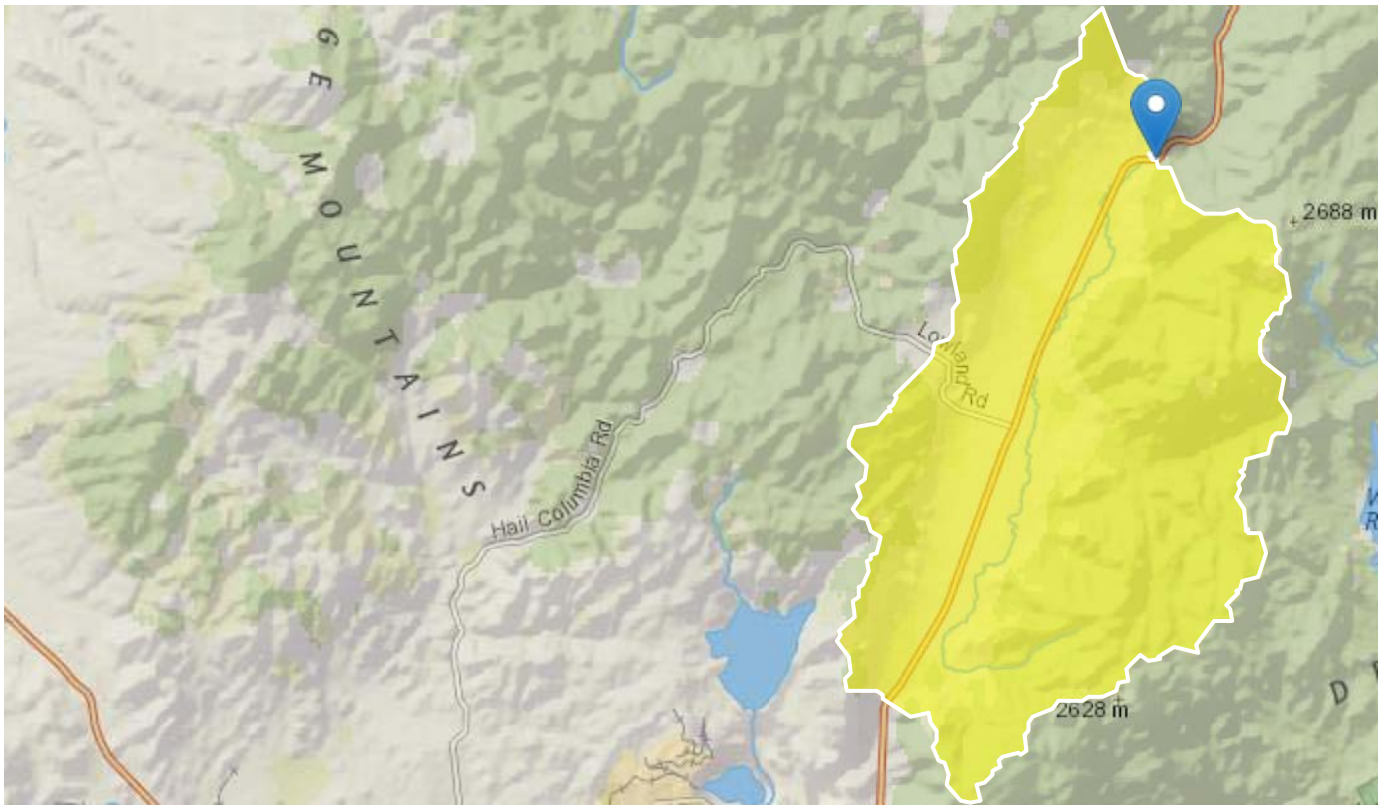
Application Version: 4.3.0

StreamStats Report - Node 900 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190402160541957000
Clicked Point (Latitude, Longitude): 46.16592, -112.36769
Time: 2019-04-02 10:05:56 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	55.5	square miles
EL6000	Percent of area above 6000 ft	100	percent
PRECIP	Mean Annual Precipitation	21.63	inches
FOREST	Percentage of area covered by forest	65.7	percent

Peak-Flow Statistics Parameters [96 Percent (53.2 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	55.5	square miles	0.42	2480
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Parameters [4 Percent (2.27 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	55.5	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	21.63	inches	14.6	62.1
FOREST	Percent Forest	65.7	percent	20.4	99.1

Peak-Flow Statistics Flow Report [96 Percent (53.2 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	126	ft^3/s	27.1	588	118
2 Year Peak Flood	162	ft^3/s	42.9	610	96
2 33 Year Peak Flood	178	ft^3/s	50.2	633	90.1
5 Year Peak Flood	263	ft^3/s	86.3	800	76.9
10 Year Peak Flood	345	ft^3/s	120	993	72.1
25 Year Peak Flood	458	ft^3/s	161	1300	71.3
50 Year Peak Flood	545	ft^3/s	191	1550	72
100 Year Peak Flood	641	ft^3/s	220	1870	73.8
200 Year Peak Flood	738	ft^3/s	246	2220	76.5
500 Year Peak Flood	879	ft^3/s	280	2760	80.3

Peak-Flow Statistics Flow Report [4 Percent (2.27 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	110	ft^3/s	44.6	272	59.4
2 Year Peak Flood	148	ft^3/s	62.1	354	56.5
2 33 Year Peak Flood	168	ft^3/s	70.9	397	55.7
5 Year Peak Flood	262	ft^3/s	115	600	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	365	ft^3/s	161	827	52.8
25 Year Peak Flood	489	ft^3/s	215	1110	53.2
50 Year Peak Flood	595	ft^3/s	257	1380	54.2
100 Year Peak Flood	711	ft^3/s	301	1680	56
200 Year Peak Flood	833	ft^3/s	343	2020	58
500 Year Peak Flood	988	ft^3/s	390	2500	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	126	ft^3/s	27.9	575
2 Year Peak Flood	161	ft^3/s	43.7	599
2 33 Year Peak Flood	178	ft^3/s	51	624
5 Year Peak Flood	263	ft^3/s	87.4	792
10 Year Peak Flood	346	ft^3/s	121	986
25 Year Peak Flood	459	ft^3/s	163	1300
50 Year Peak Flood	547	ft^3/s	194	1550
100 Year Peak Flood	644	ft^3/s	223	1860
200 Year Peak Flood	742	ft^3/s	250	2210
500 Year Peak Flood	884	ft^3/s	285	2750

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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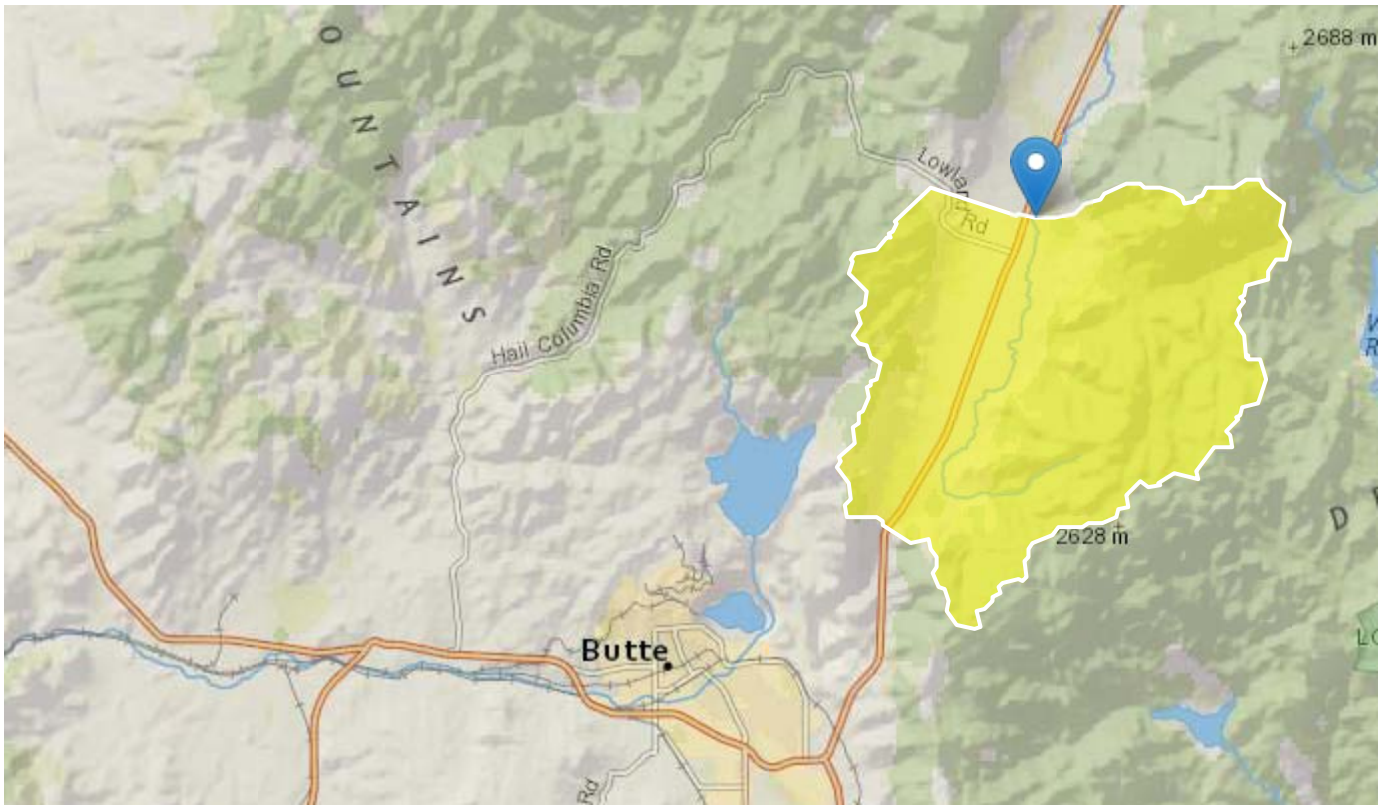
Application Version: 4.3.0

StreamStats Report - Node 1000 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190402161005821000
Clicked Point (Latitude, Longitude): 46.11097, -112.40850
Time: 2019-04-02 10:10:21 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	35.2	square miles
EL6000	Percent of area above 6000 ft	100	percent
PRECIP	Mean Annual Precipitation	22.26	inches
FOREST	Percentage of area covered by forest	72.3	percent

Peak-Flow Statistics Parameters [94 Percent (32.9 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	35.2	square miles	0.42	2480
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Parameters [6 Percent (2.27 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	35.2	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	22.26	inches	14.6	62.1
FOREST	Percent Forest	72.3	percent	20.4	99.1

Peak-Flow Statistics Flow Report [94 Percent (32.9 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	81.2	ft^3/s	17.4	379	118
2 Year Peak Flood	106	ft^3/s	28	400	96
2 33 Year Peak Flood	118	ft^3/s	33.1	420	90.1
5 Year Peak Flood	179	ft^3/s	58.6	547	76.9
10 Year Peak Flood	240	ft^3/s	83	693	72.1
25 Year Peak Flood	326	ft^3/s	114	930	71.3
50 Year Peak Flood	393	ft^3/s	137	1120	72
100 Year Peak Flood	467	ft^3/s	159	1370	73.8
200 Year Peak Flood	542	ft^3/s	180	1640	76.5
500 Year Peak Flood	654	ft^3/s	208	2060	80.3

Peak-Flow Statistics Flow Report [6 Percent (2.27 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	71.1	ft^3/s	28.7	176	59.4
2 Year Peak Flood	96.1	ft^3/s	40.2	230	56.5
2 33 Year Peak Flood	109	ft^3/s	46	258	55.7
5 Year Peak Flood	171	ft^3/s	74.8	392	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	239	ft^3/s	105	543	52.8
25 Year Peak Flood	321	ft^3/s	141	732	53.2
50 Year Peak Flood	392	ft^3/s	169	911	54.2
100 Year Peak Flood	469	ft^3/s	199	1110	56
200 Year Peak Flood	551	ft^3/s	227	1340	58
500 Year Peak Flood	655	ft^3/s	258	1660	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	80.6	ft^3/s	18.1	366
2 Year Peak Flood	105	ft^3/s	28.8	389
2 33 Year Peak Flood	117	ft^3/s	33.9	409
5 Year Peak Flood	179	ft^3/s	59.7	537
10 Year Peak Flood	240	ft^3/s	84.5	684
25 Year Peak Flood	325	ft^3/s	116	917
50 Year Peak Flood	393	ft^3/s	139	1110
100 Year Peak Flood	467	ft^3/s	162	1350
200 Year Peak Flood	543	ft^3/s	183	1620
500 Year Peak Flood	654	ft^3/s	211	2040

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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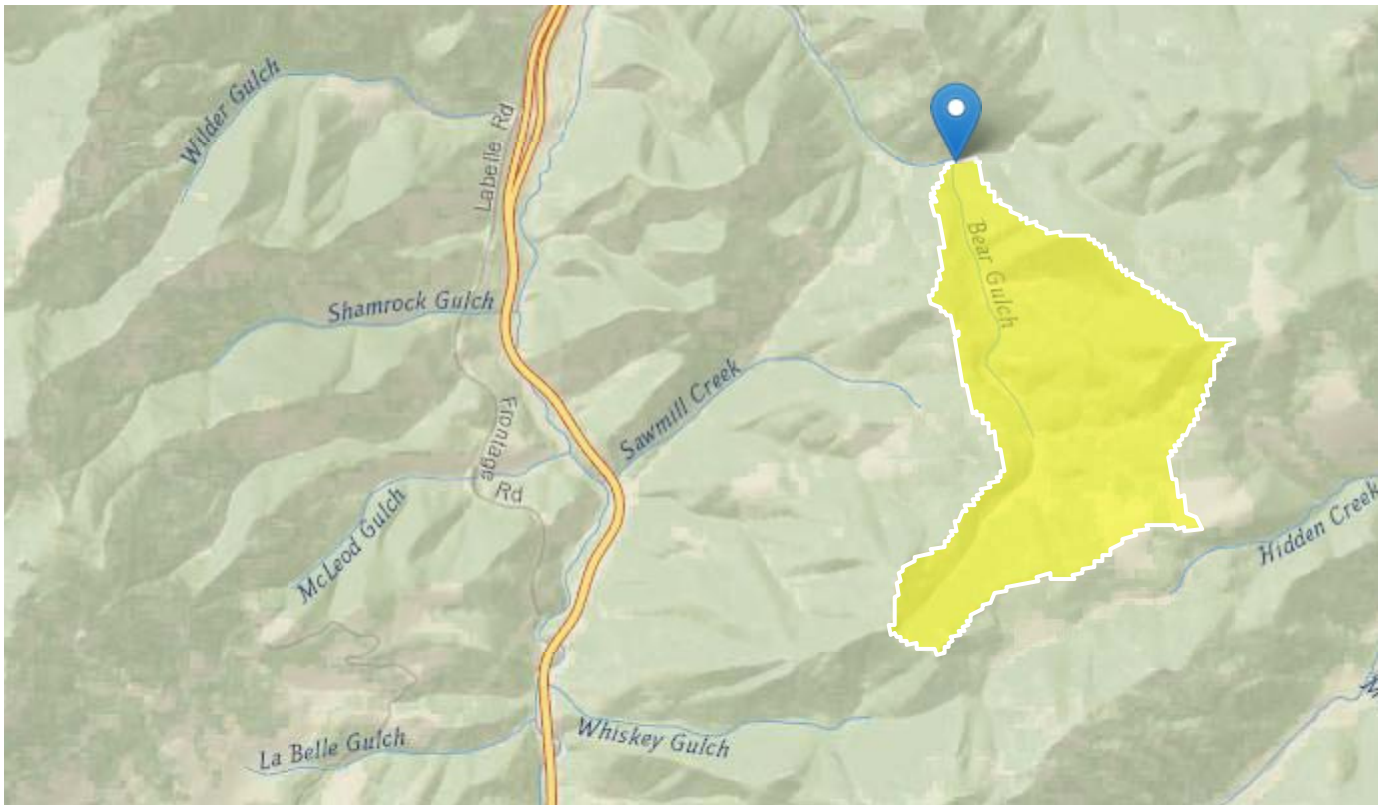
Application Version: 4.3.0

