Chapter 9
HYDROLOGY

MONTANA
Department of Transportation

HYDRAULICS MANUAL

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Chapter 9
HYDROLOGY

9.1 INTRODUCTION

Because hydrologic methodologies do not provide exact solutions, this chapter was developed to provide guidance for developing hydrology on MDT projects and to help ensure that drainage facilities are not under designed or over designed.

9.1.1 Definition

Hydrology is defined as: "The science and study concerned with the occurrence, circulation, distribution, and properties of the waters of the earth and its atmosphere, including precipitation, runoff, and groundwater." In the *MDT Hydraulics Manual*, hydrology addresses estimating flood magnitudes as the result of precipitation. Hydrologic studies are required to determine the runoff and flood characteristics to be expected at a highway drainage site and are a vital step prior to the hydraulic design of a highway drainage structure. Such studies are necessary for determining the rate of flow, runoff, or discharge that the drainage facility will be required to accommodate.

In the design of highway drainage structures, floods are usually considered in terms of peak discharge in cubic feet per second. For structures that are designed to control the volume of runoff (e.g., detention storage facilities) or where flood routing through culverts is used, then the entire discharge hydrograph will be of interest.

The relationship between the amount of precipitation on a drainage basin and the amount of runoff from the basin is complex and subject to change with time as conditions on the watershed change. Errors in the estimates could result in a structure that is either undersized and performs inadequately or is oversized and costs more than necessary. The hydraulic engineer should realize that any hydrologic analysis is an approximation that is based on the best data available and is completed per the current standard practice.

9.1.2 MDT Design Practice

This section summarizes MDT requirements for hydrologic analyses. The requirements listed below are not necessarily applicable for every study but should be included based on the level of risk, the hydraulic modeling method being used, and the data available:

- Follow the design practices, criteria, and procedures in this *Manual*.
- Analyze a minimum of three hydrologic methods for all designed drainage structures that have a drainage area greater than one square mile.
- Three valid hydrologic methods may not be available for crossings with drainage areas less than one square mile. In this case, only use methods that are applicable for the site location.

- Multiple hydrologic methods may be used on one project based on basin size. For example, basins less than one square mile may use a different hydrologic method than basins that are greater than one square mile.

- If all of the basin's variables are within the allowable ranges for the equation, use the most recently published USGS regional regression equations as one of the three methods for comparison in the hydrologic analysis.

- Compare the calculated hydrology to the flood history of the existing structure and calibrate where possible.

- Document justification of the selected hydrologic method and design flow rates developed.

9.1.3 Symbols and Definitions

To provide consistency within this *Manual*, the symbols in Figure 9.1-1 will be used. These symbols have gained wide use in hydrologic publications.

The following definitions are important to hydrologic analyses and apply to most methods:

1. Antecedent Moisture Conditions (AMC). The soil moisture conditions of the watershed at the beginning of a storm. These conditions affect the volume of runoff generated by a specific storm event. Notably, they affect the peak discharge only in the lower range of flood magnitudes, say, below approximately the 15-year event threshold. As floods become rarer, antecedent moisture has a rapidly decreasing influence on runoff.

2. Base Flood. Another term for the 100-year event.

3. Depression/Retention Storage. The natural depression within a watershed that stores runoff. Generally, after the depression storage is filled, runoff will begin.

4. Design Flood. The flowrate (or discharge) for which a drainage facility is designed to accommodate and to meet the hydraulic design criteria. The selected design flood should be consistent with the facility's highway classification, traffic volume, potential flood hazard to property, expected level of service, and ADT. (See Section 9.3.2.1).

5. Design Flood Frequency. The frequency (recurrence interval) for the selected design flood.

6. Flood Frequency. The chance of a specific magnitude flood event occurring at a particular site is its flood frequency. Flood frequencies are sometimes referred to as an x-year event (e.g., a 100-year event). This terminology means that the 100-year flood has a 1 in 100 or a 1% chance of occurring in any given year. The average time interval between floods of a specific magnitude may also be called the recurrence interval (RI). The exceedance probability equals 100/RI. (See Section 9.3.1) for additional information).

7. Hydraulic Roughness. A composite of the physical characteristics that influence the flow of water across the earth's surface, whether natural or channelized. It affects both the time response of a watershed and drainage channel and the channel storage characteristics.

8. Hydrograph. A graph of the time distribution of runoff from a watershed.

9. Hyetographs. A graph of the time distribution of rainfall over a watershed.

10. Infiltration. A complex process of allowing runoff to penetrate the ground surface and flow through the upper soil surface. The infiltration curve is a graph of the time distribution at which this occurs.

11. Interception Storage. Storage of rainfall on foliage and other intercepting surfaces during a rainfall event.

12. Lag Time. The time from the centroid of the excess rainfall to the peak of the hydrograph.

13. Level of Service. A term used to determine how well a transportation facility is operating from a traveler's perspective. Regarding flooding, the level of service for a roadway should be greater than or equal to the design event; therefore, the roadway would remain open and not overtop until an event greater than the design event occurs.

14. Peak Discharge. The peak discharge, sometimes called peak flow, is the maximum rate of flow of water passing a given point during or after a rainfall event or snowmelt.

15. Rainfall Excess. The water available to runoff after interception, depression storage, and infiltration have been satisfied.

16. Rainfall Frequency. Precipitation depth and intensity for a specific recurrence interval. See Appendix 9B for precipitation data.

17. Review Flood. A flood (or storm), larger than the selected design flood, which is used to assess the performance of a drainage facility and to evaluate the hydraulic design for resiliency and unintended flood hazards.

18. Stage. The water surface elevation above some elevation datum.

19. Time of Concentration. The time it takes a drop of water falling on the hydraulically most remote point in the watershed to travel through the watershed to the outlet.

20. Unit Hydrograph. The direct runoff hydrograph resulting from a rainfall event that has a specific temporal and spatial distribution and has unit volume (or results from a unit depth of rainfall). The ordinates of the unit hydrograph are such that the volume of direct runoff represented by the area under the hydrograph is equal to one inch of runoff from the drainage area. When a unit hydrograph is shown with units of ft^3/s, it is implied that the ordinates are ft^3/s per inch of direct runoff.

For a more complete discussion of these concepts and others related to hydrologic analysis, refer to HDS 2 (1).

Figure 9.1-1 — SYMBOLS AND DEFINITIONS TABLE

Symbol	Definition	Units
A	Drainage area	acre, mi^2
A	Cross sectional area	ft^2
AMC	Antecedent moisture conditions	—
C	Runoff coefficient	—
CN	NRCS runoff curve number	—
F_p	Adjustment factor for pond/swamp	—
i	Rainfall intensity	in/h
I_a	Initial abstraction from total rainfall	in.
k	Land cover factor	—
L	Length of mainstream to furthest divide	ft
n	Manning's roughness coefficient	—
N	Number of years of flood record	years
P	Accumulated rainfall, rainfall depth (NRCS method)	in.
Q	Rate of runoff	ft^3/s
Q	Direct runoff (NRCS method)	in.
q	Storm runoff during a time interval	in.
R	Hydraulic radius	ft
RI	Recurrence interval	years
S, SL, or Y	Ground slope, main channel slope	ft/ft, ft/mile or %
S	Potential maximum retention storage (NRCS method)	in.
t_c	Time of concentration	min or h
T_t	Travel time	min
V	Velocity	ft/s
WP	Wetted perimeter	ft

9.2 GENERAL CONSIDERATIONS

The following sections summarize overall MDT practices related to hydrology.

9.2.1 Factors Affecting Floods

In the hydrologic analysis for a drainage structure, there are many variables that affect floods. Those that should be considered on a site-by-site basis include the following:

- Drainage basin characteristics (e.g., size, shape, slope, land use, geology, soil type, surface infiltration, storage, aspect, elevation, regulation);
- Stream channel characteristics (e.g., geometry and configuration, natural and artificial controls, channel modification, aggradation/degradation, ice and debris, channel slope);
- Floodplain characteristics; and

- Meteorological characteristics (e.g., precipitation amounts and type, storm cell size and distribution characteristics, storm direction, time rate of precipitation (hyetograph), snowmelt, rain on snow or frozen ground, thunderstorms).

9.2.2 Surveys and Site Data

The magnitude and complexity of hydrologic studies should be consistent with the importance and magnitude of the project and the problems encountered. Special studies and investigations may be required at sensitive locations. Typical data includes topographic maps, aerial photographs, streamflow records, historical high-water elevations, flood discharges, and locations of hydraulic features (e.g., reservoirs, water projects, floodplains, FEMA-mapped floodplains, floodways). See Chapter 5, "Location and Hydraulic Study" and Chapter 7, "Permits" for more discussion.

9.2.3 Flood History

All hydrologic analyses should consider the flood history of the area and the effect of these historical floods on existing and proposed structures. The flood history will include the historical floods and the flood history of any existing structures. This information should be obtained from the local Maintenance staff, land owners, county staff, aerial flood photographs, etc.

9.2.4 Hydrologic Accuracy

The accuracy of the hydrologic estimates will have a major effect on the design of drainage or flood control facilities. Although it might be argued that one hydrologic procedure is more accurate than another, practice has shown that all of the methods discussed in this chapter can, if calibrated, produce acceptable results consistent with observed or measured events. The need to calibrate the method for local conditions is essential. This calibration process can result in more accurate and consistent estimates of peak flows and hydrographs. See Section 9.2.5.

Report calculated discharges to the nearest ft^3/s.

9.2.5 Calibration

The calibration process can vary depending on the data or information available for a local area. When calibrating hydrologic discharges or selecting a hydrologic method, consider the following factors:

1. Calculate several methods and determine if any of the flood frequency discharges are similar.

2. Consider the order of preference for the methods as discussed in Section 9.4.

3. Compare the predicted hydrology to historical flood information such as known flood events or overtopping events.

4. Compare the predicted hydrology to any available aerial flood photos with a known flow rate. If flood photos are unavailable, predicted hydrology may be compared with anecdotal observations.

5. Compare the calculated discharges to the channel capacities. Natural channels will typically contain between the 2-year flow and the 10-year flow within the channel banks.

9.3 DESIGN CRITERIA (FLOOD FREQUENCY)

9.3.1 Overview

Flood frequency is the probability of a specific magnitude flood occurring at a site in any given year. Flood frequencies are sometimes referred to as an x-year event (e.g., a 100-year event). See Figure 9.3-1. This terminology means that the 100-year flood has a 1 in 100 or a 1% chance of occurring in any given year. The average time interval between floods of a specific magnitude may also be called the recurrence interval (RI). The exceedance probability equals 100/RI.

Figure 9.3-1 — FLOOD FREQUENCY PROBABILITIES

Recurrence Interval (RI)	Probability of event occurring in any given year	Percent chance of event occurring in any given year (Exceedance Probability)
2-year	1 in 2	50%
5-year	1 in 5	20%
10-year	1 in 10	10%
25-year	1 in 25	4%
50-year	1 in 50	2%
100-year	1 in 100	1%
200-year	1 in 200	0.5%
500-year	1 in 500	0.2%

The hydraulic engineer should note that the 100-year flood is not an event that will necessarily be equaled or exceeded every 100 years. There is a 1% chance that the flood will be equaled or exceeded in any one year; therefore, the 100-year flood could conceivably occur in several consecutive years.

Another way to look at flood frequency is the probability that a flood condition will be exceeded in any N years or over the design life of the structure. See Figure 9.3-2.

Hydrologic analyses should include the determination of several design flood frequencies for use in the hydraulic design. These frequencies are used to optimize the size of the drainage facilities by considering both risk of damage and construction cost. Consideration should be given to the flood frequency used to design other structures along a highway corridor and along the stream.

Figure 9.3-2 — PROBABILITY OF FLOOD EXCEEDANCE OF VARIOUS FLOOD LEVELS

Flood Frequency	Probability of Exceedance in N Years (or Assumed Design Life)						
Years	N = 1	N = 5	N = 10	N = 25	N = 50	N = 75	N = 100
10	10.0%	41.0%	65.1%	92.8%	99.5%	100.0%	100.0%
25	4.0%	18.5%	33.5%	64.0%	87.0%	95.3%	98.3%
50	2.0%	9.6%	18.3%	39.7%	63.6%	78.0%	86.7%
100	1.0%	4.9%	9.6%	22.2%	39.5%	52.9%	63.4%
200	0.5%	2.5%	4.9%	11.8%	22.2%	31.3%	39.4%
500	0.2%	1.0%	2.0%	4.9%	9.5%	13.9%	18.1%

9.3.2 Design and Review Flood Frequencies

This section describes the method for determining the design and review flood frequencies for MDT projects. For specific guidance on flood frequencies for storm drains, see Chapter 14, "Storm Drain Systems" and, for bridge scour and deck drainage flood frequencies, see Chapter, 17, "Bridges."

9.3.2.1 Design Flood

Because it is not economically feasible to design a structure for the maximum runoff a watershed can produce, a design flood frequency must be selected. The crossing must be sized to pass the design flood without overtopping the road and to meet the hydraulic design criteria. Figure 9.3-3 presents design flood frequencies expressed as return periods adopted by MDT for the various drainage facilities on streets and highways.

The design flood frequency should be consistent with the facility's highway classification, traffic volume, potential flood hazard to property, expected level of service, and ADT. Design and review flood frequencies specific to culverts, bridges, and storm drains are discussed in their respective chapters.

The design flood will be established based upon consideration of three major factors — 1) ADT; 2) detour length; and 3) functional classification of the route. However, when the route is used by emergency vehicles, school buses, or as an evacuation route, a minimum design flood will be established as provided in the notes to Figure 9.3-3.

Figure 9.3-3 — DESIGN FLOOD FREQUENCY SELECTION GUIDELINES

	< 10 year	10 year	25 year	50 year
ADT	< 50	50 – 399	400 – 3000	> 3000
ADT × Miles of Detour	< 1000	1000 – 3999	4000 – 15,000	> 15,000

Notes:

1. *The design flood is the larger of the values obtained by using ADT or by using ADT times the miles of detour. A variance from the return period in Figure 9.3-2 may be considered where costs, flood duration, and road networks indicate that a higher or lower level of service is justifiable.*

2. *Special Considerations for Interstates: The minimum design flood for all interstate highway crossings must be the 50-year flood (2% chance flood). If site conditions allow, increase the design flood to the 100-year flood (1% chance flood).*

3. *The minimum design flood for routes specifically designated as community evacuation routes, by school buses, or used daily by emergency vehicles should be the 25-year flood (4% chance flood). For crossings where a new bridge (or other structures of similar cost) will be designed, the minimum design flood should be the 10-year flood (10% chance flood).*

4. *Facilities on rural highways, such as underpasses, depressed roadways, etc., where no overflow relief is available should be designed for the same return period (design event) as the remainder of the roadway.*

5. *A larger design flood can be used if justified by a risk assessment/analysis; see Section 9.3.4.*

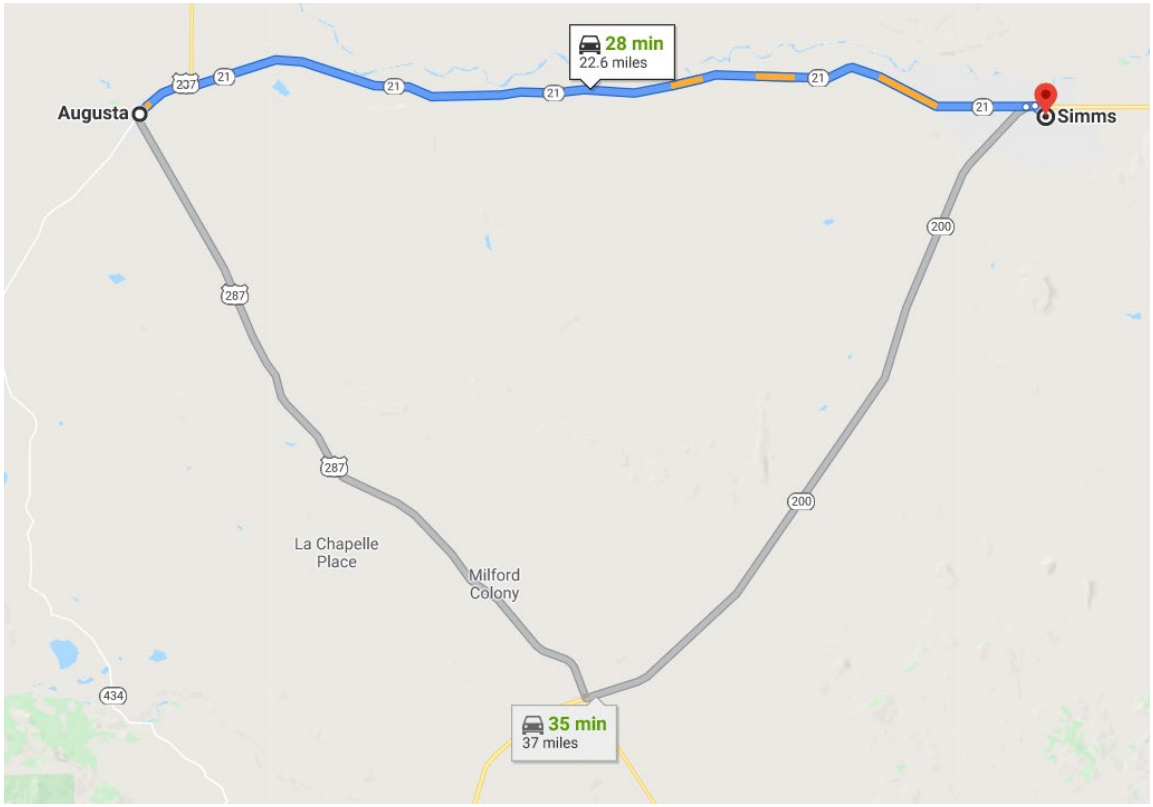
9.3.2.1.1 Definitions

1. ADT. Average daily traffic for the roadway design year of the project.

2. Detour Length. To find the detour length, subtract the normal route distance from the detour route distance. The detour route is measured between the nearest logical junction or termini on each side of a proposed drainage crossing along a route of an equal or higher classification level (when possible) to the normal route. The nearest logical termini are frequently two towns or populations centers. Borders crossing into Canada should not be used as part of normal detour length calculations.

   Detour Length Example: A project is located between Augusta and Simms, which have been selected as the termini. The normal route distance is 23 miles and the detour distance is 37 miles. The detour length is 14 miles = 37 miles – 23 miles. See Figure 9.3-4.

Figure 9.3-4 — DETOUR LENGTH EXAMPLE



9.3.2.1.2 Procedure

The minimum design flood for the preliminary design of urban, arterial, and collector route stream crossings will be determined based on Figure 9.3-3.

9.3.2.2 Review Flood Frequency

After all proposed structures are designed using the selected design frequency, they should be reviewed using a review flood to ensure that there are no unexpected flood hazards and to evaluate the design resiliency. The review flood frequency is not used in designing the size of the structure. The review flood events for culverts, bridges, and storm drains are discussed in their respective chapters.

9.3.2.3 NFIP-Mapped Floodplains

When the proposed roadway drainage structure is located in a Federal Emergency Management Agency National Flood Insurance Program (FEMA NFIP)-mapped floodplain/floodway, the hydraulic engineer must analyze the site with the 100-year (base) flood to ensure that the change in backwater elevation is within the limits permitted by FEMA. MDT practice is to review all floodplains for impacts on insurable buildings. See Chapter 7, "Permits" for additional details.

9.3.2.4 Temporary On-Site Traffic Detours/Diversions

Figure 9.3-3 is recommended for use to select the design frequency for structures on temporary, on-site traffic detours for interstate highways and for any other facility that is considered essential to maintain during most flood events. For other locations, the frequency can be determined using the procedure in Appendix 9A, "Design Frequency for Temporary Facilities."

9.3.3 Rainfall Frequency vs Flood Frequency

Drainage structures are designed based on the design flood frequency. However, certain hydrologic procedures (e.g., Rational Method in Section 9.7) use rainfall and rainfall frequency as the basic input. Thus, it is commonly assumed that the 10-year rainfall will produce the 10-year flood and, for smaller basins, the typical assumption is true. However, for larger basins there may not be a direct correlation between the events. Other factors including antecedent soil moisture conditions and hydrologic parameters such as basin size, storm size, percentage of basin receiving the rainfall, time of concentration, etc., impact the amount of runoff.

9.3.4 Risk Evaluation

MDT design practices address risk at most design locations by sizing the opening with the design flood (see Section 9.3.2.1) and assessing additional risk with the review flood (see Section 9.3.2.2).

Ideally, the hydraulic design meets all of the following risk factors:

- There is no increase in headwater over the existing condition;
- MDT design criteria are met;
- There are no insurable buildings in the 100-year floodplain; and
- Any floodplain encroachments are designed consistent with NFIP and the State of Montana floodplain criteria.

If the hydraulic design does not meet all the above risk factors, the site risk must be evaluated. Consider the following typical risk factors:

- Potential risk to human life;
- Damage to adjacent properties from changes in the hydraulic design;
- Culverts under high fills (if appropriate, upsizing, debris structures, relief structure);
- Impacts from excessive headwater;
- Changing overtopping locations;
- Impacts from changing existing flow patterns;
- Deep roadway overtopping;
- Damage to the highway facility;
- Environmental impacts to wetlands and streams;

- Disruption of traffic services (e.g., ADT and detour availability); and
- Negative floodplain impacts.

If the hydraulic design has any of the above risk factors or other significant risks identified by the hydraulic engineer, revise the design to mitigate the risk if possible. If the design criteria are not flexible or if significant risk still exists, discuss the site and parameters with the State Hydraulic Engineer.

Document site risk factors and site risk evaluation in the hydraulic report.

9.4 HYDROLOGIC PROCEDURE SELECTION

9.4.1 Overview

When selecting the hydrologic method for a site, the first consideration is whether to use a peak flow method (Section 9.4.2), a hydrograph method (Section 9.4.3), or a low flow method (Section 9.4.4). Most MDT designs use a peak flow method. Occasionally, a hydrograph will be required to route a flood flow through a culvert or to design a detention or retention pond. Some aquatic organism passage (AOP) designs will use a low flow method in addition to the design and review floods.

The methods presented below are typically used by MDT. Additional methods may be considered if appropriate.

9.4.2 Peak Flow Methods

Peak flow rates are typically used to size bridges, culverts, and storm drains.

Figure 9.4-1 summarizes the peak flow hydrologic procedures that have been adopted by MDT. The procedures are listed in order of preference; however, each site is unique and the site characteristics must be considered when choosing the appropriate hydrologic method for that site. MDT practice is to use gaged data if it is available and has a sufficient record. Similarly, if a site is in a FEMA floodplain, FEMA discharges are typically used for analysis, unless there is a known discrepancy. Where gaged data are not available, one of the other methods described in Figure 9.4-1 should be used.

For a gaged site, MDT practice is to use the flood frequencies developed by USGS. The current USGS publication contains both peak flood frequencies and adjusted peak flow frequencies for many of the gages. If both the peak flood frequency and adjusted peak flow frequencies exist, evaluate and compare the results before choosing a method.

Figure 9.4-1 — MDT PEAK FLOW METHODS

Peak Flow Methods	Overview	Summary	Design Procedure
USGS Peak Flow Frequency Analysis (Gaged Data)	If a gage has at least 20 years of continuous record and is located at the project site, this is the preferred method. Use the most recent USGS published flood frequency values.	9.4.2.1	USGS (2)
USGS Adjusted Peak Flow Frequencies (Gaged Data)	If USGS has published adjusted peak flow frequencies for a gage, this method should be compared to the peak frequency analysis described above.	9.4.2.2	USGS Report (3)
Gage Transfer on the Same Stream (Single Gage)	Gaged data may be transferred to an ungaged site on the same stream provided that the gage does not have any major diversions between the two locations and the ungaged site is between 0.5 and 1.5 times the size of the gaged site.	9.4.2.3	USGS Report (3)
Gage Transfer on the Same Stream (Between Gages)	Used when an ungaged site is located between two gages on a stream. May not be applicable if there is significant storage or diversions between the gages.	9.4.2.4	USGS Report (3)
Transposition of Data (Gage Transfer to a Nearby Drainage)	Single Gage can be used on a nearby and hydrologically similar basin.	9.4.2.5	USGS Report (3)
Published FEMA Data	Generally, published FEMA flows will be used for obtaining a Floodplain Development Permit and may be used for design.	9.4.2.6	FEMA/ FIS

Figure 9.4-1 — MDT PEAK FLOW HYDROLOGIC METHODS TABLE (*Continued)*

Peak Flow Methods	Overview	Summary	Design Procedure
USGS Peak Flow Regional Regression Equations	These equations are used frequently by MDT. The parameters for the ungaged site must fall within the parameter limits listed in the USGS report.	9.4.2.7	USGS Report (3)
USGS StreamStats	StreamStats is a web-based application of the USGS regional regression equations that generates all parameters needed for a watershed identified by the user.	9.4.2.7	9.6
USGS Channel-Width Regression Equations	USGS has developed a set of equations based on channel dimensions for the Montana hydrologic regions.	9.4.2.8	USGS Report (4)
Local Least Squares Regression Analysis (Formerly called Regional Frequency and Regional Regression Analysis)	The Local Least Squares Regression Analysis is similar to the USGS Peak Flow Regional Regression Equation analysis, except that only a limited number of gages near the project site are used instead of gages across the entire hydrologic region.	9.4.2.9	9.5
Nallick Regression Equations	Applicable to small drainage basins (less than one square mile) in the plains of eastern Montana	9.4.2.10	9.4.2.10
Rational Method	Can be used for drainage areas up to 200 acres in size. Mainly used as an urban method.	9.4.2.11	9.7
NRCS TR-55 Peak Discharge Method (Formerly SCS Method)	This method requires rainfall data, soil type, and an estimate of the Curve Number to develop peak flow rates. This method can be applied to watersheds that are less than 25 mi^2.	9.4.2.12	9.8

For an ungaged site, or a gaged site with limited years of data and a drainage basin larger than one square mile, MDT practice is to calculate three or more hydrologic methods and then evaluate the results. Three valid hydrologic methods may not be available for crossings with drainage areas less than one square mile. In this case, only use methods that are applicable for the site location.

The results from several methods should be compared, not averaged. Use the discharge that best reflects local project conditions with the reasons documented in the Hydraulic Report. Select either one hydrologic method for the entire project or select one method for larger basins and one method for smaller basins, based on the limitations of the hydrologic method.

The following methods are used by the MDT Hydraulics Section.

9.4.2.1 USGS Peak Flow Frequency Analysis (Gaged Data)

If a project site is located near a stream gaging station and the streamflow record is of sufficient length for use to provide estimates of peak discharges, this is the preferred hydrologic method. A complete record is defined as one having at least 20 years of continuous or synthesized data. However, this method has been used (with less certainty) with as few as 10 years of record.

MDT has a cooperative agreement with USGS to maintain gages throughout Montana. USGS also conducts a peak flow frequency analysis of the gaged data. Rather than conduct a Log Pearson III analysis of the gaged data, MDT recommends using the frequency analysis from USGS published in the most recent USGS Montana flood frequency report (3).

9.4.2.2 USGS Adjusted Peak Flow Frequencies (Gaged Data)

USGS has published adjusted peak flow frequency estimates for selected gages with limited or intermittent records. When a gage has an adjusted peak flow frequency, compare and evaluate the adjusted values to the peak flow values from Section 9.4.2.1. Consider the site risk, the length and continuity of the record, and whether the gage is hydrologically similar to the gages in its region.

9.4.2.3 Gage Transfer on the Same Stream — Single Gage

Gaged data may be transferred to an ungaged site on the same stream provided that the gage does not have any major diversions between the two locations and the ungaged site is between 0.5 and 1.5 times the basin size (area) of the gaged site. This method is described in the USGS Report (3) and uses a drainage area ratio adjustment to transfer flows from the gaged site to the ungaged site.

9.4.2.4 Gage Transfer on the Same Stream — Between Gages

If an ungaged site is located between two gages on the same stream, the logarithms of the peak flow frequencies of the gaged sites can be linearly interpolated to determine the flows at the ungaged site. The procedure is described in the USGS Report (3).

9.4.2.5 Transposition of Data (Gage Transfer to an Adjacent Drainage)

If an ungaged site is near a gaged site but in a separate drainage area, the equation and coefficients for the Gage Transfer on the Same Stream — Single Gage can be used for a nearby and hydrologically similar basin. The ungaged and gaged sites should have similar drainage basin orientations and basin characteristics, and the ungaged site must be between 0.5 and 1.5 times the basin size (area) of the gaged site. This method can be considered when compared with a minimum of two other hydrologic methods.

In some streams, natural peak flows may decrease downstream because of significant floodplain storage or loss of flow in aquifer recharge zones. The hydraulic engineer is cautioned not to use the transposition approach in these cases.

9.4.2.6 Published FEMA Data

Where a FEMA Flood Insurance Study has been completed, various return period flows will be published in the study. These flows should always be reported in the MDT Hydraulic Report and will generally be used as the design flows. When other reliable methods indicate that the predicted flows are greater than the FIS flows, the higher values should be used for design, but the FIS flow should be checked for compliance with the floodplain criteria. If other reliable methods indicate that the predicted flows are less than the FIS flows, the design should be evaluated at both the FIS flow and the lower flow.

9.4.2.7 USGS Peak Flow Regional Regression Equations

USGS uses the peak flow frequencies from gages throughout Montana to develop regression equations for use at ungaged sites. USGS has divided Montana into hydrologic regions and has analyzed the gages in these regions to develop regression equations using region-specific basin characteristics. The most recent USGS report (3) describes these regions, the equations specific to each region, and the range of variables that are applicable to the equations in each region. The current regression equations are also published in the USGS online program StreamStats (2); see Section 9.6.

Problems related to hydrologic boundaries may occur in selecting the appropriate regression equation. First, the watershed of interest may lie partly within two or more hydrologic regions. In this case, it is recommended to calculate the discharges with both sets of equations and to also use a weighted method. Another problem may occur when a watershed lies totally within a hydrologic region but close to a hydrologic region boundary. In this case, it is recommended to calculate the hydrology using the equations from both regions.

The following limitations should be considered when using the regression equations to compute peak-flow frequencies:

- The rural equations apply to streams that are located in rural watersheds. The equations should not be applied to watersheds substantially affected by urbanization.
- The equations should not be used where dams, flood-detention structures, and other constructed works exist that significantly affect the annual peak flows.
- The equations should be used only for streams that have drainage areas and basin and climatic characteristics that are within the range of characteristics used to develop the regression equations.

9.4.2.8 USGS Channel-Width Regression Equations

Channel dimensions are typically formed by site-specific floods and streamflow. USGS has developed a set of equations based on channel dimensions for the Montana hydrologic regions. The hydraulic engineer should follow the USGS report to measure appropriate channel variables.

The channel-width regression results can also be weighted with the regional regression equations when appropriate. However, the channel-width regression equations must be developed from the same data as the regional regression equations. Follow the procedure in the most recent USGS report (4).

9.4.2.9 Local Least Squares Regression Analyses

The Local Least Squares Regression Analysis (formerly called the Regional Regression Analysis and the Regional Frequency Analysis) is similar to the USGS Peak Flow Regression Equation analysis, except that only a limited number of gages near the project site are used instead of gages across the entire hydrologic region. This method uses drainage area alone or in conjunction with one or two other basin characteristic variables (such as mean basin elevation, annual precipitation, forest cover, etc.) to develop a best fit line and equation.

For this method, a limited number of nearby gages (generally 4 to 10) are selected. These gages should be as close as possible to the study area and should generally all be in the same USGS hydrologic region as the basin being analyzed. The selected gages should include drainage areas that are both smaller and larger than the basin being considered.

Gages should have at least 20 years of continuous or synthesized data. However, this method has been used (with less certainty) with as few as 10 years of record.

The Local Least Squares Regression Analysis uses the supplied gaged data to generate an equation of the form:

$$Q = KX^aY^bZ^c \qquad \text{Equation 9.4-1}$$

Where:

Q = peak flow for the return period of interest, ft^3/s
K = the antilog of the multiplication constant
X = drainage area, mi^2
Y, Z = additional basin characteristics
a, b, c = regression exponents

The values for a, b, c, and K are unique to each frequency for each set of gages and are calculated based on a best fit line for the one, two, or three variables. Internally, MDT uses a spreadsheet for this calculation.

An example problem for the Local Least Squares Regression Analysis is in Section 9.5.

9.4.2.10 Nallick Regression Equations

These regression equations were developed by James Nallick in cooperation with MDT. They are only applicable to small drainage basins (less than one square mile) in the plains east of the Continental Divide in Montana. The parameters are drainage area, average annual precipitation, and one-hour precipitation intensity.

The equations below were developed using gaged data through 1988. The results should be compared to results from other methods and historical data to determine the most appropriate hydrology.

The Nallick Regression Equations are as follows:

$$Q_2 = 2442\ A^{0.6986}\ P^{-1.9916}\ I_{25}^{2.3244}$$
$$Q_5 = 17{,}539\ A^{0.6357}\ P^{-2.3436}\ I_{25}^{2.0561}$$
$$Q_{10} = 51{,}964\ A^{0.6154}\ P^{-2.5528}\ I_{25}^{1.8896}$$
$$Q_{25} = 112{,}176\ A^{0.5937}\ P^{-2.6276}\ I_{25}^{1.6507}$$
$$Q_{50} = 148{,}559\ A^{0.5724}\ P^{-2.5958}\ I_{25}^{1.4537}$$
$$Q_{100} = 198{,}244\ A^{0.5569}\ P^{-2.5800}\ I_{25}^{1.2582}$$

Where:

Q_i = peak flow rate (ft^3/s) for the i^{th} year return interval in years
A = area (mi^2)
P = average annual precipitation (in.)
I_{25} = 25-year 1-hour rainfall intensity (in/h)

9.4.2.11 Rational Method

The Rational Method provides peak runoff rates for small urban and rural watersheds less than 200 acres. The Method is best suited to urban storm drainage systems. This method may also be used to determine the discharge for designing bridge deck drainage, surface drainage inlets, and pipe culverts with small discharges. Select rainfall intensity based on the time of concentration.

See Section 9.7 and the FHWA Hydraulic Toolbox, which contains this method; see Chapter 8, "Hydraulics Software."

9.4.2.12 NRCS TR-55 Peak Discharge Method

The NRCS TR-55 peak discharge method (see Section 9.8) is a graphical method for estimating peak discharge and was first presented in the Soil Conservation Service's National Engineering Handbook and the "Urban Hydrology for Small Watersheds" Technical Release 55 (TR-55). This method requires rainfall data, soil type, and an estimate of the Curve Number (CN) to develop peak flow rates. The CN can be estimated based on the hydrologic soil group of the area, land use/cover, and hydrologic condition. The method can be applied to watersheds that are less than 25 mi^2.

The NRCS method has a number of limitations. When these conditions are not met, the accuracy of estimated peak discharges decreases. The method should be used on watersheds that are homogeneous in

CN. Where parts of the watershed have CNs that differ by 5, the watershed should be subdivided and analyzed using a hydrograph method such as TR-20, see Chapter 8, "Hydraulics Software." The NRCS method should be used only when the CN is 50 or greater and the T_c is greater than 0.1 h and less than 10 h. Also, the computed value of I_a/P should be between 0.1 and 0.5. The method should be used only when the watershed has one main channel or where there are two main channels that have nearly equal times of concentration; otherwise, a hydrograph method should be used; see Section 9.4.3. Use a different method when channel or reservoir routing is required or where watershed storage is either greater than 5% or located on the flow path used to compute the T_c.

9.4.3 Hydrograph Methods

Hydrographs are used to determine the effect of flow through storage facilities. Figure 9.4-2 presents the hydrograph methods used by MDT in general order of preference. In addition to the methods below, software and additional methods within the software may be used to generate a hydrograph.

Figure 9.4-2 — MDT HYDROGRAPH METHODS

Hydrograph Methods	Overview	Summary	Design Procedure
NRCS Unit Hydrograph	A synthetic unit hydrograph procedure that uses the peak flow from the NRCS TR-55 method (see Section 9.8).	9.4.3.1	HDS 2
USGS Nationwide Urban Hydrograph	Dimensionless hydrograph derived from the USGS nationwide urban hydrograph study.	9.4.3.2	HEC 22
Montana Unit Hydrograph	For large floods at ungaged sites in Montana and for drainage areas ranging from 6.31 mi^2 to 1548 mi^2.	9.4.3.3	USGS
Wyoming Unit Hydrograph	For drainage basins smaller than 11 mi^2 in the plains and valley areas of Wyoming.	9.4.3.4	USGS
Triangular Hydrograph	For estimating storage volume required for peak flow attenuation. Not for final design.	9.4.3.5	HEC 22

9.4.3.1 NRCS Unit Hydrograph

NRCS has developed a synthetic unit hydrograph procedure, which has been widely used for developing rural and urban hydrographs. The unit hydrograph used by the NRCS method (see Section 9.8) is based upon an analysis of a large number of natural unit hydrographs from a broad cross section of geographic locations and hydrologic regions. To select the NRCS storm type distribution, follow the procedure in Section 9.8.4. The NRCS hydrographs are based on a 24-hour storm event.

The input parameters are the peak discharge, the area of the watershed, and the time to peak. With these parameters, a standard unit hydrograph is constructed. This procedure is documented in HDS 2 (1) and illustrated with an example.

9.4.3.2 USGS Nationwide Urban Hydrograph

The USGS nationwide urban hydrograph method uses information developed by the USGS that approximates the shape and characteristics of hydrographs. Information required for using this method are dimensionless hydrograph ordinates, time lag, and peak flow. These values provide the shape of the dimensionless hydrograph. The hydrograph ordinates and procedure are documented in HEC 22 with an example.

9.4.3.3 Montana Unit Hydrograph

USGS, in cooperation with the Montana DNRC, developed a unit hydrograph procedure for large floods at ungaged sites in Montana and for drainage areas ranging from 6.31 mi^2 to 1548 mi^2. This procedure utilizes drainage area, main channel length, main channel slope, and distance from basin centroid to mouth as parameters. The procedure is documented in USGS WSP 2420, available online (5). The methods described in this report only apply within the range of variables used in the analysis, and the use of the method outside those ranges may result in unreliable unit hydrographs.

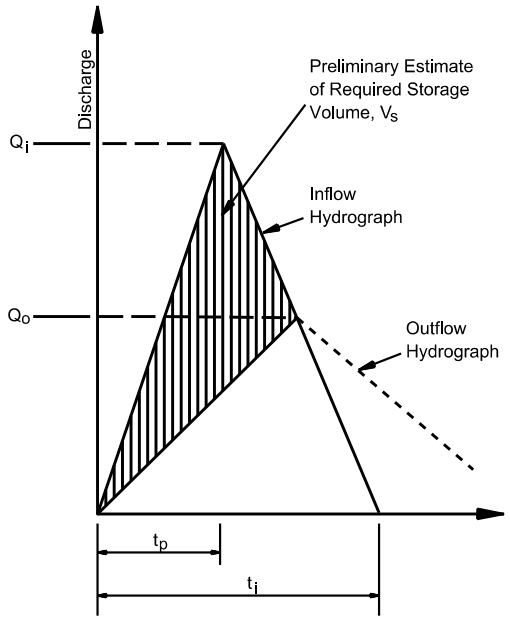
9.4.3.4 Wyoming Unit Hydrograph

USGS, in cooperation with the Wyoming State Highway Department, developed a unit hydrograph procedure for Wyoming, which is documented in USGS WSP 2056, available online (6). This flood-hydrograph study has defined the magnitude and frequency of flood volumes and flood peaks that can be expected from drainage basins smaller than 11 mi^2 in the plains and valley areas of Wyoming. The procedure can be applied in southeastern Montana to similar drainage basins. This procedure utilizes drainage area, basin slope, maximum basin relief, and channel slope as parameters.

9.4.3.5 Triangular Hydrograph

A preliminary estimate of the storage volume required for peak-flow attenuation may be obtained from a simplified design procedure that replaces the actual inflow and outflow hydrographs with the standard triangular shapes shown in Figure 9.4-3, which is from HEC 22. This method should not be applied if the hydrographs cannot be approximated by a triangular shape.

Figure 9.4-3 — TRIANGULAR SHAPED HYDROGRAPHS (FOR PRELIMINARY ESTIMATE OF REQUIRED STORAGE VOLUME)



The required storage volume may be estimated from the area above the outflow hydrograph and inside the inflow hydrograph, expressed as:

$$V_s = 0.5t_i(Q_i - Q_o) \qquad \text{Equation 9.4-2}$$

Where:

V_S = storage volume estimate, ft^3
Q_i = peak inflow rate, ft^3/s
Q_o = peak outflow rate, ft^3/s
t_i = duration of basin inflow, s (typically 2 × time of concentration)
t_p = time to peak, s (time of concentration)

The duration of basin inflow should be derived from the estimated inflow hydrograph.

9.4.4 Low Flow Methods

Low flow methods are sometimes required to determine the design flows for fish passage or stream restoration. Numerous publications, most by USGS, are available to assist in this determination; however, in general, the most recent USGS publication is probably the most applicable. The hydraulic engineer must determine the applicability of the method on a case by case basis. In addition to these publications, the hydraulic engineer can also consult USGS National Water Information System (NWIS) (7) and StreamStats (2) data, both available online. See Figure 9.4-4.

Figure 9.4-4 — MDT LOW FLOW METHODS

Low Flow Methods	Location	Overview	Summary (Section)
USGS Gaged Data	Statewide	USGS NWIS provides low flow statistics online	9.4.4.1
Montana StreamStats	Statewide	USGS Montana StreamStats provides low flow statistics online	9.4.4.2
Ungaged Sites in Western Montana	Ungaged Sites in Western Montana	WSP- 2365 provides three methods for estimating mean monthly discharge	9.4.4.3
Upper Missouri River Basin	Upper Missouri River Basin	WRI 89-4082 provides three methods for estimating mean monthly discharge	9.4.4.4
Musselshell River Basin	Musselshell River Basin	WRI 89-4165 provides four methods for estimating mean monthly discharge	9.4.4.5
National Forests of Montana	National Forests of Montana	WRIR 85-4071 provides equations for estimating mean annual discharge, 80% exceedance discharge, and 95% exceedance discharge	9.4.4.6

9.4.4.1 USGS Gaged Data

The USGS National Water Information System (NWIS) database (7), which is available online, contains all measured data for USGS gages including low flow data. The system has tools for cataloging and analyzing the data.

9.4.4.2 Montana StreamStats

The USGS Montana StreamStats Web Application (2) has methods for estimating selected low flow streamflow characteristics in Montana for ungaged sites based on basin and streamflow characteristics for gaging stations.

9.4.4.3 Ungaged Sites in Western Montana

USGS Water Supply Paper 2365 (available online) "Methods for Estimating Monthly Streamflow Characteristics at Ungaged Sites in Western Montana," 1990, provides three methods for estimating the mean monthly discharge and 90%, 70%, 50%, and 10% exceedance values for each month. The document is prepared in cooperation with the Bureau of Indian Affairs and the Confederated Salish and Kootenai Tribes and is applicable to Montana west of the Continental Divide.

9.4.4.4 Upper Missouri River Basin

USGS Water Resources Investigation Report 89-4082 (available online) "Estimates of Monthly Streamflow Characteristics at Selected Sites in the Upper Missouri River Basin, Montana, Base Period Water Years 1937-1986" provides three methods for estimating mean monthly discharge and 90%, 80%, 50% and 20% exceedance values for each month. The document is prepared in cooperation with the Montana Department of Fish, Wildlife, and Parks and is applicable to the Missouri River basin above Fort Peck Dam.

9.4.4.5 Musselshell River Basin

USGS Water Resources Investigation Report 89-4165 (available online) "Estimates of Monthly Streamflow Characteristics for Selected Sites in the Musselshell River Basin, Montana, Base Period Water Years 1937-86" provides four methods for estimating mean monthly values. The document is prepared in cooperation with the Lower Musselshell Conservation District and the Montana Department of Natural Resources and Conservation.

9.4.4.6 National Forests of Montana

USGS Water Resources Investigation Report 85-4071 (available online) "A Method for Estimating Mean and Low Flows of Streams in National Forests of Montana" provides equations for estimating mean annual discharge, 80% exceedance discharge, and 95% exceedance discharge for streams on national forest lands in Montana. The equations for mean annual discharge used active-channel width, drainage area, and mean annual precipitation as independent variables, with active-channel width being the most significant. The equations used only active-channel width as an independent variable.

9.5 LOCAL LEAST SQUARES REGRESSION ANALYSIS

9.5.1 Procedure

The gages selected for this analysis should be near the study area and should be within the same hydrologic region. Use the current peak flow frequency data for each gage from StreamStats or the current USGS publication. Enter the gage data into a spreadsheet to complete a Local Least Squares Regression Analysis. The first variable should always be the drainage area. The second and third variables, if used, are taken from the USGS Peak Flow Regional Regression Equation from the same hydrologic region. However, other variables can be used, if appropriate. For instance, Mean Annual Precipitation may be considered as a variable in the Least Squares Regression Analysis even if it is not a variable in the USGS regression equation for that region.

