REVISED TECHNIQUES FOR ESTIMATING PEAK DISCHARGES FROM CHANNEL WIDTH IN MONTANA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 87-4121

Prepared in cooperation with the
MONTANA DEPARTMENT OF HIGHWAYS and
the U.S. BUREAU OF LAND MANAGEMENT

Front cover: Upper photograph shows channel-width measurement site on Canyon Creek near Birney, Montana (station 06307520).

Lower photograph shows channel-width measurement site on Big Sheep Creek below Muddy Creek, near Dell, Montana (station 06013500).

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DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

For those readers who may prefer to use metric (International System) units rather than inch-pound units, the conversion factors for the terms used in this report are listed below.

Multiply inch-pound unit	By	To obtain metric unit
cubic foot per second	0.02832	cubic meter per second
foot	0.3048	meter
mile	1.609	kilometer

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ABSTRACT

This study was conducted to develop new estimating equations based on channel width and the updated flood-frequency curves of previous investigations. Simple regression equations for estimating peak discharges with recurrence intervals of 2, 5, 10, 25, 50, and 100 years were developed for seven regions in Montana. The standard errors of estimate for the equations that use active-channel width as the independent variable ranged from 30 to 87 percent. The standard errors of estimate for the equations that use bankfull width as the independent variable ranged from 34 to 92 percent. The smallest standard errors generally occurred in the prediction equations for the 2-year flood, 5-year flood, and 10-year flood, and the largest standard errors occurred in the prediction equations for the 100-year flood. The equations that use active-channel width and the equations that use bankfull width were determined to be about equally reliable in five regions. In the West Region, the equations that use bankfull width were slightly more reliable than those based on active-channel width, whereas in the East-Central Region the equations that use active-channel width were slightly more reliable than those based on bankfull width. Compared with similar equations previously developed, the standard errors of estimate for the new equations are substantially smaller in three regions and substantially larger in two regions.

Limitations on the use of the estimating equations include the following:

1. The equations are based on stable conditions of channel geometry and prevailing water and sediment discharge.
2. The measurement of channel width requires a site visit, preferably by a person with experience in the method, and involves appreciable measurement error.
3. Reliability of results from the equations for channel widths beyond the range of definition is unknown.

In spite of the limitations, the estimating equations derived in this study are considered to be as reliable as estimating equations based on basin and climatic variables. Because the two types of estimating equations are independent, results from each can be weighted inversely proportional to their variances and averaged. The weighted average estimate will have a variance less than either individual estimate.

INTRODUCTION

Reliable estimates of flood magnitudes for various recurrence intervals are essential for the economic design of bridges, culverts, and other structures located adjacent to streams. In addition, sound planning and land-use decisions for areas bordering streams require information about the flood potential of streams. Previous studies in Montana (Omang and others, 1983; Parrett and others, 1983) determined that measurements of channel width could be used to estimate peak discharges of various recurrence intervals with reasonably good accuracy. These studies were based on streamflow data through 1978 at 281 streamflow-gaging stations throughout Montana. By 1983, almost 100 additional stations had accumulated 10 or more years of record and all stations previously used had accumulated 5 more years of record. Accordingly, Omang and others (1986) updated the flood-frequency curves using data through 1983 at all stations having at least 10 years of record.

The purpose of this study was to develop new estimating equations based on channel width and the updated flood-frequency curves of Omang and others (1986). This report presents the revised equations, compares them with the previously developed equations, and describes their limitations and reliability. Measurements of channel width were made at all gaging-station sites in Montana where 10 years of record became available in 1983 and where channel-geometry features were discernible, and at 43 sites outside of Montana but near the State border. These data, together with channel-geometry data collected prior to 1983 and the revised flood-frequency information through 1983, were used to develop new estimating equations that relate channel width to peak discharges of various recurrence intervals.

This report was prepared in cooperation with the Montana Department of Highways and the U.S. Bureau of Land Management. The streamflow-gaging stations used in this study were funded by the U.S. Geological Survey and various other Federal, State, and local agencies.

DATA USED

Peak discharges for recurrence intervals of 2, 5, 10, 25, 50, and 100 years were computed by Omang and others (1986) using data from 361 streamflow-gaging stations having at least 10 years of record through 1983. Of these stations, 4 are in Canada, 7 are in Wyoming, 22 are in Idaho, 9 are in North Dakota, and 1 is in South Dakota. The peak discharges were computed using procedures recommended by the U.S. Water Resources Council (1981).

Channel-geometry features were measured by U.S. Geological Survey personnel at or near each gaging station used in the analysis. At stations used in the previous studies, measurements were made from 1978 through 1980. At all new sites, measurements were made in 1985. The locations of all streamflow-gaging stations where flood-peak characteristics were computed and channel geometry was measured for this analysis are shown in figure 1. The relevant information at the sites is listed in table 4 at the end of the report.