StreamStats Report - Node 1100 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190212153649500000
Clicked Point (Latitude, Longitude): 46.22413, -112.31085
Time: 2019-02-12 08:37:04 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.4	square miles
EL6000	Percent of area above 6000 ft	100	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.4	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	3.55	ft^3/s	0.697	18	118
2 Year Peak Flood	5.28	ft^3/s	1.29	21.6	96
2 33 Year Peak Flood	6.26	ft^3/s	1.63	24	90.1
5 Year Peak Flood	11.9	ft^3/s	3.61	38.9	76.9
10 Year Peak Flood	18.4	ft^3/s	5.92	57.4	72.1
25 Year Peak Flood	29	ft^3/s	9.38	89.7	71.3
50 Year Peak Flood	38.4	ft^3/s	12.3	119	72
100 Year Peak Flood	49.5	ft^3/s	15.5	158	73.8
200 Year Peak Flood	61.5	ft^3/s	18.6	204	76.5
500 Year Peak Flood	80.7	ft^3/s	23.2	281	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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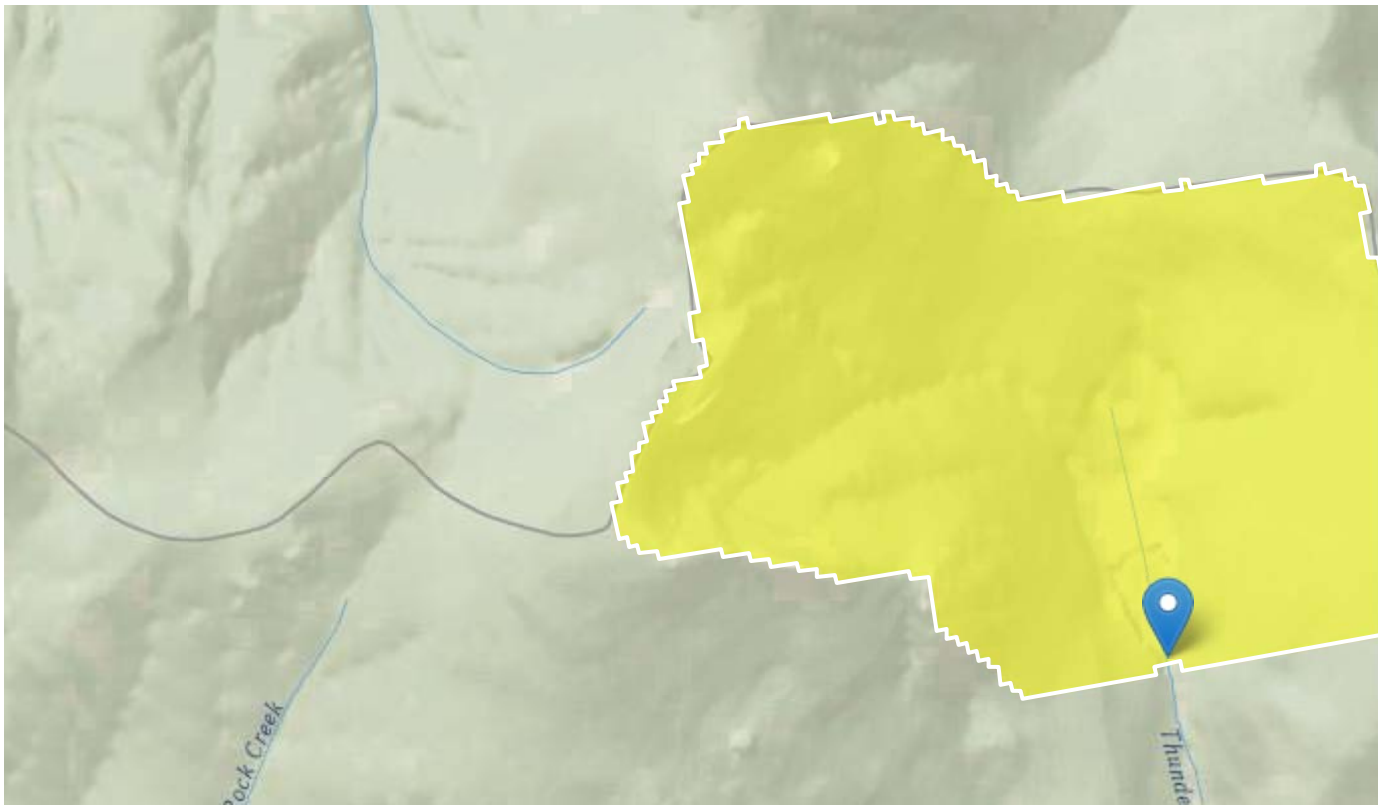
Application Version: 4.3.0

StreamStats Report - Node 1200 Boulder Tributaries

Region ID: MT
Workspace ID: MT20190327181114166000
Clicked Point (Latitude, Longitude): 46.32634, -112.47989
Time: 2019-03-27 12:11:29 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.5	square miles
EL6000	Percent of area above 6000 ft	100	percent
PRECIP	Mean Annual Precipitation	34.56	inches
FOREST	Percentage of area covered by forest	96.5	percent

Peak-Flow Statistics Parameters [10 Percent (0.156 square miles) SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.5	square miles	0.42	2480
EL6000	Percent above 6000 ft	100	percent	0	100

Peak-Flow Statistics Parameters [90 Percent (1.34 square miles) W Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.5	square miles	0.6	2470
PRECIP	Mean Annual Precipitation	34.56	inches	14.6	62.1
FOREST	Percent Forest	96.5	percent	20.4	99.1

Peak-Flow Statistics Flow Report [10 Percent (0.156 square miles) SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	3.79	ft^3/s	0.747	19.2	118
2 Year Peak Flood	5.63	ft^3/s	1.38	22.9	96
2 33 Year Peak Flood	6.67	ft^3/s	1.74	25.5	90.1
5 Year Peak Flood	12.6	ft^3/s	3.83	41.1	76.9
10 Year Peak Flood	19.5	ft^3/s	6.27	60.4	72.1
25 Year Peak Flood	30.5	ft^3/s	9.91	94.2	71.3
50 Year Peak Flood	40.3	ft^3/s	13	125	72
100 Year Peak Flood	51.9	ft^3/s	16.3	166	73.8
200 Year Peak Flood	64.5	ft^3/s	19.5	213	76.5
500 Year Peak Flood	84.4	ft^3/s	24.3	293	80.3

Peak-Flow Statistics Flow Report [90 Percent (1.34 square miles) W Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	8.35	ft^3/s	3.32	21	59.4
2 Year Peak Flood	11.1	ft^3/s	4.57	26.9	56.5
2 33 Year Peak Flood	12.5	ft^3/s	5.2	30.2	55.7
5 Year Peak Flood	19.3	ft^3/s	8.28	44.9	53.4

Statistic	Value	Unit	PIl	PIu	SEp
10 Year Peak Flood	26.8	ft^3/s	11.6	62	52.8
25 Year Peak Flood	35.5	ft^3/s	15.3	82.5	53.2
50 Year Peak Flood	43	ft^3/s	18.1	102	54.2
100 Year Peak Flood	51	ft^3/s	21	123	56
200 Year Peak Flood	59.3	ft^3/s	23.8	148	58
500 Year Peak Flood	69.8	ft^3/s	26.8	182	61.4

Peak-Flow Statistics Flow Report [Area-Averaged]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu
1.5 Year Peak Flood	7.87	ft^3/s	3.05	20.8
2 Year Peak Flood	10.5	ft^3/s	4.23	26.5
2 33 Year Peak Flood	11.9	ft^3/s	4.84	29.7
5 Year Peak Flood	18.6	ft^3/s	7.82	44.6
10 Year Peak Flood	26	ft^3/s	11	61.9
25 Year Peak Flood	35	ft^3/s	14.7	83.7
50 Year Peak Flood	42.7	ft^3/s	17.6	104
100 Year Peak Flood	51.1	ft^3/s	20.5	128
200 Year Peak Flood	59.8	ft^3/s	23.3	155
500 Year Peak Flood	71.3	ft^3/s	26.5	194

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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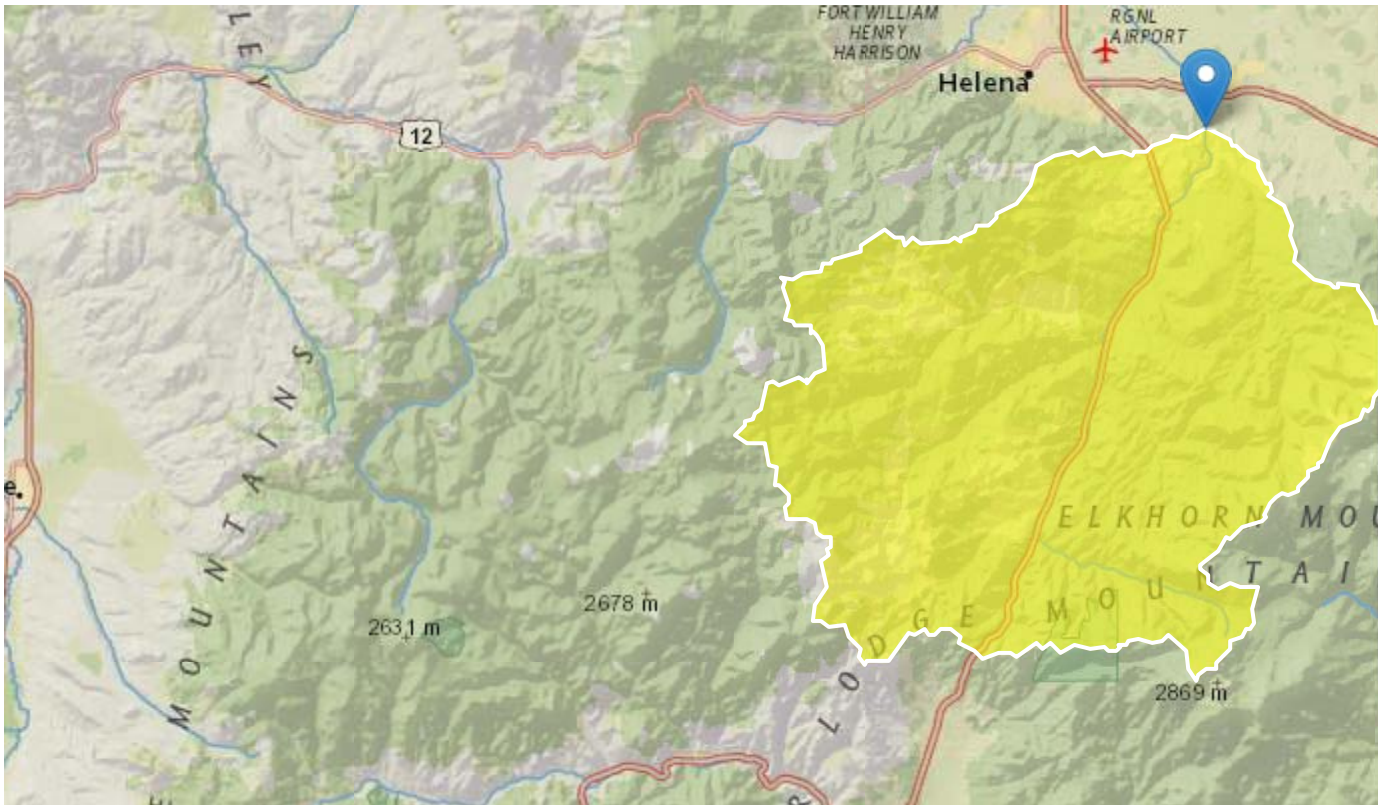
Application Version: 4.3.0