9.5.2 Example Problem

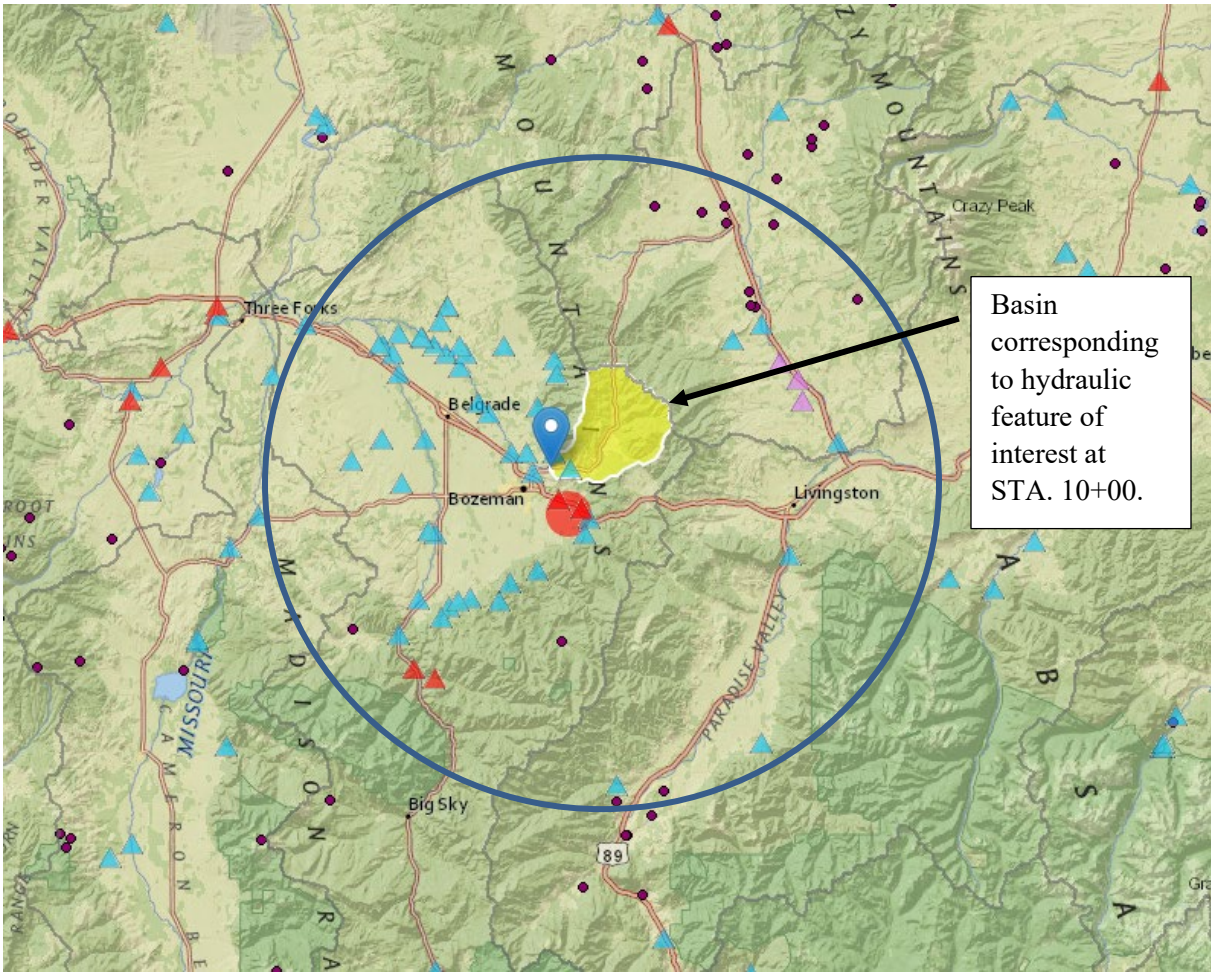
Step 1: Estimate the flood frequency discharges for a project near Bozeman with a drainage area of 65.5 mi^2, an E6000 of 61.1%, and a mean annual precipitation of 32.4 in.

Step 2: Select nearby gages (generally 4 to 10) that have drainage areas both larger and smaller than the project site and enter the gage data from StreamStats into the spreadsheet. Gages should have at least 20 years of continuous or synthesized data. However, this method has been used (with less certainty) with a gage record with as few as 10 years. See Figure 9.5-1.

Figure 9.5-1 — STREAM GAGE DATA ENTERED INTO SPREADSHEET

Name	Gage Number	Drainage Area mi^2	E6000 %	Mean Annual Precipitation	66.7 1.5	50.0 2	42.9 2.33	20.0 5	10.0 10	4.0 25	2.0 50	1.0 100	0.5 200	0.2 500
Taylor Creek near Grayling, MT	6043000	98	100.0	33.6	710	780	810	926	1010	1100	1170	1230	1290	1370
Squaw Creek near Gallatin Gateway, MT	6043200	37.3	97.0	33.1	212	259	282	392	495	644	770	906	1060	1280
Logger Creek near Gallatin Gateway, MT	6043300	2.53	90.0	29.5	11	14	15	23	31	45	58	74	93	125
Gallatin River near Gallatin Gateway, MT	6043500	819	97.0	34.7	4620	5280	5580	6790	7700	8750	9490	10200	10800	11700
Rocky Creek near Bozeman, MT	6046500	49.5	56.0	26.7	314	383	417	583	740	970	1160	1380	1620	1970
Pitcher Creek near Bozeman, MT	6046700	2.38	16.0	23.9	11	15	18	32	51	87	124	169	224	312
Bear Canyon near Bozeman, MT	6047000	17.3	86.0	31.4	120	154	171	245	310	394	459	525	593	685
East Gallatin River at Bozeman, MT	6048000	151	51.0	26.6	441	549	603	866	1120	1490	1820	2170	2570	3150
Bridger Creek near Bozeman, MT	6048500	62.3	63.0	32.9	235	299	331	489	643	870	1070	1280	1520	1870
Shields River at Clyde Park, MT	6193500	539	39.0	23.0	842	1070	1180	1750	2320	3170	3910	4750	5700	7150
Brackett Creek near Clyde Park, MT	6194000	58.1	53.0	29.8	153	205	234	391	570	870	1150	1470	1830	2380

Figure 9.5-2 — AVAILABLE GAGES SURROUNDING THE PROJECT SITE



Step 3: Enter the drainage area and basin characteristics for the project drainage basin site (multiple drainage basins may be entered) on the output tab and review the results:

Station	Name	Drainage Area mi^2	E6000 %	Mean Annual Precipitation
10+00	Example Creek	65.5	61.1	32.4

Step 4: Review the results.

Figure 9.5-3 — SINGLE VARIABLE (DRAINAGE AREA) RESULTS

Tabular Data:

Drainage Area mi^2

Q	Q	Q	Q	Q	Q	Q	Q	Q
1.5	2	5	10	25	50	100	200	500
275.7	341.8	534.4	687.7	910.7	1099.5	1302.5	1523.5	1845.7

Q_{50} Plot for 1 Variable (Drainage Area):

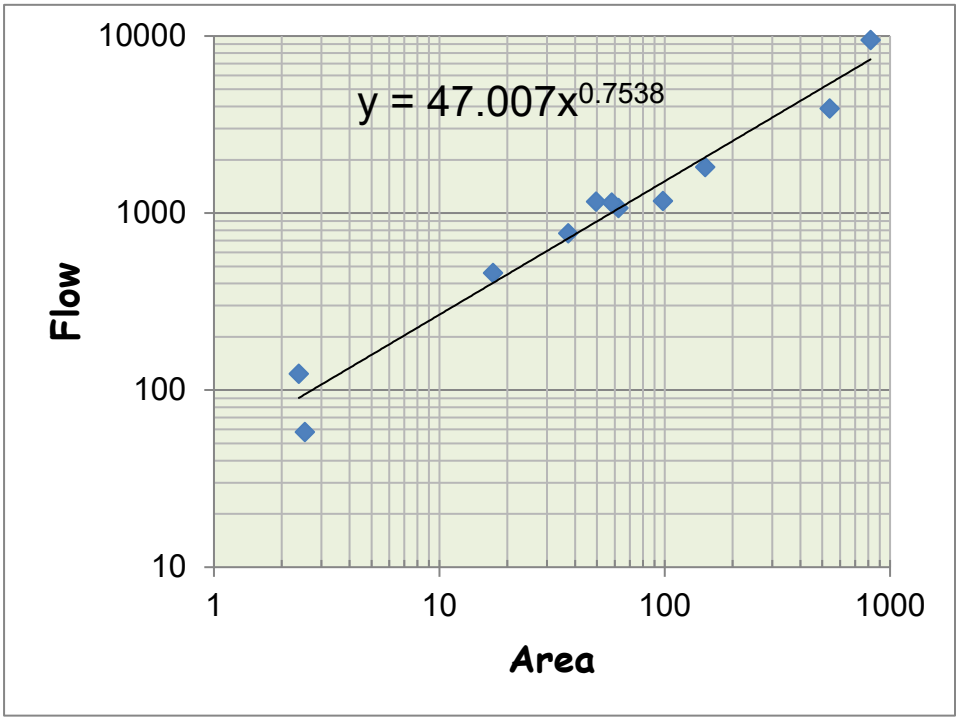


Figure 9.5-4 — TWO VARIABLE (DRAINAGE AREA AND E6000) RESULTS

Drainage Area mi^2 E6000 %

Q	Q	Q	Q	Q	Q	Q	Q	Q
1.5	2	5	10	25	50	100	200	500
273.0	339.0	531.9	686.4	911.6	1102.8	1308.6	1533.0	1860.3

Figure 9.5-5 — THREE VARIABLE (DRAINAGE AREA, E6000, AND MEAN ANNUAL PRECIP) RESULTS

		Drainage Area mi^2		E6000 %	Mean Annual Precipitation			
Q	Q	Q	Q	Q	Q	Q	Q	Q
1.5	2	5	10	25	50	100	200	500
336.7	415.9	653.7	842.9	1111.4	1336.2	1564.4	1805.4	2142.8

Step 5: Review the results and compare the values and the standard error to other methods.

9.6 USGS STREAMSTATS

9.6.1 Summary of StreamStats

StreamStats is a Web application that provides access to an assortment of Geographic Information System (GIS) analytical tools that are useful for water-resource planning and management and for engineering and design purposes. The map-based user interface can be used to delineate drainage areas for user-selected sites on streams and then to obtain basin characteristics and estimates of flow statistics for the selected sites anywhere this functionality is available. StreamStats users also can select the locations of USGS data-collection stations, shown as triangles on the StreamStats map, and obtain flow statistics and other information for the stations. A variety of additional tools are available for discovering information on streams and the activities along the streams.

Montana StreamStats documentation is available online in the latest USGS publication (2). The program has been developed in cooperation with MDT. StreamStats determines drainage-basin boundaries by using digital elevation data. It incorporates statewide USGS regional regression equations for estimating instantaneous peak flows.

The application methods allow estimation of peak flow frequencies (that is, peak flow magnitudes, in ft^3/s, associated with annual exceedance probabilities of 66.7, 50, 42.9, 20, 10, 4, 2, 1, 0.5, and 0.2 percent) at ungaged sites. The annual exceedance probabilities correspond to 1.5-, 2-, 2.33-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence intervals, respectively. In addition, for western Montana, regression equations are available for the estimation of:

- Low-flow frequencies;
- Mean annual and mean monthly streamflows; and
- 20-, 50-, and 80-% durations for annual and monthly duration streamflows for ungaged sites in western Montana.

All equations assume that estimated flows at user-selected sites are unaffected by regulation.

StreamStats for Montana also includes a tool that tests for the presence of upstream dams and computes the percentage of a delineated basin that is affected by dam regulations.

9.6.2 Considerations

The hydraulic engineer should consider the following when using StreamStats:

1. Basin Delineation. Verify and evaluate closely. Basin boundaries can be exported and placed onto topographic maps within CADD for verification.

2. Upstream Regulation. Always check for the upstream regulation (dams or other areas impounding water). StreamStats may not be reliable for estimating discharges for sites on regulated streams or sites that are affected by urbanization.

3. Basin Characteristics. StreamStats also calculates many basin characteristics that may be useful for other hydrologic methods.

9.7 RATIONAL METHOD

9.7.1 Introduction

The Rational Method is recommended for estimating the design flood peak runoff for areas up to 200 acres. The procedures presented in this section are based on HDS 2 (1).

9.7.2 Application

Some precautions should be considered when applying the Rational Method:

- The first step in applying the Rational Method is to accurately define the boundaries of the drainage area in question.

- In determining surface characteristics for the drainage area, consider any future changes in land use that might occur during the service life of the proposed facility that could result in an inadequate drainage system. Also, the effects of upstream detention facilities may be considered.

- Restrictions to the natural flow (e.g., highway crossings and dams that exist in the drainage area) should be investigated to determine how they might affect the design flows.

- The charts, graphs, and tables included in this section are not intended to replace reasonable and prudent engineering judgment that should permeate each step in the design process.

9.7.3 Characteristics

Characteristics of the Rational Method that limit its use to 200 acres include:

1. Rainfall Intensity vs Time of Concentration. The rate of runoff resulting from any rainfall intensity is a maximum when the rainfall intensity lasts as long as or longer than the time of concentration. That is, the entire drainage area does not contribute to the peak discharge until the time of concentration has elapsed.

2. Peak Discharge Frequency. The frequency of peak discharges is the same as that of the rainfall intensity for the given time of concentration.

3. Runoff. The fraction of rainfall that becomes runoff (C) is independent of rainfall intensity or volume.

9.7.4 Equation

The Rational Method equation estimates the peak rate of runoff at any location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity. The duration of rainfall is assumed to be equal to the time of concentration (the time required for water to flow from the most hydraulically remote point of the basin to the location being analyzed). The Rational equation is expressed as follows:

$$Q = CiA \qquad \text{Equation 9.7-1}$$

Where:

Q = maximum rate of runoff, ft^3/s

C = runoff coefficient representing a ratio of runoff to rainfall

i = average rainfall intensity for a duration equal to the time of concentration for a selected return period, in/h

A = drainage area tributary to the design location, acres

The results of using the Rational Method to estimate peak discharges are very sensitive to the parameters used, especially the time of concentration and runoff coefficient. The hydraulic engineer should use good engineering judgment in estimating values that are used in the Rational Method. Following is a discussion of the variables used in the Rational Method.

9.7.5 Runoff Coefficient

The runoff coefficient (C) is the variable of the Rational Method least amenable to precise determination and requires the judgment and understanding of the hydraulic engineer. Although engineering judgment will always be required in the selection of runoff coefficients, a typical coefficient represents the integrated effects of many drainage basin parameters. See Figure 9.7-1.

Figure 9.7-1 — RUNOFF COEFFICIENTS (C) FOR THE RATIONAL EQUATION

Type of Drainage Area	Runoff Coefficient (C)
Business:	
Downtown areas	0.70 – 0.95
Neighborhood areas	0.50 – 0.70
Residential:	
Single-family areas	0.30 – 0.50
Multi-units, detached	0.40 – 0.60
Multi-units, attached	0.60 – 0.75
Suburban	0.25 – 0.40
Apartment dwelling areas	0.50 – 0.70
Industrial:	
Light areas	0.50 – 0.80
Heavy areas	0.60 – 0.90
Parks, cemeteries	0.10 – 0.25
Playgrounds	0.20 – 0.40
Railroad yard areas	0.20 – 0.40
Unimproved areas	0.10 – 0.30
Lawns:	
Sandy soil, flat (< 2%)	0.05 – 0.10
Sandy soil, average (2% to 7%)	0.10 – 0.15
Sandy soil, steep (> 7%)	0.15 – 0.20
Heavy soil, flat (< 2%)	0.13 – 0.17
Heavy soil, average (2% to 7%)	0.18 – 0.22
Heavy soil, steep (> 7%)	0.25 – 0.35
Pasture:	
Flat (< 1%)	0.20 – 0.25
Rolling (1% to 3.5%)	0.25 – 0.35
Hilly (> 3.5%)	0.35 – 0.45
Woodlands:	
Flat and Rolling (< 3.5%)	0.15 – 0.20
Hilly (> 3.5%)	0.20 – 0.25
Streets:	
Asphalt	0.70 – 0.95
Concrete	0.80 – 0.95
Brick	0.70 – 0.85
Drives and walks	0.75 – 0.85
Roofs	0.75 – 0.95

Source: HDS 2 (1) and Chow (8)

9.7.6 Time of Concentration

9.7.6.1 General

The time of concentration (t_c) is the time required for water to flow from the most hydraulically remote point of the drainage area to the point under investigation. Factors that affect the time of concentration are the length of flow, the slope of the flow path, and the roughness of the flow path. For flow at the upper reaches of a watershed, rainfall characteristics, most notably the intensity, may also influence the velocity of the runoff.

Various methods can be used to estimate the time of concentration of a watershed. When selecting a method to use in design, it is important to select a method that is appropriate for the flow path. Sheet flow occurs in the upper reaches of a watershed. Such flow occurs over short distances and at shallow depths prior to the point where topography and surface characteristics cause the flow to concentrate in rills and swales. The depth of such flow is usually 0.8 in. to 1.2 in. or less. Shallow concentrated flow is runoff that occurs in rills and swales and has depths in the range of 1.6 in. to 3.9 in. Part of the principal flow path may include pipes or small streams. The travel time through these segments is computed separately. Velocities in open channels are usually determined assuming bank-full depths.
The type of flow that occurs is a function of the conveyance system and is best determined by field inspection. Development within a watershed may create changes in overland flow paths. The overland flow path is not necessarily perpendicular to the contours shown on the available mapping. Often, the land will be graded, and swales will intercept the natural contour and direct the water to the roads and streets, which reduces the time of concentration. Hydraulic engineers should identify constructed topographic changes and include existing flow characteristics in their design. After the hydraulic engineer has determined the flow type for each area within the watershed, determine the time of concentration from Section 9.7.6.2. These methods are from HDS 2 (1), and are included in the FHWA Hydraulic Toolbox.

9.7.6.2 Flow Types and Equations

Use Figure 9.7-2 to determine which equation to use to calculate the travel time for each area.

Figure 9.7-2 — FLOW TYPES AND EQUATIONS FOR TRAVEL TIME

Flow Type	Recommended Equations
Sheet Flow	Equation 9.7-3 or 9.7-4
Overland Flow	Equations 9.7-5 and 9.7-6
Shallow Concentrated Flow	Equations 9.7-5 and 9.7-6
Channel or Pipe Flow	Equations 9.7-5 and 9.7-7

The time of concentration (t_c) for the watershed is calculated by summing the travel times (T_t) for each area using Equation 9.7-2. The t_c may include all travel time types, a few types, or just a single type:

$$t_c = T_{t(sheet)} + T_{t(overland)} + T_{t(shallow)} + T_{t(channel)} + T_{t(pipe)} \quad \text{Equation 9.7-2}$$

The time of concentration from Equation 9.7-2 should be used if it is longer than the minimum t_c listed in Section 9.7.6.3. If it is shorter, use the minimum t_c.`

9.7.6.3 Minimum Time of Concentration

MDT minimum times of concentration are:

- Use a minimum t_c = 5 minutes for paved areas (sheet, channel, or pipe flow).
- Use a minimum t_c = 10 minutes for unpaved areas (sheet or shallow concentrated flow) and for unpaved roads.

9.7.6.4 Sheet-Flow Travel Time

Sheet flow is a shallow mass of runoff on a plane surface with the depth uniform across the sloping surface. Typically, flow depths will not exceed 2 in. This type of flow occurs over relatively short distances, rarely more than approximately 300 ft, but most likely less than 80 ft. Sheet flow rates are commonly estimated using a version of the kinematic wave equation (1). The original form of the kinematic wave travel time, which is used in the FHWA Hydraulic Toolbox, is:

$$T_{t(sheet)} = \frac{0.93}{i^{0.4}}\left(\frac{nL}{\sqrt{S}}\right)^{0.6} \quad \text{Equation 9.7-3}$$

Where:

T_t = travel time, min
n = roughness coefficient (see Figure 9.7-3)
L = flow length, ft
i = rainfall intensity for a storm that has a return period T and duration of t_c, in/h
S = surface slope, ft/ft

$$T_{t(sheet)} = \frac{0.42}{P_2^{0.5}}\left(\frac{nL}{\sqrt{S}}\right)^{0.8} \quad \text{Equation 9.7-4}$$

Where:

P_2 = 2-year, 24-h rainfall depth, in.
n = roughness coefficient for sheet flow (see Figure 9.7-3)

The other variables are as previously defined for Equation 9.7-3. Equation 9.7-4 is based on an assumed IDF relationship. NRCS TR-55 (9) recommends an upper limit of L = 300 ft for using this equation.

Figure 9.7-3 — ROUGHNESS COEFFICIENTS (MANNING'S n) FOR SHEET FLOW

Surface Description	n[1]
Smooth surfaces (concrete, asphalt, gravel, bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Plant residue cover ≤ 20%	0.06
Plant residue cover > 20%	0.17
Grasses:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1. *The n values are a composite of NRCS values* (9) *and are specific to overland and sheet flow.*

2. *Includes species such as weeping love grass, bluegrass, buffalo grass, blue gramma grass, and native grass mixtures.*

3. *When selecting n, consider cover to a height of approximately 1 in. This is the only part of the plant cover that will obstruct sheet flow.*

9.7.6.5 Travel Times for Other Flow Types

9.7.6.5.1 Basic Equation

Velocity can be used to estimate travel times for overland flow, shallow concentrated flow, pipe flow, or channel flow. The travel time (T_t) for a flow segment is a function of the length of flow (L) and the velocity (V):

$$T_{t(type)} = \frac{L}{60\,V} \qquad \text{Equation 9.7-5}$$

Where:

L = length of flow, ft
V = velocity, ft/s

$T_{t\,(type)}$ has units of minutes and is indicated for overland flow as $T_{t\,(overland)}$, for shallow concentrated as $T_{t(shallow)}$, for pipe flow as $T_{t\,(pipe)}$, and for channel flow as $T_{t\,(channel)}$. The travel time is computed for the principal flow path. The principal flow path is the path from the most hydrologically remote part of the drainage area to the point of interest. Where the principal flow path consists of segments that have

different slopes or land covers, the principal flow path should be divided into segments and Equation 9.7-5 used for each flow segment. The velocity of Equation 9.7-5 is a function of the type of flow, the roughness of the flow path, and the slope of the flow path.

9.7.6.5.2 Velocity for Overland and Shallow Concentrated Flow

After short distances, sheet flow tends to concentrate in rills and then gullies of increasing proportions. This flow is usually referred to as shallow concentrated flow. The velocity of the flow can be estimated using an empirical relationship between the velocity and the slope:

$$V = 33kS^{0.5} \qquad \text{Equation 9.7-6}$$

Where:

V = velocity, ft/s
S = slope, ft/ft

The value of k is a function of the land cover and flow regime, with values for selected land covers given in Figure 9.7-4.

Figure 9.7-4 — INTERCEPT COEFFICIENTS (k) FOR VELOCITY VS. SLOPE RELATIONSHIP

k	Land Cover/Flow Regime
0.076	Forest with heavy ground litter; hay meadow (overland flow)
0.152	Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland (overland flow)
0.213	Short grass pasture (overland flow)
0.274	Cultivated straight row (overland flow)
0.305	Nearly bare and untilled (overland flow)
0.457	Grassed waterway (shallow concentrated flow)
0.491	Unpaved (shallow concentrated flow)
0.619	Paved area (shallow concentrated flow); small upland gullies

After the average velocity is computed using Equation 9.7-6, the travel time for the channel segment can be calculated from Equation 9.7-5.

9.7.6.5.3 Velocity for Pipe and Channel Flow

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear in USGS maps.

Manning's equation can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full condition for channels or 50% full for pipes.

Manning's equation is:

$$V = \frac{1.486 R^{2/3} S^{1/2}}{n} \qquad \text{Equation 9.7-7}$$

Where:

V = average velocity, ft/s
R = hydraulic radius, ft (equal to A/WP)
A = cross sectional flow area, ft^2
WP = wetted perimeter, ft
S = slope of the hydraulic grade line, ft/ft
n = Manning's roughness coefficient for pipe or open channel flow

After the average velocity is computed using Equation 9.7-7, the travel time for the channel segment can be calculated from Equation 9.7-5.

9.7.7 Rainfall Intensity

9.7.7.1 General

The rainfall intensity (i) is the rainfall rate (in/h) for the duration equal to the time of concentration (subject to the minimum time of concentration) for a selected return period. Once the return period has been selected for design and a time of concentration calculated for the drainage area, the rainfall intensity can be determined from Intensity-Duration-Frequency (IDF) data available for the Montana sites. Linear interpolation may be used for time of concentration values that fall between recurrence intervals provided in Appendix 9B.

9.7.8 Design Procedure

Step 1: Determine runoff coefficient (C) from Figure 9.7-1.

Step 2: Calculate time of concentration. See Section 9.7.6.

Step 3: Determine rainfall intensity from Appendix 9B.

Step 4: Determine peak runoff using Q = CiA.

9.7.9 Design Example

Given: Location: Eastern Montana, Custer County, near Broadus
Drainage area (A) = 10 acres, pasture, flat
Design frequency = 50-year storm

L = 760 ft
S = 0.005 ft/ft
n = 0.05 (fallow — no residue)

Problem: Determine the design discharge at the given location by the Rational Method.

Solution:

Step 1: Determine Runoff Coefficient. From Figure 9.7-1, the runoff coefficient (C) is 0.25 for flat pasture.

Step 2: Calculate Time of Concentration. Use Section 9.7.6:

a. Use sheet flow Equation 9.7-4 for 300 ft:

P_2 = 2-year, 24-h rainfall depth, in. = 1.5 in. (from Appendix 9B, Figure 9.B-3, Broadus gage)

$$T_{t(sheet)} = \frac{0.42}{P_2^{0.5}}\left(\frac{nL}{\sqrt{S}}\right)^{0.8}$$

$$T_{t(sheet)} = \frac{0.42}{1.5^{0.5}}\left(\frac{0.05(300)}{\sqrt{.005}}\right)^{0.8} = 24.9 \text{ min., use } 25 \text{ min}$$

b. Use overland flow Equations 9.7-5 and 9.7-6 for last 460 ft and use k = 0.305 for nearly bare and untilled (overland flow) from Figure 9.7-4:

$$V = 33kS^{0.5} = 33(0.305)(0.005)^{0.5} = 0.712 \text{ ft/s}$$

$$T_{t(overland)} = \frac{L}{60\,V} = \frac{460}{60\,(0.712)} = 10.8 \text{ min; use } 11 \text{ min.}$$

c. Use Equation 9.7-2:

$t_c = t_{sheet} + t_{overland}$

$t_c = 25 + 11 = 36$ min

Step 3: Determine Rainfall Intensity.

a. Use Appendix 9B, Figure 9.B-3, Broadus gage.

b. Use 50-year values:

- t_c = 35 min is 2.73 in/h
- t_c = 40 min is 2.45 in/h
- Intensity (i) = 2.67 in/h for t_c = 36 min.

Step 4: Determine Peak Runoff.

a. A = 10 acres

b. Q_{Design} = CiA = (0.25)(2.67)(10) = 6.68 ft^3/s (use 7 ft^3/s)

9.8 NRCS TR-55 PEAK DISCHARGE METHOD

The NRCS method in this section is consistent with HDS 2 (1) and the source document NRCS Technical Release No. 55 (9). The method can also be used with a different procedure to produce a hydrograph through software such as HEC-HMS, HEC-WMS, and TR-55. See Chapter 8, "Hydraulics Software."

Because the results of using the NRCS method are very sensitive to the parameters that are used, the hydraulic engineer must use good engineering judgment in estimating the values that are used in the method. The NRCS method requires rainfall data, soil type, and an estimate of the Curve Number (CN) to develop peak flow rates. The NRCS method can be used where:

- Watershed area is less than 25 mi^2,
- CN is 50 or greater,
- T_c is greater than 0.1 h and less than 10 h, and
- The computed value of I_a/P is between 0.1 and 0.5.

The following steps are used to compute the peak discharge by the NRCS method.

9.8.1 Step 1 — Watershed Size

Determine the boundary of the watershed and its area.

9.8.2 Step 2 — Watershed Slope

Compute the average slope of the watershed. Software that can be used to calculate average watershed slope includes StreamStats, WMS, Arc GIS, and CADD.

9.8.3 Step 3 — Future Land Use

Determine the anticipated future land use for all subareas identified in Step 2. If the anticipated future land use will be the same as the existing, proceed to Step 4. If the land use is likely to change, assign the most likely land use; e.g., if pasture is near an urban area and adjacent to a residential area, assume that the pasture will become residential. In this way, the drainage structure should be able to accommodate the future development.

9.8.4 Step 4 — Rainfall

Define the type of rainfall and the amount of rainfall. The NRCS method is based on a 24-h storm event that has a standard time distribution. The Type II storm distribution is a "typical" time distribution that the NRCS has prepared from rainfall records for Montana. Type I and Type IA storm distributions are also appropriate for parts of Montana. To select the appropriate storm distribution, it is necessary to determine the ratio of the 6-h rainfall (P_6) to the 24-h rainfall (P_{24}). The 6-h and 24-h rainfall values should be taken from Appendix 9B or from the NOAA Atlas (available online) for the frequency of the design storm desired. The following should be used to select the distribution:

- Type IA Distribution: $P_6/P_{24} < 0.518$
- Type I Distribution: $P_6/P_{24} = 0.518$ to 0.639
- Type II Distribution: $P_6/P_{24} = 0.640$ to 0.767
- For a ratio greater than 0.767, use the Type II storm distribution but note that the result may not be as conservative.
- Type III Distribution is for coastal areas and is not applicable to Montana.

9.8.5 Step 5 — Runoff Curve Numbers

Determine the runoff curve number (CN) for the watershed. The NRCS method assigns a curve number (CN) value (or runoff factor) for different land uses (ground cover type) and hydrologic soil conditions. Separate values are given for each soil group. The runoff factors indicate the runoff potential of an area when the soil is not frozen. The higher the CN, the higher the runoff potential. Soil properties influence the relationship between rainfall and runoff by affecting the rate of infiltration. The infiltration is the movement of the water through the soil surface into the soil.

The CN is determined using the following steps.

9.8.5.1 Step 5a — Determine Soil Types/Hydrologic Groups

Determine soil types in the watershed and their hydrologic soil groups. NRCS has divided soils into four hydrologic soil groups based on infiltration rates. See the NRCS Web Soil Survey online map to outline the watershed and generate the percent of the area for each hydrologic soil group. The hydrologic soil groups are:

Group A Soils having a low runoff potential due to high infiltration rates. These soils consist primarily of deep, well-drained sands and gravels.

Group B Soils having a moderately low runoff potential due to moderate infiltration rates. These soils consist primarily of moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse textures.

Group C Soils having a moderately high runoff potential due to slow infiltration rates. These soils consist primarily of soils in which a layer exists near the surface that impedes the downward movement of water or soils with moderately fine to fine texture.

Group D Soils having a high runoff potential due to very slow infiltration rates. These soils consist primarily of clays with high swelling potential, soils with permanently high water tables, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious parent material.

9.8.5.2 Step 5b — Determine Curve Number

The hydrologic soil group and the ground cover type are used to find the CN for average moisture conditions from one of the following figures:

- Figure 9.8-1 is for urban areas.
- Figure 9.8-2 is for cultivated agricultural lands. Agricultural land uses are often subdivided by treatment or practices (e.g., contoured or straight row); this separation reflects the different hydrologic runoff potential that is associated with variations in land treatment. Row crops are typically sugar beets and corn, whereas wheat, oats, and barley are classified as small grain.
- Figure 9.8-3 is for other agricultural lands.
- Figure 9.8-4 is for arid and semi-arid range lands.

Note: The NRCS method should be used only when the CN is 50 or greater.

9.8.5.3 Step 5c — Adjust for Moisture Condition

If the soil condition is normally dry or wet, the CN can be adjusted using:

- Figure 9.8-5 for rainfall group (dry, average, wet), and
- Figure 9.8-6 for adjusted CN value.

9.8.6 Step 6 — Time of Concentration

Calculate the time of concentration (t_c). Compute time of concentration using the TR-55 method in Section 9.8.6.1 or the NRCS method for small urban areas (Section 9.8.6.2) where applicable. Section 9.8.6.1 has been duplicated from the TR-55 Manual.

Figure 9.8-1 — RUNOFF CURVE NUMBERS FOR URBAN AREAS

Urban Area[1] Cover Description		Curve Numbers for Hydrologic Soil Group A	B	C	D
Fully developed urban areas[1] (vegetation established)					
Open Space (Lawns, parks, golf courses, cemeteries, etc.)[3]					
Good condition; grass cover on 75% or more of the area		39	61	74	80
Fair condition; grass cover on 50% to 75% of the area		49	69	79	84
Poor condition; grass cover on 50% or less of the area		68	79	86	89
Impervious Areas					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved with curbs and storm sewers (excluding right-of-way)		98	98	98	98
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Paved with open ditches (including right-of-way)		83	89	92	93
Western Desert Urban Areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1-in. to 2-in. sand or gravel mulch and basin borders)		96	96	96	96
Urban Districts	Average impervious[2]				
Commercial and business areas	85	89	92	94	95
Industrial districts	72	81	88	91	93
Residential: Average Lot Size					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing Urban Areas					
Newly graded area (pervious areas only), no vegetation established)[5]		77	86	91	94

Notes:

1. *Average runoff condition, and $I_a = 0.2S$.*
2. *The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows — impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CNs for other combinations of conditions may be computed using the Composite Curve Number Estimation Procedure in TR-55* (9).
3. *CNs shown are equivalent to those of pasture. The Composite CNs may be computed for other combinations of open space cover type.*
4. *Composite CNs for natural desert landscaping should be computed using the Composite Curve Number Estimation Procedure in TR-55* (9) *based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.*
5. *Composite CNs to use for the design of temporary measures during grading and construction should be computed using the Composite Curve Number Estimation Procedure in TR-55* (9)*based on the degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.*

Figure 9.8-2 — RUNOFF CURVE NUMBERS FOR CULTIVATED AGRICULTURAL LANDS

Cultivated Agricultural Lands[1] Cover Type		Hydrologic Condition[3]	Curve Numbers for Hydrologic Soil Group			
Cover type	**Treatment[2]**		**A**	**B**	**C**	**D**
Fallow	Bare soil		77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured and terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadows	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	57	67	76	80

Notes:

1. *Average runoff condition and $I_a = 0.2S$.*
2. *Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.*
3. *Hydrologic condition is based on a combination of factors that affect infiltration and runoff, including:*
   a. *density and canopy of vegetative areas,*
   b. *amount of year-round cover,*
   c. *amount of grass or close-seeded legumes,*
   d. *percent of residue cover on the land surface (good ≥ 20%), and*
   e. *degree of surface roughness.*

Poor: Factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Figure 9.8-3 — RUNOFF CURVE NUMBERS FOR OTHER AGRICULTURAL LANDS

Other Agricultural Lands[1] Cover Descriptions	Hydrologic Condition[3]	Curve Numbers for Hydrologic Soil Group			
		A	B	C	D
Pasture, grassland or range — continuous forage for grazing[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow — continuous grass, protected from grazing and generally moved for hay	------	30	58	71	78
Brush — brush-weed-grass mixture with brush the major element[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Woods — grass combination (orchard or tree farm)[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Farmsteads — buildings, lanes driveways and surrounding lots	------	59	74	82	86

Notes:

1. *Average runoff condition and $I_a = 0.2S$.*
2. *Poor: < 50% ground cover or heavily grazed with no mulch*
   Fair: 50% to 75% ground cover and not heavily grazed
   Good: > 75% ground cover and lightly or only occasionally grazed
3. *Poor: < 50% ground cover*
   Fair: 50% to 75% ground cover
   Good: > 75% ground cover
4. *Actual curve number is less than 30; use CN = 30 for runoff computations.*
5. *CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.*
6. *Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.*
   Fair: Woods are grazed but not burned and some forest litter covers the soil.
   Good: Woods are protected from grazing and litter and brush adequately cover the soil.

Figure 9.8-4 — RUNOFF CURVE NUMBERS FOR ARID AND SEMI-ARID RANGE LANDS

Arid and Semi-Arid Range Lands[1] Cover Type	Hydrologic Condition[2]	Curve Numbers for Hydrologic Soil Group			
		A[3]	B	C	D
Herbaceous — mixture of grass, weeds, and low-growing brush, with brush the minor element	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen — mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon — juniper-pinyon, juniper or both; grass understory	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub — major plants include saltbush, greasewood, creosote bush, blackbrush, bursage, palo verde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

Notes:

1. *Average runoff condition and $I_a = 0.2S$. For range in humid regions, use Figure 9.8-6.*
2. *Poor: < 30% ground cover (litter, grass and brush overstory)*
   Fair: 30% to 70% ground cover
   Good: > 70% ground cover
3. *Curve numbers for group A have been developed only for desert shrub.*

Figure 9.8-5 — RAINFALL GROUPS FOR ANTECEDENT SOIL MOISTURE CONDITIONS DURING GROWING AND DORMANT SEASONS

Antecedent Condition	Condition Description	Growing Season Antecedent Rainfall	Dormant Season Antecedent Rainfall
Dry	An optimum condition of watershed soils, where soils are dry but not to the wilting point and when satisfactory plowing or cultivation takes place	Less than 1½ in.	Less than ½ in.
Average	The average case for annual floods	1½ in. to 2 in.	½ in. to 1 in.
Wet	When a heavy rainfall or light rainfall and low temperatures, have occurred during the five days previous to a given storm	Over 2 in.	Over 1 in.

Source: NRCS (10)

Figure 9.8-6 — CONVERSION FROM AVERAGE ANTECEDENT MOISTURE CONDITIONS TO DRY AND WET CONDITIONS

CN for Average Conditions	Corresponding CNs for	
	Dry	Wet
100	100	100
95	87	98
90	78	96
85	70	94
80	63	91
75	57	88
70	51	85
65	45	82
60	40	78
55	35	74
50	31	70
45	26	65
40	22	60
35	18	55
30	15	50
25	12	43
15	6	30
5	2	13

Source: NRCS (10)

9.8.6.1 TR-55 Time of Concentration

Section 9.7.6 presents the time of concentration methods used for the Rational Method. These also apply to the NRCS Method. If the area is a small urban area (less than 3 mi^2), use Section 9.8.6.2.

Travel time (T_t) is the time required for water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

9.8.6.1.1 Factors Affecting Time of Concentration and Travel Time

Surface Roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development; the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel Shape and Flow Patterns

In small, non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

9.8.6.1.2 Computation of Travel Time and Time of Concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{Equation 9.8-1}$$

Where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \cdots T_{t_m} \qquad \text{Equation 9.8-2}$$

Where:

T_c = time of concentration (hr)
m = number of flow segments

Sheet Flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of approximately 0.1 ft. Figure 9.8-7 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 ft, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}s^{0.4}} \qquad \text{Equation 9.8-3}$$

Where:

T_t = travel time (hr),
n = Manning's roughness coefficient (Figure 9.8-7)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow, steady, uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from Appendix 9B.

Figure 9.8-7 — ROUGHNESS COEFFICIENTS (Manning's n) FOR SHEET FLOW

Surface Description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

1 *The n values are a composite of information compiled by Engman* (11).

2 *Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.*

3 *When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.*

Shallow Concentrated Flow

After a maximum of 300 ft, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from the following equations, in which average velocity is a function of watercourse slope and type of channel:

Unpaved $V = 16.1345\ (s)^{0.5}$ Equation 9.8-4
Paved $V = 20.3282\ (s)^{0.5}$ Equation 9.8-5

Where:

V = average velocity (ft/s)
s = slope of hydraulic grade line (watercourse slope, ft/ft)

These two equations are based on the solution of Manning's equation (Equation 9.8-6) with different assumptions for n (Manning's roughness coefficient) and r (hydraulic radius, ft). For unpaved areas, n = 0.05 and r = 0.4; for paved areas, n = 0.025 and r = 0.2.

Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity from Equation 9.8-4 or 9.8-5, use Equation 9.8-1 to estimate travel time for the shallow concentrated flow segment.

Open Channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bankfull elevation.

Manning's equation is:

$$V = \frac{1.486 R^{2/3} S^{1/2}}{n} \qquad \text{Equation 9.8-6}$$

Where:

V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/p_w
a = cross sectional flow area (ft^2)
p_w = wetted perimeter (ft)
S = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (12) or Linsley, et al. (13). After average velocity is computed using Equation 9.8-4, T_t for the channel segment can be estimated using Equation 9.8-1.

Reservoirs or Lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

9.8.6.1.3 Limitations

- Manning's kinematic solution should not be used for sheet flow longer than 300 ft. Equation 9.8-3 was developed for use with the four standard rainfall intensity-duration relationships.

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The remainder of the peak flow travels by streets, lawns, etc., to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or non-pressure flow.

- The minimum T_c used in TR-55 is 0.1 hour.

- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

9.8.6.2 NRCS Watershed Lag Method for Small Urban Areas

In small urban areas (less than 3 mi^2), the watershed lag method can be used to estimate the time of concentration. The equation to estimate time of concentration in small urban areas is:

$$t_c = (L_m^{0.8} (S + 1)^{0.7}) / (1140\ Y^{0.5}) \quad \text{Equation 9.8-7}$$

Where:

t_c = time of concentration, h
L_m = length of mainstream to farthest divide, ft
Y = average slope of watershed, percent
S = potential maximum retention = [(1000/CN) – 10], in.
CN = curve number

The average watershed slope (Y) is the slope of the land and not the watercourse. This slope can be determined from soil survey data or topographic maps or calculated using software. The average watershed slope can be determined using the following relationship:

$$Y = (100 \times C \times I)/A \quad \text{Equation 9.8-8}$$

Where:

Y = average watershed slope, percent
A = drainage area, ft^2
I = contour interval, ft
C = total contour length (summation of the length of the contour lines that pass through the watershed drainage area on the quad sheet), ft

Flow length (L_m) is the longest flow path in the watershed from the watershed divide to the outlet. This is the total path that water travels overland and in small channels on the way to the outlet. Additional information on this method may be found in the NEH-4, Chapter 15.

9.8.7 Step 7 — Determine Direct Runoff (Q)

The following equation can be used to compute direct runoff (Q):

$$Q = (P - I_a)^2/(P - I_a + S) \quad \text{Equation 9.8-9}$$

MDT practice is to use $I_a = 0.2S$, Equation 9.8-9 becomes:

$$Q = (P - 0.2S)^2/(P + 0.8S) \quad \text{Equation 9.8-10}$$

Where:

Q = accumulated direct runoff, in.
P = 24-hr rainfall, in.
I_a = initial abstraction including surface storage, interception, and infiltration prior to runoff, in.
S = potential maximum retention = [(1000/CN) – 10], in.

9.8.8 Step 8 — Compute the Unit Peak Discharge (q_u)

The unit peak discharge (q_u) is obtained from Equation 9.8-11, which requires the time of concentration and the initial abstraction/rainfall (I_a/P) ratio as input:

$$q_u = 10^{c_o + c_1 \log(t_c) + c_2[\log(t_c)]^2} \quad \text{Equation 9.8-11}$$

Where:

C_0, C_1, C_2 are constants from Figure 9.8-8
t_c = time of concentration from Step 6, h
q_u = unit peak discharge, $ft^3/s/mi^2/in.$ (minimum, 0.1; maximum, 10.0)

9.8.9 Step 9 — Compute the Peak Discharge (q_p)

The peak discharge (q_p) is computed from Equation 9.8-12:

$$q_p = q_u A Q \quad \text{Equation 9.8-12}$$

Where:

q_u = unit peak discharge, $ft^3/s/mi^2/in.$ of runoff
A = drainage area, mi^2
Q = depth of runoff, in. from Step 7

9.8.10 Step 10 — Peak Discharge Adjustment for Pond and Swamp

The unit peak discharge obtained from Equation 9.8-12 assumes that the topography is such that surface flow into ditches, drains, and streams is relatively unimpeded. Where ponding or swampy areas occur in the watershed, a considerable amount of the surface runoff may be retained in temporary storage. The peak discharge rate should be reduced to reflect this condition of increased storage. Values of the pond and swamp adjustment factor (F_p) are provided in Figure 9.8-9. The adjustment factor values are a function of the percent of the total watershed area in ponds and swamps. If the watershed includes significant portions of pond and wetland storage, the peak discharge from Step 9 should be adjusted with Equation 9.8-13:

$$q_a = q_p F_p \quad \text{Equation 9.8-13}$$

Where:

q_p = adjusted peak discharge, ft^3/s of runoff from Step 9
F_p = pond and swamp adjustment from Figure 9.8-9

Figure 9.8-8 — COEFFICIENTS FOR NRCS PEAK DISCHARGE METHOD

Rainfall Type	I_a/P	C_0	C_1	C_2
I	0.10	2.30550	-0.51429	-0.11750
	0.20	2.23537	-0.50387	-0.08929
	0.25	2.18219	-0.48488	-0.06589
	0.30	2.10624	-0.45695	-0.02835
	0.35	2.00303	-0.40769	0.01983
	0.40	1.87733	-0.32274	0.05754
	0.45	1.76312	-0.15644	0.00453
	0.50	1.67889	-0.06930	0.0
IA	0.10	2.03250	-0.31583	-0.13748
	0.20	1.91978	-0.28215	-0.07020
	0.25	1.83842	-0.25543	-0.02597
	0.30	1.72657	-0.19826	0.02633
	0.50	1.63417	-0.09100	0.0
II	0.10	2.55323	-0.61512	-0.16403
	0.30	2.46532	-0.62257	-0.11657
	0.35	2.41896	-0.61594	-0.08820
	0.40	2.36409	-0.59857	-0.05621
	0.45	2.29238	-0.57005	-0.02281
	0.50	2.20282	-0.51599	-0.01259
III	0.10	2.47317	-0.51848	-0.17083
	0.30	2.39628	-0.51202	-0.13245
	0.35	2.35477	-0.49735	-0.11985
	0.40	2.30726	-0.46541	-0.11094
	0.45	2.24876	-0.41314	-0.11508
	0.50	2.17772	-0.36803	-0.09525

Figure 9.8-9 — ADJUSTMENT FACTOR (F_p) FOR POND AND SWAMP AREAS THAT ARE SPREAD THROUGHOUT THE WATERSHED

Area of Pond and Swamp (%)	F_p
0	1.00
0.2	0.97
1.0	0.87
3.0	0.75
5.0	0.72

9.8.11 NRCS Design Example

The following steps are used to compute the peak discharge by the NRCS method. Because the results of using the NRCS method are sensitive to the parameters used, the hydraulic engineer must use good engineering judgment in estimating the values that are used in the method.