CHANNEL GEOMETRY

The channel-geometry features measured at all new sites in 1985 were active-channel width and bankfull width. At sites previously measured from 1978 through 1980, active-channel depth and bankfull depth were also measured, and the material comprising the channel bed and banks was described. Previous analyses of channel geometry indicated insignificant correlation between peak flow and channel depth or between peak flow and bed or bank material; therefore these features were not measured or included in the present analysis.

The active channel has been described by Osterkamp and Hedman (1977, p. 256) as "***a short-term geomorphic feature subject to change by prevailing discharges. The upper limit is defined by a break in the relatively steep bank slope of the active channel to a more gently sloping surface beyond the channel edge. The break in slope normally coincides with the lower limit of permanent vegetation***."

The bankfull-channel width was described by Riggs (1974) as the horizontal distance between the tops of the banks of the main channel. The top of the bank is defined as the place where the flood plain and the channel intersect and is usually distinguished by an abrupt change in slope from near-vertical to horizontal. This reference level is virtually the same as the bankfull stage for perennial streams described by Wolman (1955) as the stage at which overbank flooding occurs.

At most sites used in the analysis, suitable channel reaches for measuring both active-channel width and bankfull width were found at or near the gaging stations. Each width was measured twice, and usually three times at locations separated by at least one channel width, and the separate measurements were averaged to yield a single value for each width feature. At some locations the stream channels were deeply incised, and the bankfull channel could not be readily identified. Only active-channel width was determined at these sites.

REGRESSION ANALYSIS

Equations for the estimation of peak discharge for various recurrence intervals were developed from a simple regression analysis that relates the peak discharges to active-channel width and to bankfull width. As in previous studies, all data were converted to logarithms so that the regression equations were of the following form:

$$\text{Log } Q_m = \log a + b \log W, \quad (1)$$

where

Q_m (dependent variable) is the peak discharge, in cubic feet per second, with a recurrence interval of m years;
a is the regression constant;
b is the regression coefficient; and
W is either the active-channel width or the bankfull width, in feet.