StreamStats Report - Node 100 PPC Main

Region ID: MT
Workspace ID: MT20190402183645492000
Clicked Point (Latitude, Longitude): 46.56894, -111.91534
Time: 2019-04-02 12:36:59 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	247.8	square miles
EL6000	Percent of area above 6000 ft	26.8	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	247.8	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	26.8	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	420	ft^3/s	89.1	1980	118
2 Year Peak Flood	575	ft^3/s	151	2190	96
2 33 Year Peak Flood	650	ft^3/s	181	2330	90.1
5 Year Peak Flood	1040	ft^3/s	337	3190	76.9
10 Year Peak Flood	1430	ft^3/s	490	4140	72.1
25 Year Peak Flood	2000	ft^3/s	698	5760	71.3
50 Year Peak Flood	2470	ft^3/s	859	7120	72
100 Year Peak Flood	3010	ft^3/s	1020	8860	73.8
200 Year Peak Flood	3580	ft^3/s	1180	10900	76.5
500 Year Peak Flood	4430	ft^3/s	1400	14100	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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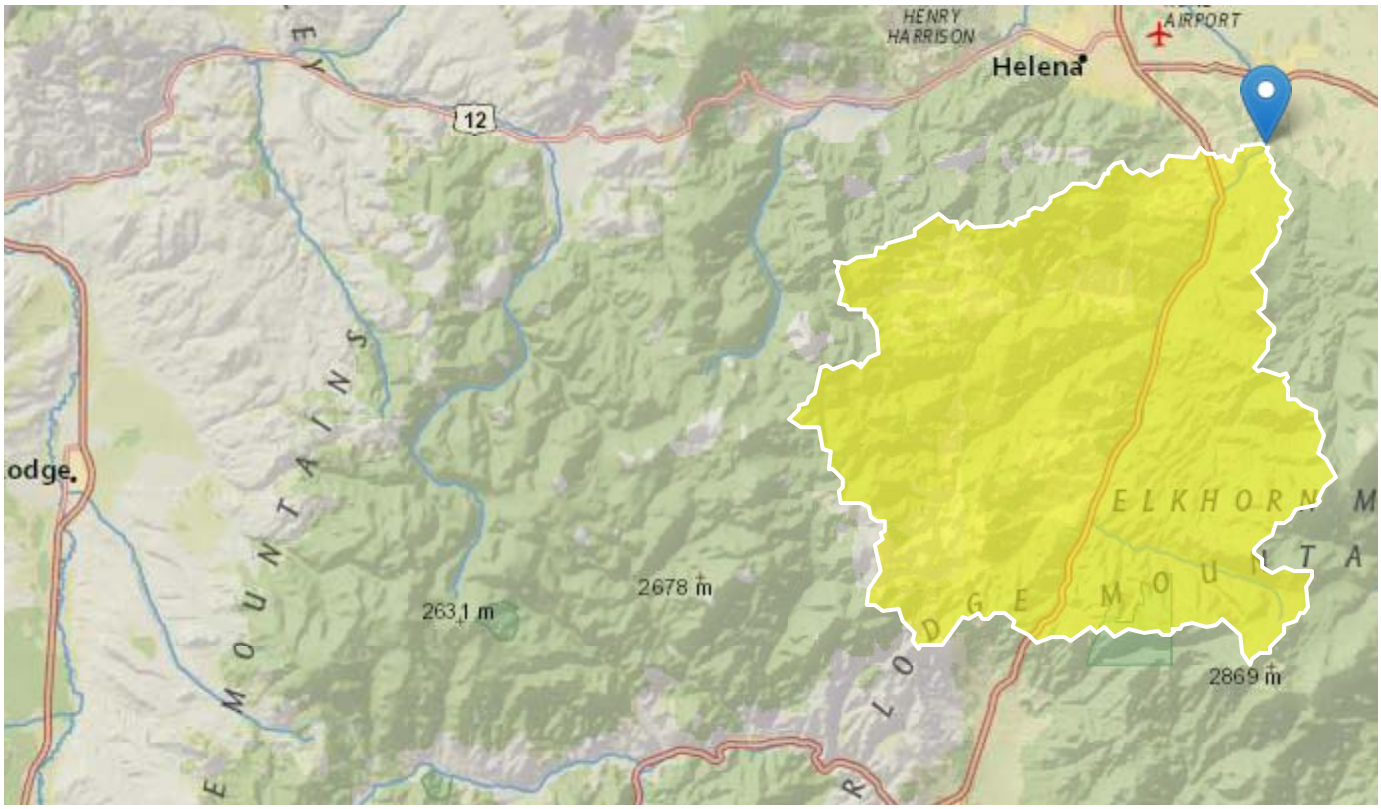
Application Version: 4.3.0

StreamStats Report - Node 200 PPC Main

Region ID: MT
Workspace ID: MT20190327205151744000
Clicked Point (Latitude, Longitude): 46.55426, -111.91056
Time: 2019-03-27 14:52:07 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	205.2	square miles
EL6000	Percent of area above 6000 ft	26.9	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	205.2	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	26.9	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	350	ft^3/s	74.5	1640	118
2 Year Peak Flood	483	ft^3/s	127	1830	96
2 33 Year Peak Flood	547	ft^3/s	153	1960	90.1
5 Year Peak Flood	885	ft^3/s	288	2710	76.9
10 Year Peak Flood	1230	ft^3/s	423	3560	72.1
25 Year Peak Flood	1740	ft^3/s	607	4980	71.3
50 Year Peak Flood	2160	ft^3/s	751	6190	72
100 Year Peak Flood	2630	ft^3/s	896	7740	73.8
200 Year Peak Flood	3150	ft^3/s	1040	9540	76.5
500 Year Peak Flood	3910	ft^3/s	1240	12400	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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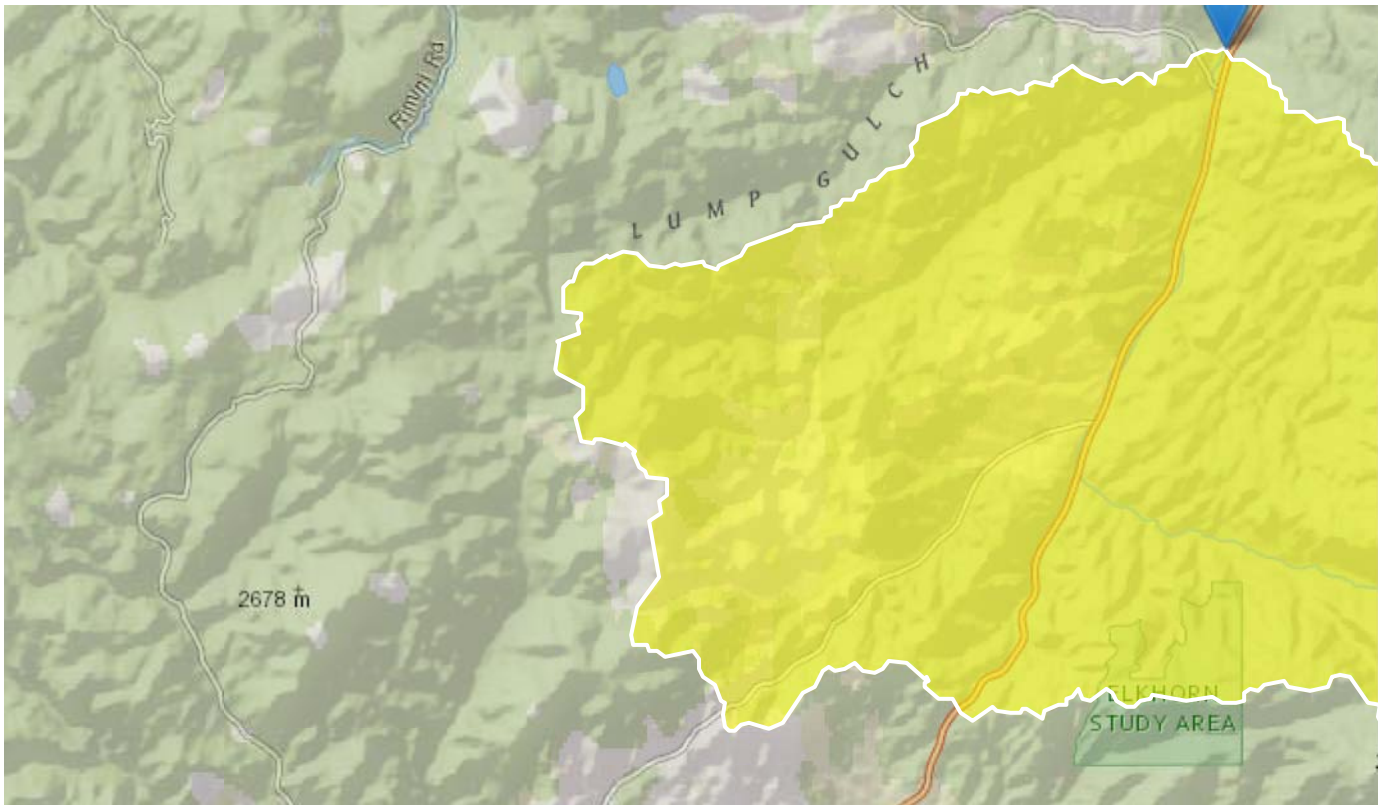
Application Version: 4.3.0

StreamStats Report - Node 300 PPC Main

Region ID: MT
Workspace ID: MT20190402184225367000
Clicked Point (Latitude, Longitude): 46.47769, -111.98008
Time: 2019-04-02 12:42:39 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	130.3	square miles
EL6000	Percent of area above 6000 ft	31.7	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	130.3	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	31.7	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	232	ft^3/s	49.9	1080	118
2 Year Peak Flood	321	ft^3/s	85.2	1210	96
2 33 Year Peak Flood	365	ft^3/s	103	1300	90.1
5 Year Peak Flood	595	ft^3/s	195	1810	76.9
10 Year Peak Flood	830	ft^3/s	288	2390	72.1
25 Year Peak Flood	1180	ft^3/s	416	3370	71.3
50 Year Peak Flood	1470	ft^3/s	517	4200	72
100 Year Peak Flood	1800	ft^3/s	618	5270	73.8
200 Year Peak Flood	2160	ft^3/s	718	6500	76.5
500 Year Peak Flood	2690	ft^3/s	857	8450	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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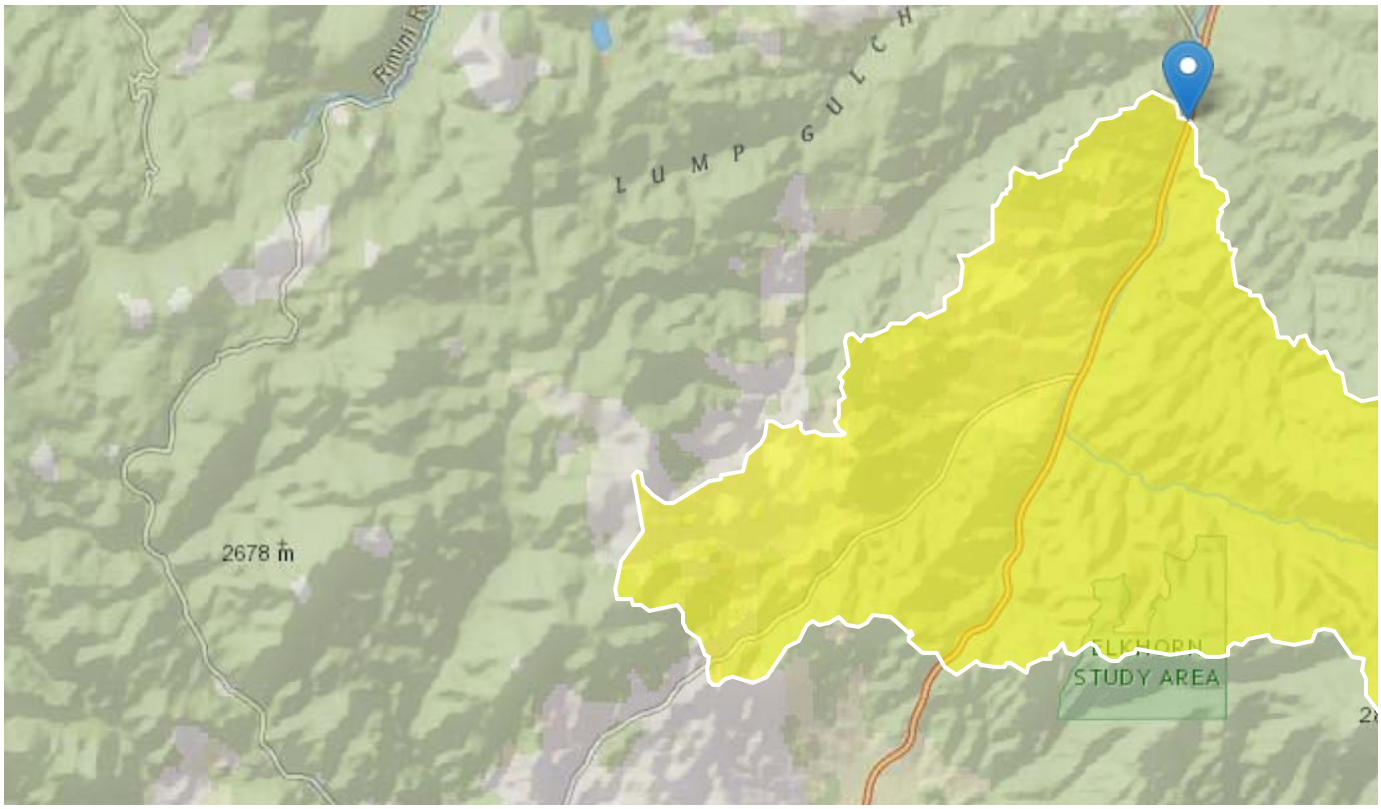
Application Version: 4.3.0

StreamStats Report - Node 400 PPC Main

Region ID: MT
Workspace ID: MT20190227182500803000
Clicked Point (Latitude, Longitude): 46.44969, -111.98744
Time: 2019-02-27 11:25:15 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	74.4	square miles
EL6000	Percent of area above 6000 ft	31.4	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	74.4	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	31.4	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	135	ft^3/s	29	624	118
2 Year Peak Flood	191	ft^3/s	50.7	717	96
2 33 Year Peak Flood	219	ft^3/s	61.8	777	90.1
5 Year Peak Flood	372	ft^3/s	122	1130	76.9
10 Year Peak Flood	532	ft^3/s	185	1530	72.1
25 Year Peak Flood	779	ft^3/s	274	2220	71.3
50 Year Peak Flood	987	ft^3/s	346	2810	72
100 Year Peak Flood	1230	ft^3/s	421	3570	73.8
200 Year Peak Flood	1490	ft^3/s	495	4460	76.5
500 Year Peak Flood	1880	ft^3/s	600	5890	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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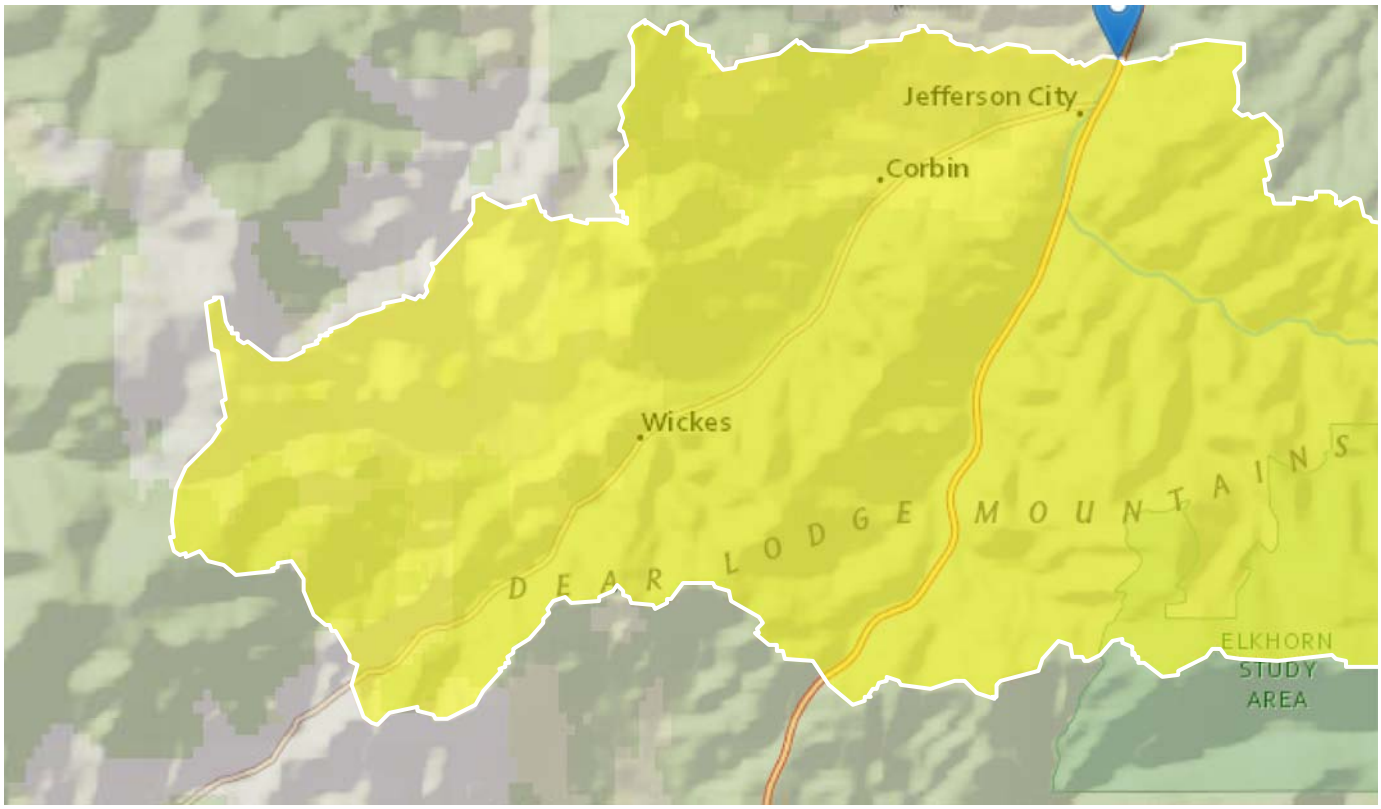
Application Version: 4.3.0