Given: Location: Approximately 6 miles north of Laurel.
Drainage Area = 0.5 mi^2
Design Frequency = 50-year storm

Cover Description: Primarily cultivated agricultural land, small grain, contoured, good condition (from aerial photographs)

Problem: Determine the peak discharges for the design event using the NRCS method.

Step 1. Determine the boundary of the watershed and its area. Drainage area was delineated in StreamStats as 0.5 mi^2.

Step 2. Compute the average slope of the watershed. From StreamStats, the average slope of the watershed is 10.9%.

Step 3. Determine the anticipated future land use for all the subareas identified in Step 2. The anticipated future land use for this area is range land.

Step 4. Define the type of rainfall and the amount of rainfall.

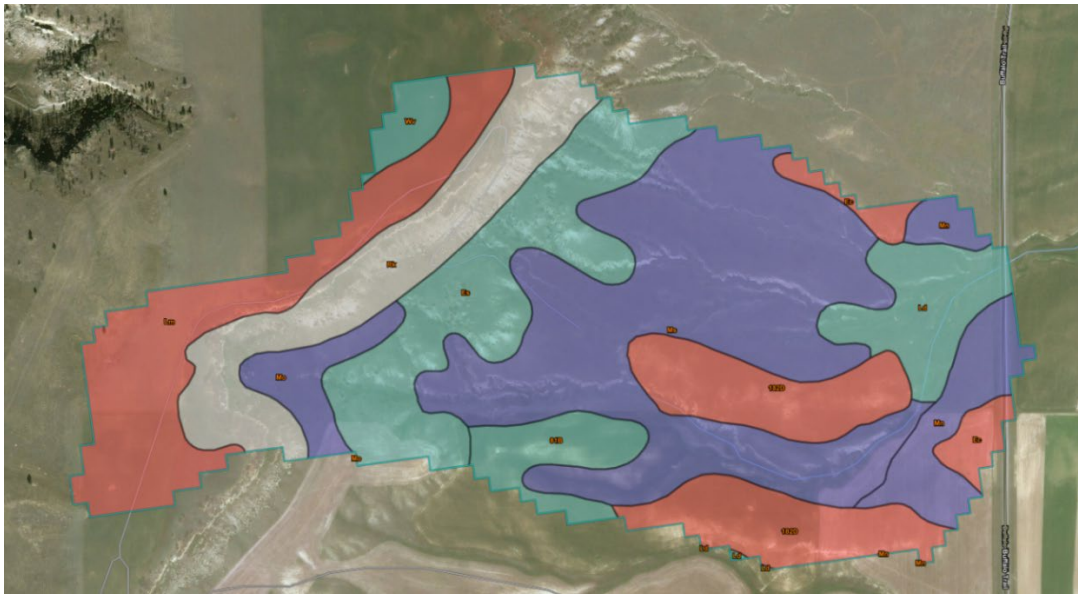
a. Determine the amount of rainfall. From Appendix 9B, the closest rainfall station is Billings Airport, and the rainfall depths at that station are:

	2-year Precipitation (in)	50-year Precipitation (in)
6-hr		2.08
24-hr	1.57	3.08
Ratio of P_6/P_{24}		0.675

b. Check the storm distribution. Per Section 9.8.4 and based on the ratios of the P_6/P_{24}, a Type II rainfall distribution is appropriate.

Step 5. Determine the runoff curve number (CN) for the watershed.

a. Determine soil types in the watershed and their hydrologic soil groups. See the NRCS Web Soil Survey Website. The shapefile for the drainage basin was exported from StreamStats and imported into the NRCS Web Soil Survey Website.



The soil properties are:

Summary by Map Unit – Yellowstone County, Montana (MT111)

Map Unit Symbol	Map Unit Name	Rating	Acres in AOI	Precent of AOI
81B	Delpoint-Cabbart loams, 2 to 8 percent slopes	C	11.7	3.6%
189D	Cabbart-Delpoint loams, 4 to 15 percent slopes	D	37.7	11.5%
Ec	Elso clay loam, 4 to 7 percent slopes	D	7.4	2.3%
Es	Elso-Lohmiller complex, 15 to 35 percent slopes	C	43.2	13.1%
Ld	Lambert soils, 7 to 35 percent slopes	C	17.7	5.4%
Lm	Lavina loam, 2 to 4 percent slopes	D	41.7	12.7%
Mn	McRae loam, 1 to 4 percent slopes	B	17.7	5.4%
Mo	McRae loam, 4 to 7 percent slopes	B	9.0	2.7%
Ms	McRae-Bainville loams, 7 to 15 percent slopes	B	99.3	30.2%
Rk	Rock land		38.4	11.7%
Wv	Wormser-Lavina clay loams, 2 to 4 percent slopes	C	5.1	1.5%
Totals for Area of Interest			**328.7**	**100.0%**

When summarized, these values correlate to 38% B, 24% C, 26% D, and 12% rock.

b. Find CN. The hydrologic soil group and the ground cover type is used to find the CN for average moisture conditions. This area is pasture/range land. Assume good conditions.

Other Agricultural Lands[1] Cover Descriptions	Hydrologic Condition[3]	Curve Numbers for Hydrologic Soil Group			
		A	B	C	D
Pasture, grassland or range — continuous forage for grazing[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80

Notes:

1. *Average runoff condition and I_a = 0.2S.*
2. *Poor: < 50% ground cover or heavily grazed with no mulch*
   Fair: 50% to 75% ground cover and not heavily grazed
   Good: > 75% ground cover and lightly or only occasionally grazed

Weighted Curve Number = 0.38(61) + 0.24(74) + 0.26(80) + 0.12(100) = 74

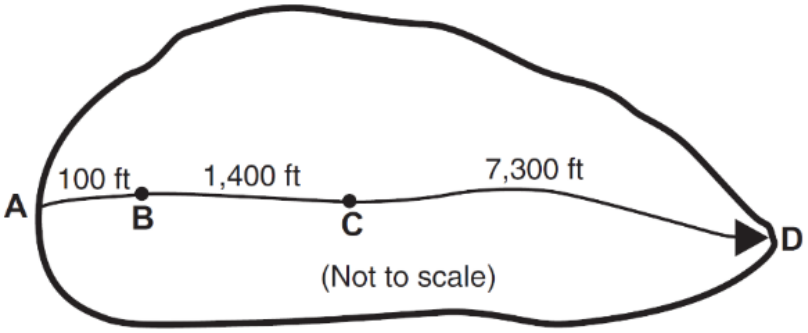
c. Adjust for moisture condition. Assume no adjustment needed.

Step 6. Calculate the time of concentration (t_c). From Section 9.7.6.2 and Section 9.8.6:

The time of concentration (t_c) for the watershed is calculated by summing the travel times (T_t) for each area using Equation 9.7-2. The t_c may include all travel time types, a few types, or just a single type:

$$t_c = T_{t(sheet)} + T_{t(shallow)} + T_{t(channel)} \qquad \text{Equation 9.8-14}$$

This example only has sheet, shallow, and channel flow. The flow lengths are shown in the figure below.



a. Sheet Flow: Calculate the $T_{t(sheet)}$. From Equation 9.8-3:

$$T_{t(sheet)} = \frac{0.007(nL)^{0.8}}{(P_2^{0.5})s^{0.4}}$$

Where:

T_t = travel time (hr),
n = Manning's roughness coefficient for sheet flow (Figure 9.8-7)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

From Step 4, P = 1.57 in.
From Figure 9.8-7, n = 0.17
For cultivated soils, residue cover >20%
Given: L = 100 ft

$$T_{t(sheet)} = \frac{0.007(0.17 * 100)^{0.8}}{(1.57^{0.5})0.109^{0.4}}$$

$T_{t(sheet)}$ = 0.131 hours

b. Shallow Concentrated Flow: Calculate $T_{(shallow)}$. From Equation 9.8-4:

Use the watercourse slope of 10.9% and Equation 9.8-4 for average velocity for estimating travel time for shallow concentrated flow for unpaved condition:

$V = 16.1345\ (s)^{0.5}$
$V = 16.1345\ (0.109)^{0.5}$
V = 5.3 ft/sec

Then, use Equation 9.8-1 to calculate the shallow concentrated flow travel time:

$$T_{t(shallow)} = \frac{L}{3600V}$$

Where:

T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversion factor from seconds to hours.

Given L = 1400 ft:

$$T_{t(shallow)} = \frac{1400}{3600\ (5.3)}$$

$T_{t(shallow)}$ = 0.073 hours

c. Open Channel Flow: Calculate $T_{(channel)}$. From Equation 9.8-6:

Average flow velocity is usually determined for bank-full condition for channels

Manning's equation is:

$$V = \frac{1.49R^{2/3}\,S^{1/2}}{n}$$

Where:

V = average velocity, ft/s
R = hydraulic radius, ft (equal to A/WP)
A = cross sectional flow area, ft^2
WP = wetted perimeter, ft
S = slope of the hydraulic grade line, ft/ft
n = Manning's roughness coefficient for pipe or open channel flow

Given:

A = 13 ft^2
WP = 16.33 ft
S = 10.9%
n = 0.035 (Figure 10.5-1 Natural Streams, Minor Streams, Streams on plain, Condition 2, Normal)

R = A/WP = 13/16.33 = 0.8 ft

$$V = \frac{(1.49)(0.8^{2/3})(0.109^{1/2})}{0.035}$$

V = 12.1 ft/sec

After the average velocity is computed using Equation 9.8-6, the travel time for the channel segment can be calculated from Equation 9.8-1:

Given: L = 7300 ft

$$T_{t(channel)} = \frac{7300}{3600\,(12.1)}$$

$$T_{t(channel)} = 0.168 \text{ hours}$$

d. Calculate t_c.

$$t_c = T_{t(sheet)} + T_{t(shallow)} + T_{t(channel)}$$

$$t_c = 0.131 \text{ hours} + 0.073 \text{ hours} + 0.168 \text{ hours}$$
$$t_c = 0.372 \text{ hours}$$

Step 7. Determine Direct Runoff (Q).

Equation 9.8-9 can be used to compute direct runoff (Q):

$$Q = (P - I_a)^2/(P - I_a + S)$$

MDT practice is to use $I_a = 0.2S$, Equation 9.8-9 becomes:

$$Q = (P - 0.2S)^2/(P + 0.8S)$$

Where:

Q = accumulated direct runoff, in.
P = 24-hr rainfall, in.
I_a = initial abstraction including surface storage, interception, and infiltration prior to runoff, in.
S = potential maximum retention = [(1000/CN) – 10], in.

S = (1000/CN) – 10
S = (1000/74) –10
S = 3.51 in

I_a = 0.2S
I_a = 0.70

From Step 4, P = 3.08 in:

$$Q = (P - 0.2S)^2/(P + 0.8S)$$
$$Q = (3.08 - 0.2 * 3.51)^2/(3.08 + 0.8 * 3.51)$$
Q = 0.96 in

Step 8. Compute the unit peak discharge (q_p).

The unit peak discharge (q_u) is obtained from Equation 9.8-11, which requires the time of concentration and the initial abstraction/rainfall (I_a/P) ratio as input:

$$q_u = 10^{c_0 + c_1 \log(t_c) + c_2[\log(t_c)]^2}$$

Where:

C_0, C_1, C_2 are constants from Figure 9.8-8:

t_c = time of concentration from Step 6, hr (minimum, 0.1; maximum, 10.0)
q_u = unit peak discharge, $ft^3/s/mi^2/in.$

I_a/P = 0.7/3.08 = 0.23

Interpolating from Figure 9.8-8 for a Type II Storm:

C_0 = 2.49609
C_1 = -0.61996
C_2 = -0.13318

$$q_u = 10^{c_o + c_1 \log(t_c) + c_2[\log(t_c)]^2}$$
$$q_u = 10^{2.49609 + -0.61996 \log(0.372) + -0.13318[\log(0.372)]^2}$$
$$q_u = 547 \text{ ft}^3/\text{s}/\text{mi}^2/\text{in}$$

Step 9. Compute the Peak Discharge (q_p).

The peak discharge (q_p) is computed from Equation 9.8-12:

$$q_p = q_u A Q$$

Where:

q_u = unit peak discharge, $\text{ft}^3/\text{s}/\text{mi}^2$/in. of runoff
A = drainage area, mi^2
Q = depth of runoff, in. from Step 7

$$q_p = q_u A Q$$
$$q_p = (547)(0.5)(0.96)$$

$$q_p = 263 \text{ ft}^3/\text{s}$$

Step 10. If necessary, adjust peak discharge for pond and swamp. No adjustment needed for this Example.

9.9 DOCUMENTATION

Use the template provided in Appendix 9C to document and justify the selected hydrology method(s). Include a comparison of the existing pipe capacities at the overtopping condition and a description of the past performance. Identify locations that will require grade raises due to hydraulics and preliminary sizes for culverts that will need to be upsized.

9.10 REFERENCES

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Appendix 9A — DESIGN FREQUENCY FOR TEMPORARY FACILITIES

9.A.1 Introduction

If MDT designs a temporary detour to be included in a contract plan set, this appendix should be used to select the design frequency for the hydraulic facilities. Typically, the design flood frequency recommended for temporary hydraulic facilities is much lower than that used for permanent hydraulic facilities.

9.A.2 Design Procedures

The selection of a design flood frequency for temporary hydraulic facilities involves consideration of several factors as discussed in Section 9.A.3. These selection factors are captured and weighted individually (see Figure 9.A-1) within an Impact Rating Value (IRV). The Total Impact Rating Value, which represents the sum of all pertinent factors at a given crossing (see Figure 9.A-2), is used in Figure 9.A-3 to determine the percent design risk. The selection of design flood frequency for temporary hydraulic facilities (see Figure 9.A-4) is then based on the percent design risk and on the anticipated time of use in months. When the design point falls between curves, this Figure can be used conservatively by sliding to the right and using the higher frequency event.

Figure 9.A-1 — IMPACT RATING VALUES

Selection Factor			Impact Rating Value (IRV)		
Average Daily Traffic (ADT)	Urban	ADT	0 – 400	401 – 1500	> 1500
		IRV	1	2	3
	Suburban	ADT	0 – 750	751 – 1500	> 1500
		IRV	1	2	3
	Rural	ADT	0 – 1500	1501 – 3000	> 3000
		IRV	1	2	3
Loss of Life (based on ADT)	Yes →		15	30	45
	No →		1	2	3
Property Damage (based on ADT)	IRV for residential, commercial, industrial areas, wastewater, storm water, and water supply systems		10	20	30
	IRV for croplands, parking, and recreational areas		5	10	15
	IRV for all others — pasture, meadow, bare soil, etc.		1	2	3
Detour Length (Section 9.3.2.1.1)	Length (mi)		< 5	5 – 9	> 9
	IRV		1	2	3
Height Above Streambed	Height (ft)		< 10	10 – 20	> 20
	IRV		1	2	3
Design Flood, Q for Permanent Structure	Flowrate (ft^3/s)		< 300	301-999	> 1000
	IRV		1	2	3
Traffic Interruption (see instructions)			IRV for ADT multiplied by IRV for Detour Length		

Figure 9.A-2 — IMPACT RATING TABLE

Selection Factor	Impact Rating Value
Average Daily Traffic (ADT)	
Loss of Life	
Property Damage	
Detour Length	
Height Above Streambed	
Design Flood Discharge for Permanent Structure	
Traffic Interruption	
TOTAL IMPACT RATING VALUE	

Figure 9.A-3 — PERCENT DESIGN RISK

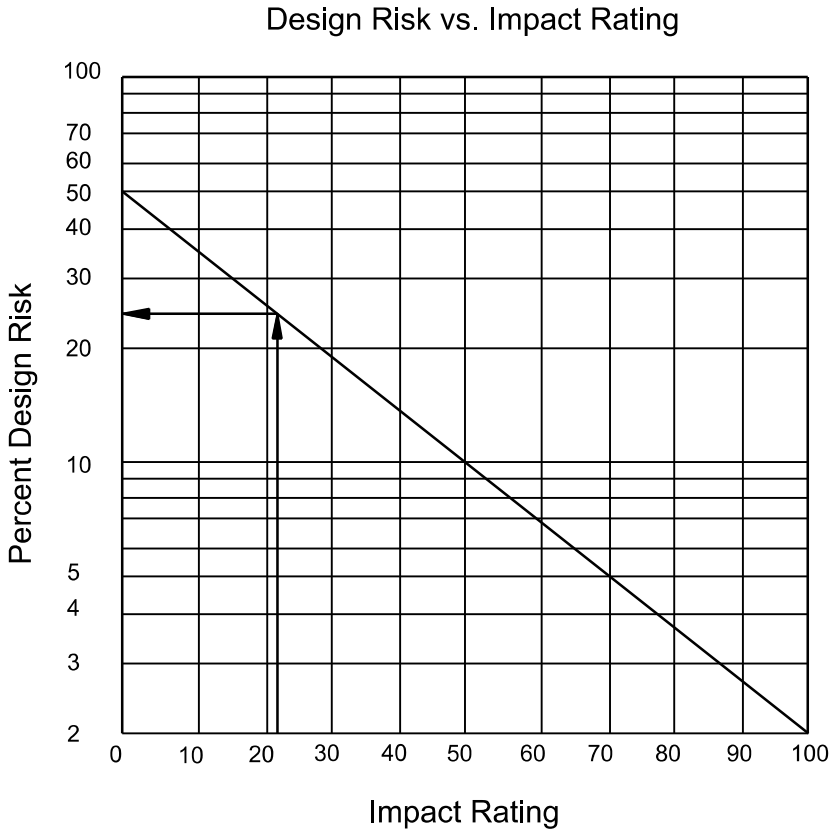
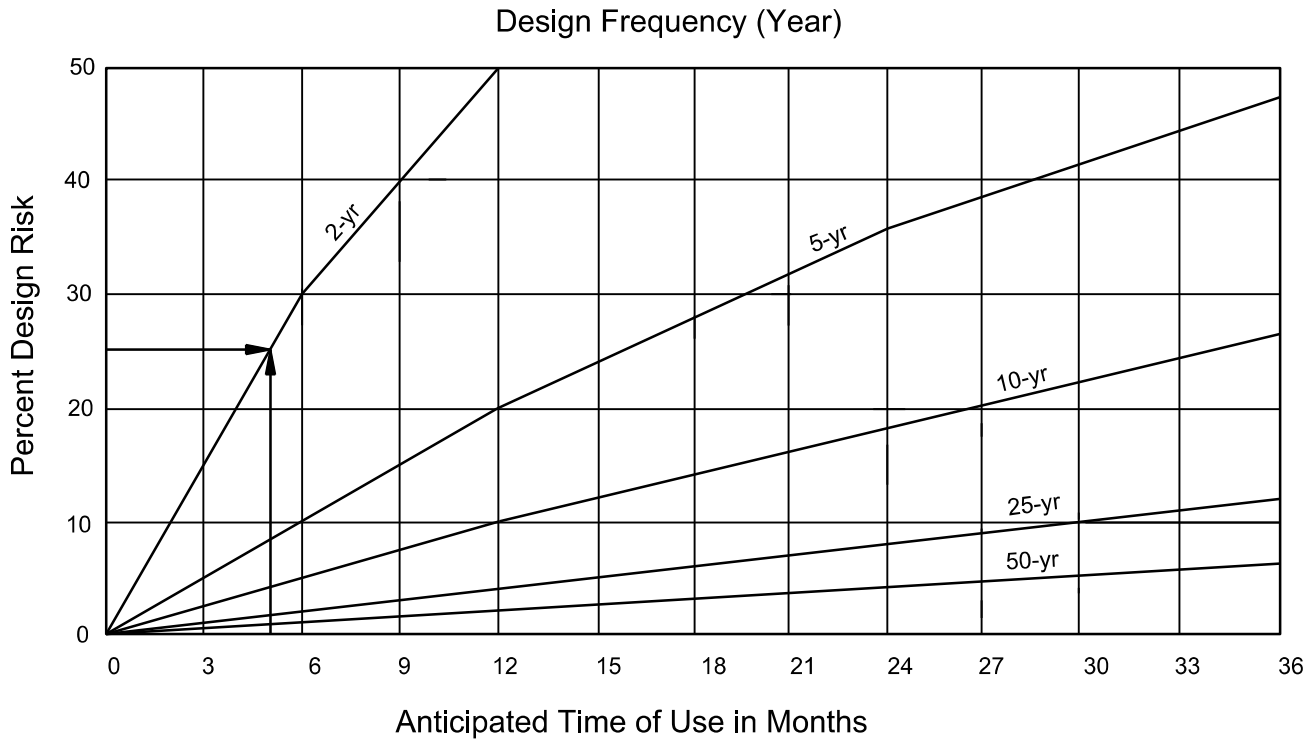


Figure 9.A-4 — DESIGN FREQUENCY



9.A.3 Selection Factors

The major factors to determine the Impact Rating Value (IRV) are:

1. Average Daily Traffic. The average number of vehicles traveling through the area in both directions in a 24-h period, also referred to as Vehicles per Day (VPD). Figure 9.A-1 shows that the IRV is not only dependent on the ADT but also on the location of the highway.

2. Loss of Life. Is there is a potential loss of life caused by the destruction of the temporary drainage structure or by washout of the temporary roadway. Consider the detour design speed and the potential size of the detour drainage structure (small culvert vs. large culvert or bridge). For the detour ADT:

   a. If loss of life is possible, use the IRV in the "Yes" row.
   b. If loss of life is unlikely, use the IRV in the "No" row.

3. Property Damage. This factor accounts for property damages attributed to the destruction/loss of the temporary drainage structure or by the roadway overtopping flood to private and public structures (residential, commercial, or manufacturing); appurtenances (e.g., sewage treatment and water supply systems); and utility structures either above or below ground. The Property Damage IRV is equal to the ADT IRV multiplied by 10.

   The property damage impact rating caused by the destruction of the temporary drainage structure or by the roadway overtopping flood to active cropland, parking lots, and recreational areas is equal to the ADT IRV multiplied by 5.

All other areas (pasture, meadow, bare land, etc.) have the same rating as the ADT IRV.

4. Detour Length. The length in miles of an emergency detour by other roads in the event the temporary facility is not functional. The detour length is defined in Section 9.3.2.1.1.

5. Height above Streambed. The difference in elevation in feet between the traveled way and the bed of the waterway. This is the approximate distance between the traveled way and the thalweg.

6. Design Flood Discharge for the Permanent Structure. The design flood discharge for the permanent crossing in ft^3/s. The design flood is defined in Section 9.3.2.1.

7. Traffic Interruption. This includes consideration for emergency supplies and rescue, delays, alternative routes, buses, etc. Short-duration flooding of a low-volume roadway might be acceptable. If the duration of flooding is long (more than one day) and there is a serviceable alternative route nearby, then the flooding of a higher volume highway might also be acceptable. The Detour Length IRV multiplied by the Roadway ADT IRV determines the Traffic Interruption IRV.

Considering the broad breadth and width of temporary hydraulic structures and their construction surroundings, this procedure and the seven selection factors cannot possibly capture all potential scenarios and all pertinent design considerations. The procedure addresses the common base set of design considerations and constraints that impact the recommended design event for a typical temporary crossing.

These seven factors should not be considered all inclusive. There may be site-specific considerations that are not captured by this procedure. An example would be an upstream flood control structure, such as a USACE reservoir that releases a known discharge on an annual or semi-annual basis. In that case, user judgment is required to adjust the procedure results or possibly replace it entirely by adopting the USACE discharge. Similarly, the design parameters or breakpoints in Figure 9.A-1 used to generate IRVs should not be considered unchangeable. For example, some detours may be sufficiently long in the judgment of the user to justify increasing the Detour Length IRV. The increase would subsequently increase the Traffic Interruption IRV and, ultimately, size the temporary structure to a larger design event.

The user is encouraged to apply judgment to each crossing, to add selection factors as required, and to integrate site-specific considerations as needed to tailor or modify the IRV weighting process. This procedure should be used cautiously and in conjunction with risk analysis that compares temporary roadway and waterway opening alternatives across a reasonable and supportable range of design discharges.

9.A.4 Example

The following example illustrates the procedure to determine the design frequency recommended for a temporary hydraulic facility.

Given: A section of a rural roadway will be widened. There is an existing 8 ft × 4 ft × 40 ft box culvert with a design flood discharge of 250 ft^3/s that must be replaced. A temporary structure and roadway will be provided on the downstream side of the existing roadway. The Average Daily Traffic (ADT) of the highway is 2000 vehicles per day (VPD). The top of the

temporary roadway is approximately 8 ft above the streambed. The land use on the upstream side of the proposed temporary hydraulic facility is predominantly croplands. If the temporary roadway becomes nonfunctional, the detour length is approximately 6 mi. The danger of loss of life due to the destruction of the temporary hydraulic facility is minimal. The anticipated use of the temporary runaround facility is five months.

Problem: Find the design flood frequency for the temporary hydraulic facility.

Solution:

Step 1. Compute the Impact Rating Value (IRV) based on Figure 9.A-1:

a. For a rural roadway with ADT of 2000 VPD, the IRV is 2.

b. The IRV for no loss of life with this type of highway is 2.

c. The Property Damage IRV is 10 (croplands).

d. For Detour Length equal to 6 mi, the IRV is 2.

e. For height above streambed of 8 ft, the IRV is 1.

f. For a design flood discharge for the permanent structure = 250 ft^3/s, the IRV is 1.

g. The IRV for traffic interruption is the product of the ADT IRV times the Detour Length IRV ($2 \times 2 = 4$).

Step 2. Total Impact Rating Value (IRV):

a. The Total Impact Rating Value = 22, as shown in Figure 9.A-5.

Step 3. Compute the Percent Design Risk Value:

a. From Figure 9.A-3, for a Total Impact Rating Value = 22, the value of the percent design risk is 25%.

Step 4. Compute the Design Frequency:

a. From Figure 9.A-4, for a Percent Design Risk of 25% and a construction time of five months, the recommended design frequency for the temporary hydraulic facility is a 2-year return period.

Figure 9.A-5 — IMPACT RATING TABLE (Example Problem)

Selection Factor	Impact Rating Value
1. Roadway ADT	2
2. Loss of Life	2
3. Property Damage	10
4. Detour Length	2
5. Height Above Streambed	1
6. Design Flood Q for the Permanent Structure	1
7. Traffic Interruption	4
TOTAL IMPACT RATING VALUE	22

Appendix 9B — RAINFALL DATA

Rainfall depths and intensities for various storm durations and recurrence intervals are provided for 100 weather stations across the state of Montana in Figure 9.B-3. The values included in this table were developed through frequency analysis using the Gumbel Distribution of hourly and sub-hourly data obtained from the National Oceanic and Atmospheric Association National Climatic Data Center. The following paragraphs summarize the methodologies used in the study. For additional information, see the "Montana State-Wide Precipitation Frequency Analysis." (14)

All weather stations with at least a 20-year period of record were included in the analysis. Periods of record (POR) were modified to account for missing or deleted data. Precipitation occurring in November, December, January, and February are assumed to be the result of snowfall and are excluded from the analysis. In general, rainfall depths and intensities reported in Figure 9.B-3 for storm durations of 1 through 24 hours are developed from frequency analyses of hourly data through 2013. Sub one-hour precipitation depths reported in Figure 9B-3 at the six first order weather stations of Billings, Glasgow, Great Falls, Havre, Helena, and Missoula are developed from frequency analysis of short-duration precipitation data through 2014. Sub one-hour depths reported for second order weather stations are estimated using the ratios reported in Figure 9.B-1, developed using the results of the short-duration frequency analysis for the six first-order weather stations. Sub one-hour depths at second order weather stations for durations other than those shown in Figure 9.B-1 are estimated through linear interpolation.

Figure 9.B-1 — STATEWIDE SHORT-DURATION PRECIPITATION RATIOS TO THE 1-HOUR EVENT

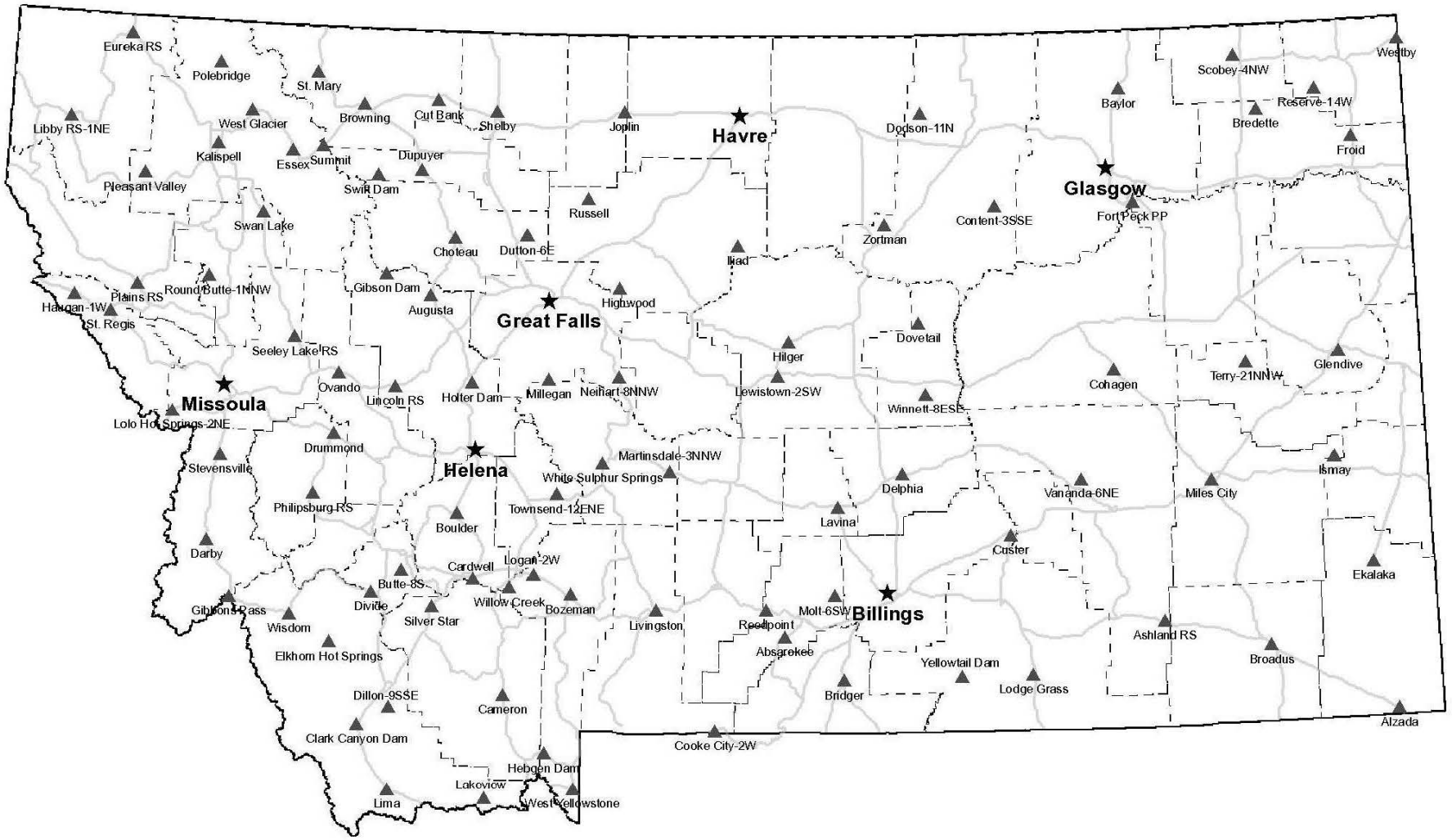
Duration	Ratio of Precipitation Depth to 1-Hour Depth
5-min	0.41
10-min	0.60
15-min	0.73
30-min	0.88
45-min	0.95

The locations of the weather stations included in the study are provided in Figure 9.B-2. The six first-order weather stations where short-duration rainfall values were developed through frequency analysis are identified in Figure 9.B-2 with a star.

Disclaimer:

The precipitation data and rainfall tables (collectively "data") presented in this *Manual* were developed by the Montana Department of Transportation (MDT) specifically for MDT use. The data were not developed for any other use or users. Users of this data do so entirely at their own risk. MDT does not assume, and it specifically disclaims, any responsibility for any other use of this data. In no event will MDT be liable for any direct, indirect, incidental, consequential, special, exemplary, or consequential damages, including lost profit, resulting from any use or misuse of the data.

Figure 9.B-2 — WEATHER STATION LOCATIONS



Weather Station Locations
★ lst Order Station
▲ 2nd Order Station

Figure 9.B-3 — RAINFALL DEPTHS/INTENSITIES BASED ON STORM DURATION/RECURRENCE

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Absarokee	5-min	0.26	0.40	0.50	0.62	0.70	0.79	3.11	4.82	5.95	7.38	8.44	9.49
COOP: 240019	10-min	0.38	0.59	0.73	0.90	1.03	1.16	2.27	3.52	4.35	5.40	6.18	6.95
Elev: 3,881 ft	15-min	0.46	0.71	0.88	1.10	1.25	1.41	1.84	2.86	3.53	4.38	5.01	5.64
Modified POR: 34	20-min	0.49	0.76	0.94	1.17	1.34	1.51	1.48	2.29	2.83	3.51	4.01	4.52
Type: 2nd Order	25-min	0.52	0.81	1.00	1.25	1.42	1.60	1.26	1.95	2.41	2.99	3.42	3.84
	30-min	0.56	0.86	1.06	1.32	1.51	1.70	1.11	1.72	2.13	2.64	3.02	3.40
	35-min	0.57	0.88	1.09	1.36	1.55	1.74	0.98	1.52	1.87	2.32	2.66	2.99
	40-min	0.59	0.91	1.12	1.39	1.59	1.79	0.88	1.36	1.68	2.09	2.38	2.68
	45-min	0.60	0.93	1.15	1.43	1.63	1.83	0.80	1.24	1.53	1.90	2.17	2.44
	50-min	0.61	0.95	1.17	1.45	1.66	1.87	0.73	1.14	1.40	1.74	1.99	2.24
	55-min	0.62	0.96	1.19	1.48	1.69	1.90	0.68	1.05	1.30	1.61	1.84	2.07
	1-hr	0.63	0.98	1.21	1.50	1.72	1.93	0.63	0.98	1.21	1.50	1.72	1.93
	2-hr	0.71	1.04	1.25	1.53	1.73	1.93	0.36	0.52	0.63	0.76	0.86	0.96
	3-hr	0.79	1.15	1.39	1.70	1.92	2.15	0.26	0.38	0.46	0.57	0.64	0.72
	6-hr	1.07	1.46	1.71	2.03	2.27	2.51	0.18	0.24	0.29	0.34	0.38	0.42
	12-hr	1.50	1.97	2.27	2.66	2.95	3.24	0.13	0.16	0.19	0.22	0.25	0.27
	24-hr	1.98	2.69	3.16	3.75	4.19	4.63	0.082	0.112	0.132	0.156	0.175	0.193
Alzada	5-min	0.30	0.41	0.48	0.58	0.64	0.71	3.58	4.91	5.79	6.91	7.74	8.56
COOP: 240165	10-min	0.44	0.60	0.71	0.84	0.94	1.04	2.62	3.59	4.24	5.06	5.66	6.26
Elev: 3,422 ft	15-min	0.53	0.73	0.86	1.03	1.15	1.27	2.12	2.91	3.44	4.10	4.59	5.08
Modified POR: 59	20-min	0.57	0.78	0.92	1.10	1.23	1.36	1.70	2.34	2.76	3.29	3.68	4.07
Type: 2nd Order	25-min	0.60	0.83	0.98	1.17	1.31	1.44	1.45	1.99	2.35	2.80	3.13	3.47
	30-min	0.64	0.88	1.04	1.24	1.38	1.53	1.28	1.76	2.07	2.47	2.77	3.06
	35-min	0.66	0.90	1.06	1.27	1.42	1.57	1.13	1.55	1.82	2.18	2.44	2.69
	40-min	0.67	0.92	1.09	1.30	1.46	1.61	1.01	1.39	1.64	1.95	2.19	2.42
	45-min	0.69	0.95	1.12	1.33	1.49	1.65	0.92	1.26	1.49	1.78	1.99	2.20
	50-min	0.70	0.96	1.14	1.36	1.52	1.68	0.84	1.16	1.37	1.63	1.82	2.02
	55-min	0.71	0.98	1.16	1.38	1.55	1.71	0.78	1.07	1.26	1.51	1.69	1.87
	1-hr	0.73	1.00	1.18	1.40	1.57	1.74	0.73	1.00	1.18	1.40	1.57	1.74
	2-hr	0.84	1.08	1.25	1.45	1.60	1.75	0.42	0.54	0.62	0.73	0.80	0.88
	3-hr	0.91	1.17	1.34	1.56	1.72	1.88	0.30	0.39	0.45	0.52	0.57	0.63
	6-hr	1.13	1.45	1.66	1.93	2.13	2.33	0.19	0.24	0.28	0.32	0.36	0.39
	12-hr	1.37	1.71	1.94	2.23	2.44	2.65	0.11	0.14	0.16	0.19	0.20	0.22
	24-hr	1.62	2.02	2.29	2.62	2.87	3.11	0.068	0.084	0.095	0.109	0.119	0.130

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Ashland RS	5-min	0.31	0.46	0.55	0.67	0.76	0.84	3.78	5.48	6.60	8.02	9.08	10.12
COOP: 240330	10-min	0.46	0.67	0.80	0.98	1.11	1.23	2.76	4.01	4.83	5.87	6.64	7.41
Elev: 3,002 ft	15-min	0.56	0.81	0.98	1.19	1.35	1.50	2.24	3.25	3.92	4.76	5.39	6.01
Modified POR: 52	20-min	0.60	0.87	1.05	1.27	1.44	1.61	1.80	2.60	3.14	3.82	4.32	4.82
Type: 2nd Order	25-min	0.64	0.92	1.11	1.35	1.53	1.71	1.53	2.22	2.67	3.25	3.68	4.10
	30-min	0.68	0.98	1.18	1.43	1.62	1.81	1.35	1.96	2.36	2.87	3.25	3.62
	35-min	0.69	1.01	1.21	1.47	1.67	1.86	1.19	1.72	2.08	2.53	2.86	3.19
	40-min	0.71	1.03	1.24	1.51	1.71	1.91	1.07	1.55	1.86	2.27	2.56	2.86
	45-min	0.73	1.06	1.27	1.55	1.75	1.95	0.97	1.41	1.70	2.07	2.34	2.61
	50-min	0.74	1.08	1.30	1.58	1.78	1.99	0.89	1.29	1.56	1.89	2.14	2.39
	55-min	0.75	1.09	1.32	1.60	1.81	2.02	0.82	1.19	1.44	1.75	1.98	2.21
	1-hr	0.77	1.11	1.34	1.63	1.84	2.06	0.77	1.11	1.34	1.63	1.84	2.06
	2-hr	0.86	1.24	1.49	1.80	2.04	2.27	0.43	0.62	0.74	0.90	1.02	1.14
	3-hr	0.93	1.36	1.65	2.01	2.28	2.54	0.31	0.45	0.55	0.67	0.76	0.85
	6-hr	1.13	1.56	1.84	2.20	2.47	2.73	0.19	0.26	0.31	0.37	0.41	0.46
	12-hr	1.31	1.74	2.02	2.38	2.64	2.90	0.11	0.14	0.17	0.20	0.22	0.24
	24-hr	1.56	2.02	2.33	2.71	3.00	3.28	0.065	0.084	0.097	0.113	0.125	0.137
Augusta	5-min	0.27	0.42	0.52	0.65	0.74	0.83	3.22	5.03	6.23	7.75	8.88	9.99
COOP: 240364	10-min	0.39	0.61	0.76	0.95	1.08	1.22	2.35	3.68	4.56	5.67	6.49	7.31
Elev: 4,070 ft	15-min	0.48	0.75	0.92	1.15	1.32	1.48	1.91	2.99	3.70	4.60	5.27	5.93
Modified POR: 54	20-min	0.51	0.80	0.99	1.23	1.41	1.58	1.53	2.39	2.96	3.69	4.22	4.75
Type: 2nd Order	25-min	0.54	0.85	1.05	1.31	1.50	1.69	1.30	2.04	2.52	3.14	3.59	4.05
	30-min	0.58	0.90	1.11	1.39	1.59	1.79	1.15	1.80	2.23	2.77	3.18	3.57
	35-min	0.59	0.92	1.14	1.42	1.63	1.83	1.01	1.58	1.96	2.44	2.79	3.15
	40-min	0.61	0.95	1.17	1.46	1.67	1.88	0.91	1.42	1.76	2.19	2.51	2.82
	45-min	0.62	0.97	1.20	1.50	1.71	1.93	0.83	1.30	1.60	2.00	2.29	2.57
	50-min	0.63	0.99	1.22	1.52	1.74	1.96	0.76	1.19	1.47	1.83	2.09	2.36
	55-min	0.64	1.01	1.25	1.55	1.77	2.00	0.70	1.10	1.36	1.69	1.94	2.18
	1-hr	0.65	1.02	1.27	1.58	1.80	2.03	0.65	1.02	1.27	1.58	1.80	2.03
	2-hr	0.74	1.09	1.32	1.61	1.83	2.04	0.37	0.55	0.66	0.81	0.91	1.02
	3-hr	0.84	1.19	1.42	1.72	1.93	2.15	0.28	0.40	0.47	0.57	0.64	0.72
	6-hr	1.06	1.39	1.61	1.89	2.09	2.30	0.18	0.23	0.27	0.31	0.35	0.38
	12-hr	1.32	1.69	1.93	2.24	2.46	2.69	0.11	0.14	0.16	0.19	0.21	0.22
	24-hr	1.68	2.15	2.47	2.86	3.16	3.45	0.070	0.090	0.103	0.119	0.132	0.144