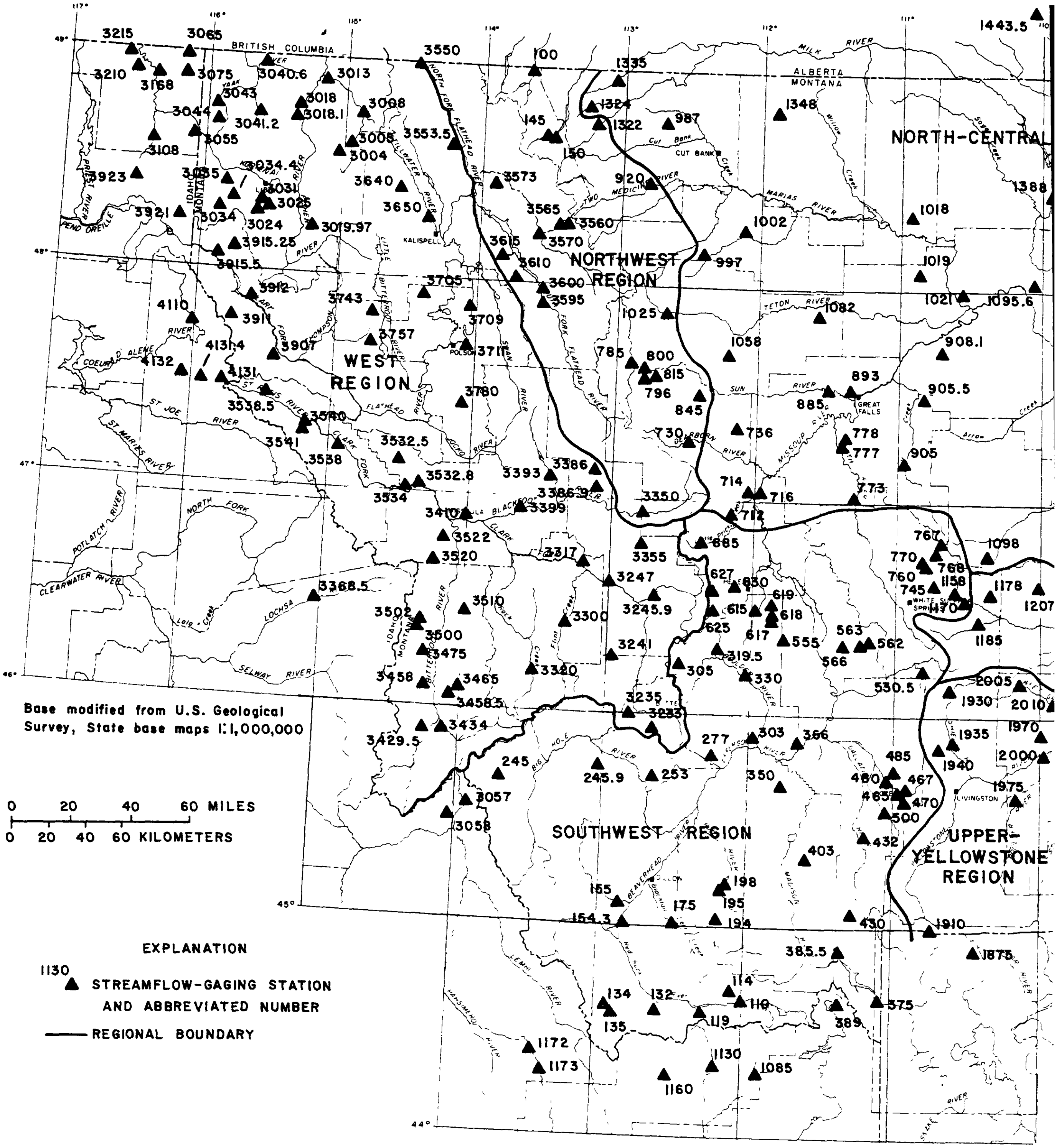
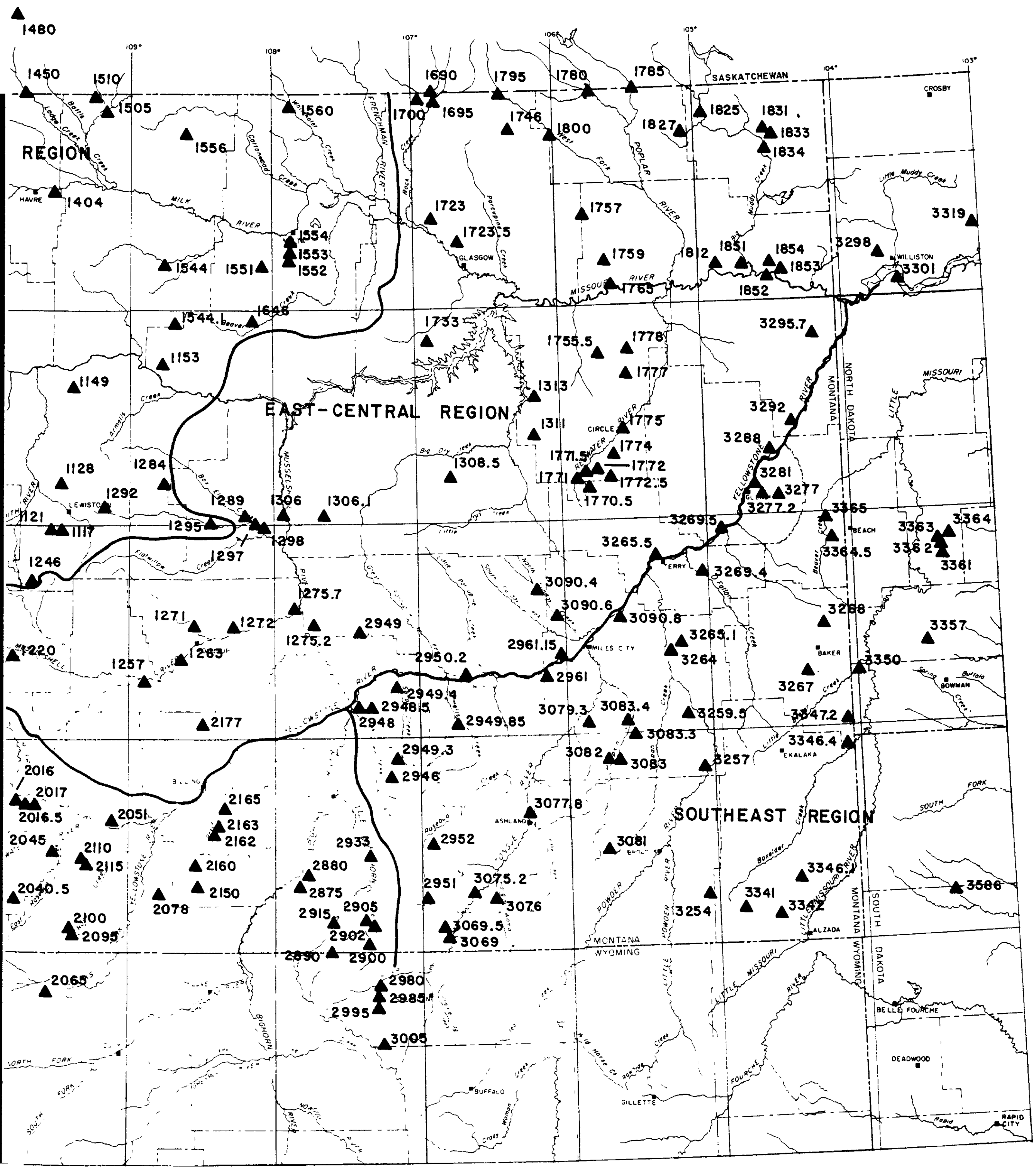


Figure 1.--Location of selected streamflow-gaging



stations and regional boundaries.