StreamStats Report - Node 500 PPC Main

Region ID: MT
Workspace ID: MT20190227181734936000
Clicked Point (Latitude, Longitude): 46.39499, -112.02139
Time: 2019-02-27 11:17:50 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	51.9	square miles
EL6000	Percent of area above 6000 ft	38.8	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	51.9	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	38.8	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	98.7	ft^3/s	21.3	457	118
2 Year Peak Flood	139	ft^3/s	37.1	522	96
2 33 Year Peak Flood	160	ft^3/s	45.1	565	90.1
5 Year Peak Flood	269	ft^3/s	88.7	818	76.9
10 Year Peak Flood	385	ft^3/s	134	1110	72.1
25 Year Peak Flood	562	ft^3/s	198	1600	71.3
50 Year Peak Flood	710	ft^3/s	250	2020	72
100 Year Peak Flood	881	ft^3/s	303	2560	73.8
200 Year Peak Flood	1060	ft^3/s	355	3190	76.5
500 Year Peak Flood	1340	ft^3/s	429	4200	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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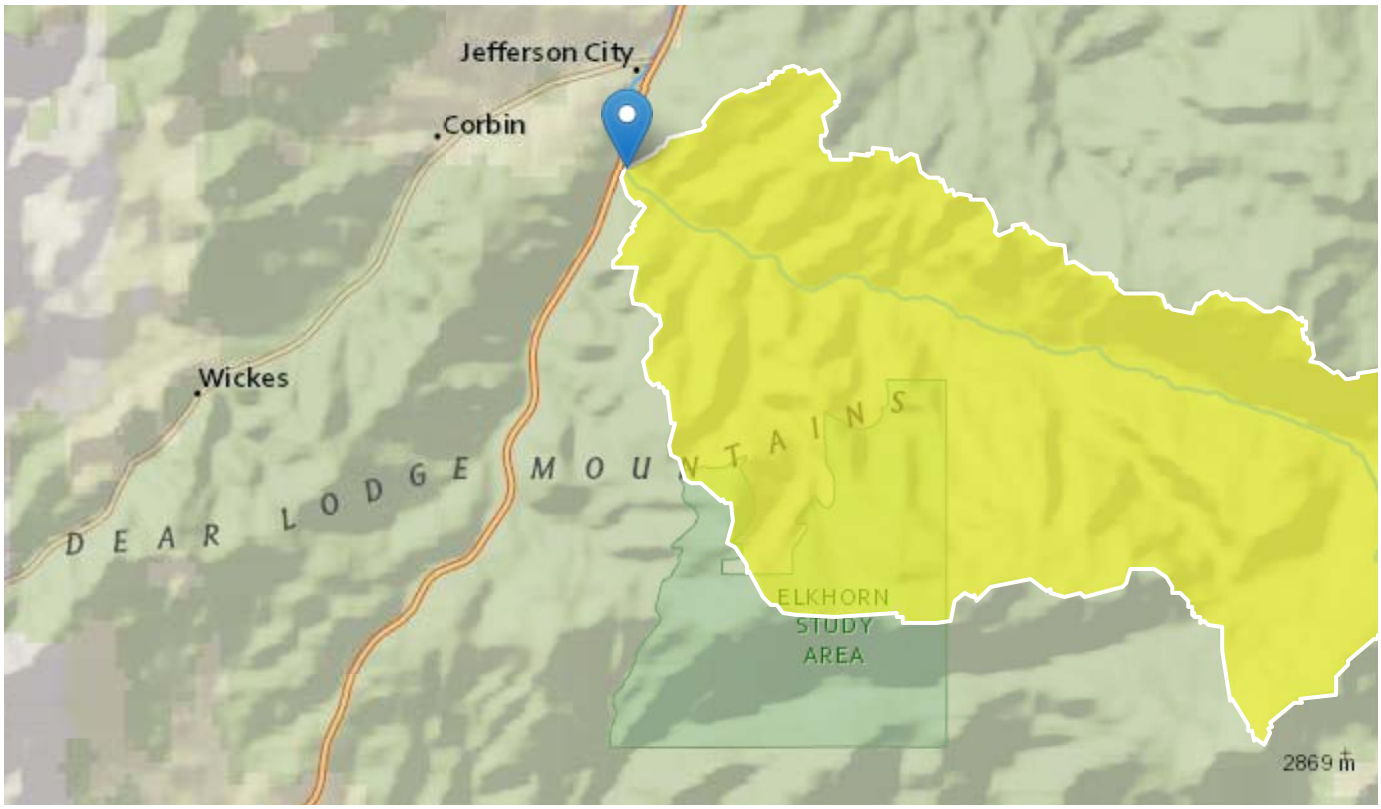
Application Version: 4.3.0

StreamStats Report - Node 600 PPC Main

Region ID: MT
Workspace ID: MT20190212162530049000
Clicked Point (Latitude, Longitude): 46.37651, -112.02952
Time: 2019-02-12 09:25:44 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	20.6	square miles
EL6000	Percent of area above 6000 ft	60.9	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	20.6	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	60.9	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	43.9	ft^3/s	9.41	205	118
2 Year Peak Flood	61.4	ft^3/s	16.3	232	96
2 33 Year Peak Flood	70.5	ft^3/s	19.8	251	90.1
5 Year Peak Flood	119	ft^3/s	39	364	76.9
10 Year Peak Flood	171	ft^3/s	59	494	72.1
25 Year Peak Flood	249	ft^3/s	87.2	712	71.3
50 Year Peak Flood	314	ft^3/s	110	901	72
100 Year Peak Flood	389	ft^3/s	133	1140	73.8
200 Year Peak Flood	469	ft^3/s	155	1420	76.5
500 Year Peak Flood	591	ft^3/s	187	1860	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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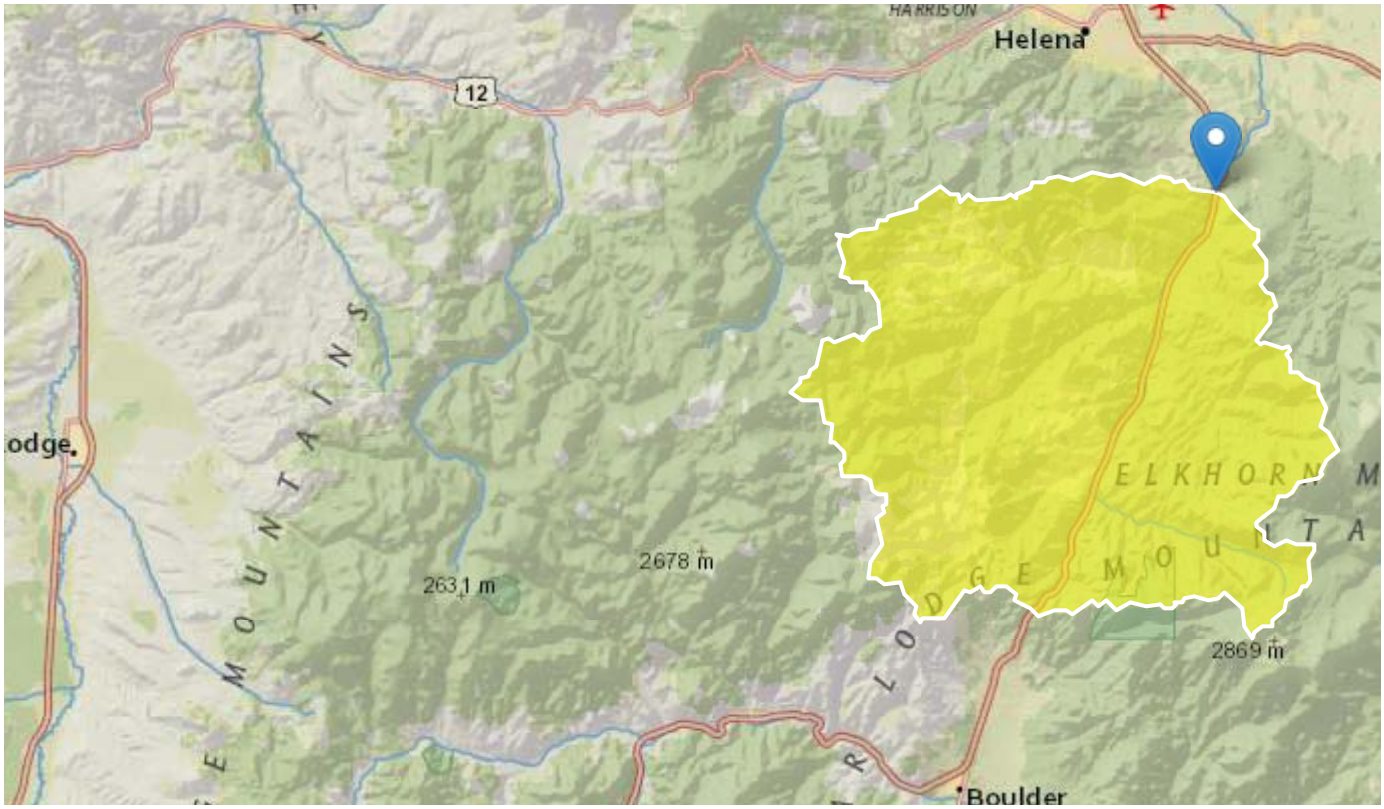
StreamStats Report - USGS Gage 06061500 PPC Main

Region ID: MT
Workspace ID: MT20190508194245678000
Clicked Point (Latitude, Longitude): 46.51919, -111.94676
Time: 2019-05-08 13:43:02 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	192.2	square miles
EL6000	Percent of area above 6000 ft	28.6	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	192.2	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	28.6	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	332	ft^3/s	70.9	1560	118
2 Year Peak Flood	457	ft^3/s	121	1730	96
2 33 Year Peak Flood	517	ft^3/s	145	1850	90.1
5 Year Peak Flood	833	ft^3/s	272	2550	76.9
10 Year Peak Flood	1150	ft^3/s	398	3330	72.1
25 Year Peak Flood	1630	ft^3/s	569	4660	71.3
50 Year Peak Flood	2020	ft^3/s	703	5780	72
100 Year Peak Flood	2460	ft^3/s	838	7220	73.8
200 Year Peak Flood	2930	ft^3/s	970	8870	76.5
500 Year Peak Flood	3640	ft^3/s	1150	11500	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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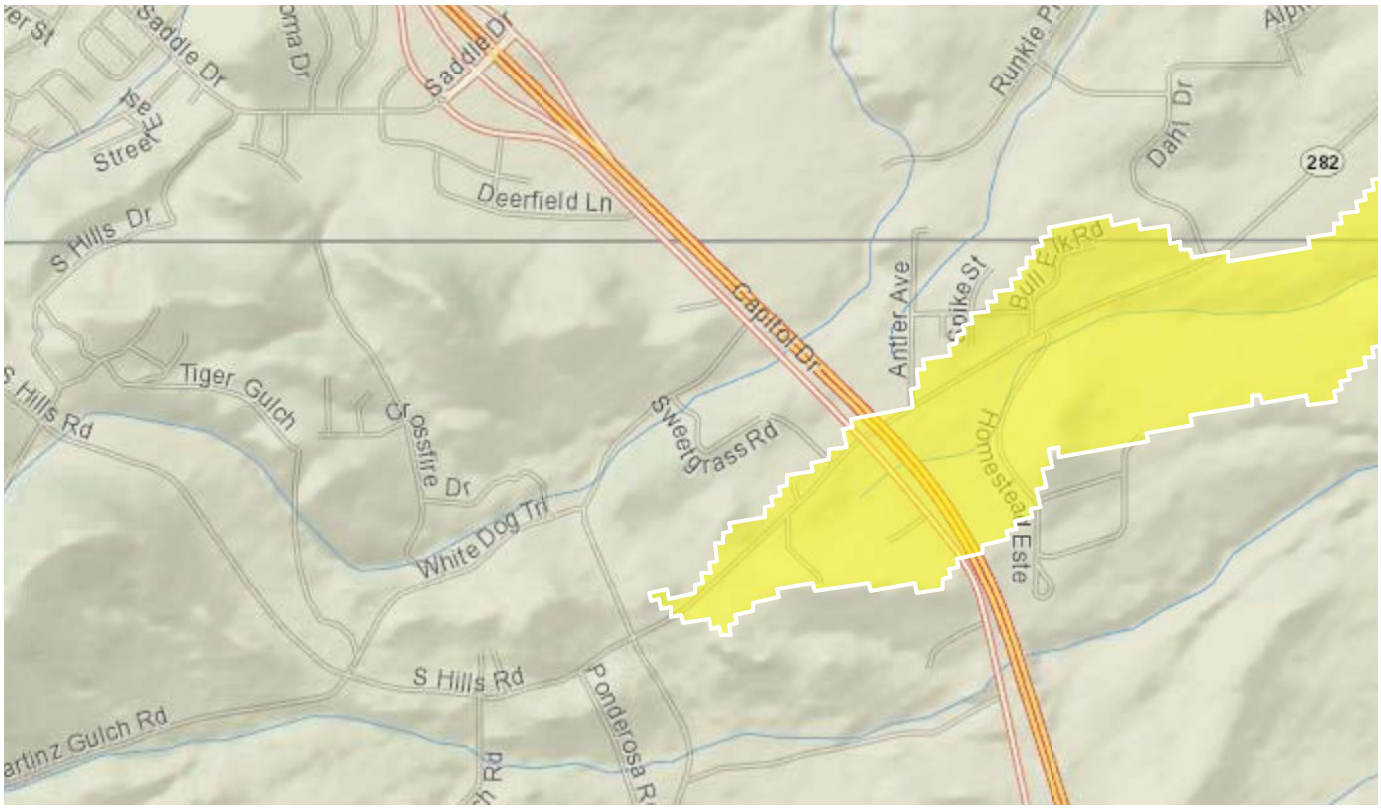
StreamStats Report - Node 100 PPC Tributaries