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Baylor	5-min	0.31	0.46	0.56	0.68	0.77	0.86	3.77	5.53	6.69	8.15	9.24	10.32
COOP: 240554	10-min	0.46	0.67	0.82	0.99	1.13	1.26	2.76	4.04	4.89	5.96	6.76	7.55
Elev: 2,933 ft	15-min	0.56	0.82	0.99	1.21	1.37	1.53	2.24	3.28	3.97	4.84	5.48	6.12
Modified POR: 58	20-min	0.60	0.88	1.06	1.29	1.46	1.64	1.80	2.63	3.18	3.88	4.39	4.91
Type: 2nd Order	25-min	0.64	0.93	1.13	1.38	1.56	1.74	1.53	2.24	2.71	3.30	3.74	4.18
	30-min	0.68	0.99	1.20	1.46	1.65	1.85	1.35	1.98	2.39	2.92	3.30	3.69
	35-min	0.69	1.01	1.23	1.50	1.70	1.89	1.19	1.74	2.10	2.57	2.91	3.25
	40-min	0.71	1.04	1.26	1.54	1.74	1.94	1.07	1.56	1.89	2.30	2.61	2.91
	45-min	0.73	1.07	1.29	1.57	1.78	1.99	0.97	1.42	1.72	2.10	2.38	2.66
	50-min	0.74	1.09	1.31	1.60	1.82	2.03	0.89	1.30	1.58	1.92	2.18	2.43
	55-min	0.75	1.10	1.34	1.63	1.85	2.06	0.82	1.20	1.46	1.78	2.01	2.25
	1-hr	0.77	1.12	1.36	1.66	1.88	2.10	0.77	1.12	1.36	1.66	1.88	2.10
	2-hr	0.89	1.28	1.54	1.87	2.11	2.35	0.45	0.64	0.77	0.93	1.05	1.17
	3-hr	0.98	1.35	1.60	1.91	2.14	2.37	0.33	0.45	0.53	0.64	0.71	0.79
	6-hr	1.13	1.48	1.71	2.00	2.22	2.44	0.19	0.25	0.28	0.33	0.37	0.41
	12-hr	1.30	1.65	1.89	2.19	2.41	2.63	0.11	0.14	0.16	0.18	0.20	0.22
	24-hr	1.53	1.95	2.24	2.59	2.86	3.12	0.064	0.081	0.093	0.108	0.119	0.130
Billings Airport	5-min	0.27	0.42	0.51	0.65	0.75	0.85	3.26	5.02	6.18	7.75	8.96	10.16
COOP: 240807	10-min	0.39	0.58	0.70	0.87	1.00	1.13	2.33	3.45	4.19	5.20	5.98	6.75
Elev: 3,567 ft	15-min	0.47	0.68	0.83	1.03	1.18	1.33	1.87	2.74	3.31	4.11	4.72	5.32
Modified POR: 66	20-min	0.50	0.74	0.90	1.12	1.29	1.46	1.49	2.23	2.71	3.37	3.87	4.37
Type: 1st Order	25-min	0.53	0.79	0.97	1.20	1.38	1.56	1.27	1.90	2.32	2.88	3.31	3.74
	30-min	0.56	0.84	1.02	1.28	1.47	1.66	1.12	1.68	2.05	2.55	2.94	3.33
	35-min	0.58	0.87	1.06	1.32	1.51	1.71	1.00	1.49	1.82	2.26	2.59	2.92
	40-min	0.60	0.90	1.10	1.36	1.57	1.77	0.91	1.35	1.65	2.05	2.35	2.65
	45-min	0.62	0.93	1.13	1.40	1.61	1.82	0.83	1.24	1.51	1.87	2.15	2.42
	50-min	0.64	0.95	1.16	1.44	1.65	1.87	0.77	1.14	1.40	1.73	1.98	2.24
	55-min	0.65	0.98	1.19	1.47	1.69	1.91	0.71	1.06	1.30	1.61	1.85	2.08
	1-hr	0.66	0.99	1.21	1.50	1.72	1.93	0.66	0.99	1.21	1.50	1.72	1.93
	2-hr	0.76	1.11	1.34	1.63	1.85	2.07	0.38	0.55	0.67	0.82	0.93	1.03
	3-hr	0.85	1.18	1.40	1.68	1.88	2.09	0.28	0.39	0.47	0.56	0.63	0.70
	6-hr	1.05	1.38	1.60	1.88	2.08	2.28	0.18	0.23	0.27	0.31	0.35	0.38
	12-hr	1.29	1.67	1.92	2.23	2.46	2.70	0.11	0.14	0.16	0.19	0.21	0.22
	24-hr	1.57	2.05	2.37	2.78	3.08	3.38	0.065	0.085	0.099	0.116	0.128	0.141

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Boulder	5-min	0.17	0.24	0.29	0.35	0.40	0.44	2.05	2.92	3.49	4.22	4.76	5.29
COOP: 241008	10-min	0.25	0.36	0.43	0.51	0.58	0.65	1.50	2.13	2.56	3.09	3.48	3.87
Elev: 4,882 ft	15-min	0.30	0.43	0.52	0.63	0.71	0.79	1.22	1.73	2.07	2.50	2.82	3.14
Modified POR: 58	20-min	0.32	0.46	0.55	0.67	0.75	0.84	0.97	1.39	1.66	2.01	2.26	2.52
Type: 2nd Order	25-min	0.35	0.49	0.59	0.71	0.80	0.89	0.83	1.18	1.41	1.71	1.93	2.14
	30-min	0.37	0.52	0.62	0.75	0.85	0.95	0.73	1.04	1.25	1.51	1.70	1.89
	35-min	0.38	0.54	0.64	0.77	0.87	0.97	0.65	0.92	1.10	1.33	1.50	1.67
	40-min	0.39	0.55	0.66	0.79	0.90	1.00	0.58	0.82	0.99	1.19	1.34	1.50
	45-min	0.40	0.56	0.67	0.81	0.92	1.02	0.53	0.75	0.90	1.09	1.22	1.36
	50-min	0.40	0.57	0.69	0.83	0.93	1.04	0.48	0.69	0.82	0.99	1.12	1.25
	55-min	0.41	0.58	0.70	0.84	0.95	1.06	0.45	0.64	0.76	0.92	1.04	1.15
	1-hr	0.42	0.59	0.71	0.86	0.97	1.08	0.42	0.59	0.71	0.86	0.97	1.08
	2-hr	0.51	0.70	0.83	1.00	1.12	1.24	0.25	0.35	0.42	0.50	0.56	0.62
	3-hr	0.56	0.77	0.91	1.08	1.21	1.34	0.19	0.26	0.30	0.36	0.40	0.45
	6-hr	0.71	0.92	1.06	1.23	1.36	1.49	0.12	0.15	0.18	0.21	0.23	0.25
	12-hr	0.88	1.13	1.30	1.52	1.68	1.83	0.07	0.09	0.11	0.13	0.14	0.15
	24-hr	1.07	1.37	1.57	1.82	2.01	2.20	0.045	0.057	0.065	0.076	0.084	0.091
Bozeman Airport	5-min	0.17	0.26	0.32	0.40	0.45	0.51	2.08	3.16	3.87	4.76	5.43	6.09
COOP: 240622	10-min	0.25	0.38	0.47	0.58	0.66	0.74	1.53	2.31	2.83	3.48	3.97	4.45
Elev: 4,459 ft	15-min	0.31	0.47	0.57	0.71	0.81	0.90	1.24	1.87	2.29	2.83	3.22	3.61
Modified POR: 40	20-min	0.33	0.50	0.61	0.75	0.86	0.96	0.99	1.50	1.84	2.26	2.58	2.89
Type: 2nd Order	25-min	0.35	0.53	0.65	0.80	0.92	1.03	0.84	1.28	1.56	1.93	2.20	2.46
	30-min	0.37	0.56	0.69	0.85	0.97	1.09	0.75	1.13	1.38	1.70	1.94	2.18
	35-min	0.38	0.58	0.71	0.87	1.00	1.12	0.66	0.99	1.22	1.50	1.71	1.92
	40-min	0.39	0.59	0.73	0.90	1.02	1.15	0.59	0.89	1.09	1.35	1.53	1.72
	45-min	0.40	0.61	0.75	0.92	1.05	1.18	0.54	0.81	1.00	1.23	1.40	1.57
	50-min	0.41	0.62	0.76	0.94	1.07	1.20	0.49	0.74	0.91	1.12	1.28	1.44
	55-min	0.42	0.63	0.77	0.95	1.08	1.22	0.45	0.69	0.84	1.04	1.18	1.33
	1-hr	0.42	0.64	0.79	0.97	1.10	1.24	0.42	0.64	0.79	0.97	1.10	1.24
	2-hr	0.49	0.68	0.81	0.98	1.10	1.22	0.24	0.34	0.41	0.49	0.55	0.61
	3-hr	0.56	0.74	0.86	1.01	1.12	1.23	0.19	0.25	0.29	0.34	0.37	0.41
	6-hr	0.71	0.88	0.99	1.14	1.24	1.35	0.12	0.15	0.17	0.19	0.21	0.22
	12-hr	0.91	1.12	1.26	1.43	1.56	1.69	0.08	0.09	0.10	0.12	0.13	0.14
	24-hr	1.18	1.49	1.70	1.96	2.15	2.34	0.049	0.062	0.071	0.082	0.090	0.098

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Bredette	5-min	0.35	0.45	0.52	0.61	0.68	0.75	4.15	5.44	6.29	7.37	8.16	8.96
COOP: 241088	10-min	0.51	0.66	0.77	0.90	1.00	1.09	3.04	3.98	4.60	5.39	5.97	6.55
Elev: 2,280 ft	15-min	0.62	0.81	0.93	1.09	1.21	1.33	2.46	3.23	3.73	4.37	4.85	5.32
Modified POR: 67	20-min	0.66	0.86	1.00	1.17	1.29	1.42	1.97	2.59	2.99	3.50	3.88	4.26
Type: 2nd Order	25-min	0.70	0.92	1.06	1.24	1.38	1.51	1.68	2.20	2.55	2.98	3.31	3.63
	30-min	0.74	0.97	1.13	1.32	1.46	1.60	1.49	1.95	2.25	2.63	2.92	3.20
	35-min	0.76	1.00	1.15	1.35	1.50	1.64	1.31	1.71	1.98	2.32	2.57	2.82
	40-min	0.78	1.02	1.18	1.39	1.54	1.69	1.17	1.54	1.78	2.08	2.31	2.53
	45-min	0.80	1.05	1.21	1.42	1.58	1.73	1.07	1.40	1.62	1.90	2.10	2.31
	50-min	0.82	1.07	1.24	1.45	1.60	1.76	0.98	1.28	1.48	1.74	1.92	2.11
	55-min	0.83	1.09	1.26	1.47	1.63	1.79	0.91	1.19	1.37	1.61	1.78	1.95
	1-hr	0.84	1.11	1.28	1.50	1.66	1.82	0.84	1.11	1.28	1.50	1.66	1.82
	2-hr	0.96	1.28	1.50	1.76	1.96	2.16	0.48	0.64	0.75	0.88	0.98	1.08
	3-hr	1.05	1.40	1.63	1.93	2.14	2.36	0.35	0.47	0.54	0.64	0.71	0.79
	6-hr	1.18	1.58	1.84	2.17	2.42	2.67	0.20	0.26	0.31	0.36	0.40	0.44
	12-hr	1.36	1.84	2.16	2.57	2.87	3.16	0.11	0.15	0.18	0.21	0.24	0.26
	24-hr	1.60	2.14	2.49	2.95	3.28	3.61	0.067	0.089	0.104	0.123	0.137	0.150
Bridger	5-min	0.16	0.23	0.27	0.33	0.37	0.41	1.89	2.72	3.27	3.96	4.47	4.98
COOP: 241102	10-min	0.23	0.33	0.40	0.48	0.55	0.61	1.38	1.99	2.39	2.90	3.27	3.64
Elev: 3,681 ft	15-min	0.28	0.40	0.48	0.59	0.66	0.74	1.12	1.61	1.94	2.35	2.65	2.96
Modified POR: 51	20-min	0.30	0.43	0.52	0.63	0.71	0.79	0.90	1.29	1.55	1.88	2.13	2.37
Type: 2nd Order	25-min	0.32	0.46	0.55	0.67	0.75	0.84	0.77	1.10	1.32	1.60	1.81	2.02
	30-min	0.34	0.49	0.58	0.71	0.80	0.89	0.68	0.97	1.17	1.42	1.60	1.78
	35-min	0.35	0.50	0.60	0.73	0.82	0.91	0.60	0.86	1.03	1.25	1.41	1.57
	40-min	0.36	0.51	0.62	0.75	0.84	0.94	0.53	0.77	0.92	1.12	1.26	1.41
	45-min	0.37	0.52	0.63	0.76	0.86	0.96	0.49	0.70	0.84	1.02	1.15	1.28
	50-min	0.37	0.53	0.64	0.78	0.88	0.98	0.45	0.64	0.77	0.93	1.05	1.17
	55-min	0.38	0.54	0.65	0.79	0.89	1.00	0.41	0.59	0.71	0.86	0.97	1.09
	1-hr	0.38	0.55	0.66	0.80	0.91	1.01	0.38	0.55	0.66	0.80	0.91	1.01
	2-hr	0.50	0.66	0.76	0.89	0.99	1.08	0.25	0.33	0.38	0.44	0.49	0.54
	3-hr	0.60	0.75	0.85	0.97	1.06	1.16	0.20	0.25	0.28	0.32	0.35	0.39
	6-hr	0.83	1.05	1.20	1.39	1.53	1.66	0.14	0.18	0.20	0.23	0.25	0.28
	12-hr	1.18	1.55	1.80	2.12	2.35	2.58	0.10	0.13	0.15	0.18	0.20	0.22
	24-hr	1.49	2.04	2.40	2.85	3.19	3.53	0.062	0.085	0.100	0.119	0.133	0.147

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Broadus	5-min	0.31	0.44	0.53	0.64	0.72	0.80	3.75	5.33	6.38	7.70	8.68	9.65
COOP: 241127	10-min	0.46	0.65	0.78	0.94	1.06	1.18	2.74	3.90	4.66	5.63	6.35	7.06
Elev: 3,031 ft	15-min	0.56	0.79	0.95	1.14	1.29	1.43	2.22	3.16	3.78	4.57	5.15	5.73
Modified POR: 63	20-min	0.59	0.84	1.01	1.22	1.38	1.53	1.78	2.53	3.03	3.66	4.13	4.59
Type: 2nd Order	25-min	0.63	0.90	1.08	1.30	1.46	1.63	1.52	2.16	2.58	3.12	3.51	3.91
	30-min	0.67	0.95	1.14	1.38	1.55	1.73	1.34	1.91	2.28	2.75	3.11	3.45
	35-min	0.69	0.98	1.17	1.41	1.59	1.77	1.18	1.68	2.01	2.42	2.73	3.04
	40-min	0.71	1.00	1.20	1.45	1.63	1.82	1.06	1.51	1.80	2.18	2.45	2.73
	45-min	0.72	1.03	1.23	1.49	1.68	1.86	0.96	1.37	1.64	1.98	2.23	2.49
	50-min	0.74	1.05	1.25	1.51	1.71	1.90	0.88	1.26	1.50	1.82	2.05	2.28
	55-min	0.75	1.06	1.27	1.54	1.73	1.93	0.82	1.16	1.39	1.68	1.89	2.11
	1-hr	0.76	1.08	1.30	1.56	1.76	1.96	0.76	1.08	1.30	1.56	1.76	1.96
	2-hr	0.88	1.29	1.56	1.89	2.15	2.40	0.44	0.64	0.78	0.95	1.07	1.20
	3-hr	0.97	1.42	1.71	2.09	2.36	2.64	0.32	0.47	0.57	0.70	0.79	0.88
	6-hr	1.14	1.62	1.94	2.33	2.63	2.92	0.19	0.27	0.32	0.39	0.44	0.49
	12-hr	1.31	1.79	2.12	2.52	2.83	3.13	0.11	0.15	0.18	0.21	0.24	0.26
	24-hr	1.50	2.02	2.37	2.81	3.13	3.46	0.063	0.084	0.099	0.117	0.131	0.144
Browning	5-min	0.23	0.32	0.37	0.45	0.50	0.56	2.73	3.79	4.50	5.38	6.04	6.70
COOP: 241202	10-min	0.33	0.46	0.55	0.66	0.74	0.82	2.00	2.78	3.29	3.94	4.42	4.90
Elev: 4,355 ft	15-min	0.41	0.56	0.67	0.80	0.90	0.99	1.62	2.25	2.67	3.20	3.59	3.98
Modified POR: 53	20-min	0.43	0.60	0.71	0.85	0.96	1.06	1.30	1.80	2.14	2.56	2.87	3.19
Type: 2nd Order	25-min	0.46	0.64	0.76	0.91	1.02	1.13	1.11	1.54	1.82	2.18	2.45	2.71
	30-min	0.49	0.68	0.80	0.96	1.08	1.20	0.98	1.36	1.61	1.93	2.16	2.40
	35-min	0.50	0.70	0.83	0.99	1.11	1.23	0.86	1.19	1.42	1.69	1.90	2.11
	40-min	0.51	0.71	0.85	1.01	1.14	1.26	0.77	1.07	1.27	1.52	1.71	1.89
	45-min	0.53	0.73	0.87	1.04	1.17	1.29	0.70	0.98	1.16	1.39	1.56	1.72
	50-min	0.54	0.75	0.88	1.06	1.19	1.32	0.64	0.89	1.06	1.27	1.42	1.58
	55-min	0.55	0.76	0.90	1.08	1.21	1.34	0.60	0.83	0.98	1.17	1.32	1.46
	1-hr	0.56	0.77	0.91	1.09	1.23	1.36	0.56	0.77	0.91	1.09	1.23	1.36
	2-hr	0.69	0.94	1.10	1.31	1.46	1.62	0.35	0.47	0.55	0.66	0.73	0.81
	3-hr	0.82	1.10	1.28	1.52	1.69	1.86	0.27	0.37	0.43	0.51	0.56	0.62
	6-hr	1.12	1.50	1.75	2.07	2.31	2.54	0.19	0.25	0.29	0.35	0.38	0.42
	12-hr	1.52	2.13	2.53	3.04	3.42	3.79	0.13	0.18	0.21	0.25	0.28	0.32
	24-hr	1.95	2.88	3.50	4.28	4.85	5.43	0.081	0.120	0.146	0.178	0.202	0.226

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Butte-8S	5-min	0.19	0.28	0.33	0.40	0.45	0.50	2.32	3.32	3.98	4.82	5.44	6.05
COOP: 241309	10-min	0.28	0.40	0.49	0.59	0.66	0.74	1.70	2.43	2.91	3.52	3.98	4.43
Elev: 5,700 ft	15-min	0.34	0.49	0.59	0.71	0.81	0.90	1.38	1.97	2.36	2.86	3.23	3.59
Modified POR: 56	20-min	0.37	0.53	0.63	0.76	0.86	0.96	1.10	1.58	1.89	2.29	2.59	2.88
Type: 2nd Order	25-min	0.39	0.56	0.67	0.81	0.92	1.02	0.94	1.34	1.61	1.95	2.20	2.45
	30-min	0.41	0.59	0.71	0.86	0.97	1.08	0.83	1.19	1.42	1.72	1.94	2.17
	35-min	0.43	0.61	0.73	0.88	1.00	1.11	0.73	1.04	1.25	1.52	1.71	1.91
	40-min	0.44	0.62	0.75	0.91	1.02	1.14	0.65	0.94	1.12	1.36	1.54	1.71
	45-min	0.45	0.64	0.77	0.93	1.05	1.17	0.60	0.85	1.02	1.24	1.40	1.56
	50-min	0.46	0.65	0.78	0.95	1.07	1.19	0.55	0.78	0.94	1.14	1.28	1.43
	55-min	0.46	0.66	0.80	0.96	1.09	1.21	0.51	0.72	0.87	1.05	1.19	1.32
	1-hr	0.47	0.67	0.81	0.98	1.11	1.23	0.47	0.67	0.81	0.98	1.11	1.23
	2-hr	0.55	0.77	0.92	1.11	1.25	1.38	0.28	0.39	0.46	0.55	0.62	0.69
	3-hr	0.63	0.83	0.97	1.14	1.26	1.39	0.21	0.28	0.32	0.38	0.42	0.46
	6-hr	0.76	0.95	1.08	1.24	1.35	1.47	0.13	0.16	0.18	0.21	0.23	0.24
	12-hr	1.02	1.30	1.49	1.72	1.90	2.07	0.09	0.11	0.12	0.14	0.16	0.17
	24-hr	1.26	1.52	1.70	1.92	2.08	2.24	0.052	0.063	0.071	0.080	0.087	0.093
Cameron	5-min	0.17	0.27	0.33	0.41	0.47	0.53	2.07	3.22	3.98	4.94	5.65	6.35
COOP: 241408	10-min	0.25	0.39	0.49	0.60	0.69	0.77	1.52	2.36	2.91	3.61	4.13	4.65
Elev: 5,505 ft	15-min	0.31	0.48	0.59	0.73	0.84	0.94	1.23	1.91	2.36	2.93	3.35	3.77
Modified POR: 44	20-min	0.33	0.51	0.63	0.78	0.90	1.01	0.99	1.53	1.89	2.35	2.69	3.02
Type: 2nd Order	25-min	0.35	0.54	0.67	0.83	0.95	1.07	0.84	1.30	1.61	2.00	2.29	2.57
	30-min	0.37	0.58	0.71	0.88	1.01	1.14	0.74	1.15	1.42	1.77	2.02	2.27
	35-min	0.38	0.59	0.73	0.91	1.04	1.17	0.65	1.01	1.25	1.55	1.78	2.00
	40-min	0.39	0.61	0.75	0.93	1.06	1.20	0.59	0.91	1.12	1.39	1.60	1.79
	45-min	0.40	0.62	0.77	0.95	1.09	1.23	0.53	0.83	1.02	1.27	1.45	1.64
	50-min	0.41	0.63	0.78	0.97	1.11	1.25	0.49	0.76	0.94	1.16	1.33	1.50
	55-min	0.41	0.64	0.79	0.99	1.13	1.27	0.45	0.70	0.87	1.08	1.23	1.38
	1-hr	0.42	0.65	0.81	1.00	1.15	1.29	0.42	0.65	0.81	1.00	1.15	1.29
	2-hr	0.49	0.73	0.89	1.09	1.24	1.39	0.24	0.36	0.44	0.55	0.62	0.70
	3-hr	0.60	0.89	1.08	1.32	1.50	1.67	0.20	0.30	0.36	0.44	0.50	0.56
	6-hr	0.77	1.06	1.25	1.49	1.66	1.84	0.13	0.18	0.21	0.25	0.28	0.31
	12-hr	0.97	1.25	1.43	1.67	1.84	2.01	0.08	0.10	0.12	0.14	0.15	0.17
	24-hr	1.16	1.43	1.61	1.84	2.01	2.18	0.048	0.060	0.067	0.077	0.084	0.091

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Cardwell	5-min	0.17	0.23	0.28	0.33	0.37	0.41	2.05	2.82	3.32	3.96	4.44	4.91
COOP: 241500	10-min	0.25	0.34	0.41	0.48	0.54	0.60	1.50	2.06	2.43	2.90	3.25	3.59
Elev: 4,270 ft	15-min	0.30	0.42	0.49	0.59	0.66	0.73	1.22	1.67	1.97	2.35	2.63	2.91
Modified POR: 30	20-min	0.33	0.45	0.53	0.63	0.70	0.78	0.98	1.34	1.58	1.88	2.11	2.33
Type: 2nd Order	25-min	0.35	0.48	0.56	0.67	0.75	0.83	0.83	1.14	1.35	1.60	1.80	1.99
	30-min	0.37	0.50	0.59	0.71	0.79	0.88	0.73	1.01	1.19	1.42	1.59	1.76
	35-min	0.38	0.52	0.61	0.73	0.81	0.90	0.65	0.89	1.05	1.25	1.40	1.54
	40-min	0.39	0.53	0.63	0.75	0.84	0.92	0.58	0.80	0.94	1.12	1.25	1.39
	45-min	0.40	0.54	0.64	0.77	0.86	0.95	0.53	0.73	0.86	1.02	1.14	1.26
	50-min	0.40	0.55	0.65	0.78	0.87	0.96	0.48	0.66	0.78	0.93	1.05	1.16
	55-min	0.41	0.56	0.66	0.79	0.89	0.98	0.45	0.61	0.72	0.86	0.97	1.07
	1-hr	0.42	0.57	0.68	0.81	0.90	1.00	0.42	0.57	0.68	0.81	0.90	1.00
	2-hr	0.51	0.69	0.81	0.97	1.08	1.19	0.26	0.35	0.41	0.48	0.54	0.60
	3-hr	0.60	0.79	0.92	1.08	1.20	1.31	0.20	0.26	0.31	0.36	0.40	0.44
	6-hr	0.78	0.97	1.10	1.26	1.38	1.49	0.13	0.16	0.18	0.21	0.23	0.25
	12-hr	1.00	1.19	1.31	1.47	1.59	1.71	0.08	0.10	0.11	0.12	0.13	0.14
	24-hr	1.20	1.41	1.55	1.73	1.86	1.99	0.050	0.059	0.065	0.072	0.078	0.083
Choteau	5-min	0.24	0.33	0.39	0.47	0.53	0.59	2.85	3.98	4.73	5.68	6.38	7.08
COOP: 241737	10-min	0.35	0.49	0.58	0.69	0.78	0.86	2.08	2.91	3.46	4.16	4.67	5.18
Elev: 3,845 ft	15-min	0.42	0.59	0.70	0.84	0.95	1.05	1.69	2.36	2.81	3.37	3.79	4.20
Modified POR: 68	20-min	0.45	0.63	0.75	0.90	1.01	1.12	1.35	1.89	2.25	2.70	3.04	3.37
Type: 2nd Order	25-min	0.48	0.67	0.80	0.96	1.08	1.19	1.15	1.61	1.92	2.30	2.58	2.87
	30-min	0.51	0.71	0.85	1.02	1.14	1.27	1.02	1.42	1.69	2.03	2.28	2.53
	35-min	0.52	0.73	0.87	1.04	1.17	1.30	0.90	1.25	1.49	1.79	2.01	2.23
	40-min	0.54	0.75	0.89	1.07	1.20	1.33	0.80	1.12	1.34	1.60	1.80	2.00
	45-min	0.55	0.77	0.91	1.10	1.23	1.37	0.73	1.03	1.22	1.46	1.64	1.82
	50-min	0.56	0.78	0.93	1.12	1.25	1.39	0.67	0.94	1.12	1.34	1.51	1.67
	55-min	0.57	0.80	0.95	1.14	1.28	1.42	0.62	0.87	1.03	1.24	1.39	1.54
	1-hr	0.58	0.81	0.96	1.15	1.30	1.44	0.58	0.81	0.96	1.15	1.30	1.44
	2-hr	0.67	0.91	1.06	1.25	1.40	1.54	0.34	0.45	0.53	0.63	0.70	0.77
	3-hr	0.76	0.99	1.14	1.34	1.48	1.62	0.25	0.33	0.38	0.45	0.49	0.54
	6-hr	0.92	1.17	1.34	1.54	1.70	1.85	0.15	0.20	0.22	0.26	0.28	0.31
	12-hr	1.16	1.53	1.77	2.08	2.30	2.53	0.10	0.13	0.15	0.17	0.19	0.21
	24-hr	1.45	2.02	2.39	2.86	3.21	3.56	0.061	0.084	0.100	0.119	0.134	0.148

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Clark Canyon Dam	5-min	0.18	0.24	0.28	0.33	0.37	0.41	2.21	2.93	3.40	4.00	4.45	4.89
COOP: 241781	10-min	0.27	0.36	0.42	0.49	0.54	0.60	1.62	2.14	2.49	2.93	3.25	3.58
Elev: 5,580 ft	15-min	0.33	0.43	0.50	0.59	0.66	0.73	1.31	1.74	2.02	2.38	2.64	2.90
Modified POR: 43	20-min	0.35	0.46	0.54	0.63	0.71	0.77	1.05	1.39	1.62	1.90	2.12	2.32
Type: 2nd Order	25-min	0.37	0.49	0.57	0.68	0.75	0.82	0.90	1.19	1.38	1.62	1.80	1.98
	30-min	0.40	0.52	0.61	0.72	0.80	0.87	0.79	1.05	1.22	1.43	1.59	1.75
	35-min	0.41	0.54	0.62	0.73	0.82	0.90	0.70	0.92	1.07	1.26	1.40	1.54
	40-min	0.42	0.55	0.64	0.75	0.84	0.92	0.63	0.83	0.96	1.13	1.26	1.38
	45-min	0.43	0.57	0.66	0.77	0.86	0.94	0.57	0.75	0.88	1.03	1.14	1.26
	50-min	0.43	0.58	0.67	0.79	0.87	0.96	0.52	0.69	0.80	0.94	1.05	1.15
	55-min	0.44	0.59	0.68	0.80	0.89	0.98	0.48	0.64	0.74	0.87	0.97	1.07
	1-hr	0.45	0.60	0.69	0.81	0.90	0.99	0.45	0.60	0.69	0.81	0.90	0.99
	2-hr	0.55	0.72	0.83	0.97	1.07	1.18	0.28	0.36	0.41	0.48	0.54	0.59
	3-hr	0.61	0.78	0.89	1.04	1.14	1.25	0.20	0.26	0.30	0.35	0.38	0.42
	6-hr	0.77	0.97	1.11	1.28	1.41	1.53	0.13	0.16	0.18	0.21	0.23	0.26
	12-hr	0.92	1.16	1.33	1.54	1.69	1.84	0.08	0.10	0.11	0.13	0.14	0.15
	24-hr	1.15	1.42	1.60	1.82	1.99	2.16	0.048	0.059	0.066	0.076	0.083	0.090
Cohagen	5-min	0.29	0.40	0.47	0.55	0.62	0.68	3.54	4.78	5.61	6.65	7.42	8.19
COOP: 241875	10-min	0.43	0.58	0.68	0.81	0.90	1.00	2.59	3.50	4.10	4.86	5.43	5.99
Elev: 2,727 ft	15-min	0.52	0.71	0.83	0.99	1.10	1.21	2.10	2.84	3.33	3.95	4.40	4.86
Modified POR: 41	20-min	0.56	0.76	0.89	1.05	1.18	1.30	1.68	2.27	2.67	3.16	3.53	3.89
Type: 2nd Order	25-min	0.60	0.81	0.95	1.12	1.25	1.38	1.43	1.94	2.27	2.69	3.00	3.31
	30-min	0.63	0.86	1.00	1.19	1.33	1.46	1.27	1.71	2.01	2.38	2.65	2.93
	35-min	0.65	0.88	1.03	1.22	1.36	1.50	1.11	1.51	1.76	2.09	2.34	2.58
	40-min	0.67	0.90	1.06	1.25	1.40	1.54	1.00	1.35	1.58	1.88	2.10	2.31
	45-min	0.68	0.92	1.08	1.28	1.43	1.58	0.91	1.23	1.44	1.71	1.91	2.11
	50-min	0.70	0.94	1.10	1.31	1.46	1.61	0.83	1.13	1.32	1.57	1.75	1.93
	55-min	0.71	0.96	1.12	1.33	1.48	1.64	0.77	1.04	1.22	1.45	1.62	1.79
	1-hr	0.72	0.97	1.14	1.35	1.51	1.66	0.72	0.97	1.14	1.35	1.51	1.66
	2-hr	0.80	1.08	1.27	1.51	1.69	1.86	0.40	0.54	0.64	0.76	0.84	0.93
	3-hr	0.87	1.15	1.34	1.58	1.75	1.93	0.29	0.38	0.45	0.53	0.58	0.64
	6-hr	1.05	1.38	1.61	1.89	2.10	2.31	0.17	0.23	0.27	0.32	0.35	0.38
	12-hr	1.27	1.64	1.88	2.19	2.42	2.65	0.11	0.14	0.16	0.18	0.20	0.22
	24-hr	1.54	2.01	2.31	2.70	2.99	3.28	0.064	0.084	0.096	0.113	0.125	0.137

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Content-3SSE	5-min	0.34	0.51	0.62	0.76	0.87	0.97	4.07	6.10	7.45	9.15	10.41	11.66
COOP: 241984	10-min	0.50	0.74	0.91	1.12	1.27	1.42	2.98	4.46	5.45	6.69	7.62	8.53
Elev: 2,260 ft	15-min	0.60	0.91	1.11	1.36	1.54	1.73	2.41	3.62	4.42	5.43	6.18	6.92
Modified POR: 50	20-min	0.64	0.97	1.18	1.45	1.65	1.85	1.93	2.90	3.54	4.35	4.95	5.55
Type: 2nd Order	25-min	0.69	1.03	1.26	1.54	1.76	1.97	1.65	2.47	3.02	3.70	4.22	4.72
	30-min	0.73	1.09	1.33	1.64	1.86	2.09	1.46	2.18	2.66	3.27	3.72	4.17
	35-min	0.75	1.12	1.37	1.68	1.91	2.14	1.28	1.92	2.34	2.88	3.28	3.67
	40-min	0.77	1.15	1.40	1.72	1.96	2.20	1.15	1.72	2.10	2.58	2.94	3.30
	45-min	0.79	1.18	1.44	1.77	2.01	2.25	1.05	1.57	1.92	2.36	2.68	3.00
	50-min	0.80	1.20	1.46	1.80	2.05	2.29	0.96	1.44	1.76	2.16	2.45	2.75
	55-min	0.81	1.22	1.49	1.83	2.08	2.33	0.89	1.33	1.62	1.99	2.27	2.54
	1-hr	0.83	1.24	1.51	1.86	2.12	2.37	0.83	1.24	1.51	1.86	2.12	2.37
	2-hr	0.93	1.35	1.62	1.97	2.23	2.49	0.47	0.67	0.81	0.99	1.12	1.24
	3-hr	1.01	1.43	1.71	2.07	2.33	2.59	0.34	0.48	0.57	0.69	0.78	0.86
	6-hr	1.22	1.65	1.93	2.30	2.56	2.83	0.20	0.27	0.32	0.38	0.43	0.47
	12-hr	1.45	1.97	2.32	2.76	3.09	3.41	0.12	0.16	0.19	0.23	0.26	0.28
	24-hr	1.78	2.46	2.91	3.47	3.89	4.31	0.074	0.103	0.121	0.145	0.162	0.180
Cooke City-2W	5-min	0.18	0.25	0.30	0.36	0.40	0.45	2.12	2.99	3.57	4.30	4.85	5.38
COOP: 241995	10-min	0.26	0.36	0.44	0.52	0.59	0.66	1.55	2.19	2.61	3.15	3.55	3.94
Elev: 7,424 ft	15-min	0.31	0.44	0.53	0.64	0.72	0.80	1.26	1.78	2.12	2.55	2.88	3.20
Modified POR: 24	20-min	0.34	0.47	0.57	0.68	0.77	0.85	1.01	1.42	1.70	2.05	2.30	2.56
Type: 2nd Order	25-min	0.36	0.50	0.60	0.73	0.82	0.91	0.86	1.21	1.45	1.74	1.96	2.18
	30-min	0.38	0.54	0.64	0.77	0.87	0.96	0.76	1.07	1.28	1.54	1.73	1.93
	35-min	0.39	0.55	0.66	0.79	0.89	0.99	0.67	0.94	1.12	1.35	1.53	1.69
	40-min	0.40	0.56	0.67	0.81	0.91	1.01	0.60	0.85	1.01	1.22	1.37	1.52
	45-min	0.41	0.58	0.69	0.83	0.94	1.04	0.54	0.77	0.92	1.11	1.25	1.39
	50-min	0.42	0.59	0.70	0.85	0.95	1.06	0.50	0.71	0.84	1.01	1.14	1.27
	55-min	0.42	0.60	0.71	0.86	0.97	1.08	0.46	0.65	0.78	0.94	1.06	1.17
	1-hr	0.43	0.61	0.73	0.87	0.98	1.09	0.43	0.61	0.73	0.87	0.98	1.09
	2-hr	0.53	0.73	0.86	1.02	1.14	1.26	0.27	0.36	0.43	0.51	0.57	0.63
	3-hr	0.62	0.84	0.98	1.16	1.29	1.43	0.21	0.28	0.33	0.39	0.43	0.48
	6-hr	0.81	1.05	1.21	1.41	1.56	1.71	0.14	0.18	0.20	0.24	0.26	0.28
	12-hr	1.00	1.27	1.45	1.67	1.84	2.01	0.08	0.11	0.12	0.14	0.15	0.17
	24-hr	1.26	1.66	1.92	2.26	2.51	2.75	0.053	0.069	0.080	0.094	0.104	0.115

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Custer	5-min	0.26	0.42	0.52	0.66	0.76	0.85	3.11	5.02	6.28	7.88	9.07	10.24
COOP: 242158	10-min	0.38	0.61	0.77	0.96	1.11	1.25	2.28	3.67	4.60	5.77	6.63	7.49
Elev: 2,884 ft	15-min	0.46	0.74	0.93	1.17	1.35	1.52	1.85	2.98	3.73	4.68	5.38	6.08
Modified POR: 22	20-min	0.49	0.80	1.00	1.25	1.44	1.62	1.48	2.39	2.99	3.75	4.31	4.87
Type: 2nd Order	25-min	0.52	0.85	1.06	1.33	1.53	1.73	1.26	2.03	2.54	3.19	3.67	4.15
	30-min	0.56	0.90	1.12	1.41	1.62	1.83	1.11	1.80	2.25	2.82	3.24	3.66
	35-min	0.57	0.92	1.15	1.45	1.66	1.88	0.98	1.58	1.98	2.48	2.85	3.22
	40-min	0.59	0.95	1.18	1.48	1.71	1.93	0.88	1.42	1.78	2.23	2.56	2.89
	45-min	0.60	0.97	1.21	1.52	1.75	1.98	0.80	1.29	1.62	2.03	2.33	2.64
	50-min	0.61	0.99	1.23	1.55	1.78	2.01	0.73	1.18	1.48	1.86	2.14	2.41
	55-min	0.62	1.00	1.26	1.58	1.81	2.05	0.68	1.09	1.37	1.72	1.98	2.23
	1-hr	0.63	1.02	1.28	1.60	1.84	2.08	0.63	1.02	1.28	1.60	1.84	2.08
	2-hr	0.74	1.11	1.36	1.67	1.90	2.13	0.37	0.56	0.68	0.84	0.95	1.07
	3-hr	0.87	1.26	1.52	1.85	2.10	2.34	0.29	0.42	0.51	0.62	0.70	0.78
	6-hr	1.05	1.41	1.65	1.95	2.18	2.40	0.17	0.23	0.27	0.33	0.36	0.40
	12-hr	1.28	1.64	1.87	2.17	2.40	2.62	0.11	0.14	0.16	0.18	0.20	0.22
	24-hr	1.53	1.99	2.30	2.68	2.97	3.25	0.064	0.083	0.096	0.112	0.124	0.136
Cut Bank Airport	5-min	0.19	0.28	0.33	0.41	0.46	0.51	2.29	3.32	4.00	4.87	5.51	6.15
COOP: 242173	10-min	0.28	0.40	0.49	0.59	0.67	0.75	1.67	2.43	2.93	3.56	4.03	4.50
Elev: 3,838 ft	15-min	0.34	0.49	0.59	0.72	0.82	0.91	1.36	1.97	2.38	2.89	3.27	3.65
Modified POR: 57	20-min	0.36	0.53	0.63	0.77	0.87	0.97	1.09	1.58	1.90	2.32	2.62	2.92
Type: 2nd Order	25-min	0.39	0.56	0.68	0.82	0.93	1.04	0.93	1.34	1.62	1.97	2.23	2.49
	30-min	0.41	0.59	0.72	0.87	0.99	1.10	0.82	1.19	1.43	1.74	1.97	2.20
	35-min	0.42	0.61	0.74	0.89	1.01	1.13	0.72	1.04	1.26	1.53	1.73	1.94
	40-min	0.43	0.63	0.75	0.92	1.04	1.16	0.65	0.94	1.13	1.38	1.56	1.74
	45-min	0.44	0.64	0.77	0.94	1.06	1.19	0.59	0.85	1.03	1.25	1.42	1.58
	50-min	0.45	0.65	0.79	0.96	1.08	1.21	0.54	0.78	0.94	1.15	1.30	1.45
	55-min	0.46	0.66	0.80	0.97	1.10	1.23	0.50	0.72	0.87	1.06	1.20	1.34
	1-hr	0.46	0.67	0.81	0.99	1.12	1.25	0.46	0.67	0.81	0.99	1.12	1.25
	2-hr	0.56	0.77	0.91	1.09	1.23	1.36	0.28	0.39	0.46	0.55	0.61	0.68
	3-hr	0.65	0.88	1.04	1.23	1.38	1.52	0.22	0.29	0.35	0.41	0.46	0.51
	6-hr	0.85	1.08	1.23	1.43	1.57	1.71	0.14	0.18	0.21	0.24	0.26	0.28
	12-hr	1.13	1.43	1.62	1.87	2.06	2.24	0.09	0.12	0.14	0.16	0.17	0.19
	24-hr	1.44	1.80	2.04	2.34	2.57	2.79	0.060	0.075	0.085	0.098	0.107	0.116

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Darby	5-min	0.16	0.24	0.29	0.36	0.41	0.46	1.97	2.91	3.53	4.31	4.89	5.47
COOP: 242221	10-min	0.24	0.35	0.43	0.53	0.60	0.67	1.44	2.13	2.58	3.15	3.58	4.00
Elev: 3,880 ft	15-min	0.29	0.43	0.52	0.64	0.73	0.81	1.17	1.72	2.09	2.56	2.90	3.24
Modified POR: 35	20-min	0.31	0.46	0.56	0.68	0.78	0.87	0.94	1.38	1.68	2.05	2.33	2.60
Type: 2nd Order	25-min	0.33	0.49	0.59	0.73	0.82	0.92	0.80	1.18	1.43	1.74	1.98	2.21
	30-min	0.35	0.52	0.63	0.77	0.87	0.98	0.70	1.04	1.26	1.54	1.75	1.96
	35-min	0.36	0.53	0.65	0.79	0.90	1.00	0.62	0.91	1.11	1.36	1.54	1.72
	40-min	0.37	0.55	0.66	0.81	0.92	1.03	0.56	0.82	1.00	1.22	1.38	1.54
	45-min	0.38	0.56	0.68	0.83	0.94	1.06	0.51	0.75	0.91	1.11	1.26	1.41
	50-min	0.39	0.57	0.69	0.85	0.96	1.07	0.46	0.69	0.83	1.02	1.15	1.29
	55-min	0.39	0.58	0.70	0.86	0.98	1.09	0.43	0.63	0.77	0.94	1.07	1.19
	1-hr	0.40	0.59	0.72	0.88	0.99	1.11	0.40	0.59	0.72	0.88	0.99	1.11
	2-hr	0.47	0.63	0.74	0.87	0.97	1.07	0.24	0.32	0.37	0.44	0.49	0.54
	3-hr	0.53	0.70	0.81	0.96	1.06	1.16	0.18	0.23	0.27	0.32	0.35	0.39
	6-hr	0.72	0.87	0.96	1.09	1.18	1.27	0.12	0.14	0.16	0.18	0.20	0.21
	12-hr	0.94	1.10	1.20	1.33	1.43	1.52	0.08	0.09	0.10	0.11	0.12	0.13
	24-hr	1.18	1.40	1.55	1.74	1.88	2.02	0.049	0.059	0.065	0.073	0.079	0.084
Delphia	5-min	0.23	0.32	0.39	0.47	0.53	0.59	2.71	3.88	4.66	5.64	6.36	7.08
COOP: 242317	10-min	0.33	0.47	0.57	0.69	0.78	0.86	1.99	2.84	3.41	4.12	4.65	5.18
Elev: 3,061 ft	15-min	0.40	0.58	0.69	0.84	0.94	1.05	1.61	2.30	2.76	3.34	3.78	4.20
Modified POR: 28	20-min	0.43	0.62	0.74	0.89	1.01	1.12	1.29	1.85	2.22	2.68	3.03	3.37
Type: 2nd Order	25-min	0.46	0.66	0.79	0.95	1.07	1.19	1.10	1.57	1.89	2.28	2.58	2.87
	30-min	0.49	0.69	0.83	1.01	1.14	1.27	0.97	1.39	1.67	2.02	2.28	2.53
	35-min	0.50	0.71	0.86	1.03	1.17	1.30	0.85	1.22	1.47	1.77	2.00	2.23
	40-min	0.51	0.73	0.88	1.06	1.20	1.33	0.77	1.10	1.32	1.59	1.80	2.00
	45-min	0.52	0.75	0.90	1.09	1.23	1.37	0.70	1.00	1.20	1.45	1.64	1.82
	50-min	0.53	0.76	0.92	1.11	1.25	1.39	0.64	0.92	1.10	1.33	1.50	1.67
	55-min	0.54	0.78	0.93	1.13	1.27	1.42	0.59	0.85	1.02	1.23	1.39	1.54
	1-hr	0.55	0.79	0.95	1.15	1.29	1.44	0.55	0.79	0.95	1.15	1.29	1.44
	2-hr	0.67	0.88	1.02	1.20	1.34	1.47	0.33	0.44	0.51	0.60	0.67	0.73
	3-hr	0.73	0.96	1.12	1.31	1.46	1.60	0.24	0.32	0.37	0.44	0.49	0.53
	6-hr	0.86	1.11	1.28	1.49	1.65	1.80	0.14	0.19	0.21	0.25	0.27	0.30
	12-hr	1.06	1.38	1.60	1.87	2.07	2.28	0.09	0.12	0.13	0.16	0.17	0.19
	24-hr	1.41	1.89	2.21	2.60	2.90	3.19	0.059	0.079	0.092	0.108	0.121	0.133