Taking antilogarithms of all values yields the following power-function form of the equation:

$$Q_m = a\ W^b \tag{2}$$

Separate equations that relate peak discharges with recurrence intervals of 2, 5, 10, 25, 50, and 100 years to active-channel width and to bankfull width were developed. The initial computations with each discharge were made with all sites in the study area included. The regression residuals (difference between actual peak discharges and computed peak discharges) from the initial computations were examined and used as a basis for separating the study area into the seven regions shown in figure 1. Separate regression equations for each discharge were then developed for each region.

The boundaries for the regions were located on topographic divides or prominent geographic features where possible. In addition, an attempt was made to locate the regional boundaries as close as possible to the regional boundaries used in the previous reports relating discharge to channel geometry. Complete agreement was not possible, although the boundaries within Montana for the West, Northwest, North-Central, and Southwest Regions are virtually identical with regional boundaries shown in the report by Parrett and others (1983). Likewise, the boundaries within Montana for the Southeast Region are virtually identical with the boundaries shown in the report by Omang and others (1983). The regional boundaries used in this study are also reasonably close to the regional boundaries used in the report by Omang and others (1986) relating peak discharges to basin and climatic characteristics. The physiographic and climatic descriptions of the regions as reported by Omang and others (1986) are considered to be applicable to the regions identified in this report.

DISCUSSION

Regression Results

The results of the regression analysis for each region are given in table 1. The standard error of estimate is the standard deviation of the residuals and is a measure of how well the regression equation fits the data. In general, the smaller the standard error, the closer the fit to the data and the more reliable the prediction equation. The coefficient of determination (r^2) is a measure of the degree of linear association between the dependent variable (peak discharge) and the independent variable (channel width). A coefficient of determination of 1.00 indicates a perfect linear correlation between the dependent and independent variables.

As indicated in table 1, the prediction equations for the 2-year flood peak, 5-year flood peak, and 10-year flood peak generally have the largest coefficients of determination and the smallest standard errors. Conversely, the prediction equations for the 100-year flood peak generally have the smallest coefficients of determination and the smallest standard errors. Notable exceptions occur in the non-mountainous regions (North-Central, East-Central, and Southeast), where prediction equations for the 2-year flood peak generally have the smallest coefficients of determination and the largest standard errors.

Table 1.--*Results of regression analysis*

[Q, peak discharge, in cubic feet per second, for a given recurrence interval, in years]

Region	Regression equation	Coefficient of determination (r^2)	Average standard error of estimate	
			Log units	Percent
	Active-channel width (W_{AC}). No. of sites = 78			
West	$Q_2 = 1.07\ W_{AC}^{1.82}$	0.93	0.199	49
	$Q_5 = 2.76\ W_{AC}^{1.66}$	.92	.192	46
	$Q_{10} = 4.49\ W_{AC}^{1.57}$	.91	.201	49
	$Q_{25} = 7.50\ W_{AC}^{1.49}$	.88	.219	54
	$Q_{50} = 10.4\ W_{AC}^{1.43}$	.85	.235	59
	$Q_{100} = 14.0\ W_{AC}^{1.38}$	.82	.253	63
	Bankfull width (W_{BF}). No. of sites = 73			
	$Q_2 = 0.265\ W_{BF}^{2.06}$	.94	.187	46
	$Q_5 = 0.743\ W_{BF}^{1.89}$	.94	.168	41
	$Q_{10} = 1.26\ W_{BF}^{1.81}$	.93	.172	41
	$Q_{25} = 2.21\ W_{BF}^{1.71}$	.91	.188	43
	$Q_{50} = 3.16\ W_{BF}^{1.65}$	.89	.203	49
	$Q_{100} = 4.34\ W_{BF}^{1.60}$	.86	.222	54

Table 1.--*Results of regression analysis*--Continued

Region	Regression equation	Coefficient of determination (r^2)	Average standard error of estimate: Log units	Average standard error of estimate: Percent
	Active-channel width (W_{AC}). No. of sites = 21			
North-west	$Q_2 = 2.31\ W_{AC}^{1.57}$	.90	.187	45
	$Q_5 = 6.40\ W_{AC}^{1.43}$	.88	.185	45
	$Q_{10} = 11.3\ W_{AC}^{1.35}$	.86	.198	48
	$Q_{25} = 21.4\ W_{AC}^{1.28}$	.83	.210	51
	$Q_{50} = 36.2\ W_{AC}^{1.24}$	.82	.206	50
	$Q_{100} = 66.0\ W_{AC}^{1.19}$	.77	.234	58
	Bankfull width (W_{BF}). No. of sites = 20			
	$Q_2 = 0.712\ W_{BF}^{1.76}$	.90	.185	45
	$Q_5 = 2.11\ W_{BF}^{1.61}$	.90	.175	42
	$Q_{10} = 3.87\ W_{BF}^{1.53}$	.88	.185	45
	$Q_{25} = 7.57\ W_{BF}^{1.45}$	.85	.195	47
	$Q_{50} = 13.1\ W_{BF}^{1.41}$	.85	.189	46
	$Q_{100} = 24.4\ W_{BF}^{1.37}$	.80	.218	54

