MHFD 1% Plus Flow Frequency Spreadsheet

What is the 1% plus flow?

The 1% plus flow is the flow corresponding to the upper 84% confidence limit of the 1% annual chance flood (the 100-year event), as defined by the Federal Emergency Management Agency (FEMA).

How is the 1% plus flow calculated?

If a reliable gage record is available, the upper 84% confidence limit of the 100-year event, or 1% plus flow, can be calculated using Bulletin 17B or 17C statistical analysis to develop a flow frequency curve and associated confidence limits.

However, in many cases the regulatory flow frequency values are based on modeled hydrology. In this case, the modeled 2-year, 10-year, and 100-year flows as well as an assumed period of record (based on confidence in the modeled hydrology) are used to calculate synthetic statistics for the flow frequency curve: the skew, mean, and standard deviation. These synthetic statistics are in turn used to calculate the upper 84% confidence limits of the 100-year event. This methodology is based on guidance from FEMA, USACE, and USGS's Bulletin 17B and Bulletin 17C. The equations found in these reference documents are the underlying equations built into the MHFD 1% plus flow frequency spreadsheet.

How to use MHFD 1% plus flow frequency spreadsheet:

1. **Input the 2-year, 10-year and 100-year flows into the respective cells.** These are the flow frequency values based on the hydrologic modeling for that location. The peak discharge values are entered into the "1% Plus Inputs" tab.
2. **Input the assumed period of record into the respective cell.** The assumed period of record, or equivalent period of record, is a reflection of the confidence in the modeled hydrologic values. A higher assumed period of record reflects greater confidence in the modeled hydrology, and thus tighter confidence limits. If the CUHP and standard modeling methodology is used, an assumed period of record of 30 years is recommended, based on guidance from the United States Army Corps of Engineers. If there is uncertainty in the modeling, or the modeled location does not fit the assumptions of CUHP, a lower assumed period of record should be used.
3. **Review the calculated synthetic logarithmic skew coefficient in the "calculations" tab.** If the calculated value is greater than +2.5 or less than -2.0, it falls outside the range recommended for use with the underlying Bulletin 17B equation. A warning will appear in the "Warnings" column of the spreadsheet. While this value can still be used for the remaining calculations of the 1% plus flow, a skew value outside the recommended range indicates that the input flow frequency values do not follow the typical shape of a flow frequency curve, and the reasonableness of these input values should be reviewed.

4. **The 1% plus flow, or 0.01 AEP upper 84% confidence limit, will be calculated.** Review this value. The spreadsheet will also display the values associated with intermediary calculations that were used to compute the final 1% plus flow value in the "Calculations" tab.

Example Spreadsheet Calculations:

The 1% plus flow can be calculated using the same spreadsheet for multiple locations. Enter a new location name and data into each row.

The 2-year, 10-year, and 100-year flows as well as the assumed period of record are input into columns B through E.

The calculated 1% plus flow is displayed in column F.

If the calculated synthetic skew is outside the recommended range, a warning will appear here.

	A	B	C	D	E	F	G
1							
2							
3	Location Name	2-year Peak Discharge (cfs)	10-year Peak Discharge (cfs)	100-year Peak Discharge (cfs)	Assumed Period of Record (N, yrs)	**0.01 AEP Upper 84% Confidence Limit [1% Plus flow] (cfs)**	Warnings
4	Example	50	300	1,000	30	**1,742**	
5						**Need Data**	
6						**Need Data**	
7						**Need Data**	
8						**Need Data**	
9						**Need Data**	
10						**Need Data**	
11						**Need Data**	
12						**Need Data**	

The intermediary calculations can be found in the "Calculations" tab of the 1% plus spreadsheet.

Additional information on the underlying 1% plus calculation methodology can be found in these sources:

England, John F. Jr., Cohn, Timothy, A., Faber, Beth A., et al. 2019. Guidelines for Determining Flood Flow Frequency Bulletin 17C. U.S. Geological Survey. Techniques and Methods 4-B5, Version 1.1, May 2019. Available at https://pubs.er.usgs.gov/publication/tm4B5

Federal Emergency Management Agency. 2019. Guidance for Flood Risk Analysis and Mapping, Hydrology: Rainfall-Runoff Analysis. Guidance Document 91.

Interagency Advisory Committee on Water Data. 1981. Guidelines for Determining Flood Flow Frequency. Bulletin #17B of the Hydrology Subcommittee. United States Geological Survey.

United States Army Corps of Engineers. 1996. Risk Based Analysis for Flood Damage Reduction Studies. Engineering Manual No. 1110-2-1619.

Wright Water Engineers. 2022. Memo to MHFD on One-Percent-Plus Flow Frequency Analysis.