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Dillon-9SSE	5-min	0.18	0.25	0.29	0.35	0.39	0.43	2.16	2.96	3.50	4.17	4.67	5.17
COOP: 242414	10-min	0.26	0.36	0.43	0.51	0.57	0.63	1.58	2.17	2.56	3.05	3.42	3.78
Elev: 5,500 ft	15-min	0.32	0.44	0.52	0.62	0.69	0.77	1.28	1.76	2.07	2.48	2.77	3.07
Modified POR: 58	20-min	0.34	0.47	0.55	0.66	0.74	0.82	1.03	1.41	1.66	1.98	2.22	2.46
Type: 2nd Order	25-min	0.36	0.50	0.59	0.70	0.79	0.87	0.87	1.20	1.42	1.69	1.89	2.09
	30-min	0.39	0.53	0.63	0.75	0.84	0.92	0.77	1.06	1.25	1.49	1.67	1.85
	35-min	0.40	0.54	0.64	0.77	0.86	0.95	0.68	0.93	1.10	1.31	1.47	1.63
	40-min	0.41	0.56	0.66	0.79	0.88	0.97	0.61	0.84	0.99	1.18	1.32	1.46
	45-min	0.42	0.57	0.68	0.81	0.90	1.00	0.56	0.76	0.90	1.07	1.20	1.33
	50-min	0.42	0.58	0.69	0.82	0.92	1.02	0.51	0.70	0.82	0.98	1.10	1.22
	55-min	0.43	0.59	0.70	0.83	0.93	1.03	0.47	0.65	0.76	0.91	1.02	1.13
	1-hr	0.44	0.60	0.71	0.85	0.95	1.05	0.44	0.60	0.71	0.85	0.95	1.05
	2-hr	0.52	0.71	0.85	1.01	1.14	1.26	0.26	0.36	0.42	0.51	0.57	0.63
	3-hr	0.58	0.79	0.92	1.09	1.22	1.35	0.19	0.26	0.31	0.36	0.41	0.45
	6-hr	0.78	1.01	1.15	1.34	1.48	1.62	0.13	0.17	0.19	0.22	0.25	0.27
	12-hr	0.99	1.21	1.35	1.53	1.67	1.80	0.08	0.10	0.11	0.13	0.14	0.15
	24-hr	1.23	1.48	1.64	1.85	2.00	2.15	0.051	0.062	0.068	0.077	0.083	0.090
Divide	5-min	0.18	0.25	0.30	0.36	0.41	0.45	2.17	3.05	3.62	4.35	4.89	5.43
COOP: 242421	10-min	0.27	0.37	0.44	0.53	0.60	0.66	1.59	2.23	2.65	3.18	3.58	3.97
Elev: 5,407 ft	15-min	0.32	0.45	0.54	0.65	0.73	0.81	1.29	1.81	2.15	2.58	2.90	3.22
Modified POR: 59	20-min	0.34	0.48	0.57	0.69	0.78	0.86	1.03	1.45	1.72	2.07	2.33	2.58
Type: 2nd Order	25-min	0.37	0.51	0.61	0.73	0.83	0.92	0.88	1.23	1.47	1.76	1.98	2.20
	30-min	0.39	0.54	0.65	0.78	0.87	0.97	0.78	1.09	1.30	1.56	1.75	1.94
	35-min	0.40	0.56	0.67	0.80	0.90	1.00	0.68	0.96	1.14	1.37	1.54	1.71
	40-min	0.41	0.57	0.68	0.82	0.92	1.02	0.61	0.86	1.02	1.23	1.38	1.53
	45-min	0.42	0.59	0.70	0.84	0.94	1.05	0.56	0.78	0.93	1.12	1.26	1.40
	50-min	0.43	0.60	0.71	0.85	0.96	1.07	0.51	0.72	0.85	1.03	1.15	1.28
	55-min	0.43	0.61	0.72	0.87	0.98	1.08	0.47	0.66	0.79	0.95	1.07	1.18
	1-hr	0.44	0.62	0.74	0.88	0.99	1.10	0.44	0.62	0.74	0.88	0.99	1.10
	2-hr	0.54	0.69	0.80	0.93	1.03	1.12	0.27	0.35	0.40	0.46	0.51	0.56
	3-hr	0.61	0.77	0.87	1.00	1.10	1.19	0.20	0.26	0.29	0.33	0.37	0.40
	6-hr	0.76	0.97	1.11	1.29	1.42	1.55	0.13	0.16	0.19	0.21	0.24	0.26
	12-hr	0.94	1.18	1.35	1.56	1.71	1.86	0.08	0.10	0.11	0.13	0.14	0.16
	24-hr	1.14	1.40	1.57	1.79	1.95	2.10	0.048	0.058	0.065	0.074	0.081	0.088

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Dodson-11N	5-min	0.27	0.38	0.46	0.55	0.62	0.69	3.25	4.60	5.50	6.62	7.46	8.29
COOP: 242441	10-min	0.40	0.56	0.67	0.81	0.91	1.01	2.38	3.37	4.02	4.85	5.46	6.07
Elev: 2,710 ft	15-min	0.48	0.68	0.82	0.98	1.11	1.23	1.93	2.73	3.26	3.93	4.43	4.92
Modified POR: 49	20-min	0.52	0.73	0.87	1.05	1.18	1.31	1.55	2.19	2.61	3.15	3.55	3.94
Type: 2nd Order	25-min	0.55	0.78	0.93	1.12	1.26	1.40	1.32	1.86	2.23	2.68	3.02	3.36
	30-min	0.58	0.82	0.98	1.18	1.33	1.48	1.16	1.65	1.97	2.37	2.67	2.97
	35-min	0.60	0.84	1.01	1.22	1.37	1.52	1.02	1.45	1.73	2.09	2.35	2.61
	40-min	0.61	0.87	1.04	1.25	1.41	1.56	0.92	1.30	1.55	1.87	2.11	2.34
	45-min	0.63	0.89	1.06	1.28	1.44	1.60	0.84	1.18	1.41	1.71	1.92	2.14
	50-min	0.64	0.90	1.08	1.30	1.47	1.63	0.77	1.09	1.30	1.56	1.76	1.96
	55-min	0.65	0.92	1.10	1.32	1.49	1.66	0.71	1.00	1.20	1.44	1.63	1.81
	1-hr	0.66	0.94	1.12	1.35	1.52	1.69	0.66	0.94	1.12	1.35	1.52	1.69
	2-hr	0.81	1.21	1.48	1.82	2.07	2.32	0.40	0.61	0.74	0.91	1.04	1.16
	3-hr	0.92	1.39	1.71	2.11	2.41	2.70	0.31	0.46	0.57	0.70	0.80	0.90
	6-hr	1.13	1.73	2.12	2.62	2.99	3.36	0.19	0.29	0.35	0.44	0.50	0.56
	12-hr	1.40	2.04	2.46	3.00	3.40	3.80	0.12	0.17	0.21	0.25	0.28	0.32
	24-hr	1.70	2.42	2.89	3.49	3.93	4.38	0.071	0.101	0.120	0.145	0.164	0.182
Dovetail	5-min	0.23	0.36	0.45	0.56	0.64	0.72	2.81	4.37	5.40	6.71	7.67	8.64
COOP: 242477	10-min	0.34	0.53	0.66	0.82	0.94	1.05	2.06	3.20	3.95	4.91	5.62	6.32
Elev: 2,743 ft	15-min	0.42	0.65	0.80	1.00	1.14	1.28	1.67	2.59	3.21	3.98	4.55	5.13
Modified POR: 28	20-min	0.45	0.69	0.86	1.06	1.22	1.37	1.34	2.08	2.57	3.19	3.65	4.11
Type: 2nd Order	25-min	0.47	0.74	0.91	1.13	1.29	1.46	1.14	1.77	2.19	2.72	3.11	3.50
	30-min	0.50	0.78	0.97	1.20	1.37	1.54	1.00	1.56	1.93	2.40	2.75	3.09
	35-min	0.52	0.80	0.99	1.23	1.41	1.59	0.88	1.38	1.70	2.11	2.42	2.72
	40-min	0.53	0.82	1.02	1.26	1.45	1.63	0.79	1.23	1.53	1.89	2.17	2.44
	45-min	0.54	0.84	1.04	1.30	1.48	1.67	0.72	1.12	1.39	1.73	1.98	2.22
	50-min	0.55	0.86	1.06	1.32	1.51	1.70	0.66	1.03	1.27	1.58	1.81	2.04
	55-min	0.56	0.87	1.08	1.34	1.53	1.73	0.61	0.95	1.18	1.46	1.67	1.88
	1-hr	0.57	0.89	1.10	1.36	1.56	1.76	0.57	0.89	1.10	1.36	1.56	1.76
	2-hr	0.71	1.14	1.43	1.79	2.06	2.33	0.35	0.57	0.71	0.90	1.03	1.16
	3-hr	0.81	1.29	1.61	2.01	2.31	2.61	0.27	0.43	0.54	0.67	0.77	0.87
	6-hr	1.00	1.63	2.05	2.57	2.96	3.35	0.17	0.27	0.34	0.43	0.49	0.56
	12-hr	1.21	2.05	2.61	3.31	3.84	4.35	0.10	0.17	0.22	0.28	0.32	0.36
	24-hr	1.49	2.45	3.09	3.89	4.49	5.08	0.062	0.102	0.129	0.162	0.187	0.212

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Drummond	5-min	0.18	0.26	0.31	0.38	0.42	0.47	2.15	3.09	3.71	4.50	5.09	5.67
COOP: 242500	10-min	0.26	0.38	0.45	0.55	0.62	0.69	1.57	2.26	2.72	3.29	3.72	4.15
Elev: 3,943 ft	15-min	0.32	0.46	0.55	0.67	0.75	0.84	1.27	1.83	2.20	2.67	3.02	3.36
Modified POR: 34	20-min	0.34	0.49	0.59	0.71	0.81	0.90	1.02	1.47	1.77	2.14	2.42	2.70
Type: 2nd Order	25-min	0.36	0.52	0.63	0.76	0.86	0.96	0.87	1.25	1.50	1.82	2.06	2.29
	30-min	0.38	0.55	0.66	0.81	0.91	1.01	0.77	1.11	1.33	1.61	1.82	2.03
	35-min	0.39	0.57	0.68	0.83	0.93	1.04	0.68	0.97	1.17	1.42	1.60	1.78
	40-min	0.40	0.58	0.70	0.85	0.96	1.07	0.61	0.87	1.05	1.27	1.44	1.60
	45-min	0.41	0.60	0.72	0.87	0.98	1.09	0.55	0.80	0.96	1.16	1.31	1.46
	50-min	0.42	0.61	0.73	0.88	1.00	1.11	0.51	0.73	0.88	1.06	1.20	1.34
	55-min	0.43	0.62	0.74	0.90	1.02	1.13	0.47	0.67	0.81	0.98	1.11	1.24
	1-hr	0.44	0.63	0.75	0.92	1.03	1.15	0.44	0.63	0.75	0.92	1.03	1.15
	2-hr	0.51	0.67	0.78	0.91	1.01	1.11	0.26	0.34	0.39	0.46	0.51	0.56
	3-hr	0.61	0.74	0.84	0.95	1.04	1.12	0.20	0.25	0.28	0.32	0.35	0.37
	6-hr	0.74	0.91	1.02	1.15	1.25	1.35	0.12	0.15	0.17	0.19	0.21	0.23
	12-hr	0.96	1.16	1.29	1.46	1.58	1.70	0.08	0.10	0.11	0.12	0.13	0.14
	24-hr	1.19	1.43	1.58	1.78	1.93	2.07	0.050	0.059	0.066	0.074	0.080	0.086
Dupuyer	5-min	0.19	0.31	0.39	0.49	0.57	0.64	2.27	3.73	4.70	5.92	6.83	7.73
COOP: 242571	10-min	0.28	0.45	0.57	0.72	0.83	0.94	1.66	2.73	3.44	4.33	5.00	5.66
Elev: 4,134 ft	15-min	0.34	0.55	0.70	0.88	1.01	1.15	1.35	2.21	2.79	3.52	4.05	4.59
Modified POR: 25	20-min	0.36	0.59	0.75	0.94	1.08	1.23	1.08	1.77	2.24	2.82	3.25	3.68
Type: 2nd Order	25-min	0.38	0.63	0.79	1.00	1.15	1.30	0.92	1.51	1.90	2.40	2.77	3.13
	30-min	0.41	0.67	0.84	1.06	1.22	1.38	0.81	1.33	1.68	2.12	2.44	2.77
	35-min	0.42	0.69	0.86	1.09	1.25	1.42	0.71	1.17	1.48	1.86	2.15	2.43
	40-min	0.43	0.70	0.89	1.12	1.29	1.46	0.64	1.05	1.33	1.67	1.93	2.18
	45-min	0.44	0.72	0.91	1.14	1.32	1.49	0.58	0.96	1.21	1.53	1.76	1.99
	50-min	0.45	0.73	0.92	1.16	1.34	1.52	0.53	0.88	1.11	1.40	1.61	1.82
	55-min	0.45	0.75	0.94	1.18	1.37	1.55	0.49	0.81	1.02	1.29	1.49	1.69
	1-hr	0.46	0.76	0.96	1.20	1.39	1.57	0.46	0.76	0.96	1.20	1.39	1.57
	2-hr	0.61	0.95	1.17	1.45	1.66	1.87	0.31	0.47	0.59	0.73	0.83	0.93
	3-hr	0.73	1.09	1.33	1.63	1.85	2.07	0.24	0.36	0.44	0.54	0.62	0.69
	6-hr	0.99	1.37	1.63	1.95	2.19	2.43	0.16	0.23	0.27	0.33	0.37	0.40
	12-hr	1.40	2.01	2.42	2.93	3.31	3.69	0.12	0.17	0.20	0.24	0.28	0.31
	24-hr	1.89	2.98	3.69	4.60	5.27	5.94	0.079	0.124	0.154	0.192	0.220	0.247

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Dutton-6E	5-min	0.24	0.36	0.44	0.54	0.62	0.69	2.91	4.35	5.31	6.51	7.41	8.30
COOP: 242584	10-min	0.35	0.53	0.65	0.79	0.90	1.01	2.13	3.18	3.88	4.77	5.42	6.07
Elev: 3,594 ft	15-min	0.43	0.65	0.79	0.97	1.10	1.23	1.73	2.58	3.15	3.87	4.40	4.92
Modified POR: 57	20-min	0.46	0.69	0.84	1.03	1.17	1.32	1.38	2.07	2.52	3.10	3.52	3.95
Type: 2nd Order	25-min	0.49	0.73	0.90	1.10	1.25	1.40	1.18	1.76	2.15	2.64	3.00	3.36
	30-min	0.52	0.78	0.95	1.16	1.33	1.48	1.04	1.56	1.90	2.33	2.65	2.97
	35-min	0.53	0.80	0.97	1.20	1.36	1.52	0.92	1.37	1.67	2.05	2.33	2.61
	40-min	0.55	0.82	1.00	1.23	1.40	1.56	0.82	1.23	1.50	1.84	2.09	2.34
	45-min	0.56	0.84	1.02	1.26	1.43	1.60	0.75	1.12	1.37	1.68	1.91	2.14
	50-min	0.57	0.86	1.04	1.28	1.46	1.63	0.69	1.03	1.25	1.54	1.75	1.96
	55-min	0.58	0.87	1.06	1.30	1.48	1.66	0.63	0.95	1.16	1.42	1.62	1.81
	1-hr	0.59	0.88	1.08	1.32	1.51	1.69	0.59	0.88	1.08	1.32	1.51	1.69
	2-hr	0.71	1.01	1.22	1.47	1.66	1.85	0.35	0.51	0.61	0.73	0.83	0.92
	3-hr	0.81	1.11	1.30	1.55	1.74	1.92	0.27	0.37	0.43	0.52	0.58	0.64
	6-hr	1.04	1.39	1.62	1.91	2.12	2.33	0.17	0.23	0.27	0.32	0.35	0.39
	12-hr	1.36	1.76	2.02	2.36	2.60	2.85	0.11	0.15	0.17	0.20	0.22	0.24
	24-hr	1.73	2.24	2.58	3.01	3.33	3.64	0.072	0.093	0.108	0.125	0.139	0.152
Ekalaka	5-min	0.33	0.42	0.48	0.56	0.62	0.67	3.97	5.07	5.79	6.72	7.40	8.08
COOP: 242689	10-min	0.48	0.62	0.71	0.82	0.90	0.98	2.90	3.71	4.24	4.91	5.41	5.91
Elev: 3,426 ft	15-min	0.59	0.75	0.86	1.00	1.10	1.20	2.35	3.01	3.44	3.99	4.39	4.79
Modified POR: 54	20-min	0.63	0.80	0.92	1.06	1.17	1.28	1.89	2.41	2.76	3.19	3.52	3.84
Type: 2nd Order	25-min	0.67	0.85	0.98	1.13	1.25	1.36	1.61	2.05	2.35	2.72	3.00	3.27
	30-min	0.71	0.91	1.04	1.20	1.32	1.44	1.42	1.81	2.07	2.40	2.65	2.89
	35-min	0.73	0.93	1.06	1.23	1.36	1.48	1.25	1.59	1.82	2.11	2.33	2.54
	40-min	0.75	0.95	1.09	1.26	1.39	1.52	1.12	1.43	1.64	1.90	2.09	2.28
	45-min	0.77	0.98	1.12	1.30	1.43	1.56	1.02	1.30	1.49	1.73	1.90	2.08
	50-min	0.78	1.00	1.14	1.32	1.45	1.59	0.94	1.19	1.37	1.58	1.74	1.90
	55-min	0.79	1.01	1.16	1.34	1.48	1.61	0.86	1.10	1.26	1.46	1.61	1.76
	1-hr	0.81	1.03	1.18	1.36	1.50	1.64	0.81	1.03	1.18	1.36	1.50	1.64
	2-hr	0.90	1.19	1.39	1.63	1.81	1.99	0.45	0.60	0.69	0.82	0.91	1.00
	3-hr	0.99	1.29	1.49	1.75	1.94	2.13	0.33	0.43	0.50	0.58	0.65	0.71
	6-hr	1.19	1.53	1.75	2.04	2.25	2.46	0.20	0.25	0.29	0.34	0.37	0.41
	12-hr	1.44	1.85	2.13	2.47	2.73	2.98	0.12	0.15	0.18	0.21	0.23	0.25
	24-hr	1.81	2.34	2.69	3.14	3.46	3.79	0.076	0.098	0.112	0.131	0.144	0.158

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Elkhorn Hot Springs	5-min	0.15	0.18	0.21	0.24	0.26	0.28	1.79	2.21	2.49	2.85	3.11	3.38
COOP: 242719	10-min	0.22	0.27	0.30	0.35	0.38	0.41	1.31	1.62	1.83	2.09	2.28	2.47
Elev: 7,385 ft	15-min	0.27	0.33	0.37	0.42	0.46	0.50	1.06	1.31	1.48	1.69	1.85	2.00
Modified POR: 36	20-min	0.28	0.35	0.40	0.45	0.49	0.54	0.85	1.05	1.19	1.36	1.48	1.61
Type: 2nd Order	25-min	0.30	0.37	0.42	0.48	0.53	0.57	0.72	0.90	1.01	1.15	1.26	1.37
	30-min	0.32	0.40	0.45	0.51	0.56	0.60	0.64	0.79	0.89	1.02	1.11	1.21
	35-min	0.33	0.41	0.46	0.52	0.57	0.62	0.56	0.70	0.79	0.90	0.98	1.06
	40-min	0.34	0.42	0.47	0.54	0.59	0.64	0.51	0.63	0.70	0.81	0.88	0.95
	45-min	0.35	0.43	0.48	0.55	0.60	0.65	0.46	0.57	0.64	0.73	0.80	0.87
	50-min	0.35	0.43	0.49	0.56	0.61	0.66	0.42	0.52	0.59	0.67	0.73	0.80
	55-min	0.36	0.44	0.50	0.57	0.62	0.67	0.39	0.48	0.54	0.62	0.68	0.74
	1-hr	0.36	0.45	0.51	0.58	0.63	0.69	0.36	0.45	0.51	0.58	0.63	0.69
	2-hr	0.44	0.53	0.59	0.66	0.72	0.78	0.22	0.26	0.29	0.33	0.36	0.39
	3-hr	0.50	0.59	0.65	0.73	0.79	0.84	0.17	0.20	0.22	0.24	0.26	0.28
	6-hr	0.71	0.82	0.90	1.00	1.07	1.14	0.12	0.14	0.15	0.17	0.18	0.19
	12-hr	0.90	1.06	1.17	1.31	1.41	1.50	0.08	0.09	0.10	0.11	0.12	0.13
	24-hr	1.11	1.35	1.50	1.70	1.84	1.99	0.046	0.056	0.063	0.071	0.077	0.083
Essex	5-min	0.16	0.23	0.27	0.33	0.38	0.42	1.91	2.75	3.30	3.99	4.51	5.02
COOP: 242812	10-min	0.23	0.33	0.40	0.49	0.55	0.61	1.40	2.01	2.41	2.92	3.30	3.68
Elev: 3,870 ft	15-min	0.28	0.41	0.49	0.59	0.67	0.75	1.14	1.63	1.96	2.37	2.68	2.98
Modified POR: 30	20-min	0.30	0.44	0.52	0.63	0.72	0.80	0.91	1.31	1.57	1.90	2.15	2.39
Type: 2nd Order	25-min	0.32	0.46	0.56	0.67	0.76	0.85	0.77	1.11	1.34	1.62	1.83	2.03
	30-min	0.34	0.49	0.59	0.71	0.81	0.90	0.68	0.98	1.18	1.43	1.61	1.80
	35-min	0.35	0.50	0.61	0.73	0.83	0.92	0.60	0.86	1.04	1.26	1.42	1.58
	40-min	0.36	0.52	0.62	0.75	0.85	0.95	0.54	0.78	0.93	1.13	1.27	1.42
	45-min	0.37	0.53	0.64	0.77	0.87	0.97	0.49	0.71	0.85	1.03	1.16	1.29
	50-min	0.38	0.54	0.65	0.78	0.89	0.99	0.45	0.65	0.78	0.94	1.06	1.18
	55-min	0.38	0.55	0.66	0.80	0.90	1.00	0.42	0.60	0.72	0.87	0.98	1.10
	1-hr	0.39	0.56	0.67	0.81	0.92	1.02	0.39	0.56	0.67	0.81	0.92	1.02
	2-hr	0.52	0.71	0.83	1.00	1.11	1.23	0.26	0.35	0.42	0.50	0.56	0.62
	3-hr	0.64	0.86	1.01	1.20	1.34	1.47	0.21	0.29	0.34	0.40	0.45	0.49
	6-hr	0.88	1.10	1.24	1.41	1.54	1.68	0.15	0.18	0.21	0.24	0.26	0.28
	12-hr	1.17	1.48	1.68	1.94	2.13	2.32	0.10	0.12	0.14	0.16	0.18	0.19
	24-hr	1.62	2.07	2.37	2.75	3.03	3.31	0.068	0.086	0.099	0.115	0.126	0.138

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Eureka RS	5-min	0.18	0.25	0.29	0.34	0.38	0.42	2.21	2.97	3.48	4.11	4.58	5.05
COOP: 242827	10-min	0.27	0.36	0.42	0.50	0.56	0.62	1.62	2.18	2.54	3.01	3.35	3.70
Elev: 2,532 ft	15-min	0.33	0.44	0.52	0.61	0.68	0.75	1.31	1.76	2.06	2.44	2.72	3.00
Modified POR: 48	20-min	0.35	0.47	0.55	0.65	0.73	0.80	1.05	1.41	1.65	1.96	2.18	2.40
Type: 2nd Order	25-min	0.37	0.50	0.59	0.69	0.77	0.85	0.90	1.20	1.41	1.67	1.86	2.05
	30-min	0.40	0.53	0.62	0.74	0.82	0.90	0.79	1.06	1.24	1.47	1.64	1.81
	35-min	0.41	0.55	0.64	0.76	0.84	0.93	0.70	0.94	1.09	1.29	1.44	1.59
	40-min	0.42	0.56	0.65	0.77	0.86	0.95	0.63	0.84	0.98	1.16	1.30	1.43
	45-min	0.43	0.57	0.67	0.79	0.89	0.98	0.57	0.77	0.90	1.06	1.18	1.30
	50-min	0.43	0.58	0.68	0.81	0.90	0.99	0.52	0.70	0.82	0.97	1.08	1.19
	55-min	0.44	0.59	0.69	0.82	0.92	1.01	0.48	0.65	0.76	0.90	1.00	1.10
	1-hr	0.45	0.60	0.71	0.84	0.93	1.03	0.45	0.60	0.71	0.84	0.93	1.03
	2-hr	0.55	0.67	0.76	0.87	0.95	1.03	0.27	0.34	0.38	0.43	0.47	0.51
	3-hr	0.62	0.75	0.84	0.95	1.03	1.11	0.21	0.25	0.28	0.32	0.34	0.37
	6-hr	0.75	0.88	0.97	1.09	1.17	1.25	0.12	0.15	0.16	0.18	0.19	0.21
	12-hr	0.92	1.10	1.22	1.37	1.49	1.60	0.08	0.09	0.10	0.11	0.12	0.13
	24-hr	1.11	1.33	1.48	1.66	1.80	1.93	0.046	0.056	0.062	0.069	0.075	0.080
Fort Peck Power Plant	5-min	0.37	0.54	0.66	0.80	0.91	1.02	4.42	6.52	7.90	9.66	10.96	12.25
COOP: 243176	10-min	0.54	0.79	0.96	1.18	1.34	1.49	3.24	4.77	5.78	7.07	8.02	8.96
Elev: 2,070 ft	15-min	0.66	0.97	1.17	1.43	1.63	1.82	2.62	3.87	4.69	5.73	6.50	7.27
Modified POR: 53	20-min	0.70	1.03	1.25	1.53	1.74	1.94	2.10	3.10	3.76	4.59	5.21	5.83
Type: 2nd Order	25-min	0.75	1.10	1.33	1.63	1.85	2.07	1.79	2.64	3.20	3.91	4.44	4.96
	30-min	0.79	1.17	1.41	1.73	1.96	2.19	1.58	2.33	2.83	3.45	3.92	4.38
	35-min	0.81	1.20	1.45	1.77	2.01	2.25	1.39	2.05	2.49	3.04	3.45	3.86
	40-min	0.83	1.23	1.49	1.82	2.06	2.31	1.25	1.84	2.23	2.73	3.10	3.46
	45-min	0.85	1.26	1.53	1.86	2.12	2.37	1.14	1.68	2.04	2.49	2.82	3.15
	50-min	0.87	1.28	1.55	1.90	2.15	2.41	1.04	1.54	1.86	2.28	2.58	2.89
	55-min	0.88	1.30	1.58	1.93	2.19	2.45	0.96	1.42	1.72	2.11	2.39	2.67
	1-hr	0.90	1.32	1.61	1.96	2.23	2.49	0.90	1.32	1.61	1.96	2.23	2.49
	2-hr	1.07	1.51	1.80	2.17	2.44	2.72	0.53	0.75	0.90	1.08	1.22	1.36
	3-hr	1.17	1.63	1.93	2.32	2.60	2.89	0.39	0.54	0.64	0.77	0.87	0.96
	6-hr	1.34	1.81	2.11	2.50	2.79	3.07	0.22	0.30	0.35	0.42	0.46	0.51
	12-hr	1.59	2.11	2.46	2.89	3.22	3.54	0.13	0.18	0.20	0.24	0.27	0.29
	24-hr	1.92	2.60	3.06	3.63	4.06	4.48	0.080	0.108	0.127	0.151	0.169	0.187

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Froid COOP: 243309 Elev: 2,030 ft Modified POR: 42 Type: 2nd Order	5-min	0.31	0.44	0.53	0.64	0.72	0.80	3.69	5.27	6.32	7.65	8.63	9.61
	10-min	0.45	0.64	0.77	0.93	1.05	1.17	2.70	3.86	4.63	5.60	6.32	7.03
	15-min	0.55	0.78	0.94	1.13	1.28	1.43	2.19	3.13	3.75	4.54	5.12	5.70
	20-min	0.58	0.84	1.00	1.21	1.37	1.52	1.75	2.51	3.01	3.64	4.11	4.57
	25-min	0.62	0.89	1.07	1.29	1.46	1.62	1.49	2.13	2.56	3.10	3.49	3.89
	30-min	0.66	0.94	1.13	1.37	1.54	1.72	1.32	1.89	2.26	2.74	3.09	3.44
	35-min	0.68	0.97	1.16	1.40	1.58	1.76	1.16	1.66	1.99	2.41	2.72	3.02
	40-min	0.69	0.99	1.19	1.44	1.63	1.81	1.04	1.49	1.79	2.16	2.44	2.71
	45-min	0.71	1.02	1.22	1.48	1.67	1.86	0.95	1.36	1.63	1.97	2.22	2.47
	50-min	0.72	1.04	1.24	1.50	1.70	1.89	0.87	1.24	1.49	1.80	2.04	2.27
	55-min	0.74	1.05	1.26	1.53	1.73	1.92	0.80	1.15	1.38	1.67	1.88	2.10
	1-hr	0.75	1.07	1.28	1.55	1.75	1.95	0.75	1.07	1.28	1.55	1.75	1.95
	2-hr	0.85	1.15	1.35	1.60	1.79	1.97	0.43	0.58	0.68	0.80	0.89	0.99
	3-hr	0.96	1.26	1.46	1.71	1.90	2.09	0.32	0.42	0.49	0.57	0.63	0.70
	6-hr	1.12	1.43	1.63	1.88	2.07	2.25	0.19	0.24	0.27	0.31	0.34	0.38
	12-hr	1.33	1.61	1.79	2.02	2.19	2.35	0.11	0.13	0.15	0.17	0.18	0.20
	24-hr	1.56	1.93	2.18	2.50	2.73	2.97	0.065	0.081	0.091	0.104	0.114	0.124
Gibbons Pass COOP: 243479 Elev: 6,999 ft Modified POR: 56 Type: 2nd Order	5-min	0.19	0.24	0.28	0.33	0.36	0.40	2.25	2.92	3.37	3.93	4.35	4.77
	10-min	0.27	0.36	0.41	0.48	0.53	0.58	1.64	2.14	2.46	2.88	3.18	3.49
	15-min	0.33	0.43	0.50	0.58	0.65	0.71	1.33	1.73	2.00	2.33	2.58	2.83
	20-min	0.36	0.46	0.53	0.62	0.69	0.76	1.07	1.39	1.60	1.87	2.07	2.27
	25-min	0.38	0.49	0.57	0.66	0.73	0.80	0.91	1.18	1.36	1.59	1.76	1.93
	30-min	0.40	0.52	0.60	0.70	0.78	0.85	0.80	1.05	1.20	1.41	1.56	1.71
	35-min	0.41	0.54	0.62	0.72	0.80	0.88	0.71	0.92	1.06	1.24	1.37	1.50
	40-min	0.42	0.55	0.63	0.74	0.82	0.90	0.63	0.83	0.95	1.11	1.23	1.35
	45-min	0.43	0.56	0.65	0.76	0.84	0.92	0.58	0.75	0.87	1.01	1.12	1.23
	50-min	0.44	0.57	0.66	0.77	0.86	0.94	0.53	0.69	0.79	0.93	1.03	1.12
	55-min	0.45	0.58	0.67	0.79	0.87	0.95	0.49	0.64	0.73	0.86	0.95	1.04
	1-hr	0.46	0.59	0.68	0.80	0.88	0.97	0.46	0.59	0.68	0.80	0.88	0.97
	2-hr	0.55	0.68	0.76	0.87	0.95	1.03	0.27	0.34	0.38	0.43	0.47	0.51
	3-hr	0.61	0.73	0.81	0.91	0.98	1.05	0.20	0.24	0.27	0.30	0.33	0.35
	6-hr	0.80	1.09	1.28	1.52	1.70	1.88	0.13	0.18	0.21	0.25	0.28	0.31
	12-hr	1.09	1.40	1.61	1.87	2.07	2.26	0.09	0.12	0.13	0.16	0.17	0.19
	24-hr	1.46	1.73	1.90	2.12	2.28	2.44	0.061	0.072	0.079	0.088	0.095	0.102

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Gibson Dam	5-min	0.20	0.31	0.38	0.47	0.54	0.60	2.39	3.68	4.54	5.62	6.42	7.22
COOP: 243489	10-min	0.29	0.45	0.55	0.69	0.78	0.88	1.75	2.70	3.32	4.11	4.70	5.28
Elev: 4,593 ft	15-min	0.35	0.55	0.67	0.83	0.95	1.07	1.42	2.19	2.69	3.34	3.81	4.29
Modified POR: 56	20-min	0.38	0.58	0.72	0.89	1.02	1.14	1.14	1.75	2.16	2.67	3.06	3.43
Type: 2nd Order	25-min	0.40	0.62	0.77	0.95	1.08	1.22	0.97	1.49	1.84	2.28	2.60	2.92
	30-min	0.43	0.66	0.81	1.01	1.15	1.29	0.86	1.32	1.62	2.01	2.30	2.58
	35-min	0.44	0.68	0.83	1.03	1.18	1.33	0.75	1.16	1.43	1.77	2.02	2.27
	40-min	0.45	0.69	0.86	1.06	1.21	1.36	0.68	1.04	1.28	1.59	1.81	2.04
	45-min	0.46	0.71	0.88	1.09	1.24	1.39	0.62	0.95	1.17	1.45	1.65	1.86
	50-min	0.47	0.72	0.89	1.10	1.26	1.42	0.56	0.87	1.07	1.33	1.51	1.70
	55-min	0.48	0.74	0.91	1.12	1.28	1.44	0.52	0.80	0.99	1.23	1.40	1.57
	1-hr	0.49	0.75	0.92	1.14	1.31	1.47	0.49	0.75	0.92	1.14	1.31	1.47
	2-hr	0.68	1.01	1.23	1.51	1.71	1.91	0.34	0.51	0.61	0.75	0.86	0.96
	3-hr	0.84	1.21	1.45	1.76	1.99	2.22	0.28	0.40	0.48	0.59	0.66	0.74
	6-hr	1.17	1.66	1.99	2.40	2.70	3.01	0.20	0.28	0.33	0.40	0.45	0.50
	12-hr	1.59	2.27	2.72	3.30	3.72	4.14	0.13	0.19	0.23	0.27	0.31	0.35
	24-hr	2.08	3.01	3.63	4.41	4.99	5.56	0.086	0.125	0.151	0.184	0.208	0.232
Glasgow Airport	5-min	0.37	0.53	0.64	0.79	0.91	1.03	4.42	6.37	7.67	9.50	10.92	12.33
COOP: 243558	10-min	0.52	0.74	0.89	1.09	1.25	1.41	3.09	4.43	5.32	6.55	7.50	8.45
Elev: 2,284 ft	15-min	0.60	0.86	1.03	1.27	1.45	1.63	2.40	3.44	4.13	5.07	5.80	6.52
Modified POR: 54	20-min	0.66	0.95	1.14	1.39	1.59	1.79	1.99	2.84	3.41	4.18	4.77	5.36
Type: 1st Order	25-min	0.71	1.01	1.22	1.49	1.70	1.91	1.70	2.43	2.92	3.58	4.08	4.58
	30-min	0.75	1.07	1.28	1.57	1.79	2.01	1.50	2.14	2.56	3.14	3.58	4.02
	35-min	0.78	1.11	1.34	1.64	1.87	2.09	1.34	1.91	2.29	2.80	3.20	3.59
	40-min	0.81	1.15	1.38	1.69	1.93	2.17	1.21	1.73	2.08	2.54	2.90	3.25
	45-min	0.83	1.19	1.43	1.74	1.99	2.23	1.11	1.59	1.90	2.33	2.65	2.98
	50-min	0.85	1.21	1.45	1.77	2.01	2.25	1.02	1.45	1.74	2.12	2.41	2.70
	55-min	0.86	1.22	1.46	1.78	2.02	2.26	0.94	1.33	1.59	1.94	2.21	2.47
	1-hr	0.87	1.23	1.47	1.79	2.04	2.28	0.87	1.23	1.47	1.79	2.04	2.28
	2-hr	0.99	1.37	1.62	1.94	2.18	2.42	0.49	0.69	0.81	0.97	1.09	1.21
	3-hr	1.07	1.46	1.71	2.03	2.27	2.51	0.36	0.49	0.57	0.68	0.76	0.84
	6-hr	1.25	1.72	2.03	2.42	2.70	2.99	0.21	0.29	0.34	0.40	0.45	0.50
	12-hr	1.45	1.91	2.22	2.61	2.90	3.19	0.12	0.16	0.19	0.22	0.24	0.27
	24-hr	1.70	2.36	2.80	3.35	3.76	4.17	0.071	0.098	0.117	0.140	0.157	0.174

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Glendive	5-min	0.36	0.49	0.58	0.69	0.78	0.86	4.29	5.91	6.98	8.33	9.34	10.34
COOP: 243581	10-min	0.52	0.72	0.85	1.02	1.14	1.26	3.14	4.32	5.11	6.10	6.83	7.56
Elev: 2,076 ft	15-min	0.64	0.88	1.04	1.24	1.39	1.53	2.54	3.50	4.14	4.95	5.54	6.13
Modified POR: 55	20-min	0.68	0.94	1.11	1.32	1.48	1.64	2.04	2.81	3.32	3.96	4.44	4.92
Type: 2nd Order	25-min	0.72	1.00	1.18	1.41	1.58	1.74	1.74	2.39	2.83	3.37	3.78	4.18
	30-min	0.77	1.06	1.25	1.49	1.67	1.85	1.53	2.11	2.50	2.98	3.34	3.70
	35-min	0.79	1.08	1.28	1.53	1.71	1.90	1.35	1.86	2.20	2.62	2.94	3.25
	40-min	0.81	1.11	1.31	1.57	1.76	1.95	1.21	1.67	1.97	2.35	2.64	2.92
	45-min	0.83	1.14	1.35	1.61	1.80	2.00	1.10	1.52	1.80	2.15	2.40	2.66
	50-min	0.84	1.16	1.37	1.64	1.83	2.03	1.01	1.39	1.65	1.96	2.20	2.44
	55-min	0.86	1.18	1.39	1.67	1.87	2.07	0.93	1.29	1.52	1.82	2.04	2.25
	1-hr	0.87	1.20	1.42	1.69	1.90	2.10	0.87	1.20	1.42	1.69	1.90	2.10
	2-hr	1.03	1.46	1.74	2.09	2.35	2.62	0.52	0.73	0.87	1.05	1.18	1.31
	3-hr	1.12	1.55	1.83	2.19	2.45	2.71	0.37	0.52	0.61	0.73	0.82	0.90
	6-hr	1.39	1.84	2.13	2.50	2.78	3.05	0.23	0.31	0.35	0.42	0.46	0.51
	12-hr	1.63	2.07	2.36	2.73	3.00	3.27	0.14	0.17	0.20	0.23	0.25	0.27
	24-hr	1.92	2.47	2.84	3.30	3.64	3.98	0.080	0.103	0.118	0.137	0.152	0.166
Great Falls Airport	5-min	0.29	0.39	0.45	0.55	0.63	0.70	3.43	4.63	5.44	6.60	7.51	8.42
COOP: 243751	10-min	0.40	0.54	0.63	0.77	0.87	0.98	2.37	3.23	3.80	4.61	5.24	5.86
Elev: 3,664 ft	15-min	0.46	0.63	0.74	0.90	1.02	1.14	1.84	2.51	2.96	3.58	4.07	4.55
Modified POR: 65	20-min	0.50	0.69	0.82	0.99	1.12	1.25	1.51	2.07	2.45	2.96	3.36	3.75
Type: 1st Order	25-min	0.54	0.74	0.87	1.06	1.20	1.34	1.29	1.77	2.10	2.54	2.88	3.21
	30-min	0.57	0.78	0.92	1.11	1.26	1.41	1.14	1.56	1.84	2.23	2.53	2.82
	35-min	0.59	0.81	0.96	1.16	1.32	1.47	1.01	1.39	1.65	1.99	2.26	2.52
	40-min	0.61	0.84	1.00	1.21	1.37	1.53	0.92	1.26	1.49	1.81	2.05	2.29
	45-min	0.63	0.87	1.03	1.24	1.41	1.57	0.84	1.16	1.37	1.66	1.88	2.10
	50-min	0.64	0.88	1.04	1.26	1.42	1.59	0.77	1.06	1.25	1.51	1.71	1.90
	55-min	0.65	0.89	1.05	1.26	1.43	1.59	0.70	0.97	1.14	1.38	1.56	1.73
	1-hr	0.65	0.89	1.05	1.27	1.43	1.59	0.65	0.89	1.05	1.27	1.43	1.59
	2-hr	0.70	0.95	1.11	1.32	1.47	1.63	0.35	0.48	0.56	0.66	0.74	0.81
	3-hr	0.79	1.02	1.18	1.37	1.52	1.66	0.26	0.34	0.39	0.46	0.51	0.55
	6-hr	1.02	1.24	1.39	1.58	1.72	1.86	0.17	0.21	0.23	0.26	0.29	0.31
	12-hr	1.31	1.63	1.85	2.12	2.32	2.52	0.11	0.14	0.15	0.18	0.19	0.21
	24-hr	1.66	2.16	2.49	2.91	3.22	3.52	0.069	0.090	0.104	0.121	0.134	0.147

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Haugan-1W	5-min	0.16	0.23	0.27	0.33	0.37	0.41	1.96	2.76	3.29	3.96	4.45	4.95
COOP: 243984	10-min	0.24	0.34	0.40	0.48	0.54	0.60	1.43	2.02	2.40	2.89	3.26	3.62
Elev: 3,153 ft	15-min	0.29	0.41	0.49	0.59	0.66	0.73	1.16	1.64	1.95	2.35	2.64	2.94
Modified POR: 38	20-min	0.31	0.44	0.52	0.63	0.71	0.78	0.93	1.31	1.56	1.88	2.12	2.35
Type: 2nd Order	25-min	0.33	0.47	0.55	0.67	0.75	0.83	0.79	1.12	1.33	1.60	1.80	2.00
	30-min	0.35	0.49	0.59	0.71	0.80	0.88	0.70	0.99	1.18	1.42	1.59	1.77
	35-min	0.36	0.51	0.60	0.73	0.82	0.91	0.62	0.87	1.03	1.25	1.40	1.56
	40-min	0.37	0.52	0.62	0.75	0.84	0.93	0.55	0.78	0.93	1.12	1.26	1.40
	45-min	0.38	0.53	0.63	0.76	0.86	0.95	0.50	0.71	0.85	1.02	1.15	1.27
	50-min	0.38	0.54	0.65	0.78	0.87	0.97	0.46	0.65	0.77	0.93	1.05	1.17
	55-min	0.39	0.55	0.66	0.79	0.89	0.99	0.43	0.60	0.72	0.86	0.97	1.08
	1-hr	0.40	0.56	0.67	0.80	0.90	1.01	0.40	0.56	0.67	0.80	0.90	1.01
	2-hr	0.50	0.68	0.80	0.95	1.06	1.18	0.25	0.34	0.40	0.48	0.53	0.59
	3-hr	0.58	0.77	0.90	1.06	1.18	1.29	0.19	0.26	0.30	0.35	0.39	0.43
	6-hr	0.77	0.97	1.10	1.27	1.39	1.52	0.13	0.16	0.18	0.21	0.23	0.25
	12-hr	1.04	1.30	1.47	1.69	1.85	2.01	0.09	0.11	0.12	0.14	0.15	0.17
	24-hr	1.36	1.73	1.97	2.27	2.50	2.72	0.057	0.072	0.082	0.095	0.104	0.113
Havre Airport	5-min	0.26	0.37	0.44	0.54	0.61	0.69	3.14	4.40	5.25	6.44	7.38	8.30
COOP: 243996	10-min	0.37	0.53	0.63	0.77	0.88	0.99	2.23	3.15	3.77	4.62	5.28	5.94
Elev: 2,585 ft	15-min	0.44	0.62	0.74	0.91	1.04	1.16	1.74	2.47	2.96	3.63	4.14	4.65
Modified POR: 51	20-min	0.48	0.68	0.82	1.00	1.15	1.29	1.44	2.05	2.46	3.01	3.44	3.86
Type: 1st Order	25-min	0.52	0.73	0.88	1.08	1.23	1.38	1.24	1.76	2.11	2.59	2.96	3.32
	30-min	0.54	0.78	0.93	1.14	1.30	1.46	1.09	1.55	1.86	2.28	2.60	2.92
	35-min	0.57	0.81	0.97	1.19	1.36	1.53	0.97	1.39	1.67	2.04	2.33	2.62
	40-min	0.58	0.84	1.01	1.24	1.41	1.58	0.88	1.26	1.52	1.86	2.12	2.38
	45-min	0.59	0.85	1.03	1.26	1.43	1.61	0.79	1.14	1.37	1.68	1.91	2.15
	50-min	0.60	0.86	1.03	1.27	1.44	1.62	0.72	1.03	1.24	1.52	1.73	1.94
	55-min	0.61	0.87	1.04	1.28	1.45	1.63	0.66	0.95	1.14	1.39	1.58	1.77
	1-hr	0.62	0.88	1.05	1.28	1.46	1.63	0.62	0.88	1.05	1.28	1.46	1.63
	2-hr	0.72	0.99	1.17	1.40	1.56	1.73	0.36	0.49	0.58	0.70	0.78	0.87
	3-hr	0.81	1.08	1.26	1.49	1.66	1.83	0.27	0.36	0.42	0.50	0.55	0.61
	6-hr	0.99	1.28	1.47	1.71	1.89	2.07	0.16	0.21	0.25	0.29	0.32	0.35
	12-hr	1.27	1.58	1.79	2.06	2.25	2.45	0.11	0.13	0.15	0.17	0.19	0.20
	24-hr	1.55	1.93	2.18	2.49	2.73	2.96	0.065	0.080	0.091	0.104	0.114	0.123