Table 1.--*Results of regression analysis*--Continued

Region	Regression equation	Coefficient of determination (r^2)	Average standard error of estimate	
			Log units	Percent
	Active-channel width (W_{AC}). No. of sites = 50			
North-Central	$Q_2 = 5.38 \; W_{AC}^{1.23}$	.70	.318	85
	$Q_5 = 17.3 \; W_{AC}^{1.19}$	.80	.238	60
	$Q_{10} = 32.8 \; W_{AC}^{1.15}$	.80	.225	57
	$Q_{25} = 66.1 \; W_{AC}^{1.10}$	.78	.234	57
	$Q_{50} = 106 \; W_{AC}^{1.06}$	.73	.255	63
	$Q_{100} = 165 \; W_{AC}^{1.01}$	.66	.286	75
	Bankfull width (W_{BF}). No. of sites = 49			
	$Q_2 = 1.40 \; W_{BF}^{1.40}$	.65	.343	92
	$Q_5 = 4.28 \; W_{BF}^{1.49}$	.78	.249	63
	$Q_{10} = 8.19 \; W_{BF}^{1.46}$	.80	.227	57
	$Q_{25} = 16.9 \; W_{BF}^{1.41}$	.79	.227	57
	$Q_{50} = 28.1 \; W_{BF}^{1.36}$	.75	.246	63
	$Q_{100} = 45.3 \; W_{BF}^{1.31}$	.69	.276	71

Table 1.--*Results of regression analysis*--Continued

Region	Regression equation	Coefficient of determination (r^2)	Average standard error of estimate: Log units	Average standard error of estimate: Percent
	Active-channel width (W_{AC}). No. of sites = 65			
East-Central	$Q_2 = 11.6 \; W_{AC}^{1.10}$	.61	.325	87
	$Q_5 = 35.3 \; W_{AC}^{1.10}$	.70	.267	68
	$Q_{10} = 62.1 \; W_{AC}^{1.09}$	.70	.261	66
	$Q_{25} = 111 \; W_{AC}^{1.07}$	.68	.271	69
	$Q_{50} = 160 \; W_{AC}^{1.06}$	.65	.285	73
	$Q_{100} = 221 \; W_{AC}^{1.04}$	.62	.300	78
	Bankfull width (W_{BF}). No. of sites = 63			
	$Q_2 = 4.11 \; W_{BF}^{1.20}$	.58	.337	91
	$Q_5 = 12.1 \; W_{BF}^{1.22}$	.68	.276	71
	$Q_{10} = 21.4 \; W_{BF}^{1.21}$	.69	.269	68
	$Q_{25} = 39.1 \; W_{BF}^{1.19}$	.66	.279	71
	$Q_{50} = 57.4 \; W_{BF}^{1.17}$	.63	.292	76
	$Q_{100} = 81.7 \; W_{BF}^{1.14}$	.59	.310	82

Table 1.--*Results of regression analysis*--Continued

Region	Regression equation	Coefficient of determination (r^2)	Average standard error of estimate: Log units	Average standard error of estimate: Percent
	Active-channel width (W_{AC}). No. of sites = 46			
South-east	$Q_2 = 7.07 \; W_{AC}^{1.27}$	.70	.311	82
	$Q_5 = 20.3 \; W_{AC}^{1.25}$	.79	.245	60
	$Q_{10} = 33.5 \; W_{AC}^{1.25}$	.81	.227	57
	$Q_{25} = 56.8 \; W_{AC}^{1.25}$	.80	.238	60
	$Q_{50} = 78.5 \; W_{AC}^{1.25}$	.77	.257	66
	$Q_{100} = 105 \; W_{AC}^{1.25}$	.73	.283	72
	Bankfull width (W_{BF}). No. of sites = 46			
	$Q_2 = 1.87 \; W_{BF}^{1.43}$	.75	.283	72
	$Q_5 = 5.85 \; W_{BF}^{1.38}$	.81	.228	57
	$Q_{10} = 10.0 \; W_{BF}^{1.37}$	.82	.222	54
	$Q_{25} = 17.8 \; W_{BF}^{1.35}$	.78	.247	63
	$Q_{50} = 25.5 \; W_{BF}^{1.34}$	.74	.274	69
	$Q_{100} = 35.2 \; W_{BF}^{1.32}$	.69	.306	82