Region ID: MT
Workspace ID: MT20190212164043584000
Clicked Point (Latitude, Longitude): 46.56922, -111.93313
Time: 2019-02-12 09:40:59 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.6	square miles
EL6000	Percent of area above 6000 ft	0	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.6	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	0	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	0.633	ft^3/s	0.119	3.38	118
2 Year Peak Flood	1.55	ft^3/s	0.362	6.62	96
2 33 Year Peak Flood	2.27	ft^3/s	0.565	9.11	90.1
5 Year Peak Flood	8.72	ft^3/s	2.53	30.1	76.9
10 Year Peak Flood	21.2	ft^3/s	6.46	69.8	72.1
25 Year Peak Flood	54.4	ft^3/s	16.6	179	71.3
50 Year Peak Flood	98.3	ft^3/s	29.6	326	72
100 Year Peak Flood	167	ft^3/s	48.7	571	73.8
200 Year Peak Flood	267	ft^3/s	75	950	76.5
500 Year Peak Flood	470	ft^3/s	125	1770	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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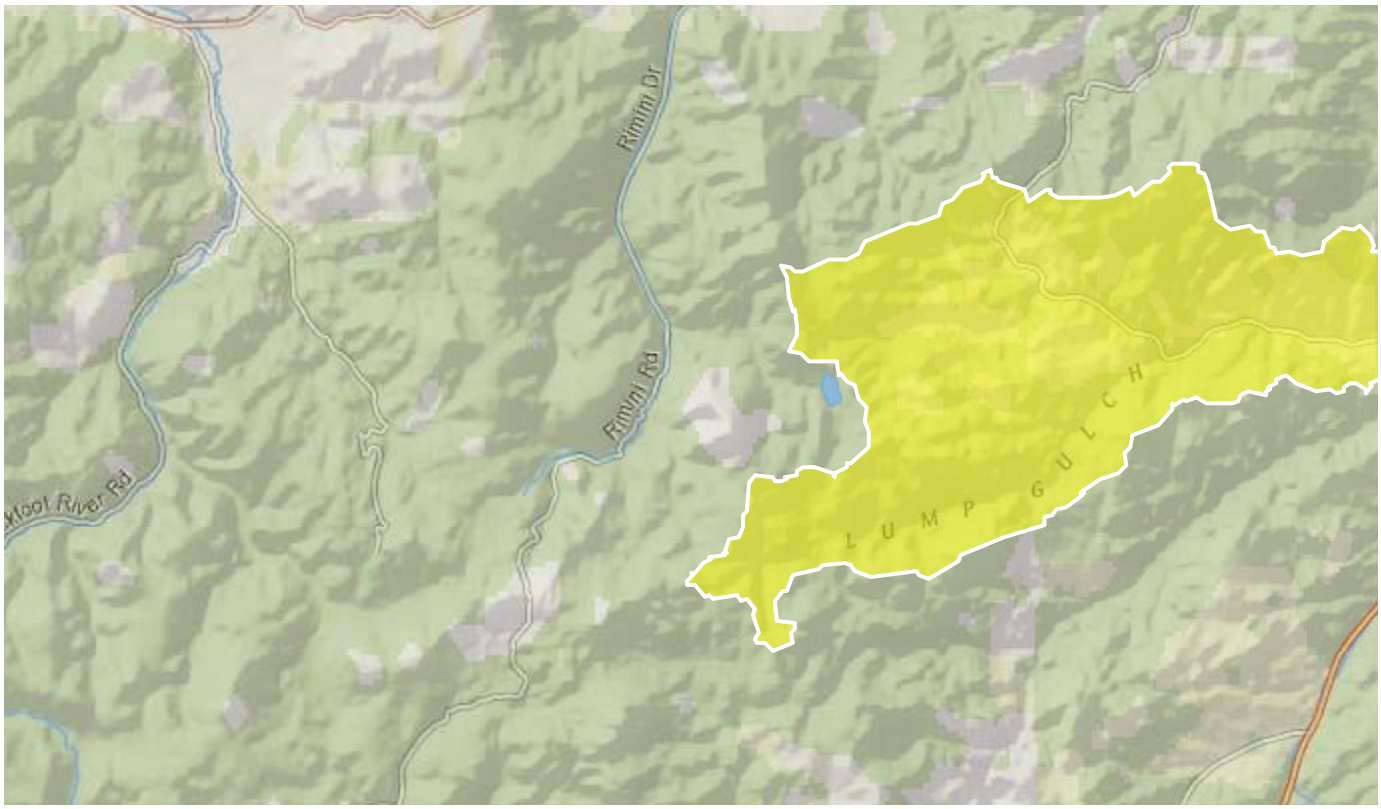
StreamStats Report - Node 200 PPC Tributaries

Region ID: MT
Workspace ID: MT20190212164246703000
Clicked Point (Latitude, Longitude): 46.47846, -111.98081
Time: 2019-02-12 09:43:01 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	43.6	square miles
EL6000	Percent of area above 6000 ft	30.2	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	43.6	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	30.2	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	79.5	ft^3/s	17.1	369	118
2 Year Peak Flood	116	ft^3/s	30.7	435	96
2 33 Year Peak Flood	134	ft^3/s	37.9	477	90.1
5 Year Peak Flood	238	ft^3/s	78.1	724	76.9
10 Year Peak Flood	350	ft^3/s	121	1010	72.1
25 Year Peak Flood	527	ft^3/s	185	1500	71.3
50 Year Peak Flood	680	ft^3/s	238	1940	72
100 Year Peak Flood	858	ft^3/s	294	2510	73.8
200 Year Peak Flood	1050	ft^3/s	350	3170	76.5
500 Year Peak Flood	1350	ft^3/s	431	4260	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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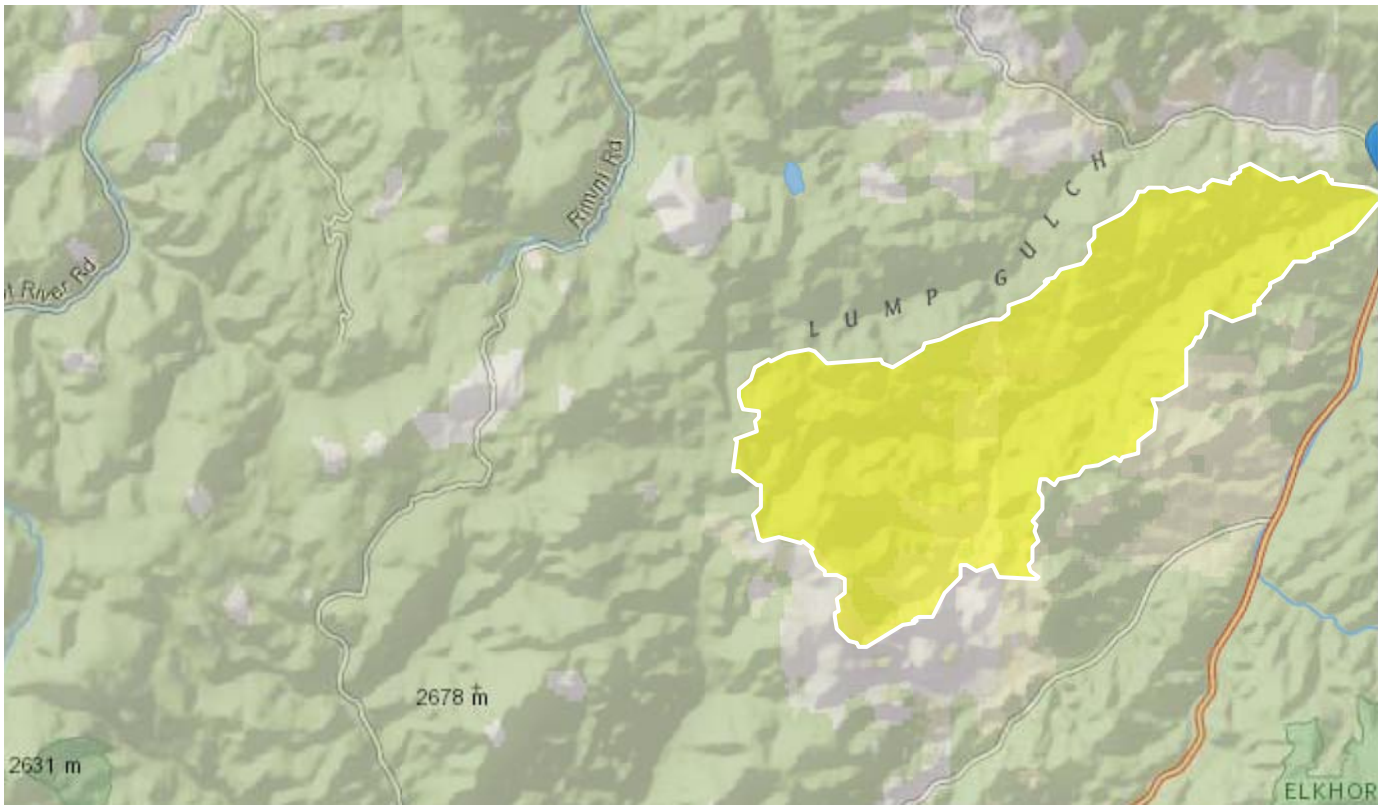
Application Version: 4.3.0

StreamStats Report - Node 300 PPC Tributaries

Region ID: MT
Workspace ID: MT20190228163534088000
Clicked Point (Latitude, Longitude): 46.46600, -111.98439
Time: 2019-02-28 09:35:48 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	32.8	square miles
EL6000	Percent of area above 6000 ft	35.9	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	32.8	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	35.9	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	62.3	ft^3/s	13.4	289	118
2 Year Peak Flood	90.1	ft^3/s	24	339	96
2 33 Year Peak Flood	105	ft^3/s	29.5	371	90.1
5 Year Peak Flood	184	ft^3/s	60.5	561	76.9
10 Year Peak Flood	271	ft^3/s	94	781	72.1
25 Year Peak Flood	407	ft^3/s	143	1160	71.3
50 Year Peak Flood	523	ft^3/s	183	1490	72
100 Year Peak Flood	659	ft^3/s	226	1920	73.8
200 Year Peak Flood	807	ft^3/s	268	2430	76.5
500 Year Peak Flood	1040	ft^3/s	329	3250	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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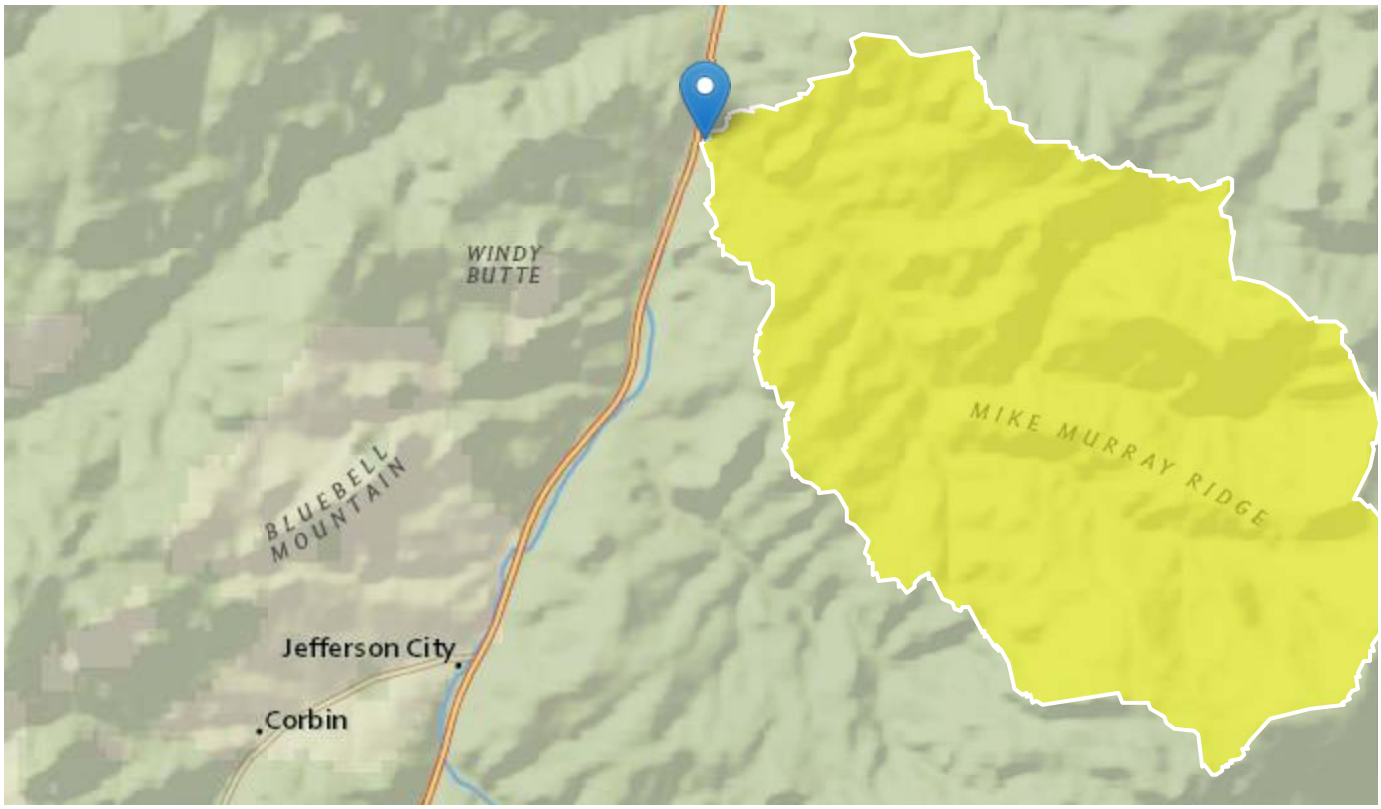
Application Version: 4.3.0