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Hebgen Dam	5-min	0.18	0.26	0.31	0.37	0.41	0.46	2.20	3.08	3.67	4.40	4.95	5.49
COOP: 244038	10-min	0.27	0.38	0.45	0.54	0.60	0.67	1.61	2.26	2.68	3.22	3.62	4.02
Elev: 6,489 ft	15-min	0.33	0.46	0.54	0.65	0.73	0.82	1.31	1.83	2.18	2.61	2.94	3.26
Modified POR: 54	20-min	0.35	0.49	0.58	0.70	0.78	0.87	1.05	1.47	1.74	2.09	2.35	2.61
Type: 2nd Order	25-min	0.37	0.52	0.62	0.74	0.84	0.93	0.89	1.25	1.48	1.78	2.00	2.22
	30-min	0.39	0.55	0.66	0.79	0.89	0.98	0.79	1.10	1.31	1.58	1.77	1.97
	35-min	0.40	0.57	0.67	0.81	0.91	1.01	0.69	0.97	1.15	1.39	1.56	1.73
	40-min	0.41	0.58	0.69	0.83	0.93	1.03	0.62	0.87	1.04	1.24	1.40	1.55
	45-min	0.43	0.60	0.71	0.85	0.96	1.06	0.57	0.79	0.94	1.13	1.27	1.41
	50-min	0.43	0.61	0.72	0.87	0.97	1.08	0.52	0.73	0.86	1.04	1.17	1.30
	55-min	0.44	0.62	0.73	0.88	0.99	1.10	0.48	0.67	0.80	0.96	1.08	1.20
	1-hr	0.45	0.63	0.75	0.90	1.01	1.12	0.45	0.63	0.75	0.90	1.01	1.12
	2-hr	0.54	0.71	0.83	0.97	1.08	1.18	0.27	0.36	0.41	0.49	0.54	0.59
	3-hr	0.61	0.79	0.92	1.07	1.18	1.29	0.20	0.26	0.31	0.36	0.39	0.43
	6-hr	0.79	0.96	1.08	1.23	1.33	1.44	0.13	0.16	0.18	0.20	0.22	0.24
	12-hr	1.02	1.21	1.34	1.50	1.62	1.74	0.08	0.10	0.11	0.12	0.13	0.14
	24-hr	1.32	1.56	1.71	1.91	2.05	2.20	0.055	0.065	0.071	0.079	0.085	0.091
Helena Airport	5-min	0.24	0.35	0.43	0.53	0.61	0.69	2.92	4.26	5.14	6.38	7.35	8.31
COOP: 244055	10-min	0.32	0.47	0.57	0.70	0.81	0.91	1.94	2.82	3.41	4.21	4.84	5.45
Elev: 3,828 ft	15-min	0.37	0.54	0.65	0.80	0.92	1.04	1.48	2.15	2.60	3.21	3.68	4.14
Modified POR: 64	20-min	0.40	0.59	0.71	0.87	1.00	1.13	1.21	1.76	2.12	2.62	3.00	3.38
Type: 1st Order	25-min	0.43	0.62	0.75	0.93	1.06	1.20	1.03	1.50	1.81	2.23	2.55	2.87
	30-min	0.45	0.65	0.79	0.97	1.11	1.25	0.90	1.31	1.58	1.95	2.23	2.51
	35-min	0.47	0.68	0.82	1.01	1.16	1.30	0.80	1.16	1.41	1.73	1.98	2.23
	40-min	0.48	0.70	0.84	1.03	1.18	1.32	0.72	1.05	1.26	1.54	1.76	1.98
	45-min	0.49	0.71	0.85	1.04	1.19	1.34	0.65	0.94	1.14	1.39	1.59	1.78
	50-min	0.50	0.72	0.86	1.06	1.21	1.35	0.60	0.86	1.04	1.27	1.45	1.62
	55-min	0.51	0.73	0.88	1.07	1.22	1.37	0.55	0.80	0.96	1.17	1.33	1.50
	1-hr	0.51	0.74	0.89	1.09	1.24	1.39	0.51	0.74	0.89	1.09	1.24	1.39
	2-hr	0.61	0.87	1.04	1.26	1.43	1.59	0.30	0.43	0.52	0.63	0.71	0.79
	3-hr	0.68	0.94	1.11	1.33	1.49	1.65	0.23	0.31	0.37	0.44	0.50	0.55
	6-hr	0.83	1.07	1.24	1.44	1.60	1.75	0.14	0.18	0.21	0.24	0.27	0.29
	12-hr	1.04	1.30	1.47	1.69	1.86	2.02	0.09	0.11	0.12	0.14	0.15	0.17
	24-hr	1.26	1.57	1.78	2.05	2.24	2.44	0.052	0.066	0.074	0.085	0.093	0.102

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Highwood	5-min	0.21	0.30	0.35	0.42	0.47	0.53	2.53	3.54	4.22	5.07	5.70	6.32
COOP: 244120	10-min	0.31	0.43	0.51	0.62	0.69	0.77	1.85	2.59	3.09	3.71	4.17	4.63
Elev: 3,402 ft	15-min	0.38	0.53	0.63	0.75	0.85	0.94	1.50	2.10	2.50	3.01	3.38	3.75
Modified POR: 31	20-min	0.40	0.56	0.67	0.80	0.90	1.00	1.20	1.69	2.01	2.41	2.71	3.01
Type: 2nd Order	25-min	0.43	0.60	0.71	0.85	0.96	1.07	1.02	1.44	1.71	2.05	2.31	2.56
	30-min	0.45	0.63	0.75	0.91	1.02	1.13	0.90	1.27	1.51	1.81	2.04	2.26
	35-min	0.46	0.65	0.77	0.93	1.05	1.16	0.80	1.12	1.33	1.59	1.79	1.99
	40-min	0.48	0.67	0.79	0.95	1.07	1.19	0.71	1.00	1.19	1.43	1.61	1.79
	45-min	0.49	0.68	0.81	0.98	1.10	1.22	0.65	0.91	1.09	1.30	1.47	1.63
	50-min	0.50	0.70	0.83	1.00	1.12	1.24	0.60	0.84	0.99	1.19	1.34	1.49
	55-min	0.51	0.71	0.84	1.01	1.14	1.26	0.55	0.77	0.92	1.10	1.24	1.38
	1-hr	0.51	0.72	0.86	1.03	1.16	1.29	0.51	0.72	0.86	1.03	1.16	1.29
	2-hr	0.64	0.84	0.97	1.14	1.26	1.38	0.32	0.42	0.49	0.57	0.63	0.69
	3-hr	0.76	0.98	1.12	1.31	1.44	1.57	0.25	0.33	0.37	0.44	0.48	0.52
	6-hr	1.07	1.34	1.52	1.75	1.92	2.09	0.18	0.22	0.25	0.29	0.32	0.35
	12-hr	1.47	1.95	2.27	2.67	2.97	3.26	0.12	0.16	0.19	0.22	0.25	0.27
	24-hr	2.04	2.84	3.37	4.03	4.52	5.01	0.085	0.118	0.140	0.168	0.188	0.209
Hilger	5-min	0.26	0.36	0.43	0.51	0.57	0.63	3.10	4.30	5.10	6.11	6.86	7.60
COOP: 244143	10-min	0.38	0.52	0.62	0.74	0.84	0.93	2.27	3.15	3.73	4.47	5.02	5.56
Elev: 4,080 ft	15-min	0.46	0.64	0.76	0.91	1.02	1.13	1.84	2.55	3.03	3.63	4.07	4.51
Modified POR: 53	20-min	0.49	0.68	0.81	0.97	1.09	1.20	1.47	2.05	2.43	2.91	3.26	3.61
Type: 2nd Order	25-min	0.52	0.73	0.86	1.03	1.16	1.28	1.26	1.74	2.07	2.47	2.78	3.08
	30-min	0.55	0.77	0.91	1.09	1.23	1.36	1.11	1.54	1.82	2.19	2.45	2.72
	35-min	0.57	0.79	0.94	1.12	1.26	1.39	0.98	1.35	1.61	1.92	2.16	2.39
	40-min	0.58	0.81	0.96	1.15	1.29	1.43	0.88	1.22	1.44	1.73	1.94	2.15
	45-min	0.60	0.83	0.98	1.18	1.32	1.47	0.80	1.11	1.31	1.57	1.76	1.96
	50-min	0.61	0.85	1.00	1.20	1.35	1.49	0.73	1.01	1.20	1.44	1.62	1.79
	55-min	0.62	0.86	1.02	1.22	1.37	1.52	0.68	0.94	1.11	1.33	1.49	1.66
	1-hr	0.63	0.87	1.04	1.24	1.39	1.54	0.63	0.87	1.04	1.24	1.39	1.54
	2-hr	0.74	1.09	1.32	1.61	1.83	2.05	0.37	0.54	0.66	0.81	0.91	1.02
	3-hr	0.84	1.19	1.42	1.72	1.93	2.15	0.28	0.40	0.47	0.57	0.64	0.72
	6-hr	1.03	1.37	1.59	1.88	2.09	2.30	0.17	0.23	0.27	0.31	0.35	0.38
	12-hr	1.34	1.72	1.97	2.28	2.52	2.75	0.11	0.14	0.16	0.19	0.21	0.23
	24-hr	1.70	2.21	2.55	2.98	3.29	3.61	0.071	0.092	0.106	0.124	0.137	0.150

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Holter Dam	5-min	0.20	0.31	0.38	0.47	0.54	0.60	2.44	3.73	4.58	5.65	6.45	7.24
COOP: 244241	10-min	0.30	0.45	0.56	0.69	0.79	0.88	1.79	2.73	3.35	4.14	4.72	5.30
Elev: 3,487 ft	15-min	0.36	0.55	0.68	0.84	0.96	1.07	1.45	2.21	2.72	3.35	3.83	4.30
Modified POR: 56	20-min	0.39	0.59	0.73	0.90	1.02	1.15	1.16	1.77	2.18	2.69	3.07	3.44
Type: 2nd Order	25-min	0.41	0.63	0.77	0.95	1.09	1.22	0.99	1.51	1.85	2.29	2.61	2.93
	30-min	0.44	0.67	0.82	1.01	1.15	1.30	0.87	1.33	1.64	2.02	2.31	2.59
	35-min	0.45	0.68	0.84	1.04	1.18	1.33	0.77	1.17	1.44	1.78	2.03	2.28
	40-min	0.46	0.70	0.86	1.06	1.22	1.36	0.69	1.05	1.29	1.60	1.82	2.05
	45-min	0.47	0.72	0.88	1.09	1.25	1.40	0.63	0.96	1.18	1.46	1.66	1.86
	50-min	0.48	0.73	0.90	1.11	1.27	1.42	0.58	0.88	1.08	1.33	1.52	1.71
	55-min	0.49	0.74	0.91	1.13	1.29	1.45	0.53	0.81	1.00	1.23	1.41	1.58
	1-hr	0.50	0.76	0.93	1.15	1.31	1.47	0.50	0.76	0.93	1.15	1.31	1.47
	2-hr	0.57	0.79	0.94	1.13	1.27	1.40	0.28	0.40	0.47	0.56	0.63	0.70
	3-hr	0.66	0.87	1.00	1.18	1.31	1.44	0.22	0.29	0.33	0.39	0.44	0.48
	6-hr	0.86	1.12	1.29	1.51	1.67	1.83	0.14	0.19	0.21	0.25	0.28	0.30
	12-hr	1.15	1.45	1.65	1.91	2.09	2.28	0.10	0.12	0.14	0.16	0.17	0.19
	24-hr	1.43	1.87	2.16	2.52	2.79	3.06	0.060	0.078	0.090	0.105	0.116	0.128
Iliad	5-min	0.25	0.35	0.42	0.51	0.58	0.64	2.96	4.23	5.07	6.14	6.92	7.71
COOP: 244368	10-min	0.36	0.52	0.62	0.75	0.84	0.94	2.17	3.10	3.71	4.49	5.07	5.64
Elev: 2,950 ft	15-min	0.44	0.63	0.75	0.91	1.03	1.14	1.76	2.51	3.01	3.64	4.11	4.57
Modified POR: 35	20-min	0.47	0.67	0.80	0.97	1.10	1.22	1.41	2.01	2.41	2.92	3.29	3.67
Type: 2nd Order	25-min	0.50	0.71	0.86	1.04	1.17	1.30	1.20	1.71	2.05	2.48	2.80	3.12
	30-min	0.53	0.76	0.91	1.10	1.24	1.38	1.06	1.51	1.82	2.20	2.48	2.76
	35-min	0.54	0.78	0.93	1.13	1.27	1.42	0.93	1.33	1.60	1.93	2.18	2.43
	40-min	0.56	0.80	0.96	1.16	1.30	1.45	0.84	1.20	1.43	1.73	1.96	2.18
	45-min	0.57	0.82	0.98	1.18	1.34	1.49	0.76	1.09	1.31	1.58	1.78	1.98
	50-min	0.58	0.83	1.00	1.21	1.36	1.51	0.70	1.00	1.20	1.45	1.63	1.82
	55-min	0.59	0.85	1.01	1.23	1.38	1.54	0.65	0.92	1.11	1.34	1.51	1.68
	1-hr	0.60	0.86	1.03	1.25	1.41	1.57	0.60	0.86	1.03	1.25	1.41	1.57
	2-hr	0.70	0.97	1.14	1.36	1.52	1.68	0.35	0.48	0.57	0.68	0.76	0.84
	3-hr	0.81	1.08	1.25	1.48	1.64	1.81	0.27	0.36	0.42	0.49	0.55	0.60
	6-hr	0.97	1.30	1.52	1.80	2.00	2.21	0.16	0.22	0.25	0.30	0.33	0.37
	12-hr	1.19	1.57	1.81	2.13	2.36	2.59	0.10	0.13	0.15	0.18	0.20	0.22
	24-hr	1.54	2.08	2.43	2.88	3.21	3.54	0.064	0.087	0.101	0.120	0.134	0.147

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Ismay	5-min	0.35	0.46	0.53	0.62	0.68	0.75	4.18	5.46	6.32	7.39	8.19	8.98
COOP: 244442	10-min	0.51	0.67	0.77	0.90	1.00	1.10	3.06	4.00	4.62	5.41	5.99	6.57
Elev: 2,500 ft	15-min	0.62	0.81	0.94	1.10	1.22	1.33	2.48	3.24	3.75	4.39	4.86	5.33
Modified POR: 55	20-min	0.66	0.87	1.00	1.17	1.30	1.42	1.99	2.60	3.00	3.52	3.90	4.27
Type: 2nd Order	25-min	0.70	0.92	1.07	1.25	1.38	1.52	1.69	2.21	2.56	2.99	3.32	3.64
	30-min	0.75	0.98	1.13	1.32	1.46	1.61	1.49	1.95	2.26	2.64	2.93	3.21
	35-min	0.77	1.00	1.16	1.36	1.50	1.65	1.31	1.72	1.99	2.33	2.58	2.83
	40-min	0.79	1.03	1.19	1.39	1.54	1.69	1.18	1.54	1.78	2.09	2.31	2.54
	45-min	0.81	1.05	1.22	1.43	1.58	1.73	1.08	1.41	1.63	1.90	2.11	2.31
	50-min	0.82	1.07	1.24	1.45	1.61	1.76	0.98	1.29	1.49	1.74	1.93	2.12
	55-min	0.83	1.09	1.26	1.48	1.64	1.80	0.91	1.19	1.38	1.61	1.79	1.96
	1-hr	0.85	1.11	1.28	1.50	1.66	1.83	0.85	1.11	1.28	1.50	1.66	1.83
	2-hr	0.97	1.26	1.46	1.71	1.89	2.07	0.48	0.63	0.73	0.85	0.95	1.04
	3-hr	1.05	1.35	1.55	1.80	1.99	2.17	0.35	0.45	0.52	0.60	0.66	0.72
	6-hr	1.20	1.54	1.77	2.05	2.26	2.47	0.20	0.26	0.29	0.34	0.38	0.41
	12-hr	1.41	1.87	2.18	2.57	2.86	3.15	0.12	0.16	0.18	0.21	0.24	0.26
	24-hr	1.70	2.24	2.59	3.04	3.37	3.70	0.071	0.093	0.108	0.127	0.140	0.154
Joplin	5-min	0.25	0.40	0.50	0.63	0.72	0.81	2.97	4.79	6.00	7.53	8.66	9.78
COOP: 244512	10-min	0.36	0.58	0.73	0.92	1.06	1.19	2.17	3.51	4.39	5.51	6.33	7.15
Elev: 3,323 ft	15-min	0.44	0.71	0.89	1.12	1.28	1.45	1.76	2.85	3.56	4.47	5.14	5.80
Modified POR: 47	20-min	0.47	0.76	0.95	1.19	1.37	1.55	1.41	2.28	2.85	3.58	4.12	4.65
Type: 2nd Order	25-min	0.50	0.81	1.01	1.27	1.46	1.65	1.20	1.94	2.43	3.05	3.50	3.96
	30-min	0.53	0.86	1.07	1.35	1.55	1.75	1.06	1.71	2.15	2.69	3.10	3.50
	35-min	0.55	0.88	1.10	1.38	1.59	1.80	0.94	1.51	1.89	2.37	2.72	3.08
	40-min	0.56	0.90	1.13	1.42	1.63	1.84	0.84	1.35	1.70	2.13	2.45	2.76
	45-min	0.57	0.93	1.16	1.45	1.67	1.89	0.77	1.23	1.54	1.94	2.23	2.52
	50-min	0.58	0.94	1.18	1.48	1.70	1.92	0.70	1.13	1.41	1.77	2.04	2.31
	55-min	0.59	0.96	1.20	1.50	1.73	1.95	0.65	1.05	1.31	1.64	1.89	2.13
	1-hr	0.60	0.97	1.22	1.53	1.76	1.99	0.60	0.97	1.22	1.53	1.76	1.99
	2-hr	0.71	1.10	1.36	1.68	1.92	2.16	0.36	0.55	0.68	0.84	0.96	1.08
	3-hr	0.79	1.22	1.51	1.87	2.13	2.40	0.26	0.41	0.50	0.62	0.71	0.80
	6-hr	0.98	1.42	1.70	2.07	2.34	2.60	0.16	0.24	0.28	0.34	0.39	0.43
	12-hr	1.22	1.62	1.89	2.23	2.48	2.73	0.10	0.14	0.16	0.19	0.21	0.23
	24-hr	1.49	1.95	2.25	2.63	2.91	3.19	0.062	0.081	0.094	0.110	0.121	0.133

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Kalispell Airport	5-min	0.18	0.24	0.28	0.33	0.37	0.41	2.12	2.86	3.35	3.96	4.42	4.88
COOP: 244558	10-min	0.26	0.35	0.41	0.48	0.54	0.59	1.55	2.09	2.45	2.90	3.24	3.57
Elev: 2,957 ft	15-min	0.31	0.42	0.50	0.59	0.66	0.72	1.26	1.70	1.99	2.35	2.62	2.89
Modified POR: 60	20-min	0.34	0.45	0.53	0.63	0.70	0.77	1.01	1.36	1.59	1.89	2.10	2.32
Type: 2nd Order	25-min	0.36	0.48	0.56	0.67	0.75	0.82	0.86	1.16	1.36	1.61	1.79	1.97
	30-min	0.38	0.51	0.60	0.71	0.79	0.87	0.76	1.02	1.20	1.42	1.58	1.74
	35-min	0.39	0.52	0.61	0.73	0.81	0.90	0.67	0.90	1.05	1.25	1.39	1.53
	40-min	0.40	0.54	0.63	0.75	0.83	0.92	0.60	0.81	0.95	1.12	1.25	1.38
	45-min	0.41	0.55	0.65	0.77	0.85	0.94	0.55	0.74	0.86	1.02	1.14	1.26
	50-min	0.42	0.56	0.66	0.78	0.87	0.96	0.50	0.67	0.79	0.93	1.04	1.15
	55-min	0.42	0.57	0.67	0.79	0.88	0.97	0.46	0.62	0.73	0.86	0.96	1.06
	1-hr	0.43	0.58	0.68	0.81	0.90	0.99	0.43	0.58	0.68	0.81	0.90	0.99
	2-hr	0.51	0.67	0.77	0.90	1.00	1.09	0.26	0.33	0.39	0.45	0.50	0.55
	3-hr	0.58	0.77	0.89	1.05	1.16	1.28	0.19	0.26	0.30	0.35	0.39	0.43
	6-hr	0.75	0.93	1.05	1.20	1.31	1.42	0.13	0.16	0.17	0.20	0.22	0.24
	12-hr	1.00	1.22	1.37	1.55	1.69	1.83	0.08	0.10	0.11	0.13	0.14	0.15
	24-hr	1.26	1.53	1.71	1.94	2.11	2.28	0.052	0.064	0.071	0.081	0.088	0.095
Lakeview	5-min	0.20	0.28	0.33	0.39	0.43	0.48	2.45	3.32	3.90	4.64	5.18	5.72
COOP: 244820	10-min	0.30	0.41	0.48	0.57	0.63	0.70	1.79	2.43	2.86	3.39	3.79	4.19
Elev: 6,710 ft	15-min	0.36	0.49	0.58	0.69	0.77	0.85	1.45	1.97	2.32	2.75	3.08	3.40
Modified POR: 57	20-min	0.39	0.53	0.62	0.74	0.82	0.91	1.16	1.58	1.86	2.21	2.47	2.72
Type: 2nd Order	25-min	0.41	0.56	0.66	0.78	0.87	0.97	0.99	1.35	1.58	1.88	2.10	2.32
	30-min	0.44	0.59	0.70	0.83	0.93	1.02	0.88	1.19	1.40	1.66	1.85	2.05
	35-min	0.45	0.61	0.72	0.85	0.95	1.05	0.77	1.05	1.23	1.46	1.63	1.80
	40-min	0.46	0.63	0.74	0.87	0.98	1.08	0.69	0.94	1.10	1.31	1.46	1.62
	45-min	0.47	0.64	0.75	0.90	1.00	1.11	0.63	0.86	1.01	1.19	1.33	1.47
	50-min	0.48	0.65	0.77	0.91	1.02	1.12	0.58	0.78	0.92	1.09	1.22	1.35
	55-min	0.49	0.66	0.78	0.93	1.04	1.14	0.53	0.72	0.85	1.01	1.13	1.25
	1-hr	0.50	0.68	0.79	0.94	1.05	1.16	0.50	0.68	0.79	0.94	1.05	1.16
	2-hr	0.62	0.80	0.92	1.08	1.19	1.31	0.31	0.40	0.46	0.54	0.60	0.65
	3-hr	0.70	0.88	1.00	1.16	1.27	1.38	0.23	0.29	0.33	0.39	0.42	0.46
	6-hr	0.88	1.09	1.23	1.41	1.54	1.67	0.15	0.18	0.20	0.23	0.26	0.28
	12-hr	1.11	1.33	1.48	1.66	1.79	1.93	0.09	0.11	0.12	0.14	0.15	0.16
	24-hr	1.42	1.69	1.86	2.09	2.26	2.42	0.059	0.070	0.078	0.087	0.094	0.101

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Lavina	5-min	0.25	0.34	0.40	0.47	0.52	0.58	3.00	4.05	4.74	5.62	6.26	6.91
COOP: 244904	10-min	0.37	0.49	0.58	0.68	0.76	0.84	2.20	2.96	3.47	4.11	4.58	5.05
Elev: 3,434 ft	15-min	0.45	0.60	0.70	0.83	0.93	1.03	1.78	2.40	2.81	3.33	3.72	4.10
Modified POR: 59	20-min	0.48	0.64	0.75	0.89	0.99	1.10	1.43	1.93	2.26	2.67	2.98	3.29
Type: 2nd Order	25-min	0.51	0.68	0.80	0.95	1.06	1.17	1.22	1.64	1.92	2.27	2.54	2.80
	30-min	0.54	0.72	0.85	1.00	1.12	1.24	1.07	1.45	1.70	2.01	2.24	2.47
	35-min	0.55	0.74	0.87	1.03	1.15	1.27	0.95	1.27	1.49	1.77	1.97	2.17
	40-min	0.57	0.76	0.89	1.06	1.18	1.30	0.85	1.14	1.34	1.59	1.77	1.95
	45-min	0.58	0.78	0.92	1.08	1.21	1.33	0.77	1.04	1.22	1.45	1.61	1.78
	50-min	0.59	0.80	0.93	1.10	1.23	1.36	0.71	0.95	1.12	1.32	1.48	1.63
	55-min	0.60	0.81	0.95	1.12	1.25	1.38	0.66	0.88	1.03	1.22	1.37	1.51
	1-hr	0.61	0.82	0.96	1.14	1.27	1.40	0.61	0.82	0.96	1.14	1.27	1.40
	2-hr	0.68	0.89	1.03	1.21	1.34	1.47	0.34	0.45	0.52	0.60	0.67	0.74
	3-hr	0.75	0.98	1.14	1.34	1.49	1.64	0.25	0.33	0.38	0.45	0.50	0.55
	6-hr	0.93	1.26	1.48	1.75	1.95	2.15	0.16	0.21	0.25	0.29	0.33	0.36
	12-hr	1.13	1.61	1.93	2.33	2.63	2.92	0.09	0.13	0.16	0.19	0.22	0.24
	24-hr	1.34	1.97	2.38	2.91	3.30	3.69	0.056	0.082	0.099	0.121	0.137	0.154
Lewistown-2SW	5-min	0.27	0.34	0.39	0.46	0.50	0.55	3.21	4.12	4.73	5.49	6.06	6.62
COOP: 244983	10-min	0.39	0.50	0.58	0.67	0.74	0.81	2.35	3.02	3.46	4.02	4.43	4.84
Elev: 4,100 ft	15-min	0.48	0.61	0.70	0.81	0.90	0.98	1.91	2.45	2.81	3.26	3.59	3.93
Modified POR: 42	20-min	0.51	0.65	0.75	0.87	0.96	1.05	1.53	1.96	2.25	2.61	2.88	3.15
Type: 2nd Order	25-min	0.54	0.70	0.80	0.93	1.02	1.12	1.30	1.67	1.91	2.22	2.45	2.68
	30-min	0.57	0.74	0.85	0.98	1.08	1.18	1.15	1.48	1.69	1.96	2.17	2.37
	35-min	0.59	0.76	0.87	1.01	1.11	1.21	1.01	1.30	1.49	1.73	1.91	2.08
	40-min	0.61	0.78	0.89	1.03	1.14	1.25	0.91	1.17	1.34	1.55	1.71	1.87
	45-min	0.62	0.80	0.91	1.06	1.17	1.28	0.83	1.06	1.22	1.41	1.56	1.70
	50-min	0.63	0.81	0.93	1.08	1.19	1.30	0.76	0.97	1.11	1.29	1.43	1.56
	55-min	0.64	0.82	0.94	1.10	1.21	1.32	0.70	0.90	1.03	1.20	1.32	1.44
	1-hr	0.65	0.84	0.96	1.12	1.23	1.34	0.65	0.84	0.96	1.12	1.23	1.34
	2-hr	0.77	1.03	1.20	1.41	1.57	1.73	0.38	0.51	0.60	0.71	0.78	0.86
	3-hr	0.87	1.14	1.33	1.56	1.73	1.90	0.29	0.38	0.44	0.52	0.58	0.63
	6-hr	1.05	1.38	1.59	1.87	2.07	2.27	0.18	0.23	0.27	0.31	0.35	0.38
	12-hr	1.31	1.75	2.03	2.40	2.67	2.93	0.11	0.15	0.17	0.20	0.22	0.24
	24-hr	1.71	2.30	2.68	3.17	3.54	3.90	0.071	0.096	0.112	0.132	0.147	0.162

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Libby RS-1NE	5-min	0.17	0.25	0.30	0.36	0.41	0.46	2.08	2.99	3.60	4.36	4.92	5.48
COOP: 245015	10-min	0.25	0.37	0.44	0.53	0.60	0.67	1.52	2.19	2.63	3.19	3.60	4.01
Elev: 2,096 ft	15-min	0.31	0.44	0.53	0.65	0.73	0.81	1.24	1.78	2.13	2.59	2.92	3.25
Modified POR: 55	20-min	0.33	0.47	0.57	0.69	0.78	0.87	0.99	1.42	1.71	2.07	2.34	2.61
Type: 2nd Order	25-min	0.35	0.50	0.61	0.74	0.83	0.93	0.84	1.21	1.46	1.76	1.99	2.22
	30-min	0.37	0.54	0.64	0.78	0.88	0.98	0.75	1.07	1.29	1.56	1.76	1.96
	35-min	0.38	0.55	0.66	0.80	0.90	1.01	0.66	0.94	1.13	1.37	1.55	1.73
	40-min	0.39	0.56	0.68	0.82	0.93	1.03	0.59	0.85	1.02	1.23	1.39	1.55
	45-min	0.40	0.58	0.69	0.84	0.95	1.06	0.54	0.77	0.93	1.12	1.27	1.41
	50-min	0.41	0.59	0.71	0.86	0.97	1.08	0.49	0.71	0.85	1.03	1.16	1.29
	55-min	0.42	0.60	0.72	0.87	0.98	1.10	0.45	0.65	0.78	0.95	1.07	1.20
	1-hr	0.42	0.61	0.73	0.89	1.00	1.11	0.42	0.61	0.73	0.89	1.00	1.11
	2-hr	0.51	0.70	0.83	0.99	1.10	1.22	0.26	0.35	0.41	0.49	0.55	0.61
	3-hr	0.59	0.77	0.89	1.05	1.16	1.28	0.20	0.26	0.30	0.35	0.39	0.43
	6-hr	0.74	1.04	1.24	1.49	1.68	1.86	0.12	0.17	0.21	0.25	0.28	0.31
	12-hr	0.89	1.23	1.46	1.74	1.95	2.16	0.07	0.10	0.12	0.15	0.16	0.18
	24-hr	1.06	1.46	1.72	2.05	2.30	2.54	0.044	0.061	0.072	0.085	0.096	0.106
Lima	5-min	0.18	0.24	0.28	0.33	0.36	0.40	2.18	2.88	3.34	3.93	4.37	4.80
COOP: 245030	10-min	0.27	0.35	0.41	0.48	0.53	0.58	1.60	2.11	2.45	2.88	3.19	3.51
Elev: 6,279 ft	15-min	0.32	0.43	0.50	0.58	0.65	0.71	1.29	1.71	1.98	2.33	2.59	2.85
Modified POR: 53	20-min	0.35	0.46	0.53	0.62	0.69	0.76	1.04	1.37	1.59	1.87	2.08	2.28
Type: 2nd Order	25-min	0.37	0.49	0.56	0.66	0.74	0.81	0.88	1.17	1.35	1.59	1.77	1.94
	30-min	0.39	0.52	0.60	0.70	0.78	0.86	0.78	1.03	1.20	1.41	1.56	1.72
	35-min	0.40	0.53	0.61	0.72	0.80	0.88	0.69	0.91	1.05	1.24	1.37	1.51
	40-min	0.41	0.54	0.63	0.74	0.82	0.90	0.62	0.81	0.94	1.11	1.23	1.36
	45-min	0.42	0.56	0.65	0.76	0.84	0.93	0.56	0.74	0.86	1.01	1.12	1.23
	50-min	0.43	0.57	0.66	0.77	0.86	0.94	0.51	0.68	0.79	0.93	1.03	1.13
	55-min	0.44	0.58	0.67	0.79	0.87	0.96	0.48	0.63	0.73	0.86	0.95	1.05
	1-hr	0.44	0.59	0.68	0.80	0.89	0.97	0.44	0.59	0.68	0.80	0.89	0.97
	2-hr	0.52	0.65	0.74	0.86	0.94	1.02	0.26	0.33	0.37	0.43	0.47	0.51
	3-hr	0.58	0.71	0.80	0.91	0.99	1.07	0.19	0.24	0.27	0.30	0.33	0.36
	6-hr	0.69	0.82	0.90	1.01	1.09	1.17	0.12	0.14	0.15	0.17	0.18	0.19
	12-hr	0.86	1.07	1.20	1.37	1.49	1.61	0.07	0.09	0.10	0.11	0.12	0.13
	24-hr	1.07	1.30	1.46	1.66	1.80	1.95	0.044	0.054	0.061	0.069	0.075	0.081

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Lincoln RS	5-min	0.20	0.27	0.32	0.37	0.42	0.46	2.40	3.23	3.79	4.48	5.00	5.51
COOP: 245040	10-min	0.29	0.39	0.46	0.55	0.61	0.67	1.76	2.37	2.77	3.28	3.66	4.03
Elev: 4,575 ft	15-min	0.36	0.48	0.56	0.67	0.74	0.82	1.43	1.92	2.25	2.66	2.97	3.27
Modified POR: 26	20-min	0.38	0.51	0.60	0.71	0.79	0.87	1.14	1.54	1.80	2.13	2.38	2.62
Type: 2nd Order	25-min	0.41	0.55	0.64	0.76	0.84	0.93	0.97	1.31	1.53	1.81	2.02	2.23
	30-min	0.43	0.58	0.68	0.80	0.89	0.99	0.86	1.16	1.35	1.60	1.79	1.97
	35-min	0.44	0.59	0.70	0.82	0.92	1.01	0.76	1.02	1.19	1.41	1.57	1.73
	40-min	0.45	0.61	0.71	0.84	0.94	1.04	0.68	0.91	1.07	1.27	1.41	1.56
	45-min	0.46	0.62	0.73	0.87	0.97	1.06	0.62	0.83	0.97	1.15	1.29	1.42
	50-min	0.47	0.64	0.74	0.88	0.98	1.08	0.57	0.76	0.89	1.06	1.18	1.30
	55-min	0.48	0.65	0.76	0.90	1.00	1.10	0.52	0.71	0.83	0.98	1.09	1.20
	1-hr	0.49	0.66	0.77	0.91	1.02	1.12	0.49	0.66	0.77	0.91	1.02	1.12
	2-hr	0.55	0.71	0.82	0.96	1.06	1.16	0.28	0.36	0.41	0.48	0.53	0.58
	3-hr	0.60	0.76	0.86	0.99	1.08	1.18	0.20	0.25	0.29	0.33	0.36	0.39
	6-hr	0.75	0.90	1.00	1.13	1.22	1.32	0.12	0.15	0.17	0.19	0.20	0.22
	12-hr	0.98	1.23	1.41	1.62	1.78	1.94	0.08	0.10	0.12	0.14	0.15	0.16
	24-hr	1.24	1.65	1.93	2.27	2.53	2.78	0.052	0.069	0.080	0.095	0.105	0.116
Livingston Airport	5-min	0.19	0.29	0.36	0.45	0.51	0.58	2.28	3.52	4.34	5.37	6.14	6.90
COOP: 245086	10-min	0.28	0.43	0.53	0.65	0.75	0.84	1.67	2.57	3.17	3.93	4.49	5.05
Elev: 4,643 ft	15-min	0.34	0.52	0.64	0.80	0.91	1.02	1.35	2.09	2.57	3.19	3.64	4.10
Modified POR: 64	20-min	0.36	0.56	0.69	0.85	0.97	1.09	1.08	1.67	2.06	2.55	2.92	3.28
Type: 2nd Order	25-min	0.38	0.59	0.73	0.91	1.04	1.16	0.92	1.42	1.76	2.17	2.49	2.79
	30-min	0.41	0.63	0.78	0.96	1.10	1.23	0.81	1.26	1.55	1.92	2.20	2.47
	35-min	0.42	0.65	0.80	0.99	1.13	1.27	0.72	1.11	1.36	1.69	1.93	2.17
	40-min	0.43	0.66	0.82	1.01	1.16	1.30	0.64	0.99	1.22	1.52	1.73	1.95
	45-min	0.44	0.68	0.84	1.04	1.19	1.33	0.59	0.91	1.12	1.38	1.58	1.78
	50-min	0.45	0.69	0.85	1.06	1.21	1.36	0.54	0.83	1.02	1.27	1.45	1.63
	55-min	0.46	0.70	0.87	1.07	1.23	1.38	0.50	0.77	0.95	1.17	1.34	1.50
	1-hr	0.46	0.71	0.88	1.09	1.25	1.40	0.46	0.71	0.88	1.09	1.25	1.40
	2-hr	0.56	0.79	0.94	1.13	1.28	1.42	0.28	0.39	0.47	0.57	0.64	0.71
	3-hr	0.66	0.89	1.04	1.24	1.38	1.53	0.22	0.30	0.35	0.41	0.46	0.51
	6-hr	0.86	1.08	1.23	1.42	1.55	1.69	0.14	0.18	0.20	0.24	0.26	0.28
	12-hr	1.07	1.38	1.57	1.83	2.01	2.20	0.09	0.11	0.13	0.15	0.17	0.18
	24-hr	1.34	1.74	2.01	2.35	2.60	2.84	0.056	0.073	0.084	0.098	0.108	0.119

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Lodge Grass	5-min	0.26	0.37	0.44	0.53	0.59	0.66	3.13	4.41	5.26	6.34	7.13	7.92
COOP: 245106	10-min	0.38	0.54	0.64	0.77	0.87	0.97	2.29	3.23	3.85	4.64	5.22	5.80
Elev: 3,360 ft	15-min	0.46	0.65	0.78	0.94	1.06	1.18	1.86	2.62	3.12	3.76	4.23	4.70
Modified POR: 49	20-min	0.50	0.70	0.83	1.00	1.13	1.26	1.49	2.10	2.50	3.01	3.39	3.77
Type: 2nd Order	25-min	0.53	0.74	0.89	1.07	1.20	1.34	1.27	1.79	2.13	2.57	2.89	3.21
	30-min	0.56	0.79	0.94	1.13	1.28	1.42	1.12	1.58	1.88	2.27	2.55	2.83
	35-min	0.57	0.81	0.97	1.16	1.31	1.46	0.98	1.39	1.66	1.99	2.25	2.49
	40-min	0.59	0.83	0.99	1.19	1.34	1.49	0.88	1.25	1.49	1.79	2.02	2.24
	45-min	0.60	0.85	1.02	1.22	1.38	1.53	0.81	1.14	1.35	1.63	1.84	2.04
	50-min	0.61	0.87	1.03	1.25	1.40	1.56	0.74	1.04	1.24	1.49	1.68	1.87
	55-min	0.63	0.88	1.05	1.27	1.43	1.58	0.68	0.96	1.15	1.38	1.56	1.73
	1-hr	0.64	0.90	1.07	1.29	1.45	1.61	0.64	0.90	1.07	1.29	1.45	1.61
	2-hr	0.70	0.99	1.18	1.42	1.60	1.78	0.35	0.50	0.59	0.71	0.80	0.89
	3-hr	0.77	1.06	1.25	1.49	1.67	1.85	0.26	0.35	0.42	0.50	0.56	0.62
	6-hr	0.96	1.31	1.54	1.83	2.04	2.26	0.16	0.22	0.26	0.30	0.34	0.38
	12-hr	1.26	1.66	1.94	2.28	2.53	2.78	0.10	0.14	0.16	0.19	0.21	0.23
	24-hr	1.62	2.02	2.28	2.62	2.87	3.12	0.067	0.084	0.095	0.109	0.120	0.130
Logan-2W	5-min	0.21	0.28	0.32	0.37	0.41	0.45	2.53	3.31	3.83	4.48	4.96	5.45
COOP: 245122	10-min	0.31	0.40	0.47	0.55	0.61	0.66	1.85	2.42	2.80	3.28	3.63	3.99
Elev: 4,089 ft	15-min	0.37	0.49	0.57	0.66	0.74	0.81	1.50	1.96	2.27	2.66	2.95	3.23
Modified POR: 33	20-min	0.40	0.52	0.61	0.71	0.79	0.86	1.20	1.57	1.82	2.13	2.36	2.59
Type: 2nd Order	25-min	0.43	0.56	0.65	0.76	0.84	0.92	1.02	1.34	1.55	1.81	2.01	2.21
	30-min	0.45	0.59	0.68	0.80	0.89	0.97	0.90	1.18	1.37	1.60	1.78	1.95
	35-min	0.46	0.61	0.70	0.82	0.91	1.00	0.80	1.04	1.20	1.41	1.56	1.71
	40-min	0.48	0.62	0.72	0.84	0.94	1.03	0.71	0.93	1.08	1.27	1.40	1.54
	45-min	0.49	0.64	0.74	0.86	0.96	1.05	0.65	0.85	0.98	1.15	1.28	1.40
	50-min	0.50	0.65	0.75	0.88	0.98	1.07	0.60	0.78	0.90	1.06	1.17	1.28
	55-min	0.50	0.66	0.76	0.90	0.99	1.09	0.55	0.72	0.83	0.98	1.08	1.19
	1-hr	0.51	0.67	0.78	0.91	1.01	1.11	0.51	0.67	0.78	0.91	1.01	1.11
	2-hr	0.58	0.72	0.82	0.94	1.03	1.12	0.29	0.36	0.41	0.47	0.52	0.56
	3-hr	0.63	0.78	0.89	1.02	1.11	1.21	0.21	0.26	0.30	0.34	0.37	0.40
	6-hr	0.76	0.91	1.01	1.13	1.23	1.32	0.13	0.15	0.17	0.19	0.20	0.22
	12-hr	0.98	1.15	1.26	1.40	1.51	1.61	0.08	0.10	0.11	0.12	0.13	0.13
	24-hr	1.22	1.45	1.60	1.78	1.92	2.06	0.051	0.060	0.066	0.074	0.080	0.086

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Lolo Hot Springs-2NE	5-min	0.18	0.26	0.32	0.39	0.45	0.50	2.13	3.17	3.86	4.74	5.39	6.03
COOP: 245146	10-min	0.26	0.39	0.47	0.58	0.66	0.74	1.56	2.32	2.83	3.47	3.94	4.41
Elev: 4,055 ft	15-min	0.32	0.47	0.57	0.70	0.80	0.89	1.26	1.88	2.29	2.81	3.20	3.58
Modified POR: 29	20-min	0.34	0.50	0.61	0.75	0.85	0.96	1.01	1.51	1.84	2.25	2.56	2.87
Type: 2nd Order	25-min	0.36	0.53	0.65	0.80	0.91	1.02	0.86	1.28	1.56	1.92	2.18	2.44
	30-min	0.38	0.57	0.69	0.85	0.96	1.08	0.76	1.13	1.38	1.69	1.93	2.16
	35-min	0.39	0.58	0.71	0.87	0.99	1.11	0.67	1.00	1.22	1.49	1.70	1.90
	40-min	0.40	0.60	0.73	0.89	1.01	1.14	0.60	0.90	1.09	1.34	1.52	1.70
	45-min	0.41	0.61	0.75	0.91	1.04	1.16	0.55	0.82	0.99	1.22	1.39	1.55
	50-min	0.42	0.62	0.76	0.93	1.06	1.18	0.50	0.75	0.91	1.12	1.27	1.42
	55-min	0.42	0.63	0.77	0.95	1.08	1.21	0.46	0.69	0.84	1.03	1.17	1.31
	1-hr	0.43	0.64	0.79	0.96	1.09	1.23	0.43	0.64	0.79	0.96	1.09	1.23
	2-hr	0.52	0.76	0.92	1.12	1.27	1.42	0.26	0.38	0.46	0.56	0.64	0.71
	3-hr	0.60	0.82	0.97	1.16	1.30	1.44	0.20	0.27	0.32	0.39	0.43	0.48
	6-hr	0.75	0.97	1.11	1.28	1.42	1.55	0.13	0.16	0.18	0.21	0.24	0.26
	12-hr	0.97	1.25	1.43	1.66	1.83	2.00	0.08	0.10	0.12	0.14	0.15	0.17
	24-hr	1.22	1.52	1.72	1.97	2.16	2.35	0.051	0.063	0.072	0.082	0.090	0.098
Martinsdale-3NNW	5-min	0.23	0.33	0.40	0.48	0.54	0.61	2.74	3.96	4.77	5.78	6.54	7.29
COOP: 245387	10-min	0.33	0.48	0.58	0.71	0.80	0.89	2.01	2.90	3.49	4.23	4.78	5.33
Elev: 4,800 ft	15-min	0.41	0.59	0.71	0.86	0.97	1.08	1.63	2.35	2.83	3.43	3.88	4.32
Modified POR: 60	20-min	0.44	0.63	0.76	0.92	1.04	1.16	1.31	1.88	2.27	2.75	3.11	3.47
Type: 2nd Order	25-min	0.46	0.67	0.80	0.98	1.10	1.23	1.11	1.60	1.93	2.34	2.65	2.95
	30-min	0.49	0.71	0.85	1.03	1.17	1.30	0.98	1.42	1.70	2.07	2.34	2.61
	35-min	0.50	0.73	0.87	1.06	1.20	1.34	0.86	1.25	1.50	1.82	2.06	2.29
	40-min	0.52	0.75	0.90	1.09	1.23	1.37	0.78	1.12	1.35	1.63	1.85	2.06
	45-min	0.53	0.76	0.92	1.12	1.26	1.41	0.71	1.02	1.23	1.49	1.68	1.88
	50-min	0.54	0.78	0.94	1.14	1.28	1.43	0.65	0.93	1.12	1.36	1.54	1.72
	55-min	0.55	0.79	0.95	1.16	1.31	1.46	0.60	0.86	1.04	1.26	1.43	1.59
	1-hr	0.56	0.80	0.97	1.18	1.33	1.48	0.56	0.80	0.97	1.18	1.33	1.48
	2-hr	0.65	0.89	1.05	1.25	1.40	1.55	0.32	0.45	0.53	0.63	0.70	0.78
	3-hr	0.74	1.00	1.17	1.39	1.56	1.72	0.25	0.33	0.39	0.46	0.52	0.57
	6-hr	0.88	1.12	1.28	1.48	1.63	1.77	0.15	0.19	0.21	0.25	0.27	0.30
	12-hr	1.12	1.37	1.54	1.75	1.90	2.06	0.09	0.11	0.13	0.15	0.16	0.17
	24-hr	1.35	1.65	1.85	2.10	2.29	2.48	0.056	0.069	0.077	0.088	0.096	0.103