Table 1.--*Results of regression analysis*--Continued

Region	Regression equation	Coefficient of determination (r^2)	Average standard error of estimate: Log units	Average standard error of estimate: Percent
	Active-channel width (W_{AC}). No. of sites = 39			
Upper Yellow-stone	$Q_2 = 2.86\ W_{AC}^{1.48}$	.93	.157	37
	$Q_5 = 14.6\ W_{AC}^{1.18}$	.92	.128	30
	$Q_{10} = 35.6\ W_{AC}^{1.01}$	.89	.139	33
	$Q_{25} = 94.5\ W_{AC}^{0.83}$	.78	.169	40
	$Q_{50} = 180\ W_{AC}^{0.71}$	.66	.196	48
	$Q_{100} = 326\ W_{AC}^{0.60}$	.51	.224	55
	Bankfull width (W_{BF}). No. of sites = 37			
	$Q_2 = 0.726\ W_{BF}^{1.73}$	.88	.201	49
	$Q_5 = 4.67\ W_{BF}^{1.39}$	.90	.149	36
	$Q_{10} = 12.7\ W_{BF}^{1.21}$	.88	.142	34
	$Q_{25} = 37.6\ W_{BF}^{1.01}$	.81	.158	38
	$Q_{50} = 76.3\ W_{BF}^{0.89}$	.71	.180	43
	$Q_{100} = 145\ W_{BF}^{0.77}$	.59	.205	50

Table 1.--*Results of regression analysis*--Continued

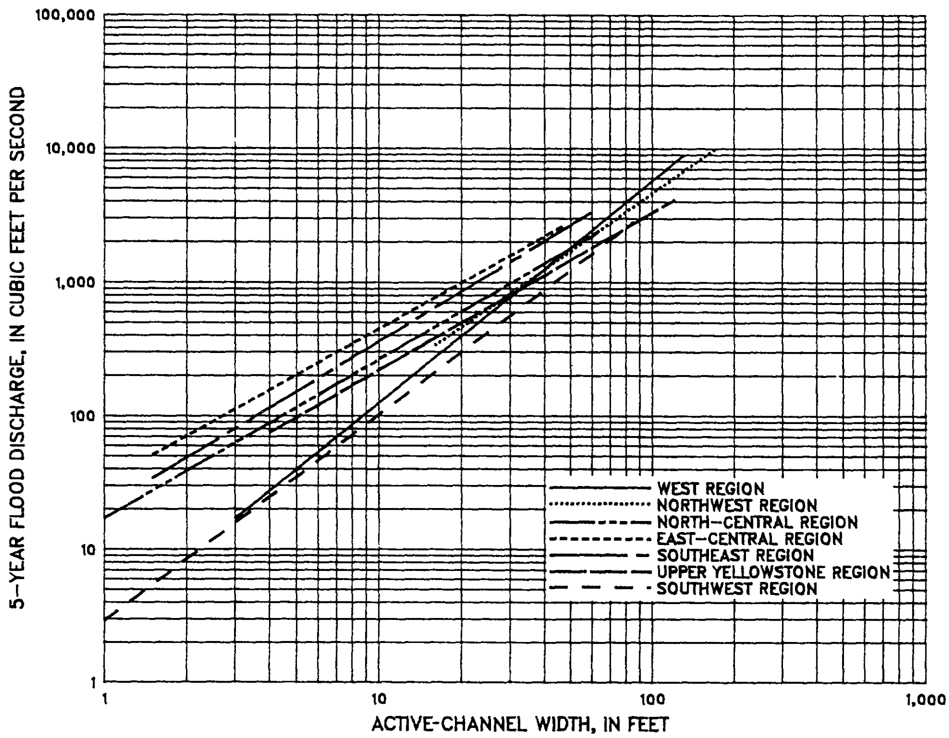
Region	Regression equation	Coefficient of determination (r^2)	Average standard error of estimate: Log units	Average standard error of estimate: Percent
	Active-channel width (W_{AC}). No. of sites = 61			
Southwest	$Q_2 = 0.915\ W_{AC}^{1.76}$	.89	.234	57
	$Q_5 = 2.89\ W_{AC}^{1.55}$	.90	.198	49
	$Q_{10} = 5.21\ W_{AC}^{1.45}$	.89	.195	49
	$Q_{25} = 9.90\ W_{AC}^{1.33}$	.86	.206	51
	$Q_{50} = 14.9\ W_{AC}^{1.26}$	.83	.220	54
	$Q_{100} = 21.6\ W_{AC}^{1.20}$	.78	.239	60
	Bankfull width (W_{BF}). No. of sites = 59			
	$Q_2 = 0.189\ W_{BF}^{2.07}$	.89	.235	60
	$Q_5 = 0.722\ W_{BF}^{1.82}$	.90	.199	49
	$Q_{10} = 1.42\ W_{BF}^{1.70}$	.89	.194	46
	$Q_{25} = 2.94\ W_{BF}^{1.57}$	.87	.200	49
	$Q_{50} = 4.64\ W_{BF}^{1.49}$	.84	.212	51
	$Q_{100} = 7.02\ W_{BF}^{1.42}$	.80	.228	57

In most regions, the equations based on active-channel width and the equations based on bankfull width have about the same standard errors. In the West Region, the equations based on bankfull width have standard errors that are slightly less than those based on active-channel width. In the East-Central Region the equations based on active-channel width have standard errors that are slightly smaller than those based on bankfull width.