StreamStats Report - Node 400 PPC Tributaries

Region ID: MT
Workspace ID: MT20190212165013097000
Clicked Point (Latitude, Longitude): 46.45047, -111.98568
Time: 2019-02-12 09:50:27 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	20.7	square miles
EL6000	Percent of area above 6000 ft	29.7	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	20.7	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	29.7	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	38.4	ft^3/s	8.24	179	118
2 Year Peak Flood	57.7	ft^3/s	15.3	218	96
2 33 Year Peak Flood	68.2	ft^3/s	19.1	243	90.1
5 Year Peak Flood	127	ft^3/s	41.5	389	76.9
10 Year Peak Flood	194	ft^3/s	66.9	563	72.1
25 Year Peak Flood	303	ft^3/s	106	869	71.3
50 Year Peak Flood	399	ft^3/s	139	1150	72
100 Year Peak Flood	514	ft^3/s	175	1510	73.8
200 Year Peak Flood	642	ft^3/s	211	1950	76.5
500 Year Peak Flood	842	ft^3/s	266	2670	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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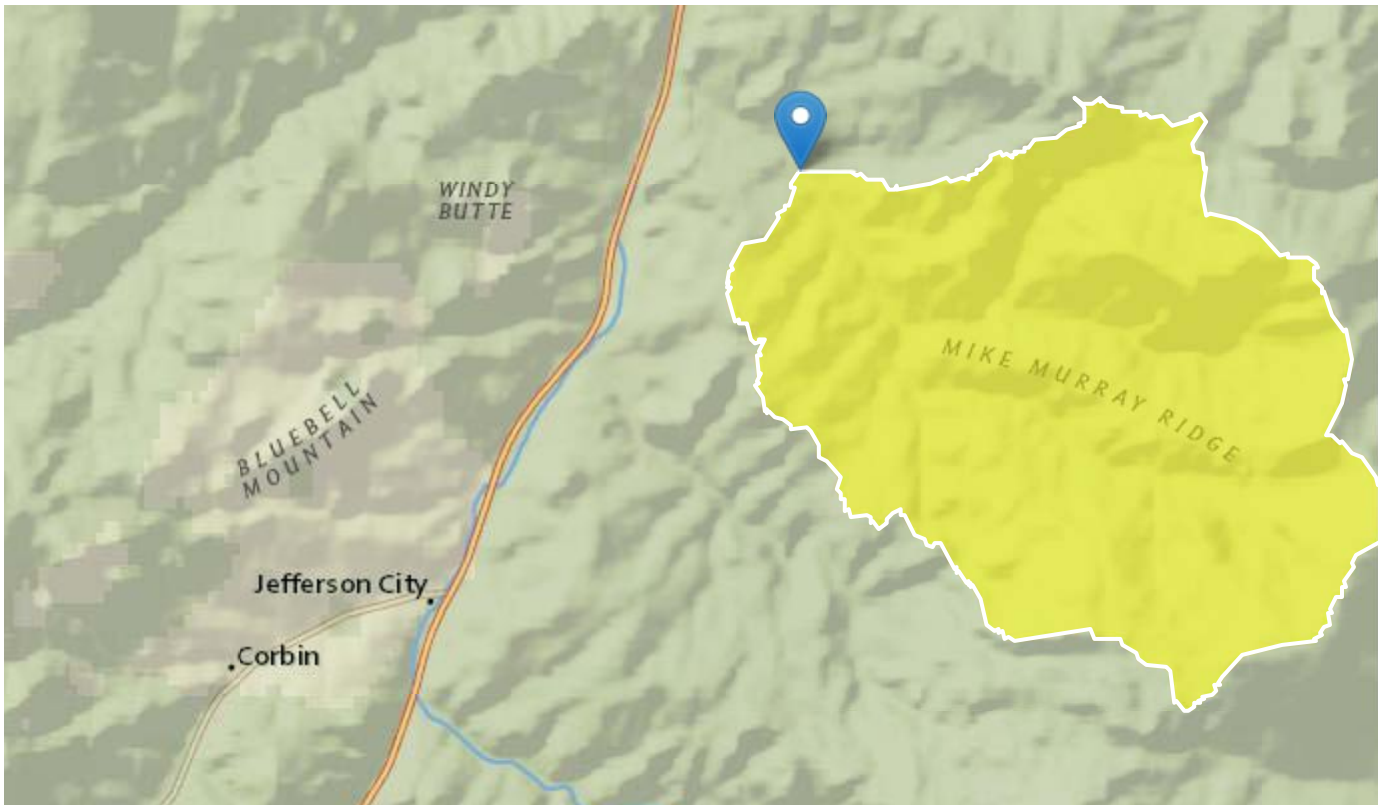
Application Version: 4.3.0

StreamStats Report - Node 500 PPC Tributaries

Region ID: MT
Workspace ID: MT20190327214223372000
Clicked Point (Latitude, Longitude): 46.43922, -111.96433
Time: 2019-03-27 15:42:38 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	16.7	square miles
EL6000	Percent of area above 6000 ft	36.9	percent

Peak-Flow Statistics Parameters [SW Region BasinC 2015 5019F]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	16.7	square miles	0.42	2480

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
EL6000	Percent above 6000 ft	36.9	percent	0	100

Peak-Flow Statistics Flow Report [SW Region BasinC 2015 5019F]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
1.5 Year Peak Flood	32.5	ft^3/s	6.96	152	118
2 Year Peak Flood	48.2	ft^3/s	12.7	183	96
2 33 Year Peak Flood	56.7	ft^3/s	15.9	203	90.1
5 Year Peak Flood	104	ft^3/s	34	319	76.9
10 Year Peak Flood	158	ft^3/s	54.3	458	72.1
25 Year Peak Flood	243	ft^3/s	84.9	699	71.3
50 Year Peak Flood	319	ft^3/s	111	917	72
100 Year Peak Flood	408	ft^3/s	138	1200	73.8
200 Year Peak Flood	506	ft^3/s	167	1540	76.5
500 Year Peak Flood	659	ft^3/s	208	2090	80.3

Peak-Flow Statistics Citations

Sando, Roy, Sando, S.K., McCarthy, P.M., and Dutton, D.M.,2016, Methods for estimating peak-flow frequencies at ungaged sites in Montana based on data through water year 2011: U.S. Geological Survey Scientific Investigations Report 2015–5019–F, 30 p. (http://dx.doi.org/10.3133/sir20155019F)

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Application Version: 4.3.0

Appendix D

NID Reports

STANDING OPERATING PROCEDURES

DELMOE LAKE DAM

Pipestone Water Users Association
Whitehall, Montana 59759

July 1, 1995

Prepared by

Michele M. Lemieux, P.E.
Dam Safety Program
Montana Department
of Natural Resources and Conservation

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I. GENERAL INFORMATION

A. Purpose

This document provides guidance for the operation of Delmoe Lake Dam which is used for irrigation, stock watering, and recreation in Jefferson County, Montana. The dam is classified as high hazard by the State of Montana.

B. Responsibility

The Pipestone Water Users Association has final authority and responsibility for the safety, operation, and maintenance of Delmoe Lake Dam. The Association assigns the dam tender responsibilities for manually adjusting gates and valves as well as performing maintenance.

C. Attendance

The dam tender for Delmoe Lake Dam lives at the dam during the irrigation season, approximately from April 1 to September 15. The remainder of the year, Delmoe Lake Dam is unattended. The nearest operating personnel are in the town of Whitehall, as shown on the map in Appendix A.

D. Communication and Warning

The dam tender has a radio to contact the local deputy sheriff's office (287-3914). Pipestone Water Users Association Personnel may be contacted at the home of John Kountz, at 287-3849. Mr. Kountz is the president of the association.

E. Interaction With Others

Major maintenance and repair of Delmoe Lake Dam components should be coordinated with the dam's engineer and the Dam Safety Program of the Montana Department of Natural Resources and Conservation (DNRC).

F. Operation Log

Contained in Appendix B, this log will be used to annotate:

1. Water elevations and discharges
2. Tests and use of outlet control devices (gates and valves)
3. Minor and major maintenance activities including scheduled maintenance
4. Reservoir surveillance
5. Initial acknowledgment of emergency or unusual conditions
6. Acts of vandalism
7. Communications network checks
8. Certification of Standing Operating Procedures (SOP) review by

operating personnel

G. Data Reporting

Data in the forms shown in Appendix C will be recorded by the dam tender during visits to the dam and recorded in the log book. Data shall include:

1. Reservoir water surface elevation
2. Reservoir outflow
3. Seepage flows
4. Piezometer Water Levels

H. Restricted Areas

The access road to the dam has a locked gate. The key to the gate must be obtained from Mr. John Kountz (287-3849)

I. Supporting Documents and References

Appendix D contains a list of documents and references supporting operation of Delmoe Lake Dam and Reservoir.

II. MECHANICAL AND STRUCTURAL

A. General Description

Delmoe Lake Dam is a 60-foot high, 290-foot long, earthen embankment constructed of hydraulic fill with a central unreinforced concrete core. Normal reservoir storage is 6585 acre-feet at the crest of the emergency spillway. The outlet consists of two 24" diameter steel pipes encased in unreinforced concrete. Outflow is regulated by two 24" diameter slide gate valves on the upstream side of the embankment in an outlet tower. The outlet works has a capacity of 150 cubic feet per second (cfs) with the reservoir level at the dam crest. The emergency spillway consists of a 26-foot wide uncontrolled unlined chute which leads to down to the natural river drainage and has a capacity of 1900 cfs with the reservoir at the dam crest. Other pertinent data are listed below.

B. Operating Data

LOCATION . . . . . Sect 27, Township 3N, Range 6W, Jefferson County
WATERSHED . . . . . Big Pipestone Creek, tributary of Jefferson River
OWNER . . . . . Pipestone Water Users Association, Whitehall, Montana
PURPOSE . . . . . Irrigation

YEAR CONSTRUCTED 1913-1914
STRUCTURE . . . . . Hydraulic earth fill, with concrete
OUTLET WORKS Two 24" steel pipes encased in unreinforced concrete
EMERGENCY SPILLWAY . . . . . Uncontrolled, unlined chute
DAM CLASSIFICATION . . . . . High Hazard
KEY ELEVATIONS
Top of Dam . . . . . 6110.0 feet
Top of Emergency Spillway . . . . . 6101.4 feet
Normal Operating Pool . . . . . ? feet
Maximum Operating Pool (spillway crest) . . . . . 6101.4 feet
MAIN DAM DIMENSIONS
Hydraulic Height . . . . . 51.4 feet
Dam Height . . . . . 60.0 feet
Crest Length . . . . . 290 feet
Crest Breadth . . . . . 40 feet
Face Slopes (Horizonal to Vertical)
. . . . . 3:1 on upstream side
. . . . . 2:1 on downstream side
OUTLET WORKS
Conduit . . . . . Two 24" diameter concrete encased steel conduits
Length . . . . . 290 feet each
Control . . . . . One 24" diameter gate valve per conduit

EMERGENCY SPILLWAY
Width . . . . . 26 feet
Capacity . . . . . 1900 cfs with reservoir at dam crest
RESERVOIR
Surface Area . . . . . 310 acres at spillway crest
Storage at:
Top of Dam . . . . . 9900 acre-feet
Emergency Spillway Crest . . . . . 6585 acre-feet

C. Outlet Works Operation

The outlet works is located through the embankment near the center of the dam. Two 24" diameter concrete encased steel conduits extend 240 feet from the intake structure to the outlet structure. The location of the outlet works is shown in Appendix E. Each conduit has a 24" diameter gate valve. The intake structure is combined with the gate tower and is located in the reservoir about 125 feet from the axis of the dam. Each conduit is controlled by a 24-inch diameter gate valve operated from the top of the tower. The discharge through the outlet works is estimated to be 150 cfs with the reservoir level at the dam crest.

D. Emergency Spillway Operation

The emergency spillway is an uncontrolled, unlined, trapezoidal earth channel excavated in bedrock of the right abutment. The right side of the spillway is massive bedrock. The left bank is composed of earth and rock that has been cemented in place for the first 100 feet. The spillway is 26.5 feet wide at its entrance and narrows to 18 feet at the point where it discharges over the left bank to Big Pipestone Creek. A concrete control section is located at the crest of the spillway. The discharge channel is about 200 feet long. The grade of the channel ranges from approximately 2% to 5%. The channel discharges to the native drainage of Pipestone Creek. The maximum discharge capacity of the emergency spillway with the reservoir level at the dam crest is 1900 cfs.

III. INSTRUMENTATION

A. General Description

Five open stand pipe piezometers are located on the embankment. The concrete outlet channel is equipped with a weir to monitor flow. Regular measurements of reservoir levels and discharges are made by the dam tender. A monitoring plan is being developed to regularly measure piezometers water levels. Additional measuring devices may need to be installed.

B. Instructions

Reservoir water level measurements shall be taken whenever the piezometers are measured to correlate the two readings.

C. Records

Instrumentation readings are taken by the dam tender and water commissioner and recorded on the data sheet. Instrumentation data will be kept at the president of the water user's address.