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Miles City COOP: 245685/245690 Elev: 2,392 ft Modified POR: 40 Type: 2nd Order *Note: Frequency analysis for this weather station is based on the combined periods of another with non-overlapping records.*	5-min	0.30	0.41	0.49	0.59	0.67	0.75	3.64	4.95	5.84	7.08	8.05	9.00
	10-min	0.44	0.60	0.71	0.86	0.98	1.10	2.66	3.63	4.28	5.18	5.89	6.59
	15-min	0.54	0.74	0.87	1.05	1.19	1.34	2.16	2.94	3.47	4.20	4.78	5.34
	20-min	0.58	0.79	0.93	1.12	1.28	1.43	1.73	2.36	2.78	3.37	3.83	4.28
	25-min	0.61	0.84	0.99	1.19	1.36	1.52	1.47	2.01	2.37	2.87	3.26	3.64
	30-min	0.65	0.89	1.05	1.27	1.44	1.61	1.30	1.77	2.09	2.53	2.88	3.22
	35-min	0.67	0.91	1.07	1.30	1.48	1.65	1.15	1.56	1.84	2.23	2.53	2.83
	40-min	0.69	0.93	1.10	1.33	1.52	1.70	1.03	1.40	1.65	2.00	2.27	2.54
	45-min	0.70	0.96	1.13	1.37	1.55	1.74	0.94	1.28	1.50	1.82	2.07	2.32
	50-min	0.72	0.97	1.15	1.39	1.58	1.77	0.86	1.17	1.38	1.67	1.90	2.12
	2-hr	0.88	1.21	1.43	1.74	1.98	2.22	0.44	0.60	0.72	0.87	0.99	1.11
	3-hr	0.95	1.29	1.52	1.85	2.10	2.35	0.32	0.43	0.51	0.62	0.70	0.78
	6-hr	1.14	1.46	1.68	1.99	2.23	2.48	0.19	0.24	0.28	0.33	0.37	0.41
	12-hr	1.30	1.68	1.94	2.30	2.59	2.88	0.11	0.14	0.16	0.19	0.22	0.24
	24-hr	1.60	2.04	2.34	2.77	3.11	3.44	0.067	0.085	0.097	0.115	0.130	0.144
Millegan COOP: 245706 Elev: 4,500 ft Modified POR: 65 Type: 2nd Order	5-min	0.21	0.31	0.37	0.45	0.51	0.56	2.58	3.70	4.44	5.38	6.08	6.77
	10-min	0.31	0.45	0.54	0.66	0.74	0.83	1.89	2.71	3.25	3.94	4.45	4.95
	15-min	0.38	0.55	0.66	0.80	0.90	1.00	1.53	2.20	2.64	3.19	3.61	4.02
	20-min	0.41	0.59	0.70	0.85	0.96	1.07	1.23	1.76	2.11	2.56	2.89	3.22
	25-min	0.44	0.62	0.75	0.91	1.03	1.14	1.04	1.50	1.80	2.18	2.46	2.74
	30-min	0.46	0.66	0.79	0.96	1.09	1.21	0.92	1.32	1.59	1.93	2.17	2.42
	35-min	0.47	0.68	0.82	0.99	1.12	1.24	0.81	1.16	1.40	1.69	1.91	2.13
	40-min	0.49	0.70	0.84	1.01	1.14	1.28	0.73	1.05	1.26	1.52	1.72	1.91
	45-min	0.50	0.71	0.86	1.04	1.17	1.31	0.66	0.95	1.14	1.39	1.57	1.74
	50-min	0.51	0.73	0.87	1.06	1.19	1.33	0.61	0.87	1.05	1.27	1.43	1.60
	55-min	0.52	0.74	0.89	1.08	1.21	1.35	0.56	0.81	0.97	1.17	1.33	1.48
	1-hr	0.52	0.75	0.90	1.09	1.24	1.38	0.52	0.75	0.90	1.09	1.24	1.38
	2-hr	0.64	0.88	1.03	1.22	1.37	1.51	0.32	0.44	0.51	0.61	0.68	0.75
	3-hr	0.75	0.97	1.12	1.31	1.45	1.59	0.25	0.32	0.37	0.44	0.48	0.53
	6-hr	1.00	1.26	1.44	1.67	1.83	2.00	0.17	0.21	0.24	0.28	0.31	0.33
	12-hr	1.30	1.67	1.91	2.22	2.45	2.68	0.11	0.14	0.16	0.19	0.20	0.22
	24-hr	1.68	2.24	2.60	3.07	3.41	3.75	0.070	0.093	0.108	0.128	0.142	0.156

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Missoula Airport	5-min	0.17	0.25	0.31	0.38	0.44	0.50	2.07	3.04	3.68	4.57	5.27	5.97
COOP: 245745	10-min	0.24	0.35	0.43	0.53	0.61	0.69	1.45	2.12	2.57	3.18	3.65	4.11
Elev: 3,192 ft	15-min	0.28	0.41	0.50	0.62	0.71	0.80	1.13	1.65	2.00	2.47	2.83	3.18
Modified POR: 64	20-min	0.31	0.45	0.55	0.68	0.78	0.87	0.93	1.36	1.65	2.03	2.33	2.62
Type: 1st Order	25-min	0.33	0.49	0.59	0.73	0.83	0.93	0.80	1.17	1.41	1.74	1.99	2.24
	30-min	0.35	0.51	0.62	0.76	0.87	0.98	0.70	1.03	1.24	1.53	1.75	1.97
	35-min	0.37	0.54	0.65	0.80	0.91	1.03	0.63	0.92	1.11	1.37	1.56	1.76
	40-min	0.38	0.56	0.67	0.83	0.94	1.06	0.57	0.83	1.01	1.24	1.42	1.59
	45-min	0.39	0.57	0.69	0.85	0.97	1.09	0.52	0.76	0.92	1.14	1.30	1.46
	50-min	0.40	0.59	0.71	0.87	1.00	1.12	0.48	0.71	0.85	1.05	1.20	1.35
	55-min	0.41	0.60	0.73	0.89	1.01	1.13	0.45	0.66	0.79	0.97	1.10	1.23
	1-hr	0.42	0.61	0.74	0.90	1.02	1.14	0.42	0.61	0.74	0.90	1.02	1.14
	2-hr	0.53	0.72	0.85	1.01	1.13	1.25	0.26	0.36	0.42	0.51	0.57	0.63
	3-hr	0.61	0.81	0.94	1.11	1.23	1.36	0.20	0.27	0.31	0.37	0.41	0.45
	6-hr	0.77	0.98	1.11	1.28	1.41	1.53	0.13	0.16	0.19	0.21	0.23	0.26
	12-hr	0.95	1.20	1.36	1.56	1.72	1.87	0.08	0.10	0.11	0.13	0.14	0.16
	24-hr	1.17	1.47	1.66	1.91	2.09	2.28	0.049	0.061	0.069	0.080	0.087	0.095
Molt-6SW	5-min	0.24	0.38	0.46	0.57	0.66	0.74	2.92	4.51	5.56	6.89	7.87	8.85
COOP: 245791	10-min	0.36	0.55	0.68	0.84	0.96	1.08	2.14	3.30	4.07	5.04	5.76	6.47
Elev: 4,000 ft	15-min	0.43	0.67	0.82	1.02	1.17	1.31	1.74	2.68	3.30	4.09	4.67	5.25
Modified POR: 58	20-min	0.46	0.72	0.88	1.09	1.25	1.40	1.39	2.15	2.64	3.28	3.74	4.21
Type: 2nd Order	25-min	0.49	0.76	0.94	1.16	1.33	1.49	1.18	1.83	2.25	2.79	3.19	3.58
	30-min	0.52	0.81	0.99	1.23	1.41	1.58	1.05	1.61	1.99	2.46	2.82	3.16
	35-min	0.54	0.83	1.02	1.26	1.44	1.62	0.92	1.42	1.75	2.17	2.48	2.78
	40-min	0.55	0.85	1.05	1.30	1.48	1.67	0.83	1.27	1.57	1.95	2.22	2.50
	45-min	0.56	0.87	1.07	1.33	1.52	1.71	0.75	1.16	1.43	1.77	2.03	2.28
	50-min	0.57	0.89	1.09	1.35	1.55	1.74	0.69	1.06	1.31	1.62	1.86	2.09
	55-min	0.58	0.90	1.11	1.38	1.57	1.77	0.64	0.98	1.21	1.50	1.72	1.93
	1-hr	0.59	0.92	1.13	1.40	1.60	1.80	0.59	0.92	1.13	1.40	1.60	1.80
	2-hr	0.68	1.01	1.23	1.50	1.70	1.91	0.34	0.51	0.61	0.75	0.85	0.95
	3-hr	0.75	1.08	1.30	1.58	1.79	2.00	0.25	0.36	0.43	0.53	0.60	0.67
	6-hr	0.96	1.28	1.48	1.75	1.94	2.14	0.16	0.21	0.25	0.29	0.32	0.36
	12-hr	1.18	1.53	1.76	2.06	2.28	2.50	0.10	0.13	0.15	0.17	0.19	0.21
	24-hr	1.45	1.87	2.15	2.50	2.76	3.01	0.060	0.078	0.089	0.104	0.115	0.126

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Neihart-8NNW	5-min	0.23	0.32	0.38	0.45	0.51	0.56	2.81	3.85	4.55	5.42	6.07	6.72
COOP: 246008	10-min	0.34	0.47	0.55	0.66	0.74	0.82	2.05	2.82	3.33	3.97	4.44	4.92
Elev: 5,230 ft	15-min	0.42	0.57	0.67	0.80	0.90	1.00	1.66	2.29	2.70	3.22	3.60	3.99
Modified POR: 41	20-min	0.44	0.61	0.72	0.86	0.96	1.07	1.33	1.83	2.16	2.58	2.89	3.20
Type: 2nd Order	25-min	0.47	0.65	0.77	0.91	1.02	1.13	1.14	1.56	1.84	2.20	2.46	2.72
	30-min	0.50	0.69	0.81	0.97	1.09	1.20	1.00	1.38	1.63	1.94	2.17	2.40
	35-min	0.52	0.71	0.83	1.00	1.12	1.23	0.88	1.21	1.43	1.71	1.91	2.11
	40-min	0.53	0.73	0.86	1.02	1.14	1.27	0.79	1.09	1.28	1.53	1.72	1.90
	45-min	0.54	0.74	0.88	1.05	1.17	1.30	0.72	0.99	1.17	1.40	1.56	1.73
	50-min	0.55	0.76	0.89	1.07	1.19	1.32	0.66	0.91	1.07	1.28	1.43	1.58
	55-min	0.56	0.77	0.91	1.08	1.21	1.34	0.61	0.84	0.99	1.18	1.32	1.47
	1-hr	0.57	0.78	0.92	1.10	1.23	1.37	0.57	0.78	0.92	1.10	1.23	1.37
	2-hr	0.69	0.92	1.07	1.27	1.41	1.56	0.34	0.46	0.54	0.63	0.71	0.78
	3-hr	0.78	1.02	1.17	1.37	1.52	1.66	0.26	0.34	0.39	0.46	0.51	0.55
	6-hr	1.04	1.28	1.43	1.62	1.77	1.91	0.17	0.21	0.24	0.27	0.29	0.32
	12-hr	1.45	1.79	2.02	2.30	2.52	2.73	0.12	0.15	0.17	0.19	0.21	0.23
	24-hr	1.92	2.42	2.76	3.18	3.50	3.81	0.080	0.101	0.115	0.133	0.146	0.159
Ovando	5-min	0.19	0.26	0.31	0.37	0.41	0.46	2.26	3.12	3.69	4.41	4.95	5.48
COOP: 246302	10-min	0.28	0.38	0.45	0.54	0.60	0.67	1.65	2.28	2.70	3.23	3.62	4.01
Elev: 4,109 ft	15-min	0.34	0.46	0.55	0.65	0.73	0.81	1.34	1.85	2.19	2.62	2.94	3.25
Modified POR: 36	20-min	0.36	0.49	0.59	0.70	0.78	0.87	1.08	1.48	1.76	2.10	2.35	2.61
Type: 2nd Order	25-min	0.38	0.53	0.62	0.74	0.83	0.92	0.92	1.26	1.49	1.79	2.00	2.22
	30-min	0.40	0.56	0.66	0.79	0.88	0.98	0.81	1.12	1.32	1.58	1.77	1.96
	35-min	0.42	0.57	0.68	0.81	0.91	1.01	0.71	0.98	1.16	1.39	1.56	1.72
	40-min	0.43	0.59	0.70	0.83	0.93	1.03	0.64	0.88	1.04	1.25	1.40	1.55
	45-min	0.44	0.60	0.71	0.85	0.96	1.06	0.58	0.80	0.95	1.14	1.27	1.41
	50-min	0.44	0.61	0.73	0.87	0.97	1.08	0.53	0.74	0.87	1.04	1.17	1.29
	55-min	0.45	0.62	0.74	0.88	0.99	1.09	0.49	0.68	0.81	0.96	1.08	1.19
	1-hr	0.46	0.63	0.75	0.90	1.01	1.11	0.46	0.63	0.75	0.90	1.01	1.11
	2-hr	0.53	0.77	0.93	1.13	1.28	1.42	0.27	0.39	0.46	0.56	0.64	0.71
	3-hr	0.59	0.82	0.97	1.17	1.31	1.46	0.20	0.27	0.32	0.39	0.44	0.49
	6-hr	0.71	0.95	1.11	1.32	1.46	1.61	0.12	0.16	0.19	0.22	0.24	0.27
	12-hr	0.93	1.16	1.31	1.50	1.64	1.78	0.08	0.10	0.11	0.13	0.14	0.15
	24-hr	1.10	1.32	1.47	1.66	1.80	1.94	0.046	0.055	0.061	0.069	0.075	0.081

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Philipsburg RS	5-min	0.18	0.23	0.27	0.31	0.35	0.38	2.11	2.76	3.19	3.74	4.14	4.55
COOP: 246472	10-min	0.26	0.34	0.39	0.46	0.51	0.55	1.54	2.02	2.34	2.74	3.03	3.33
Elev: 5,270 ft	15-min	0.31	0.41	0.47	0.55	0.61	0.67	1.25	1.64	1.89	2.22	2.46	2.70
Modified POR: 29	20-min	0.33	0.44	0.51	0.59	0.66	0.72	1.00	1.31	1.52	1.78	1.97	2.16
Type: 2nd Order	25-min	0.36	0.47	0.54	0.63	0.70	0.77	0.85	1.12	1.29	1.51	1.68	1.84
	30-min	0.38	0.49	0.57	0.67	0.74	0.81	0.75	0.99	1.14	1.34	1.48	1.63
	35-min	0.39	0.51	0.59	0.69	0.76	0.83	0.66	0.87	1.00	1.18	1.30	1.43
	40-min	0.40	0.52	0.60	0.70	0.78	0.86	0.60	0.78	0.90	1.06	1.17	1.28
	45-min	0.41	0.53	0.62	0.72	0.80	0.88	0.54	0.71	0.82	0.96	1.07	1.17
	50-min	0.41	0.54	0.63	0.73	0.81	0.89	0.50	0.65	0.75	0.88	0.98	1.07
	55-min	0.42	0.55	0.64	0.75	0.83	0.91	0.46	0.60	0.70	0.82	0.90	0.99
	1-hr	0.43	0.56	0.65	0.76	0.84	0.92	0.43	0.56	0.65	0.76	0.84	0.92
	2-hr	0.54	0.67	0.76	0.88	0.96	1.05	0.27	0.34	0.38	0.44	0.48	0.52
	3-hr	0.61	0.73	0.81	0.90	0.98	1.05	0.20	0.24	0.27	0.30	0.33	0.35
	6-hr	0.76	0.91	1.01	1.14	1.23	1.32	0.13	0.15	0.17	0.19	0.20	0.22
	12-hr	1.03	1.31	1.50	1.73	1.90	2.07	0.09	0.11	0.12	0.14	0.16	0.17
	24-hr	1.31	1.68	1.93	2.23	2.46	2.69	0.055	0.070	0.080	0.093	0.103	0.112
Plains RS	5-min	0.17	0.26	0.32	0.39	0.44	0.50	2.08	3.12	3.80	4.67	5.31	5.95
COOP: 246562	10-min	0.25	0.38	0.46	0.57	0.65	0.73	1.52	2.28	2.78	3.42	3.89	4.35
Elev: 2,490 ft	15-min	0.31	0.46	0.56	0.69	0.79	0.88	1.24	1.85	2.26	2.77	3.15	3.53
Modified POR: 52	20-min	0.33	0.49	0.60	0.74	0.84	0.94	0.99	1.48	1.81	2.22	2.53	2.83
Type: 2nd Order	25-min	0.35	0.53	0.64	0.79	0.90	1.00	0.84	1.26	1.54	1.89	2.15	2.41
	30-min	0.37	0.56	0.68	0.84	0.95	1.06	0.75	1.12	1.36	1.67	1.90	2.13
	35-min	0.38	0.57	0.70	0.86	0.98	1.09	0.66	0.98	1.20	1.47	1.67	1.87
	40-min	0.39	0.59	0.72	0.88	1.00	1.12	0.59	0.88	1.07	1.32	1.50	1.68
	45-min	0.40	0.60	0.73	0.90	1.03	1.15	0.54	0.80	0.98	1.20	1.37	1.53
	50-min	0.41	0.61	0.75	0.92	1.04	1.17	0.49	0.74	0.90	1.10	1.25	1.40
	55-min	0.42	0.62	0.76	0.93	1.06	1.19	0.45	0.68	0.83	1.02	1.16	1.30
	1-hr	0.42	0.63	0.77	0.95	1.08	1.21	0.42	0.63	0.77	0.95	1.08	1.21
	2-hr	0.52	0.73	0.88	1.06	1.19	1.32	0.26	0.37	0.44	0.53	0.59	0.66
	3-hr	0.61	0.83	0.98	1.17	1.31	1.45	0.20	0.28	0.33	0.39	0.44	0.48
	6-hr	0.73	0.95	1.10	1.29	1.42	1.56	0.12	0.16	0.18	0.21	0.24	0.26
	12-hr	0.94	1.25	1.46	1.73	1.92	2.12	0.08	0.10	0.12	0.14	0.16	0.18
	24-hr	1.13	1.51	1.77	2.08	2.32	2.55	0.047	0.063	0.074	0.087	0.097	0.106

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Pleasant Valley	5-min	0.16	0.22	0.26	0.32	0.36	0.40	1.92	2.68	3.18	3.81	4.28	4.74
COOP: 246580	10-min	0.23	0.33	0.39	0.46	0.52	0.58	1.40	1.96	2.32	2.79	3.13	3.47
Elev: 3,540 ft	15-min	0.28	0.40	0.47	0.57	0.63	0.70	1.14	1.59	1.89	2.26	2.54	2.82
Modified POR: 50	20-min	0.30	0.42	0.50	0.60	0.68	0.75	0.91	1.27	1.51	1.81	2.03	2.26
Type: 2nd Order	25-min	0.32	0.45	0.54	0.64	0.72	0.80	0.78	1.08	1.29	1.54	1.73	1.92
	30-min	0.34	0.48	0.57	0.68	0.77	0.85	0.69	0.96	1.14	1.36	1.53	1.70
	35-min	0.35	0.49	0.58	0.70	0.79	0.87	0.60	0.84	1.00	1.20	1.35	1.49
	40-min	0.36	0.50	0.60	0.72	0.81	0.89	0.54	0.76	0.90	1.08	1.21	1.34
	45-min	0.37	0.52	0.61	0.74	0.83	0.92	0.49	0.69	0.82	0.98	1.10	1.22
	50-min	0.38	0.53	0.62	0.75	0.84	0.93	0.45	0.63	0.75	0.90	1.01	1.12
	55-min	0.38	0.53	0.63	0.76	0.86	0.95	0.42	0.58	0.69	0.83	0.93	1.03
	1-hr	0.39	0.54	0.65	0.77	0.87	0.96	0.39	0.54	0.65	0.77	0.87	0.96
	2-hr	0.48	0.66	0.78	0.93	1.05	1.16	0.24	0.33	0.39	0.47	0.52	0.58
	3-hr	0.57	0.75	0.86	1.01	1.11	1.22	0.19	0.25	0.29	0.34	0.37	0.41
	6-hr	0.76	0.98	1.13	1.32	1.46	1.60	0.13	0.16	0.19	0.22	0.24	0.27
	12-hr	0.95	1.21	1.38	1.59	1.75	1.91	0.08	0.10	0.11	0.13	0.15	0.16
	24-hr	1.16	1.42	1.59	1.80	1.96	2.11	0.048	0.059	0.066	0.075	0.081	0.088
Polebridge	5-min	0.17	0.22	0.25	0.29	0.32	0.35	1.99	2.60	3.00	3.50	3.88	4.25
COOP: 246615	10-min	0.24	0.32	0.37	0.43	0.47	0.52	1.46	1.90	2.19	2.56	2.84	3.11
Elev: 3,520 ft	15-min	0.30	0.39	0.44	0.52	0.58	0.63	1.18	1.54	1.78	2.08	2.30	2.52
Modified POR: 41	20-min	0.32	0.41	0.47	0.56	0.61	0.67	0.95	1.23	1.42	1.67	1.84	2.02
Type: 2nd Order	25-min	0.34	0.44	0.51	0.59	0.65	0.72	0.81	1.05	1.21	1.42	1.57	1.72
	30-min	0.36	0.46	0.54	0.63	0.69	0.76	0.71	0.93	1.07	1.25	1.39	1.52
	35-min	0.37	0.48	0.55	0.64	0.71	0.78	0.63	0.82	0.94	1.10	1.22	1.34
	40-min	0.37	0.49	0.56	0.66	0.73	0.80	0.56	0.73	0.85	0.99	1.10	1.20
	45-min	0.38	0.50	0.58	0.68	0.75	0.82	0.51	0.67	0.77	0.90	1.00	1.09
	50-min	0.39	0.51	0.59	0.69	0.76	0.84	0.47	0.61	0.71	0.83	0.91	1.00
	55-min	0.40	0.52	0.60	0.70	0.77	0.85	0.43	0.57	0.65	0.76	0.85	0.93
	1-hr	0.40	0.53	0.61	0.71	0.79	0.86	0.40	0.53	0.61	0.71	0.79	0.86
	2-hr	0.48	0.59	0.67	0.76	0.83	0.90	0.24	0.30	0.33	0.38	0.42	0.45
	3-hr	0.55	0.68	0.76	0.87	0.95	1.03	0.18	0.23	0.25	0.29	0.32	0.34
	6-hr	0.73	0.94	1.08	1.26	1.39	1.52	0.12	0.16	0.18	0.21	0.23	0.25
	12-hr	0.94	1.28	1.50	1.78	1.99	2.20	0.08	0.11	0.13	0.15	0.17	0.18
	24-hr	1.16	1.55	1.81	2.14	2.39	2.63	0.048	0.065	0.076	0.089	0.099	0.109

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Reedpoint	5-min	0.23	0.32	0.38	0.45	0.51	0.56	2.77	3.83	4.52	5.41	6.06	6.71
COOP: 246946	10-min	0.34	0.47	0.55	0.66	0.74	0.82	2.03	2.80	3.31	3.96	4.44	4.91
Elev: 3,744 ft	15-min	0.41	0.57	0.67	0.80	0.90	1.00	1.64	2.27	2.69	3.21	3.60	3.98
Modified POR: 56	20-min	0.44	0.61	0.72	0.86	0.96	1.06	1.32	1.82	2.15	2.57	2.88	3.19
Type: 2nd Order	25-min	0.47	0.65	0.76	0.91	1.02	1.13	1.12	1.55	1.83	2.19	2.45	2.72
	30-min	0.50	0.68	0.81	0.97	1.08	1.20	0.99	1.37	1.62	1.93	2.17	2.40
	35-min	0.51	0.70	0.83	0.99	1.11	1.23	0.87	1.20	1.42	1.70	1.91	2.11
	40-min	0.52	0.72	0.85	1.02	1.14	1.26	0.78	1.08	1.28	1.53	1.71	1.90
	45-min	0.54	0.74	0.87	1.04	1.17	1.30	0.71	0.99	1.16	1.39	1.56	1.73
	50-min	0.54	0.75	0.89	1.06	1.19	1.32	0.65	0.90	1.07	1.27	1.43	1.58
	55-min	0.55	0.76	0.90	1.08	1.21	1.34	0.60	0.83	0.99	1.18	1.32	1.46
	1-hr	0.56	0.78	0.92	1.10	1.23	1.36	0.56	0.78	0.92	1.10	1.23	1.36
	2-hr	0.65	0.92	1.10	1.33	1.50	1.67	0.32	0.46	0.55	0.67	0.75	0.84
	3-hr	0.75	1.09	1.32	1.60	1.81	2.02	0.25	0.36	0.44	0.53	0.60	0.67
	6-hr	1.00	1.36	1.60	1.90	2.13	2.35	0.17	0.23	0.27	0.32	0.35	0.39
	12-hr	1.29	1.69	1.95	2.29	2.53	2.78	0.11	0.14	0.16	0.19	0.21	0.23
	24-hr	1.62	2.21	2.60	3.09	3.46	3.82	0.068	0.092	0.108	0.129	0.144	0.159
Reserve-14W	5-min	0.30	0.48	0.59	0.74	0.85	0.96	3.62	5.73	7.13	8.89	10.20	11.50
COOP: 246976	10-min	0.44	0.70	0.87	1.08	1.24	1.40	2.65	4.19	5.22	6.51	7.46	8.41
Elev: 2,260 ft	15-min	0.54	0.85	1.06	1.32	1.51	1.71	2.15	3.40	4.23	5.28	6.05	6.82
Modified POR: 29	20-min	0.57	0.91	1.13	1.41	1.62	1.82	1.72	2.73	3.39	4.23	4.85	5.47
Type: 2nd Order	25-min	0.61	0.97	1.20	1.50	1.72	1.94	1.47	2.32	2.89	3.60	4.13	4.66
	30-min	0.65	1.03	1.27	1.59	1.82	2.06	1.30	2.05	2.55	3.18	3.65	4.11
	35-min	0.67	1.05	1.31	1.63	1.87	2.11	1.14	1.80	2.24	2.80	3.21	3.62
	40-min	0.68	1.08	1.34	1.67	1.92	2.17	1.02	1.62	2.01	2.51	2.88	3.25
	45-min	0.70	1.11	1.38	1.72	1.97	2.22	0.93	1.48	1.84	2.29	2.63	2.96
	50-min	0.71	1.13	1.40	1.75	2.00	2.26	0.85	1.35	1.68	2.10	2.41	2.71
	55-min	0.72	1.15	1.42	1.78	2.04	2.30	0.79	1.25	1.55	1.94	2.22	2.51
	1-hr	0.74	1.17	1.45	1.81	2.07	2.34	0.74	1.17	1.45	1.81	2.07	2.34
	2-hr	0.86	1.28	1.56	1.91	2.17	2.43	0.43	0.64	0.78	0.95	1.08	1.21
	3-hr	1.00	1.44	1.73	2.10	2.37	2.64	0.33	0.48	0.58	0.70	0.79	0.88
	6-hr	1.21	1.69	2.02	2.42	2.73	3.02	0.20	0.28	0.34	0.40	0.45	0.50
	12-hr	1.45	1.91	2.21	2.60	2.89	3.17	0.12	0.16	0.18	0.22	0.24	0.26
	24-hr	1.70	2.24	2.60	3.06	3.40	3.73	0.071	0.094	0.109	0.127	0.141	0.155

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Round Butte-1NNW	5-min	0.18	0.23	0.26	0.30	0.33	0.36	2.20	2.76	3.13	3.60	3.94	4.28
COOP: 247204	10-min	0.27	0.34	0.38	0.44	0.48	0.52	1.61	2.02	2.29	2.63	2.88	3.14
Elev: 3,100 ft	15-min	0.33	0.41	0.46	0.53	0.58	0.64	1.31	1.64	1.86	2.13	2.34	2.54
Modified POR: 55	20-min	0.35	0.44	0.50	0.57	0.62	0.68	1.05	1.31	1.49	1.71	1.87	2.04
Type: 2nd Order	25-min	0.37	0.47	0.53	0.61	0.66	0.72	0.89	1.12	1.27	1.46	1.60	1.73
	30-min	0.39	0.49	0.56	0.64	0.70	0.77	0.79	0.99	1.12	1.29	1.41	1.53
	35-min	0.40	0.51	0.57	0.66	0.72	0.79	0.69	0.87	0.98	1.13	1.24	1.35
	40-min	0.41	0.52	0.59	0.68	0.74	0.81	0.62	0.78	0.88	1.02	1.11	1.21
	45-min	0.43	0.53	0.60	0.69	0.76	0.83	0.57	0.71	0.81	0.93	1.01	1.10
	50-min	0.43	0.54	0.61	0.71	0.77	0.84	0.52	0.65	0.74	0.85	0.93	1.01
	55-min	0.44	0.55	0.63	0.72	0.79	0.86	0.48	0.60	0.68	0.78	0.86	0.93
	1-hr	0.45	0.56	0.64	0.73	0.80	0.87	0.45	0.56	0.64	0.73	0.80	0.87
	2-hr	0.52	0.64	0.73	0.83	0.91	0.98	0.26	0.32	0.36	0.41	0.45	0.49
	3-hr	0.59	0.72	0.80	0.91	0.99	1.07	0.20	0.24	0.27	0.30	0.33	0.36
	6-hr	0.76	1.11	1.34	1.64	1.86	2.08	0.13	0.19	0.22	0.27	0.31	0.35
	12-hr	0.98	1.34	1.58	1.89	2.11	2.34	0.08	0.11	0.13	0.16	0.18	0.19
	24-hr	1.23	1.65	1.92	2.27	2.53	2.78	0.051	0.069	0.080	0.095	0.105	0.116
Russell	5-min	0.25	0.35	0.42	0.50	0.56	0.62	2.99	4.20	5.00	6.01	6.76	7.50
COOP: 247258	10-min	0.37	0.51	0.61	0.73	0.82	0.91	2.19	3.07	3.66	4.40	4.94	5.49
Elev: 3,200 ft	15-min	0.44	0.62	0.74	0.89	1.00	1.11	1.78	2.49	2.97	3.57	4.01	4.45
Modified POR: 34	20-min	0.47	0.67	0.79	0.95	1.07	1.19	1.42	2.00	2.38	2.86	3.21	3.57
Type: 2nd Order	25-min	0.51	0.71	0.84	1.01	1.14	1.27	1.21	1.70	2.02	2.43	2.74	3.04
	30-min	0.54	0.75	0.89	1.07	1.21	1.34	1.07	1.50	1.79	2.15	2.42	2.68
	35-min	0.55	0.77	0.92	1.10	1.24	1.38	0.94	1.32	1.57	1.89	2.13	2.36
	40-min	0.56	0.79	0.94	1.13	1.27	1.41	0.85	1.19	1.41	1.70	1.91	2.12
	45-min	0.58	0.81	0.97	1.16	1.30	1.45	0.77	1.08	1.29	1.55	1.74	1.93
	50-min	0.59	0.83	0.98	1.18	1.33	1.47	0.71	0.99	1.18	1.42	1.59	1.77
	55-min	0.60	0.84	1.00	1.20	1.35	1.50	0.65	0.92	1.09	1.31	1.47	1.64
	1-hr	0.61	0.85	1.02	1.22	1.37	1.52	0.61	0.85	1.02	1.22	1.37	1.52
	2-hr	0.71	1.04	1.26	1.53	1.73	1.94	0.36	0.52	0.63	0.77	0.87	0.97
	3-hr	0.79	1.13	1.36	1.65	1.86	2.08	0.26	0.38	0.45	0.55	0.62	0.69
	6-hr	0.96	1.29	1.51	1.79	1.99	2.20	0.16	0.22	0.25	0.30	0.33	0.37
	12-hr	1.23	1.59	1.83	2.13	2.36	2.58	0.10	0.13	0.15	0.18	0.20	0.22
	24-hr	1.47	1.98	2.32	2.75	3.06	3.38	0.061	0.083	0.097	0.114	0.128	0.141

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Scobey-4NW	5-min	0.32	0.46	0.56	0.68	0.76	0.85	3.81	5.53	6.67	8.10	9.17	10.23
COOP: 247425	10-min	0.46	0.67	0.81	0.99	1.12	1.25	2.79	4.04	4.88	5.93	6.71	7.49
Elev: 2,374 ft	15-min	0.57	0.82	0.99	1.20	1.36	1.52	2.26	3.28	3.96	4.81	5.44	6.07
Modified POR: 29	20-min	0.60	0.88	1.06	1.28	1.45	1.62	1.81	2.63	3.17	3.85	4.36	4.87
Type: 2nd Order	25-min	0.64	0.93	1.12	1.37	1.55	1.73	1.54	2.24	2.70	3.28	3.71	4.14
	30-min	0.68	0.99	1.19	1.45	1.64	1.83	1.36	1.98	2.38	2.90	3.28	3.66
	35-min	0.70	1.01	1.22	1.49	1.68	1.88	1.20	1.74	2.10	2.55	2.89	3.22
	40-min	0.72	1.04	1.26	1.53	1.73	1.93	1.08	1.56	1.88	2.29	2.59	2.89
	45-min	0.74	1.07	1.29	1.56	1.77	1.98	0.98	1.42	1.72	2.09	2.36	2.63
	50-min	0.75	1.09	1.31	1.59	1.80	2.01	0.90	1.30	1.57	1.91	2.16	2.41
	55-min	0.76	1.10	1.33	1.62	1.83	2.04	0.83	1.21	1.45	1.77	2.00	2.23
	1-hr	0.77	1.12	1.35	1.65	1.86	2.08	0.77	1.12	1.35	1.65	1.86	2.08
	2-hr	0.95	1.33	1.58	1.90	2.14	2.37	0.47	0.66	0.79	0.95	1.07	1.19
	3-hr	1.08	1.49	1.76	2.10	2.35	2.60	0.36	0.50	0.59	0.70	0.78	0.87
	6-hr	1.24	1.67	1.96	2.32	2.58	2.85	0.21	0.28	0.33	0.39	0.43	0.47
	12-hr	1.44	1.94	2.28	2.69	3.00	3.31	0.12	0.16	0.19	0.22	0.25	0.28
	24-hr	1.65	2.23	2.61	3.09	3.45	3.81	0.069	0.093	0.109	0.129	0.144	0.159
Seeley Lake RS	5-min	0.18	0.24	0.28	0.33	0.37	0.40	2.19	2.89	3.36	3.95	4.38	4.82
COOP: 247448	10-min	0.27	0.35	0.41	0.48	0.53	0.59	1.60	2.12	2.46	2.89	3.21	3.53
Elev: 4,100 ft	15-min	0.33	0.43	0.50	0.59	0.65	0.71	1.30	1.72	1.99	2.34	2.60	2.86
Modified POR: 55	20-min	0.35	0.46	0.53	0.63	0.70	0.76	1.04	1.38	1.60	1.88	2.09	2.29
Type: 2nd Order	25-min	0.37	0.49	0.57	0.67	0.74	0.81	0.89	1.17	1.36	1.60	1.78	1.95
	30-min	0.39	0.52	0.60	0.71	0.78	0.86	0.78	1.04	1.20	1.41	1.57	1.72
	35-min	0.40	0.53	0.62	0.72	0.81	0.88	0.69	0.91	1.06	1.24	1.38	1.52
	40-min	0.41	0.55	0.63	0.74	0.83	0.91	0.62	0.82	0.95	1.12	1.24	1.36
	45-min	0.42	0.56	0.65	0.76	0.85	0.93	0.56	0.75	0.87	1.02	1.13	1.24
	50-min	0.43	0.57	0.66	0.78	0.86	0.95	0.52	0.68	0.79	0.93	1.03	1.14
	55-min	0.44	0.58	0.67	0.79	0.88	0.96	0.48	0.63	0.73	0.86	0.96	1.05
	1-hr	0.45	0.59	0.68	0.80	0.89	0.98	0.45	0.59	0.68	0.80	0.89	0.98
	2-hr	0.53	0.69	0.79	0.93	1.03	1.12	0.26	0.34	0.40	0.46	0.51	0.56
	3-hr	0.61	0.78	0.90	1.04	1.14	1.25	0.20	0.26	0.30	0.35	0.38	0.42
	6-hr	0.74	0.92	1.05	1.20	1.31	1.43	0.12	0.15	0.17	0.20	0.22	0.24
	12-hr	0.92	1.16	1.32	1.53	1.68	1.83	0.08	0.10	0.11	0.13	0.14	0.15
	24-hr	1.14	1.49	1.72	2.01	2.23	2.44	0.047	0.062	0.072	0.084	0.093	0.102

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Shelby Airport	5-min	0.25	0.36	0.42	0.51	0.57	0.64	3.05	4.28	5.09	6.12	6.88	7.63
COOP: 247501	10-min	0.37	0.52	0.62	0.75	0.84	0.93	2.23	3.13	3.72	4.48	5.03	5.59
Elev: 3,426 ft	15-min	0.45	0.63	0.76	0.91	1.02	1.13	1.81	2.54	3.02	3.63	4.08	4.53
Modified POR: 29	20-min	0.48	0.68	0.81	0.97	1.09	1.21	1.45	2.03	2.42	2.91	3.27	3.63
Type: 2nd Order	25-min	0.51	0.72	0.86	1.03	1.16	1.29	1.24	1.73	2.06	2.48	2.78	3.09
	30-min	0.55	0.77	0.91	1.09	1.23	1.37	1.09	1.53	1.82	2.19	2.46	2.73
	35-min	0.56	0.79	0.93	1.12	1.26	1.40	0.96	1.35	1.60	1.93	2.16	2.40
	40-min	0.57	0.81	0.96	1.15	1.30	1.44	0.86	1.21	1.44	1.73	1.94	2.16
	45-min	0.59	0.83	0.98	1.18	1.33	1.47	0.79	1.10	1.31	1.57	1.77	1.97
	50-min	0.60	0.84	1.00	1.20	1.35	1.50	0.72	1.01	1.20	1.44	1.62	1.80
	55-min	0.61	0.86	1.02	1.22	1.37	1.53	0.67	0.93	1.11	1.33	1.50	1.66
	1-hr	0.62	0.87	1.03	1.24	1.40	1.55	0.62	0.87	1.03	1.24	1.40	1.55
	2-hr	0.75	1.12	1.37	1.68	1.91	2.13	0.38	0.56	0.68	0.84	0.95	1.07
	3-hr	0.84	1.27	1.55	1.91	2.17	2.44	0.28	0.42	0.52	0.64	0.72	0.81
	6-hr	1.04	1.49	1.78	2.16	2.43	2.71	0.17	0.25	0.30	0.36	0.41	0.45
	12-hr	1.24	1.71	2.02	2.41	2.69	2.98	0.10	0.14	0.17	0.20	0.22	0.25
	24-hr	1.52	2.13	2.54	3.05	3.43	3.81	0.063	0.089	0.106	0.127	0.143	0.159
Silver Star	5-min	0.16	0.22	0.26	0.31	0.35	0.38	1.89	2.62	3.10	3.71	4.16	4.61
COOP: 247610	10-min	0.23	0.32	0.38	0.45	0.51	0.56	1.38	1.91	2.27	2.72	3.05	3.38
Elev: 4,585 ft	15-min	0.28	0.39	0.46	0.55	0.62	0.68	1.12	1.55	1.84	2.20	2.47	2.74
Modified POR: 58	20-min	0.30	0.41	0.49	0.59	0.66	0.73	0.90	1.24	1.47	1.76	1.98	2.19
Type: 2nd Order	25-min	0.32	0.44	0.52	0.63	0.70	0.78	0.76	1.06	1.26	1.50	1.69	1.87
	30-min	0.34	0.47	0.55	0.66	0.74	0.83	0.67	0.94	1.11	1.33	1.49	1.65
	35-min	0.35	0.48	0.57	0.68	0.76	0.85	0.59	0.82	0.98	1.17	1.31	1.45
	40-min	0.36	0.49	0.58	0.70	0.78	0.87	0.53	0.74	0.88	1.05	1.18	1.30
	45-min	0.36	0.51	0.60	0.72	0.80	0.89	0.49	0.67	0.80	0.96	1.07	1.19
	50-min	0.37	0.51	0.61	0.73	0.82	0.91	0.44	0.62	0.73	0.87	0.98	1.09
	55-min	0.38	0.52	0.62	0.74	0.83	0.92	0.41	0.57	0.68	0.81	0.91	1.01
	1-hr	0.38	0.53	0.63	0.75	0.85	0.94	0.38	0.53	0.63	0.75	0.85	0.94
	2-hr	0.44	0.69	0.85	1.06	1.21	1.36	0.22	0.34	0.43	0.53	0.60	0.68
	3-hr	0.51	0.76	0.93	1.14	1.30	1.46	0.17	0.25	0.31	0.38	0.43	0.49
	6-hr	0.67	0.93	1.10	1.32	1.48	1.64	0.11	0.16	0.18	0.22	0.25	0.27
	12-hr	0.86	1.18	1.38	1.64	1.84	2.03	0.07	0.10	0.12	0.14	0.15	0.17
	24-hr	1.05	1.35	1.54	1.79	1.98	2.16	0.044	0.056	0.064	0.075	0.082	0.090

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
St. Mary	5-min	0.23	0.39	0.49	0.62	0.72	0.82	2.74	4.63	5.88	7.46	8.63	9.79
COOP: 247292	10-min	0.33	0.56	0.72	0.91	1.05	1.19	2.00	3.39	4.30	5.46	6.31	7.17
Elev: 4,560 ft	15-min	0.41	0.69	0.87	1.11	1.28	1.45	1.63	2.75	3.49	4.43	5.12	5.81
Modified POR: 24	20-min	0.43	0.73	0.93	1.18	1.37	1.55	1.30	2.20	2.80	3.55	4.10	4.66
Type: 2nd Order	25-min	0.46	0.78	0.99	1.26	1.46	1.65	1.11	1.87	2.38	3.02	3.49	3.97
	30-min	0.49	0.83	1.05	1.33	1.54	1.75	0.98	1.66	2.10	2.67	3.09	3.50
	35-min	0.50	0.85	1.08	1.37	1.58	1.80	0.86	1.46	1.85	2.35	2.72	3.08
	40-min	0.52	0.87	1.11	1.40	1.63	1.84	0.77	1.31	1.66	2.11	2.44	2.77
	45-min	0.53	0.89	1.14	1.44	1.67	1.89	0.71	1.19	1.51	1.92	2.22	2.52
	50-min	0.54	0.91	1.15	1.47	1.70	1.92	0.65	1.09	1.39	1.76	2.03	2.31
	55-min	0.55	0.93	1.17	1.49	1.72	1.96	0.60	1.01	1.28	1.63	1.88	2.14
	1-hr	0.56	0.94	1.19	1.52	1.75	1.99	0.56	0.94	1.19	1.52	1.75	1.99
	2-hr	0.74	1.14	1.40	1.74	1.99	2.23	0.37	0.57	0.70	0.87	0.99	1.12
	3-hr	0.89	1.29	1.56	1.89	2.14	2.39	0.30	0.43	0.52	0.63	0.71	0.80
	6-hr	1.24	1.69	1.99	2.37	2.65	2.93	0.21	0.28	0.33	0.39	0.44	0.49
	12-hr	1.75	2.24	2.56	2.97	3.27	3.57	0.15	0.19	0.21	0.25	0.27	0.30
	24-hr	2.39	3.13	3.62	4.24	4.70	5.15	0.100	0.130	0.151	0.177	0.196	0.215
St. Regis	5-min	0.22	0.35	0.45	0.56	0.65	0.73	2.61	4.26	5.35	6.73	7.75	8.76
COOP: 247316	10-min	0.32	0.52	0.65	0.82	0.94	1.07	1.91	3.11	3.91	4.92	5.67	6.41
Elev: 2,600 ft	15-min	0.39	0.63	0.79	1.00	1.15	1.30	1.55	2.53	3.17	3.99	4.60	5.20
Modified POR: 30	20-min	0.41	0.67	0.85	1.07	1.23	1.39	1.24	2.02	2.54	3.20	3.69	4.17
Type: 2nd Order	25-min	0.44	0.72	0.90	1.13	1.31	1.48	1.06	1.72	2.16	2.72	3.14	3.55
	30-min	0.47	0.76	0.96	1.20	1.39	1.57	0.93	1.52	1.91	2.41	2.77	3.13
	35-min	0.48	0.78	0.98	1.23	1.42	1.61	0.82	1.34	1.68	2.12	2.44	2.76
	40-min	0.49	0.80	1.01	1.27	1.46	1.65	0.74	1.20	1.51	1.90	2.19	2.48
	45-min	0.50	0.82	1.03	1.30	1.50	1.69	0.67	1.10	1.38	1.73	1.99	2.26
	50-min	0.51	0.84	1.05	1.32	1.52	1.72	0.61	1.00	1.26	1.59	1.83	2.07
	55-min	0.52	0.85	1.07	1.34	1.55	1.75	0.57	0.93	1.17	1.47	1.69	1.91
	1-hr	0.53	0.86	1.09	1.37	1.57	1.78	0.53	0.86	1.09	1.37	1.57	1.78
	2-hr	0.58	0.89	1.09	1.35	1.54	1.73	0.29	0.44	0.55	0.67	0.77	0.86
	3-hr	0.65	0.95	1.14	1.39	1.57	1.76	0.22	0.32	0.38	0.46	0.52	0.59
	6-hr	0.79	1.04	1.20	1.41	1.56	1.71	0.13	0.17	0.20	0.23	0.26	0.29
	12-hr	1.01	1.29	1.47	1.69	1.86	2.03	0.08	0.11	0.12	0.14	0.16	0.17
	24-hr	1.19	1.48	1.68	1.92	2.11	2.29	0.050	0.062	0.070	0.080	0.088	0.095