Among regions, the equations appear to be more reliable in the mountainous western and southern parts of the State (West, Northwest, Southwest, and Upper Yellowstone Regions) than in the plains areas of the eastern and northern parts of the study area (North-Central, East-Central, and Southeast Regions). Peak flows in the plains regions commonly are the result of sporadic, intense thunderstorms and thus exhibit much larger variability than in the mountainous regions where peak flows are more commonly the result of snowmelt and large-scale frontal rainfall.

The differences in peak discharge estimation from region to region are illustrated in figures 2 through 4. The relationships between predicted peak discharge with a 5-year recurrence interval and widths, both active-channel and bankfull, are shown in figure 2. The slopes of these regression lines are about the same in all regions except the West and Southwest. The regression lines for these two regions have the steepest slopes, and the equations yield the smallest estimates of the 5-year flood for widths less than about 30 feet. The trend is similar for the 25-year flood (fig. 3), where the West and Southwest Regions have regression lines with the steepest slopes that yield substantially smaller estimates of 25-year peak discharge than the other regions for widths less than about 50 feet. In addition, figure 3 shows that the Upper Yellowstone Region has the regression line with the flattest slope. In figure 4, the regression lines for all regions except the Upper Yellowstone have about the same slope, but the West and Southwest Regions have lines that yield markedly smaller estimates of the 100-year flood for widths less than about 50 feet. The regression line for the Upper Yellowstone Region is significantly flatter than the regression line for any other region and yields the smallest estimates of the 100-year flood for widths larger than about 50 feet.

These figures indicate that, except for the Northwest Region and for small streams in the Upper Yellowstone Region, the channel width equations for the mountainous areas of Montana yield estimates of peak discharge for given channel widths and for recurrence intervals larger than 25 years that are consistently smaller than those for non-mountainous areas. The streams in the Northwest Region probably respond differently than other mountainous streams because the Northwest Region is susceptible to torrential rains originating in the Gulf of Mexico. As described by Parrett and Omang (1981), flood-frequency curves in the Northwest Region thus are particularly steep for recurrence intervals larger than about 50 years. In the Upper Yellowstone Region, many of the smaller streams drain foothills and plains areas that are more like the Southeast or East-Central Plains than the more mountainous areas where the larger streams in the region originate. Flood-frequency curves for the larger streams thus are flatter than for many of the smaller streams where intense thunderstorms may result in very large flood peaks.