D. Abnormal Readings

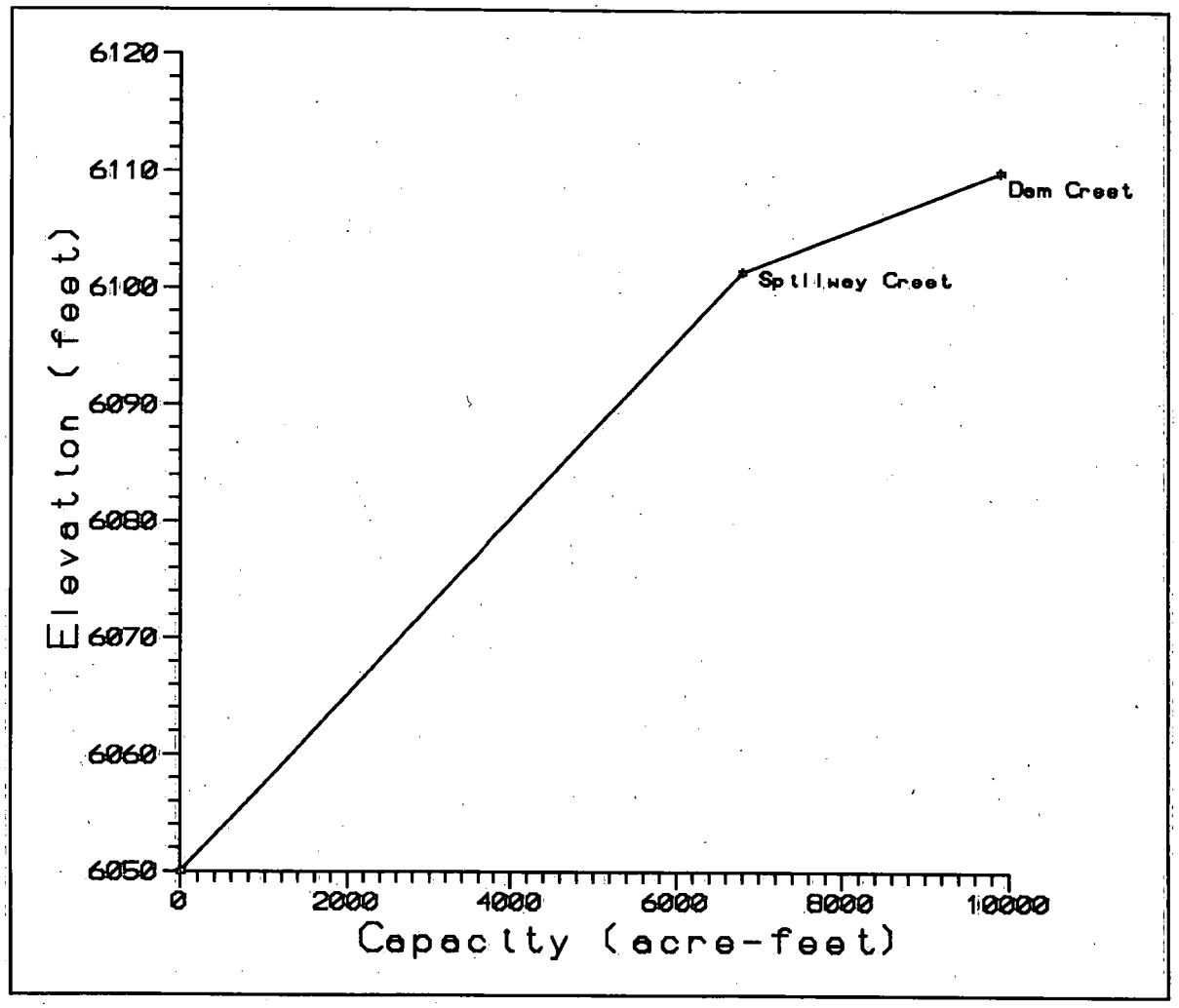
The dam tender will review the instrumentation readings to determine whether they are reasonable. If based on past readings, the seepage is unusually high for a given reservoir level, the dam tender will notify John Kountz (President of Water Users) who should notify their engineer.

IV. RESERVOIR OPERATIONS

A. Elevation v. Capacity Curve

The storage capacity of the reservoir at varying elevation of the water surface level is given in the figure below.

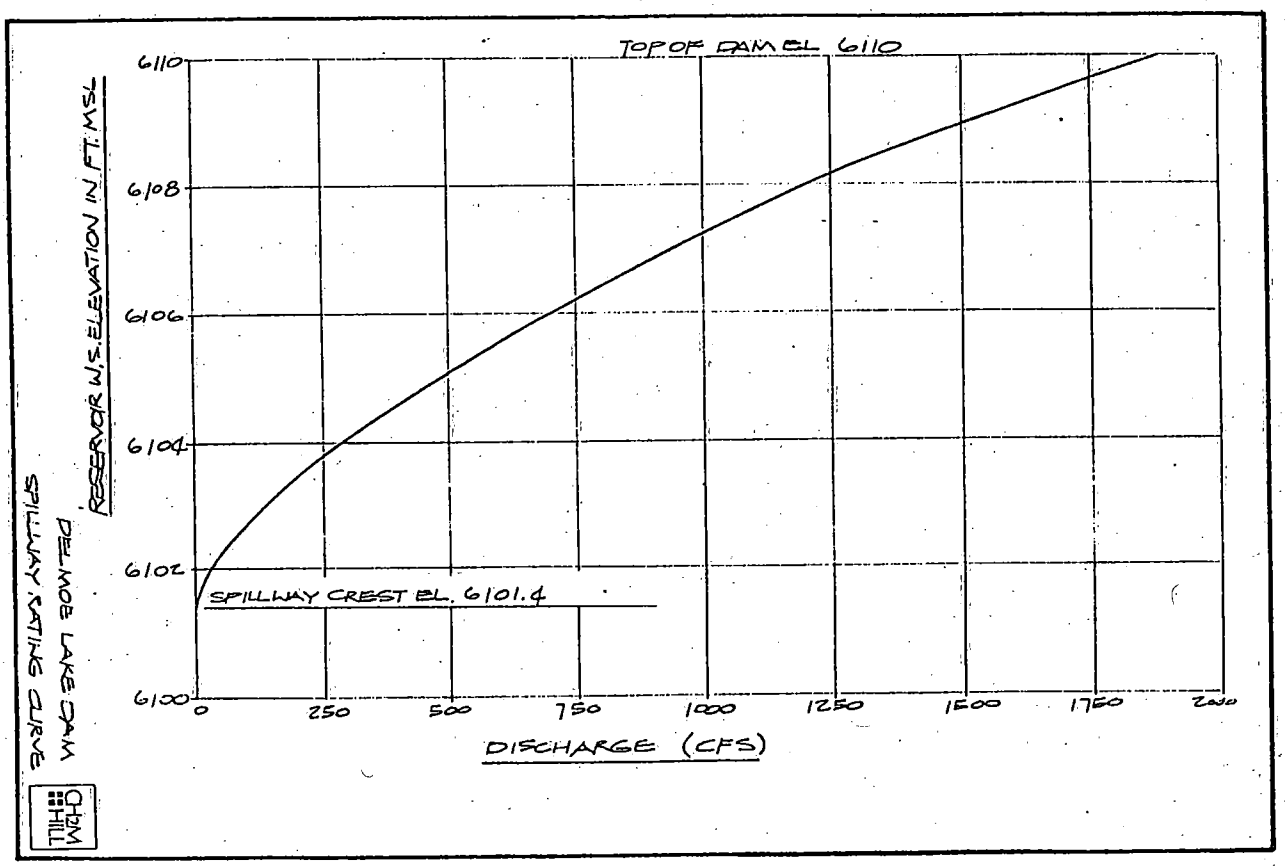
Figure 1
Stage - Storage



B. Emergency Spillway Rating Curve

The emergency spillway rating curve defined by reservoir elevation (feet) versus discharge (cfs) is given in the figure below.

Figure 2
Emergency Spillway Rating Curve

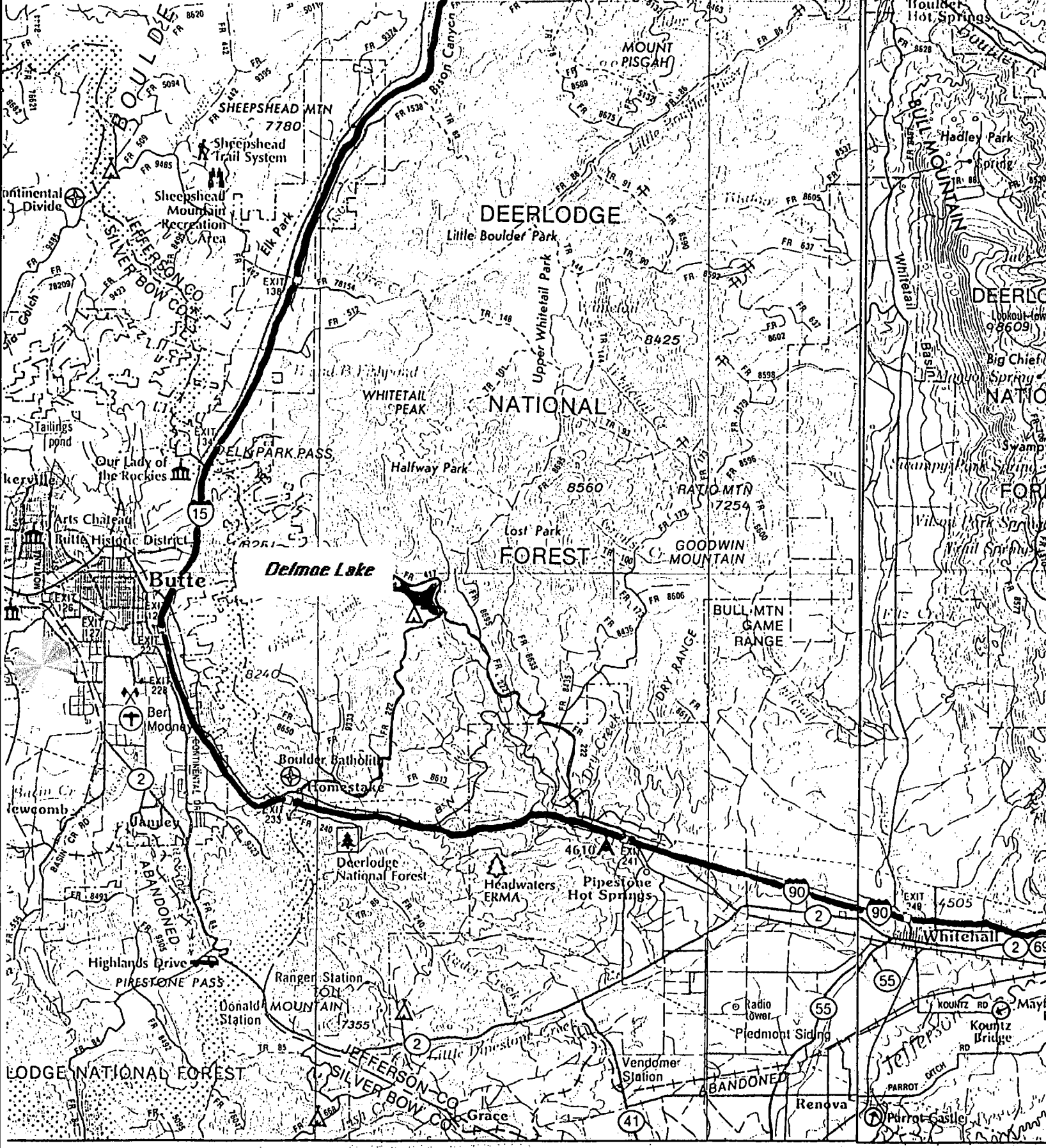


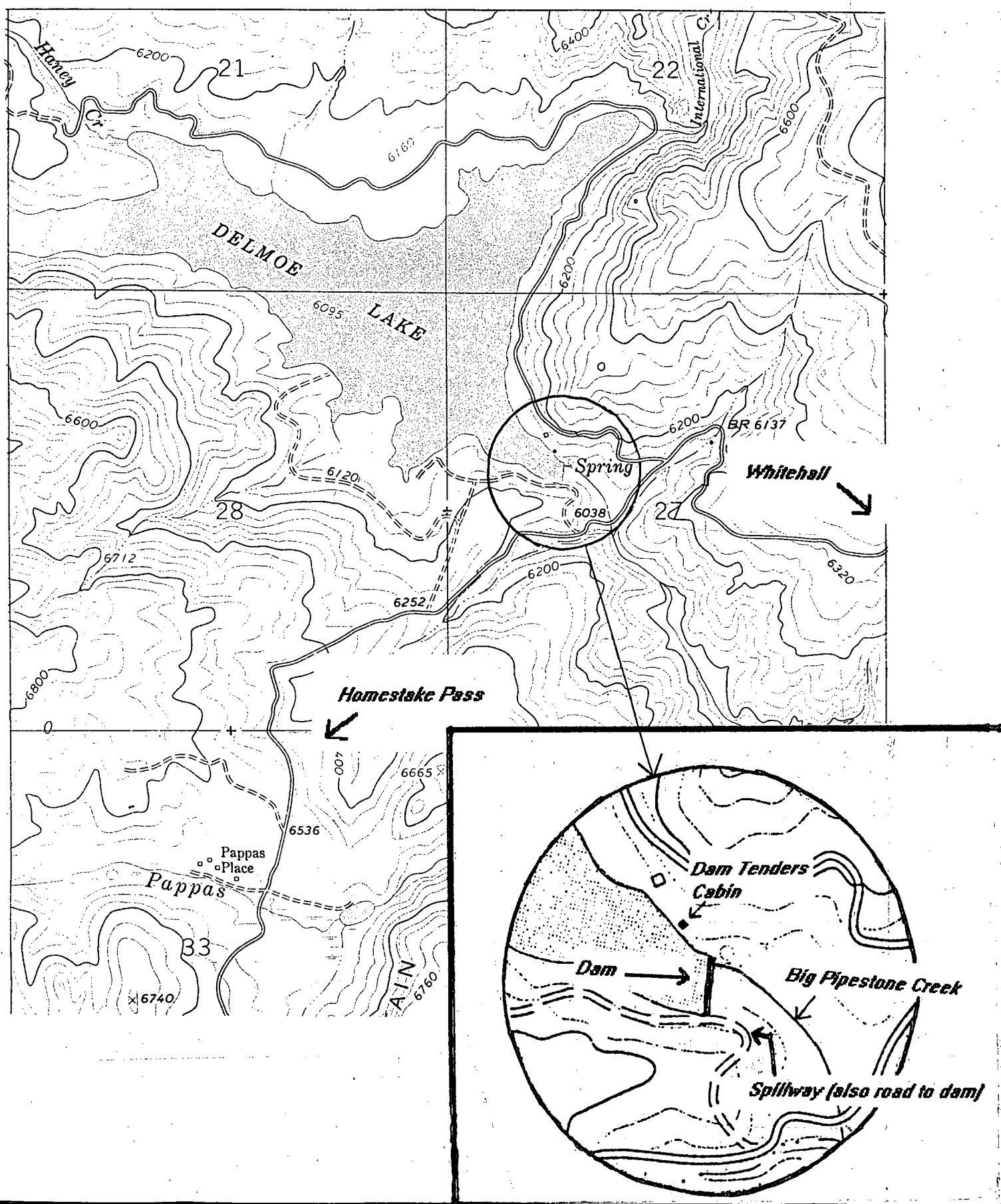
D. Flood Operations

At the earliest possible indication of abnormally heavy rainfall or runoff in the Big Pipestone Creek basin, the dam tender should station himself at the dam and open the outlet to its maximum state capacity. If it appears likely that significant outflow from the emergency spillway will occur, a warning should be given to downstream residents to prepare for evacuation as outlined in the *Emergency Action Plan*.