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Stevensville	5-min	0.17	0.33	0.43	0.56	0.65	0.75	2.06	3.91	5.14	6.69	7.83	8.97
COOP: 247894	10-min	0.25	0.48	0.63	0.82	0.96	1.09	1.51	2.86	3.76	4.89	5.73	6.57
Elev: 3,375 ft	15-min	0.31	0.58	0.76	0.99	1.16	1.33	1.22	2.32	3.05	3.97	4.65	5.32
Modified POR: 22	20-min	0.33	0.62	0.81	1.06	1.24	1.42	0.98	1.86	2.44	3.18	3.73	4.27
Type: 2nd Order	25-min	0.35	0.66	0.87	1.13	1.32	1.51	0.84	1.58	2.08	2.71	3.17	3.63
	30-min	0.37	0.70	0.92	1.20	1.40	1.60	0.74	1.40	1.84	2.39	2.80	3.21
	35-min	0.38	0.72	0.94	1.23	1.44	1.65	0.65	1.23	1.62	2.10	2.47	2.82
	40-min	0.39	0.74	0.97	1.26	1.48	1.69	0.58	1.11	1.45	1.89	2.21	2.53
	45-min	0.40	0.76	0.99	1.29	1.51	1.73	0.53	1.01	1.32	1.72	2.02	2.31
	50-min	0.41	0.77	1.01	1.31	1.54	1.76	0.49	0.92	1.21	1.58	1.85	2.12
	55-min	0.41	0.78	1.03	1.34	1.57	1.79	0.45	0.85	1.12	1.46	1.71	1.96
	1-hr	0.42	0.80	1.04	1.36	1.59	1.82	0.42	0.80	1.04	1.36	1.59	1.82
	2-hr	0.47	0.84	1.08	1.39	1.62	1.85	0.24	0.42	0.54	0.70	0.81	0.92
	3-hr	0.53	0.88	1.12	1.41	1.63	1.85	0.18	0.29	0.37	0.47	0.54	0.62
	6-hr	0.68	1.02	1.24	1.53	1.74	1.95	0.11	0.17	0.21	0.25	0.29	0.33
	12-hr	0.85	1.23	1.48	1.81	2.04	2.28	0.07	0.10	0.12	0.15	0.17	0.19
	24-hr	1.02	1.38	1.61	1.91	2.13	2.35	0.043	0.057	0.067	0.080	0.089	0.098
Summit	5-min	0.17	0.26	0.32	0.39	0.44	0.49	2.09	3.11	3.78	4.63	5.27	5.89
COOP: 247978	10-min	0.25	0.38	0.46	0.57	0.64	0.72	1.53	2.27	2.77	3.39	3.85	4.31
Elev: 5,233 ft	15-min	0.31	0.46	0.56	0.69	0.78	0.87	1.24	1.84	2.24	2.75	3.13	3.50
Modified POR: 53	20-min	0.33	0.49	0.60	0.73	0.83	0.93	0.99	1.48	1.80	2.20	2.50	2.80
Type: 2nd Order	25-min	0.35	0.52	0.64	0.78	0.89	0.99	0.84	1.26	1.53	1.88	2.13	2.39
	30-min	0.37	0.56	0.68	0.83	0.94	1.05	0.75	1.11	1.35	1.66	1.88	2.11
	35-min	0.38	0.57	0.69	0.85	0.97	1.08	0.66	0.98	1.19	1.46	1.66	1.86
	40-min	0.39	0.58	0.71	0.87	0.99	1.11	0.59	0.88	1.07	1.31	1.49	1.67
	45-min	0.40	0.60	0.73	0.89	1.02	1.14	0.54	0.80	0.97	1.19	1.36	1.52
	50-min	0.41	0.61	0.74	0.91	1.03	1.16	0.49	0.73	0.89	1.09	1.24	1.39
	55-min	0.42	0.62	0.76	0.93	1.05	1.18	0.45	0.68	0.82	1.01	1.15	1.29
	1-hr	0.42	0.63	0.77	0.94	1.07	1.20	0.42	0.63	0.77	0.94	1.07	1.20
	2-hr	0.57	0.77	0.90	1.06	1.18	1.30	0.29	0.38	0.45	0.53	0.59	0.65
	3-hr	0.70	0.93	1.08	1.27	1.41	1.55	0.23	0.31	0.36	0.42	0.47	0.52
	6-hr	0.98	1.35	1.59	1.90	2.13	2.35	0.16	0.22	0.27	0.32	0.35	0.39
	12-hr	1.40	2.42	3.10	3.95	4.58	5.21	0.12	0.20	0.26	0.33	0.38	0.43
	24-hr	1.94	3.14	3.94	4.94	5.68	6.42	0.081	0.131	0.164	0.206	0.237	0.268

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Swan Lake	5-min	0.18	0.24	0.28	0.33	0.36	0.40	2.13	2.84	3.32	3.92	4.36	4.81
COOP: 248087	10-min	0.26	0.35	0.40	0.48	0.53	0.59	1.56	2.08	2.43	2.87	3.19	3.52
Elev: 3,100 ft	15-min	0.32	0.42	0.49	0.58	0.65	0.71	1.26	1.69	1.97	2.33	2.59	2.85
Modified POR: 46	20-min	0.34	0.45	0.53	0.62	0.69	0.76	1.01	1.35	1.58	1.86	2.08	2.29
Type: 2nd Order	25-min	0.36	0.48	0.56	0.66	0.74	0.81	0.86	1.15	1.34	1.59	1.77	1.95
	30-min	0.38	0.51	0.59	0.70	0.78	0.86	0.76	1.02	1.19	1.40	1.56	1.72
	35-min	0.39	0.52	0.61	0.72	0.80	0.88	0.67	0.89	1.04	1.23	1.37	1.51
	40-min	0.40	0.54	0.63	0.74	0.82	0.91	0.60	0.80	0.94	1.11	1.23	1.36
	45-min	0.41	0.55	0.64	0.76	0.84	0.93	0.55	0.73	0.85	1.01	1.12	1.24
	50-min	0.42	0.56	0.65	0.77	0.86	0.94	0.50	0.67	0.78	0.92	1.03	1.13
	55-min	0.42	0.57	0.66	0.78	0.87	0.96	0.46	0.62	0.72	0.85	0.95	1.05
	1-hr	0.43	0.58	0.67	0.80	0.89	0.98	0.43	0.58	0.67	0.80	0.89	0.98
	2-hr	0.56	0.70	0.80	0.92	1.01	1.10	0.28	0.35	0.40	0.46	0.50	0.55
	3-hr	0.67	0.83	0.94	1.08	1.19	1.29	0.22	0.28	0.31	0.36	0.40	0.43
	6-hr	0.89	1.13	1.29	1.49	1.64	1.79	0.15	0.19	0.21	0.25	0.27	0.30
	12-hr	1.18	1.55	1.79	2.09	2.31	2.54	0.10	0.13	0.15	0.17	0.19	0.21
	24-hr	1.58	2.03	2.33	2.70	2.98	3.25	0.066	0.085	0.097	0.113	0.124	0.136
Swift Dam	5-min	0.21	0.29	0.34	0.41	0.45	0.50	2.55	3.48	4.09	4.87	5.44	6.01
COOP: 248101	10-min	0.31	0.42	0.50	0.59	0.66	0.73	1.87	2.54	2.99	3.56	3.98	4.40
Elev: 4,780 ft	15-min	0.38	0.52	0.61	0.72	0.81	0.89	1.51	2.06	2.43	2.89	3.23	3.57
Modified POR: 42	20-min	0.40	0.55	0.65	0.77	0.86	0.95	1.21	1.65	1.95	2.32	2.59	2.86
Type: 2nd Order	25-min	0.43	0.59	0.69	0.82	0.92	1.01	1.03	1.41	1.66	1.97	2.20	2.44
	30-min	0.46	0.62	0.73	0.87	0.97	1.08	0.91	1.24	1.46	1.74	1.95	2.15
	35-min	0.47	0.64	0.75	0.89	1.00	1.10	0.80	1.09	1.29	1.53	1.71	1.89
	40-min	0.48	0.66	0.77	0.92	1.03	1.13	0.72	0.98	1.16	1.38	1.54	1.70
	45-min	0.49	0.67	0.79	0.94	1.05	1.16	0.66	0.90	1.05	1.25	1.40	1.55
	50-min	0.50	0.68	0.80	0.96	1.07	1.18	0.60	0.82	0.96	1.15	1.28	1.42
	55-min	0.51	0.70	0.82	0.97	1.09	1.20	0.56	0.76	0.89	1.06	1.19	1.31
	1-hr	0.52	0.71	0.83	0.99	1.11	1.22	0.52	0.71	0.83	0.99	1.11	1.22
	2-hr	0.69	0.89	1.01	1.18	1.30	1.42	0.34	0.44	0.51	0.59	0.65	0.71
	3-hr	0.86	1.04	1.16	1.32	1.43	1.54	0.29	0.35	0.39	0.44	0.48	0.51
	6-hr	1.25	1.47	1.62	1.81	1.95	2.09	0.21	0.25	0.27	0.30	0.33	0.35
	12-hr	1.70	2.06	2.30	2.60	2.82	3.04	0.14	0.17	0.19	0.22	0.24	0.25
	24-hr	2.23	2.89	3.32	3.87	4.28	4.68	0.093	0.120	0.138	0.161	0.178	0.195

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Terry-21NNW	5-min	0.32	0.44	0.52	0.62	0.69	0.77	3.85	5.28	6.23	7.42	8.31	9.19
COOP: 248169	10-min	0.47	0.64	0.76	0.90	1.01	1.12	2.82	3.86	4.56	5.43	6.08	6.72
Elev: 3,142 ft	15-min	0.57	0.78	0.92	1.10	1.23	1.36	2.29	3.13	3.69	4.40	4.93	5.45
Modified POR: 68	20-min	0.61	0.84	0.99	1.18	1.32	1.46	1.83	2.51	2.96	3.53	3.95	4.37
Type: 2nd Order	25-min	0.65	0.89	1.05	1.25	1.40	1.55	1.56	2.14	2.52	3.00	3.36	3.72
	30-min	0.69	0.94	1.11	1.33	1.49	1.64	1.38	1.89	2.23	2.65	2.97	3.29
	35-min	0.71	0.97	1.14	1.36	1.52	1.69	1.21	1.66	1.96	2.34	2.61	2.89
	40-min	0.73	0.99	1.17	1.40	1.56	1.73	1.09	1.49	1.76	2.10	2.35	2.59
	45-min	0.74	1.02	1.20	1.43	1.60	1.77	0.99	1.36	1.60	1.91	2.14	2.36
	50-min	0.76	1.04	1.22	1.46	1.63	1.80	0.91	1.24	1.47	1.75	1.96	2.17
	55-min	0.77	1.06	1.24	1.48	1.66	1.84	0.84	1.15	1.36	1.62	1.81	2.00
	1-hr	0.78	1.07	1.27	1.51	1.69	1.87	0.78	1.07	1.27	1.51	1.69	1.87
	2-hr	0.92	1.26	1.48	1.76	1.97	2.18	0.46	0.63	0.74	0.88	0.99	1.09
	3-hr	1.01	1.36	1.59	1.88	2.09	2.31	0.34	0.45	0.53	0.63	0.70	0.77
	6-hr	1.20	1.56	1.79	2.09	2.31	2.53	0.20	0.26	0.30	0.35	0.39	0.42
	12-hr	1.45	1.86	2.14	2.48	2.74	3.00	0.12	0.16	0.18	0.21	0.23	0.25
	24-hr	1.84	2.49	2.93	3.48	3.89	4.29	0.077	0.104	0.122	0.145	0.162	0.179
Townsend-12ENE	5-min	0.19	0.28	0.33	0.40	0.45	0.50	2.31	3.30	3.96	4.79	5.41	6.02
COOP: 248329	10-min	0.28	0.40	0.48	0.58	0.66	0.73	1.69	2.42	2.90	3.50	3.96	4.40
Elev: 5,050 ft	15-min	0.34	0.49	0.59	0.71	0.80	0.89	1.37	1.96	2.35	2.84	3.21	3.57
Modified POR: 60	20-min	0.37	0.52	0.63	0.76	0.86	0.95	1.10	1.57	1.88	2.28	2.57	2.86
Type: 2nd Order	25-min	0.39	0.56	0.67	0.81	0.91	1.02	0.93	1.34	1.60	1.94	2.19	2.44
	30-min	0.41	0.59	0.71	0.86	0.97	1.08	0.83	1.18	1.42	1.71	1.93	2.15
	35-min	0.42	0.61	0.73	0.88	0.99	1.11	0.73	1.04	1.25	1.51	1.70	1.89
	40-min	0.43	0.62	0.75	0.90	1.02	1.13	0.65	0.93	1.12	1.35	1.53	1.70
	45-min	0.45	0.64	0.76	0.92	1.04	1.16	0.59	0.85	1.02	1.23	1.39	1.55
	50-min	0.45	0.65	0.78	0.94	1.06	1.18	0.54	0.78	0.93	1.13	1.27	1.42
	55-min	0.46	0.66	0.79	0.96	1.08	1.20	0.50	0.72	0.86	1.04	1.18	1.31
	1-hr	0.47	0.67	0.80	0.97	1.10	1.22	0.47	0.67	0.80	0.97	1.10	1.22
	2-hr	0.55	0.74	0.87	1.04	1.16	1.28	0.28	0.37	0.44	0.52	0.58	0.64
	3-hr	0.65	0.82	0.94	1.08	1.19	1.29	0.22	0.27	0.31	0.36	0.40	0.43
	6-hr	0.83	1.00	1.11	1.26	1.36	1.47	0.14	0.17	0.19	0.21	0.23	0.24
	12-hr	1.11	1.35	1.51	1.72	1.87	2.02	0.09	0.11	0.13	0.14	0.16	0.17
	24-hr	1.43	1.75	1.97	2.24	2.44	2.64	0.060	0.073	0.082	0.093	0.102	0.110

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Vananda-6NE	5-min	0.28	0.46	0.57	0.72	0.83	0.94	3.36	5.49	6.89	8.67	9.99	11.30
COOP: 248511	10-min	0.41	0.67	0.84	1.06	1.22	1.38	2.46	4.01	5.04	6.35	7.31	8.27
Elev: 2,625 ft	15-min	0.50	0.81	1.02	1.29	1.48	1.68	1.99	3.26	4.09	5.15	5.93	6.71
Modified POR: 57	20-min	0.53	0.87	1.09	1.37	1.58	1.79	1.60	2.61	3.28	4.12	4.75	5.37
Type: 2nd Order	25-min	0.57	0.93	1.16	1.46	1.69	1.91	1.36	2.22	2.79	3.51	4.05	4.58
	30-min	0.60	0.98	1.23	1.55	1.79	2.02	1.20	1.96	2.47	3.10	3.57	4.04
	35-min	0.62	1.01	1.27	1.59	1.83	2.07	1.06	1.73	2.17	2.73	3.14	3.56
	40-min	0.63	1.03	1.30	1.63	1.88	2.13	0.95	1.55	1.95	2.45	2.82	3.19
	45-min	0.65	1.06	1.33	1.67	1.93	2.18	0.87	1.41	1.77	2.23	2.57	2.91
	50-min	0.66	1.08	1.35	1.70	1.96	2.22	0.79	1.29	1.63	2.04	2.36	2.66
	55-min	0.67	1.10	1.38	1.73	2.00	2.26	0.73	1.20	1.50	1.89	2.18	2.46
	1-hr	0.68	1.12	1.40	1.76	2.03	2.30	0.68	1.12	1.40	1.76	2.03	2.30
	2-hr	0.80	1.26	1.58	1.97	2.26	2.55	0.40	0.63	0.79	0.98	1.13	1.27
	3-hr	0.86	1.35	1.68	2.08	2.39	2.69	0.29	0.45	0.56	0.69	0.80	0.90
	6-hr	1.07	1.68	2.08	2.59	2.97	3.34	0.18	0.28	0.35	0.43	0.49	0.56
	12-hr	1.23	1.81	2.20	2.69	3.05	3.41	0.10	0.15	0.18	0.22	0.25	0.28
	24-hr	1.43	2.01	2.40	2.88	3.24	3.60	0.060	0.084	0.100	0.120	0.135	0.150
West Glacier	5-min	0.18	0.23	0.27	0.31	0.35	0.38	2.15	2.80	3.22	3.76	4.16	4.56
COOP: 248809	10-min	0.26	0.34	0.39	0.46	0.51	0.56	1.58	2.05	2.36	2.75	3.05	3.34
Elev: 3,154 ft	15-min	0.32	0.42	0.48	0.56	0.62	0.68	1.28	1.66	1.91	2.23	2.47	2.71
Modified POR: 38	20-min	0.34	0.44	0.51	0.60	0.66	0.72	1.02	1.33	1.53	1.79	1.98	2.17
Type: 2nd Order	25-min	0.36	0.47	0.54	0.63	0.70	0.77	0.87	1.13	1.31	1.52	1.68	1.85
	30-min	0.39	0.50	0.58	0.67	0.74	0.82	0.77	1.00	1.15	1.35	1.49	1.63
	35-min	0.40	0.51	0.59	0.69	0.76	0.84	0.68	0.88	1.01	1.18	1.31	1.43
	40-min	0.41	0.53	0.61	0.71	0.78	0.86	0.61	0.79	0.91	1.06	1.18	1.29
	45-min	0.42	0.54	0.62	0.73	0.80	0.88	0.55	0.72	0.83	0.97	1.07	1.17
	50-min	0.42	0.55	0.63	0.74	0.82	0.90	0.51	0.66	0.76	0.89	0.98	1.07
	55-min	0.43	0.56	0.64	0.75	0.83	0.91	0.47	0.61	0.70	0.82	0.91	0.99
	1-hr	0.44	0.57	0.66	0.76	0.85	0.93	0.44	0.57	0.66	0.76	0.85	0.93
	2-hr	0.55	0.68	0.77	0.88	0.96	1.04	0.27	0.34	0.38	0.44	0.48	0.52
	3-hr	0.63	0.76	0.84	0.95	1.02	1.10	0.21	0.25	0.28	0.32	0.34	0.37
	6-hr	0.85	0.99	1.09	1.21	1.30	1.39	0.14	0.17	0.18	0.20	0.22	0.23
	12-hr	1.12	1.31	1.44	1.60	1.71	1.83	0.09	0.11	0.12	0.13	0.14	0.15
	24-hr	1.45	1.72	1.90	2.13	2.30	2.47	0.060	0.072	0.079	0.089	0.096	0.103

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Westby	5-min	0.33	0.47	0.57	0.68	0.77	0.86	3.98	5.68	6.80	8.22	9.27	10.31
COOP: 248777	10-min	0.49	0.69	0.83	1.00	1.13	1.26	2.92	4.15	4.98	6.01	6.78	7.54
Elev: 2,105 ft	15-min	0.59	0.84	1.01	1.22	1.38	1.53	2.36	3.37	4.04	4.88	5.50	6.12
Modified POR: 50	20-min	0.63	0.90	1.08	1.30	1.47	1.63	1.90	2.70	3.23	3.91	4.41	4.90
Type: 2nd Order	25-min	0.67	0.96	1.15	1.39	1.56	1.74	1.61	2.30	2.75	3.33	3.75	4.17
	30-min	0.71	1.02	1.22	1.47	1.66	1.84	1.43	2.03	2.43	2.94	3.32	3.69
	35-min	0.73	1.04	1.25	1.51	1.70	1.89	1.25	1.79	2.14	2.59	2.92	3.25
	40-min	0.75	1.07	1.28	1.55	1.75	1.94	1.13	1.60	1.92	2.32	2.62	2.91
	45-min	0.77	1.10	1.31	1.59	1.79	1.99	1.03	1.46	1.75	2.12	2.39	2.65
	50-min	0.78	1.12	1.34	1.61	1.82	2.03	0.94	1.34	1.60	1.94	2.19	2.43
	55-min	0.80	1.13	1.36	1.64	1.85	2.06	0.87	1.24	1.48	1.79	2.02	2.25
	1-hr	0.81	1.15	1.38	1.67	1.88	2.10	0.81	1.15	1.38	1.67	1.88	2.10
	2-hr	0.95	1.36	1.63	1.97	2.22	2.47	0.48	0.68	0.81	0.99	1.11	1.24
	3-hr	1.06	1.47	1.74	2.08	2.33	2.58	0.35	0.49	0.58	0.69	0.78	0.86
	6-hr	1.22	1.65	1.93	2.29	2.55	2.82	0.20	0.27	0.32	0.38	0.43	0.47
	12-hr	1.40	1.89	2.22	2.62	2.93	3.23	0.12	0.16	0.18	0.22	0.24	0.27
	24-hr	1.63	2.18	2.54	3.01	3.35	3.69	0.068	0.091	0.106	0.125	0.139	0.154
White Sulphur Springs	5-min	0.22	0.30	0.36	0.42	0.47	0.52	2.68	3.63	4.27	5.07	5.66	6.25
COOP: 248927	10-min	0.33	0.44	0.52	0.62	0.69	0.76	1.96	2.66	3.12	3.71	4.14	4.57
Elev: 5,160 ft	15-min	0.40	0.54	0.63	0.75	0.84	0.93	1.59	2.16	2.53	3.01	3.36	3.71
Modified POR: 28	20-min	0.42	0.58	0.68	0.80	0.90	0.99	1.27	1.73	2.03	2.41	2.69	2.97
Type: 2nd Order	25-min	0.45	0.61	0.72	0.85	0.95	1.05	1.08	1.47	1.73	2.05	2.29	2.53
	30-min	0.48	0.65	0.76	0.91	1.01	1.12	0.96	1.30	1.53	1.81	2.02	2.24
	35-min	0.49	0.67	0.78	0.93	1.04	1.15	0.84	1.14	1.34	1.59	1.78	1.97
	40-min	0.50	0.68	0.80	0.95	1.07	1.18	0.76	1.03	1.21	1.43	1.60	1.77
	45-min	0.52	0.70	0.82	0.98	1.09	1.21	0.69	0.94	1.10	1.30	1.46	1.61
	50-min	0.53	0.71	0.84	1.00	1.11	1.23	0.63	0.86	1.01	1.19	1.33	1.47
	55-min	0.54	0.73	0.85	1.01	1.13	1.25	0.58	0.79	0.93	1.10	1.23	1.36
	1-hr	0.54	0.74	0.87	1.03	1.15	1.27	0.54	0.74	0.87	1.03	1.15	1.27
	2-hr	0.66	0.89	1.05	1.24	1.39	1.53	0.33	0.45	0.52	0.62	0.69	0.76
	3-hr	0.73	1.03	1.23	1.49	1.67	1.86	0.24	0.34	0.41	0.50	0.56	0.62
	6-hr	0.89	1.20	1.40	1.65	1.84	2.03	0.15	0.20	0.23	0.28	0.31	0.34
	12-hr	1.07	1.38	1.59	1.85	2.04	2.23	0.09	0.12	0.13	0.15	0.17	0.19
	24-hr	1.33	1.70	1.95	2.26	2.49	2.72	0.055	0.071	0.081	0.094	0.104	0.113

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Willow Creek	5-min	0.19	0.23	0.25	0.28	0.31	0.33	2.29	2.73	3.02	3.39	3.66	3.94
COOP: 249008	10-min	0.28	0.33	0.37	0.41	0.45	0.48	1.68	2.00	2.21	2.48	2.68	2.88
Elev: 4,163 ft	15-min	0.34	0.41	0.45	0.50	0.54	0.58	1.36	1.62	1.79	2.01	2.18	2.34
Modified POR: 20	20-min	0.36	0.43	0.48	0.54	0.58	0.62	1.09	1.30	1.44	1.61	1.74	1.87
Type: 2nd Order	25-min	0.39	0.46	0.51	0.57	0.62	0.66	0.93	1.11	1.22	1.37	1.48	1.59
	30-min	0.41	0.49	0.54	0.61	0.66	0.70	0.82	0.98	1.08	1.21	1.31	1.41
	35-min	0.42	0.50	0.56	0.62	0.67	0.72	0.72	0.86	0.95	1.07	1.15	1.24
	40-min	0.43	0.51	0.57	0.64	0.69	0.74	0.65	0.77	0.85	0.96	1.04	1.11
	45-min	0.44	0.53	0.58	0.65	0.71	0.76	0.59	0.70	0.78	0.87	0.94	1.01
	50-min	0.45	0.54	0.59	0.67	0.72	0.77	0.54	0.64	0.71	0.80	0.86	0.93
	55-min	0.46	0.55	0.60	0.68	0.73	0.79	0.50	0.60	0.66	0.74	0.80	0.86
	1-hr	0.47	0.56	0.61	0.69	0.74	0.80	0.47	0.56	0.61	0.69	0.74	0.80
	2-hr	0.54	0.65	0.71	0.80	0.86	0.92	0.27	0.32	0.36	0.40	0.43	0.46
	3-hr	0.63	0.82	0.94	1.09	1.21	1.32	0.21	0.27	0.31	0.36	0.40	0.44
	6-hr	0.79	1.04	1.20	1.41	1.56	1.71	0.13	0.17	0.20	0.23	0.26	0.29
	12-hr	0.99	1.31	1.52	1.79	1.99	2.19	0.08	0.11	0.13	0.15	0.17	0.18
	24-hr	1.30	1.63	1.84	2.12	2.32	2.52	0.054	0.068	0.077	0.088	0.097	0.105
Winnett-8ESE	5-min	0.25	0.36	0.44	0.53	0.60	0.67	2.98	4.33	5.23	6.36	7.20	8.03
COOP: 249052	10-min	0.36	0.53	0.64	0.78	0.88	0.98	2.18	3.17	3.83	4.65	5.27	5.88
Elev: 2,810 ft	15-min	0.44	0.64	0.78	0.94	1.07	1.19	1.77	2.57	3.10	3.78	4.27	4.77
Modified POR: 61	20-min	0.47	0.69	0.83	1.01	1.14	1.27	1.42	2.06	2.49	3.03	3.42	3.82
Type: 2nd Order	25-min	0.50	0.73	0.88	1.07	1.21	1.36	1.21	1.75	2.12	2.58	2.92	3.25
	30-min	0.53	0.78	0.94	1.14	1.29	1.44	1.07	1.55	1.87	2.28	2.58	2.87
	35-min	0.55	0.80	0.96	1.17	1.32	1.48	0.94	1.36	1.65	2.00	2.27	2.53
	40-min	0.56	0.82	0.98	1.20	1.36	1.51	0.84	1.22	1.48	1.80	2.03	2.27
	45-min	0.58	0.84	1.01	1.23	1.39	1.55	0.77	1.12	1.35	1.64	1.85	2.07
	50-min	0.59	0.85	1.03	1.25	1.41	1.58	0.70	1.02	1.23	1.50	1.70	1.89
	55-min	0.60	0.87	1.05	1.27	1.44	1.61	0.65	0.94	1.14	1.39	1.57	1.75
	1-hr	0.61	0.88	1.06	1.29	1.46	1.63	0.61	0.88	1.06	1.29	1.46	1.63
	2-hr	0.73	1.09	1.33	1.64	1.86	2.09	0.36	0.55	0.67	0.82	0.93	1.04
	3-hr	0.82	1.23	1.49	1.83	2.09	2.34	0.27	0.41	0.50	0.61	0.70	0.78
	6-hr	1.00	1.39	1.65	1.98	2.22	2.46	0.17	0.23	0.27	0.33	0.37	0.41
	12-hr	1.22	1.62	1.89	2.22	2.47	2.72	0.10	0.14	0.16	0.19	0.21	0.23
	24-hr	1.52	1.98	2.29	2.67	2.96	3.24	0.063	0.083	0.095	0.111	0.123	0.135

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Wisdom	5-min	0.16	0.22	0.27	0.32	0.37	0.41	1.89	2.69	3.22	3.90	4.39	4.89
COOP: 249067	10-min	0.23	0.33	0.39	0.48	0.54	0.60	1.38	1.97	2.36	2.85	3.22	3.58
Elev: 6,060 ft	15-min	0.28	0.40	0.48	0.58	0.65	0.73	1.12	1.60	1.91	2.31	2.61	2.90
Modified POR: 58	20-min	0.30	0.43	0.51	0.62	0.70	0.78	0.90	1.28	1.53	1.85	2.09	2.33
Type: 2nd Order	25-min	0.32	0.45	0.54	0.66	0.74	0.82	0.76	1.09	1.31	1.58	1.78	1.98
	30-min	0.34	0.48	0.58	0.70	0.79	0.87	0.68	0.96	1.15	1.39	1.57	1.75
	35-min	0.35	0.49	0.59	0.72	0.81	0.90	0.59	0.85	1.01	1.23	1.38	1.54
	40-min	0.36	0.51	0.61	0.73	0.83	0.92	0.53	0.76	0.91	1.10	1.24	1.38
	45-min	0.36	0.52	0.62	0.75	0.85	0.94	0.49	0.69	0.83	1.00	1.13	1.26
	50-min	0.37	0.53	0.63	0.77	0.86	0.96	0.45	0.63	0.76	0.92	1.04	1.15
	55-min	0.38	0.54	0.64	0.78	0.88	0.98	0.41	0.59	0.70	0.85	0.96	1.07
	1-hr	0.38	0.55	0.66	0.79	0.89	0.99	0.38	0.55	0.66	0.79	0.89	0.99
	2-hr	0.45	0.63	0.75	0.90	1.01	1.12	0.22	0.31	0.37	0.45	0.51	0.56
	3-hr	0.51	0.68	0.80	0.95	1.06	1.17	0.17	0.23	0.27	0.32	0.35	0.39
	6-hr	0.62	0.80	0.92	1.06	1.17	1.28	0.10	0.13	0.15	0.18	0.20	0.21
	12-hr	0.80	1.02	1.16	1.35	1.48	1.61	0.07	0.09	0.10	0.11	0.12	0.13
	24-hr	0.98	1.20	1.36	1.55	1.69	1.83	0.041	0.050	0.056	0.064	0.070	0.076
West Yellowstone	5-min	0.22	0.36	0.45	0.57	0.66	0.74	2.60	4.29	5.40	6.81	7.86	8.90
COOP: 248866	10-min	0.32	0.52	0.66	0.83	0.96	1.09	1.90	3.14	3.95	4.99	5.75	6.51
Elev: 6,660 ft	15-min	0.39	0.64	0.80	1.01	1.17	1.32	1.54	2.54	3.21	4.04	4.67	5.28
Modified POR: 25	20-min	0.41	0.68	0.86	1.08	1.25	1.41	1.24	2.04	2.57	3.24	3.74	4.23
Type: 2nd Order	25-min	0.44	0.72	0.91	1.15	1.33	1.50	1.05	1.74	2.19	2.76	3.18	3.60
	30-min	0.47	0.77	0.97	1.22	1.41	1.59	0.93	1.53	1.93	2.44	2.81	3.18
	35-min	0.48	0.79	0.99	1.25	1.44	1.63	0.82	1.35	1.70	2.14	2.47	2.80
	40-min	0.49	0.81	1.02	1.28	1.48	1.68	0.74	1.21	1.53	1.93	2.22	2.51
	45-min	0.50	0.83	1.04	1.32	1.52	1.72	0.67	1.10	1.39	1.75	2.02	2.29
	50-min	0.51	0.84	1.06	1.34	1.54	1.75	0.61	1.01	1.27	1.61	1.85	2.10
	55-min	0.52	0.86	1.08	1.36	1.57	1.78	0.57	0.93	1.18	1.49	1.71	1.94
	1-hr	0.53	0.87	1.10	1.39	1.60	1.81	0.53	0.87	1.10	1.39	1.60	1.81
	2-hr	0.62	0.98	1.22	1.52	1.74	1.96	0.31	0.49	0.61	0.76	0.87	0.98
	3-hr	0.69	1.08	1.34	1.66	1.91	2.15	0.23	0.36	0.45	0.55	0.64	0.72
	6-hr	0.88	1.27	1.53	1.85	2.09	2.33	0.15	0.21	0.25	0.31	0.35	0.39
	12-hr	1.05	1.42	1.66	1.96	2.19	2.42	0.09	0.12	0.14	0.16	0.18	0.20
	24-hr	1.28	1.60	1.82	2.09	2.29	2.48	0.053	0.067	0.076	0.087	0.095	0.103

Station Information	Storm Duration	Depth at Selected Recurrence Intervals (inches)						Intensity at Selected Recurrence Intervals (inches/hour)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Yellowtail Dam	5-min	0.28	0.38	0.45	0.54	0.61	0.67	3.31	4.58	5.42	6.49	7.28	8.06
COOP: 249240	10-min	0.40	0.56	0.66	0.79	0.89	0.98	2.42	3.35	3.97	4.75	5.33	5.90
Elev: 3,305 ft	15-min	0.49	0.68	0.80	0.96	1.08	1.20	1.96	2.72	3.22	3.85	4.32	4.79
Modified POR: 39	20-min	0.52	0.73	0.86	1.03	1.15	1.28	1.57	2.18	2.58	3.09	3.46	3.84
Type: 2nd Order	25-min	0.56	0.77	0.91	1.09	1.23	1.36	1.34	1.85	2.20	2.63	2.95	3.26
	30-min	0.59	0.82	0.97	1.16	1.30	1.44	1.18	1.64	1.94	2.32	2.60	2.88
	35-min	0.61	0.84	1.00	1.19	1.34	1.48	1.04	1.44	1.71	2.04	2.29	2.54
	40-min	0.62	0.86	1.02	1.22	1.37	1.52	0.93	1.29	1.53	1.83	2.06	2.28
	45-min	0.64	0.88	1.05	1.25	1.41	1.56	0.85	1.18	1.40	1.67	1.87	2.08
	50-min	0.65	0.90	1.07	1.27	1.43	1.58	0.78	1.08	1.28	1.53	1.72	1.90
	55-min	0.66	0.92	1.08	1.30	1.45	1.61	0.72	1.00	1.18	1.41	1.59	1.76
	1-hr	0.67	0.93	1.10	1.32	1.48	1.64	0.67	0.93	1.10	1.32	1.48	1.64
	2-hr	0.81	1.18	1.43	1.74	1.97	2.20	0.40	0.59	0.71	0.87	0.98	1.10
	3-hr	0.89	1.31	1.58	1.93	2.19	2.45	0.30	0.44	0.53	0.64	0.73	0.82
	6-hr	1.13	1.62	1.95	2.36	2.66	2.96	0.19	0.27	0.32	0.39	0.44	0.49
	12-hr	1.49	2.14	2.57	3.11	3.51	3.90	0.12	0.18	0.21	0.26	0.29	0.33
	24-hr	1.90	2.67	3.19	3.83	4.31	4.79	0.079	0.111	0.133	0.160	0.180	0.199
Zortman	5-min	0.32	0.47	0.57	0.70	0.79	0.89	3.87	5.69	6.89	8.41	9.54	10.66
COOP: 249900	10-min	0.47	0.69	0.84	1.03	1.16	1.30	2.83	4.16	5.04	6.15	6.98	7.80
Elev: 4,035 ft	15-min	0.57	0.84	1.02	1.25	1.42	1.58	2.30	3.38	4.09	4.99	5.66	6.33
Modified POR: 35	20-min	0.61	0.90	1.09	1.33	1.51	1.69	1.84	2.71	3.28	4.00	4.54	5.07
Type: 2nd Order	25-min	0.65	0.96	1.16	1.42	1.61	1.80	1.57	2.30	2.79	3.41	3.86	4.32
	30-min	0.69	1.02	1.23	1.50	1.71	1.91	1.39	2.04	2.47	3.01	3.41	3.81
	35-min	0.71	1.04	1.27	1.54	1.75	1.96	1.22	1.79	2.17	2.65	3.00	3.35
	40-min	0.73	1.07	1.30	1.58	1.80	2.01	1.09	1.61	1.95	2.38	2.69	3.01
	45-min	0.75	1.10	1.33	1.62	1.84	2.06	1.00	1.46	1.77	2.17	2.46	2.74
	50-min	0.76	1.12	1.35	1.65	1.87	2.09	0.91	1.34	1.63	1.98	2.25	2.51
	55-min	0.77	1.14	1.38	1.68	1.91	2.13	0.84	1.24	1.50	1.83	2.08	2.32
	1-hr	0.79	1.16	1.40	1.71	1.94	2.17	0.79	1.16	1.40	1.71	1.94	2.17
	2-hr	0.93	1.22	1.41	1.65	1.82	2.00	0.47	0.61	0.70	0.82	0.91	1.00
	3-hr	1.04	1.30	1.48	1.70	1.87	2.04	0.35	0.43	0.49	0.57	0.62	0.68
	6-hr	1.34	1.71	1.95	2.27	2.50	2.73	0.22	0.28	0.33	0.38	0.42	0.45
	12-hr	1.91	2.60	3.06	3.64	4.06	4.49	0.16	0.22	0.25	0.30	0.34	0.37
	24-hr	2.57	3.64	4.35	5.25	5.91	6.57	0.107	0.152	0.181	0.219	0.246	0.274

Appendix 9C — HYDROLOGY REPORT TEMPLATE

Montana Department of Transportation
PO Box 201001
Helena, MT 59620-1001

Hydrologic Analysis and Existing Pipe Capacities Report

Project Name:
Project Number:
UPN:
By:
Date:

INTRODUCTION

Provide a brief description of the project location, route, project limits, and scope of work.

Include a general description of the project area (terrain, land use, etc.).

DESIGN EVENT

Describe both the ADT & ADT × Detour (Typically one Design Event calculation per project).

Include a figure of route & detour route.

Identify the selected design storm and identify if site constraints such as an emergency route dictate a higher design storm.

HYDROLOGY

Drainage Basins Discussion

All basins within the project should be delineated to establish drainage patterns.

Describe method used to delineate basins (by hand in CADD with topo maps, StreamStats, GIS, etc.).

Describe the large basins — named streams (if applicable), major features, ephemeral/perennial, topography, elevation, drainage area, aspect, vegetation, StreamStats hydrologic region and variables, etc.

Include figures of the delineated basins in Appendix A.

Methods Analyzed

Note: Not all projects will have large, medium, and small drainage basins. It may be necessary to add additional categories and, in other cases, fewer categories may be appropriate.

Large Basins (> 1000 ft^3/s for Design Event)

(Includes named basins, large culverts, and bridges)

Describe a minimum of three methods used to calculate hydrology; include variables and results.

Complete the table below comparing a minimum of three hydrologic methods for each large-basin site and highlight the selected hydrologic method.

Hydrologic Methods Analyzed for the XXX Site

Hydrologic Method	Q_2 (ft^3/s)	Q_5 (ft^3/s)	Q_{10} (ft^3/s)	Q_{25} (ft^3/s)	Q_{50} (ft^3/s)	Q_{100} (ft^3/s)	Q_{200} (ft^3/s)	Q_{500} (ft^3/s)
Hydrologic Method #1 *(Title should be the method used)*	100,000	100,000	100,000	100,000	100,000			100,000
Hydrologic Method #2 *(Title should be the method used)*								
Hydrologic Method #3 *(Title should be the method used)*								

(Highlighted row designates the selected method)

Justify the selected hydrologic method and flow rates.

Medium Basins (≥ 1 mi^2 and < 1000 ft^3/s for Design Event)

Describe a minimum of three methods used to calculate hydrology for medium basins; include variables and results.

Complete the tables below summarizing the Q_{Design} and Q_{100} hydrology results for the analyzed methods and highlight the selected hydrologic method.

Hydrologic Methods Analyzed for the Medium Basins — Q_{Design} Discharges

(Change "Design" to appropriate year)

Project Station of Existing Culvert	Ref Post	Existing Size & Type	Function	Drainage Area (mi^2)	Hydrologic Method #1 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #2 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #3 (ft^3/s) *(Title should be the method used)*
100 + 00	27.2	48″ CMP	Dr				
100 + 65	27.8	72″ RCP	Dr				
270 + 01			Irr/Dr				
289 + 46			Dr				
300 + 10			Dr				

(Highlighted row designates the selected method)

Hydrologic Methods Analyzed for the Medium Basins — Q_{100} Discharges

Project Station of Existing Culvert	Ref Post	Existing Size & Type	Function	Drainage Area (mi^2)	Hydrologic Method #1 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #2 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #3 (ft^3/s) *(Title should be the method used)*
100 + 00	27.2	48″ CMP	Dr				
100 + 65	27.8	72″ RCP	Dr				
270 + 01			Irr/Dr				
289 + 46			Dr				
300 + 10			Dr				

(Highlighted row designates the selected method)

Small Basins (< 1 mi^2)

Describe methods used to calculate hydrology for small basins; include variables and results.

Complete tables below comparing hydrologic methods for each site and highlight the selected hydrologic method.

Hydrologic Methods Analyzed for the Small Basins — Q_{Design} Discharge

(Change "Design" to appropriate year)

Project Station of Existing Culvert	Ref Post	Existing Size & Type	Function	Drainage Area (mi^2)	Hydrologic Method #1 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #2 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #3 (ft^3/s) *(Title should be the method used)*
200+01	29.0	24″ CMP	Irr/Dr				
205+87	29.2	24″ RCP	Dr				
314+19			Dr				
367+88			Dr				
406+33			Dr				

(Highlighted row designates the selected method)

Hydrologic Methods Analyzed for the Small Basins — Q_{100} Discharges

Project Station of Existing Culvert	Ref Post	Existing Size & Type	Function	Drainage Area (mi^2)	Hydrologic Method #1 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #2 (ft^3/s) *(Title should be the method used)*	Hydrologic Method #3 (ft^3/s) *(Title should be the method used)*
200 + 01	29.0	24″ CMP	Irr/Dr				
205 + 87	29.2	24″ RCP	Dr				
314 + 19			Dr				
367 + 88			Dr				
406 + 33			Dr				

(Highlighted row designates the selected method)

Justify the selected hydrologic method and flow rates

EXISTING DRAINAGE PIPE CAPACITY VS. SELECTED HYDROLOGY

Describe historical adequacy — research past flooding. Contact Maintenance personnel and landowners and document discussions. Also, check the flood map and aerial flood photos. If the flooding history is documented in the LHSR, repeat that information here.

Complete the table below to compare the selected hydrologic method with the culvert performance, and verify that the selected hydrologic method fits the existing culvert size and past performance. Identify with a comment, and highlight the row of undersized crossings that have had performance issues and have the potential to impact the proposed alignment and grade. The comments column may also be used to note concerns with the existing culvert such as *erosion, scour hole, sediment, debris, ice, beaver, road overtopping, or none, etc., that may warrant upsizing the culvert.*

Selected Hydrologic Method Compared to Overtopping (Basin or Road) and Existing Pipe Past Performance

Station	Existing Size & Type	Selected Drainage Hydrology Q_{Design} (ft^3/s)	Q_{OT} (ft^3/s)	OT Elev (ft)	OT Location (Road, basin divide, etc.)	Q (ft^3/s) OT to Next Basin (Ahead or Back station)	HW Elev Q_{Design} (ft)	Max Allow HW Q_{Design} (ft)	Comments *(Past performance issues, need to upsize, etc.)*
100 + 00	24″ CMP					15 ft^3/s Ahead			
100 + 65	48″ RCP					N/A			

(Highlighted rows designate culverts needing to be upsized.)

AREAS OF CONCERN

Areas identified as being undersized will need a preliminary sizing for Alignment and Grade comments.

Complete preliminary sizing only for the areas of concern; include calculations in Appendix F.

Preliminary Recommendation Summary

Include discussion of preliminary recommendations only for areas with drainage concerns that need to be addressed at Alignment and Grade. All other preliminary recommendations will be made later in the design process.

APPENDICES

Appendix A — Drainage Basins Boundary Map(s)

(Label roadway stations, basin names, drainage areas, flow arrows, existing crossings, channels, irrigation ditches, travel paths (optional), etc.)

Appendix B — Hydrologic Calculations for Large Basins (> 1000 ft^3/s for Design Event)

Appendix C — Hydrologic Calculations for Medium Basins (≥ 1 mi^2 and < 1000 ft^3/s for Design Event)

Appendix D — Hydrologic Calculations for Small Basins (< 1 mi^2)

Appendix E — Existing Culverts Documentation

(Consider using a spreadsheet with the existing culvert data known at this time and used to develop the HY8 runs.)

Appendix F — Preliminary Proposed Calculations for Sites Needing Additional Hydraulic Capacity