APPENDICES

APPENDIX A - VICINITY MAP


Delmoe Lake
Butte
Our Lady of the Rockies
Arts Chateau
Butte Historic District
Tailings pond
Continental Divide
SHEEPSHEAD MTN
7780
Sheepshead Trail System
Sheepshead Mountain Recreation Area
Elk Park
ELK PARK PASS
JEFFERSON CO
SILVER BOW CO
DEERLODGE
Little Boulder Park
Upper Whitetail Park
WHITETAIL PEAK
NATIONAL
FOREST
Halfway Park
Lost Park
GOODWIN MOUNTAIN
RATIO MTN
7254
BULL MTN GAME RANGE
DRY RANGE
Dry Creek
MOUNT PISGAH
Bison Canyon
Little Boulder
Hadley Park
Spring
BULL MOUNTAIN
Whitetail
Big Chief Spring
Swamp
Boulder Hot Springs
Boulder Batholith
Homestake
Janney
Deerlodge National Forest
Headwaters ERMA
Pipestone Hot Springs
Highlands Drive
PIRESTONE PASS
Ranger Station
TOLL MOUNTAIN
7355
Donald Station
Little Pipestone Creek
Radio Tower
Piedmont Siding
Vendome Station
ABANDONED
Grace
Renova
Parrot Castle
Kountz Bridge
Whitehall
LODGE NATIONAL FOREST
8425
8560
4610
4505
EXIT 138
EXIT 134
EXIT 126
EXIT 127
EXIT 228
EXIT 235
EXIT 241
EXIT 249


Haney Cr.
6200
21
22
6400
International Cr.
6600
6160
DELMOE LAKE
6095
6200
6600
6200
BR 6137
Spring
6120
6038
Whitehall
28
27
6712
6320
6200
6252
6800
Homestake Pass
400
6665
6536
Pappas Place
Pappas
33
6740
A I N
6760
Dam Tenders Cabin
Dam
Big Pipestone Creek
Spillway (also road to dam)

APPENDIX B - OPERATION LOG

OPERATION LOG

DATE	EVENT OR COMMENT	INITIALS

APPENDIX C - DATA SHEET

DATA SHEET

DATE	RESERVOIR ELEVATION	TOE SEEPAGE MEASUREMENT (gpm)	OUTLET FLOW (cfs)

Date	Reservoir Elevation	Piezometers (depth of water below measuring point, in feet) P1	P2	P3	P4	P5	Comments

APPENDIX D - REFERENCES

REFERENCES

1. Corp of Engineers Delmoe Lake Dam Phase I Inspection Report, National Dam Safety Program, Prepared by CH2M Hill, April 1980.

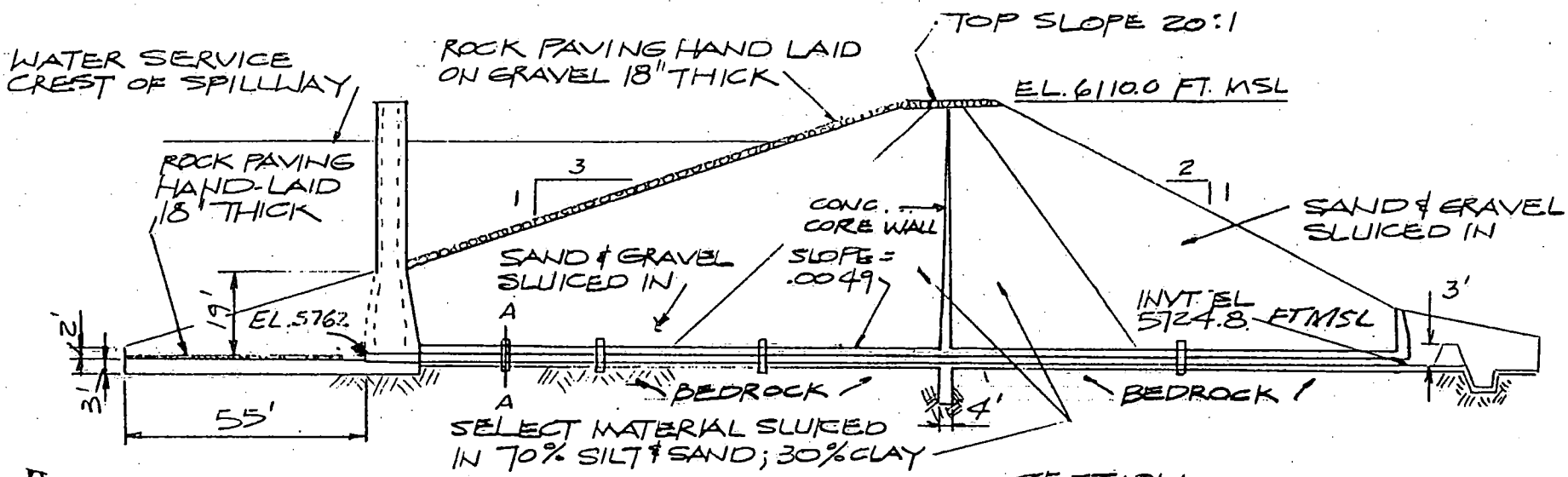
2. Inspection Report Delmoe Lake Dam, Prepared by MSE, inc. February, 1995

4. Department of Natural Resources and Conservation Dam Safety Section, "Dam Safety Operation and Maintenance Plan Notebook."

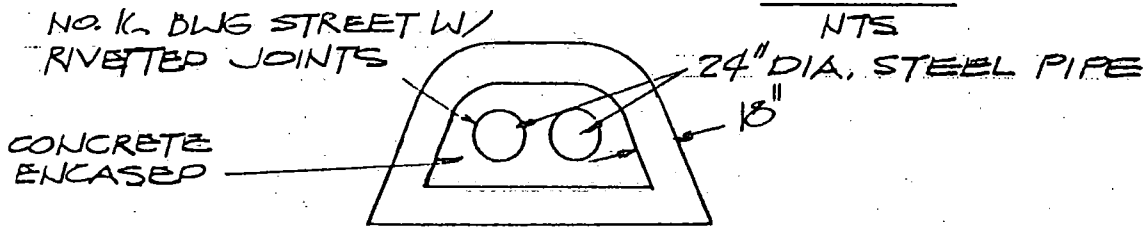
5. US Bureau of Reclamation, Training Aids for Dam Safety, Module: Inspection of Embankment Dams, 1988.

APPENDIX E - DAM DRAWINGS AND SKETCHES

NOTE:
FOOTBRIDGE TO TOWER SUSPENDED ON CABLE ATTACHED TO RESERVOIR SHORE



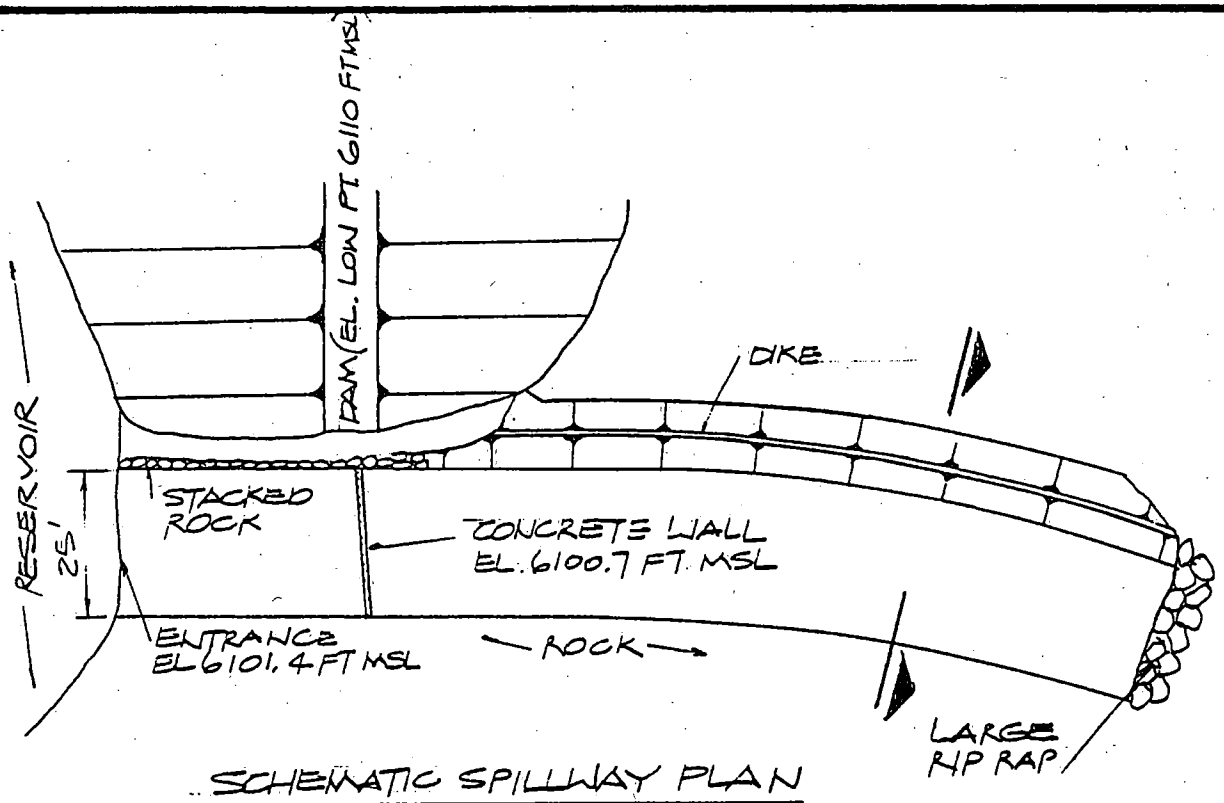
SECTION
NTS



OUTLET CONDUIT SECTION

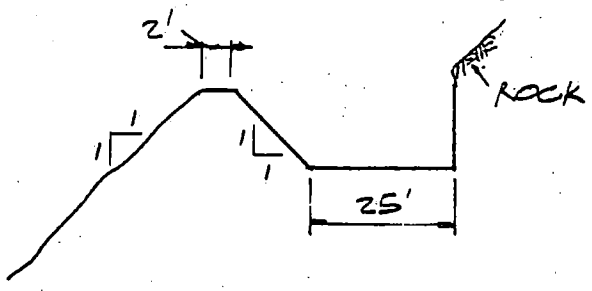
DELMOE LAKE DAM
SECTION

CH2M HILL



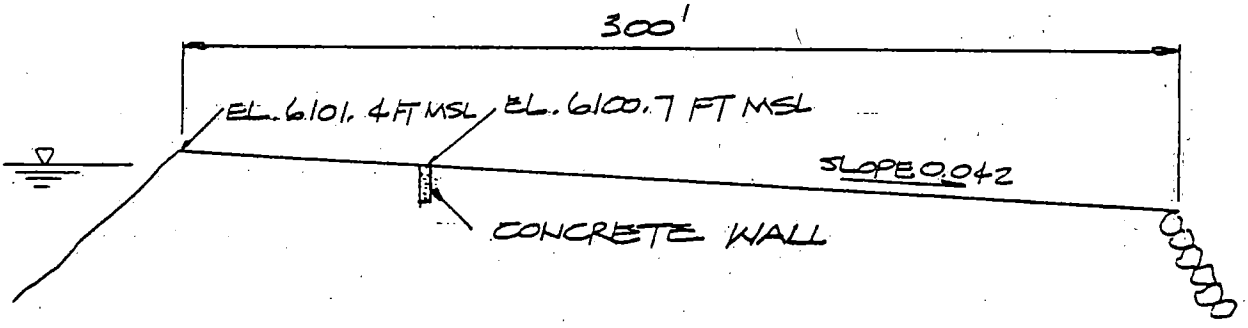
SCHEMATIC SPILLWAY PLAN

N.T.S.



SCHEMATIC SECTION

N.T.S.



SCHEMATIC SPILLWAY PROFILE

N.T.S.

DELMOE LAKE DAM

SPILLWAY

CH2M HILL

Search

Zoom To	Dam Name	Other Dam Name	NIDID	Inspection Date	Hazard potential	Owner Type	Owner Name	NID Height (Ft.)	NID Storage	Primary Purpose	All Purposes	Dam Type	River	City	Distance	County	State	Congressional District	Congressional Rep.	Permitting Authority	Inspection Authority	Enforcement Authority	Eap Last Rev Date
	B AND B FISH POND	-	MT03754	-	Low	Private	JOHN/VINCE CAPP	8	75	Fire Protection, Stock, Or Small Fish Pond	Fire Protection, Stock, Or Small Fish Pond	Earth	BISON CREEK	ELK PARK	2	JEFFERSON	MT	MT00	Greg Gianforte (R)	Y	Y	Y	-

Search

Owner Name	Dam Type	State	Zoom To	Dam Name	Other Dam Name	NIDID	Inspection Date	Hazard potential	Owner Type	NID Height (Ft.)	NID Storage	Primary Purpose	All Purposes	River	City	Distance	County	Congressional District	Congressional Rep.	Permitting Authority	Inspection Authority	Enforcement Authority	Eap Last Rev Date
PIPESTONE WATER USERS	Earth	MT		DELMOE LAKE DAM	-	MT00117	10/23/2017	High	Private	60	9900	Irrigation	Irrigation	BIG PIPESTONE CREEK	WHITEHALL	21	JEFFERSON	MT00	Greg Gianforte (R)	Y	Y	Y	08/12/2015

Search

Zoom To	Dam Name	Other Dam Name	NIDID	Inspection Date	Hazard potential	Owner Type	Owner Name	NID Height (Ft.)	NID Storage	Primary Purpose	All Purposes	Dam Type	River	City	Distance	County	State	Congressional District	Congressional Rep.	Permitting Authority	Inspection Authority	Enforcement Authority	Eap Last Rev Date
	KEOGH	-	MT00219	-	Low	Federal	U.S. D.O.I. F.W.S.	30	43	Irrigation	Irrigation	Earth	LITTLE WHITETAIL CREEK	WHITEHALL	21	JEFFERSON	MT	MT00	Greg Gianforte (R)	N	N	N	-

Search

Zoom To	Dam Name	Other Dam Name	NIDID	Inspection Date	Hazard potential	Owner Type	Owner Name	NID Height (Ft.)	NID Storage	Primary Purpose	All Purposes	Dam Type	River	City	Distance	County	State	Congressional District	Congressional Rep.	Permitting Authority	Inspection Authority	Enforcement Authority	Eap Last Rev Date
	WHITETAIL DAM	-	MT00118	9/29/1980	High	Private	WHITETAIL WATER USERS ASSN	29	21400	Irrigation	Irrigation	Earth	WHITETAIL CREEK	WHITEHALL	-	JEFFERSON	MT	MT00	Greg Gianforte (R)	N	N	N	-

Appendix E

Digital Data and Calculation Files