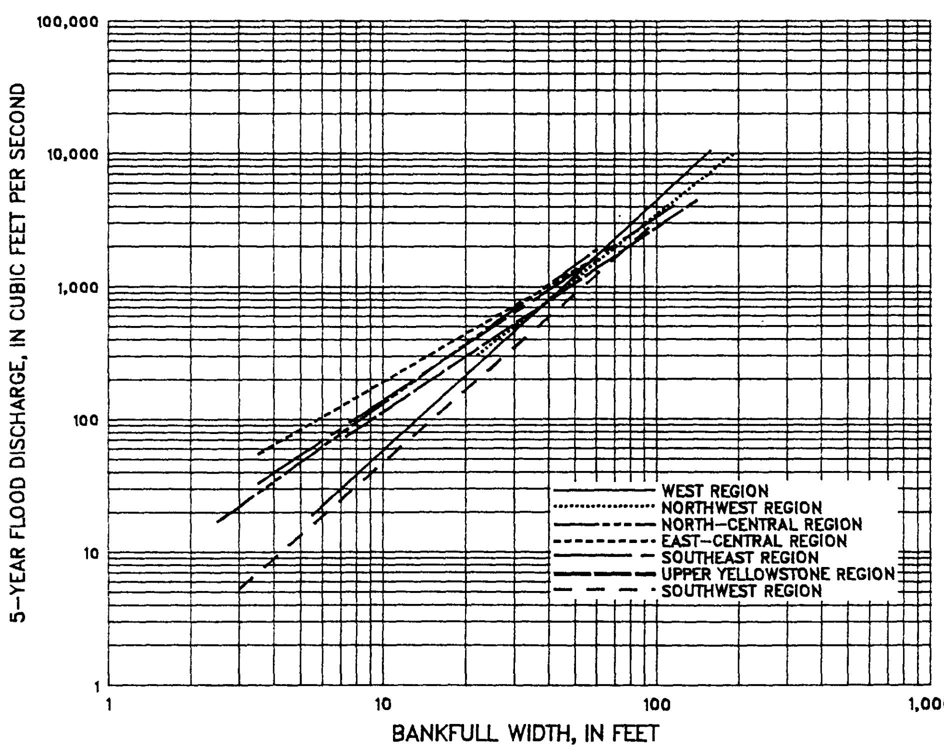
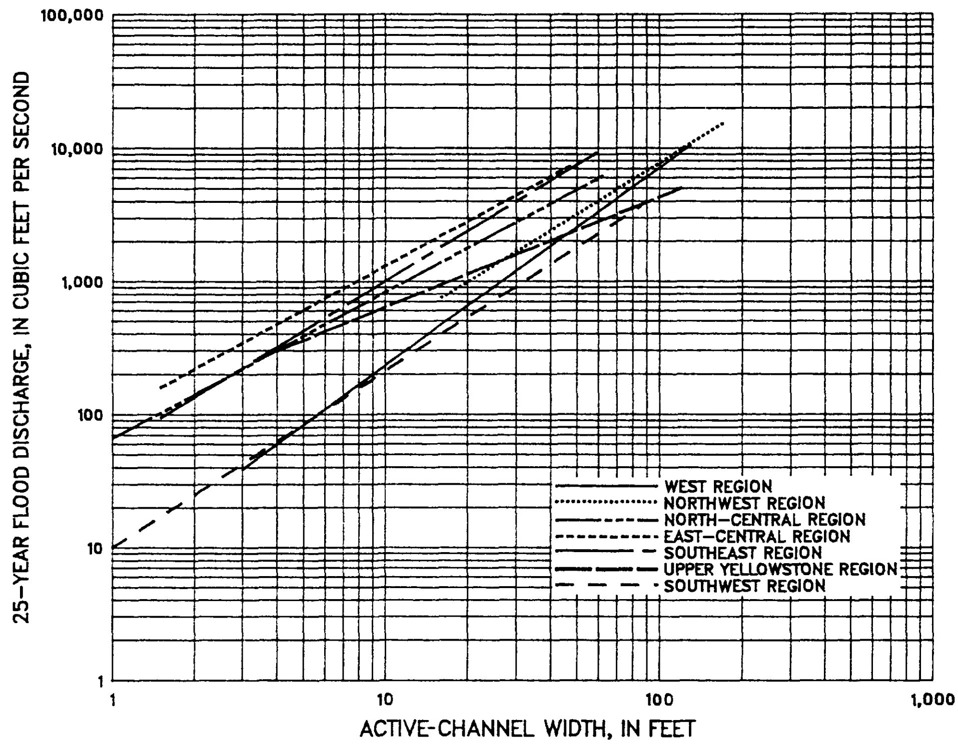


Figure 2.--Relations between 5-year flood and channel width.



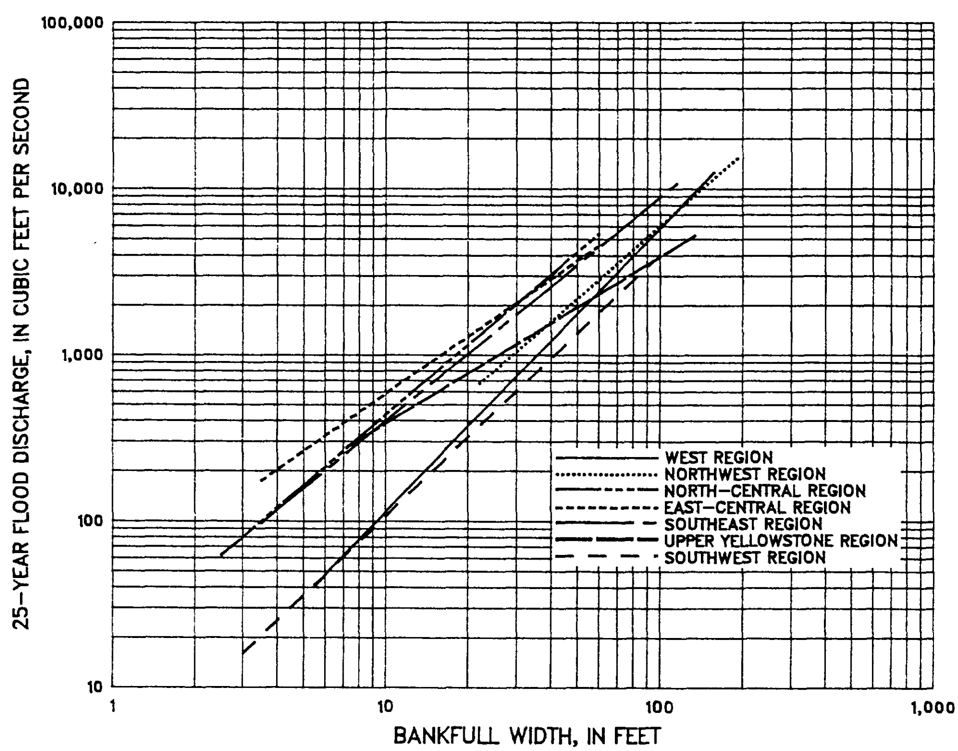


Figure 3.--Relations between 25-year flood and channel width.

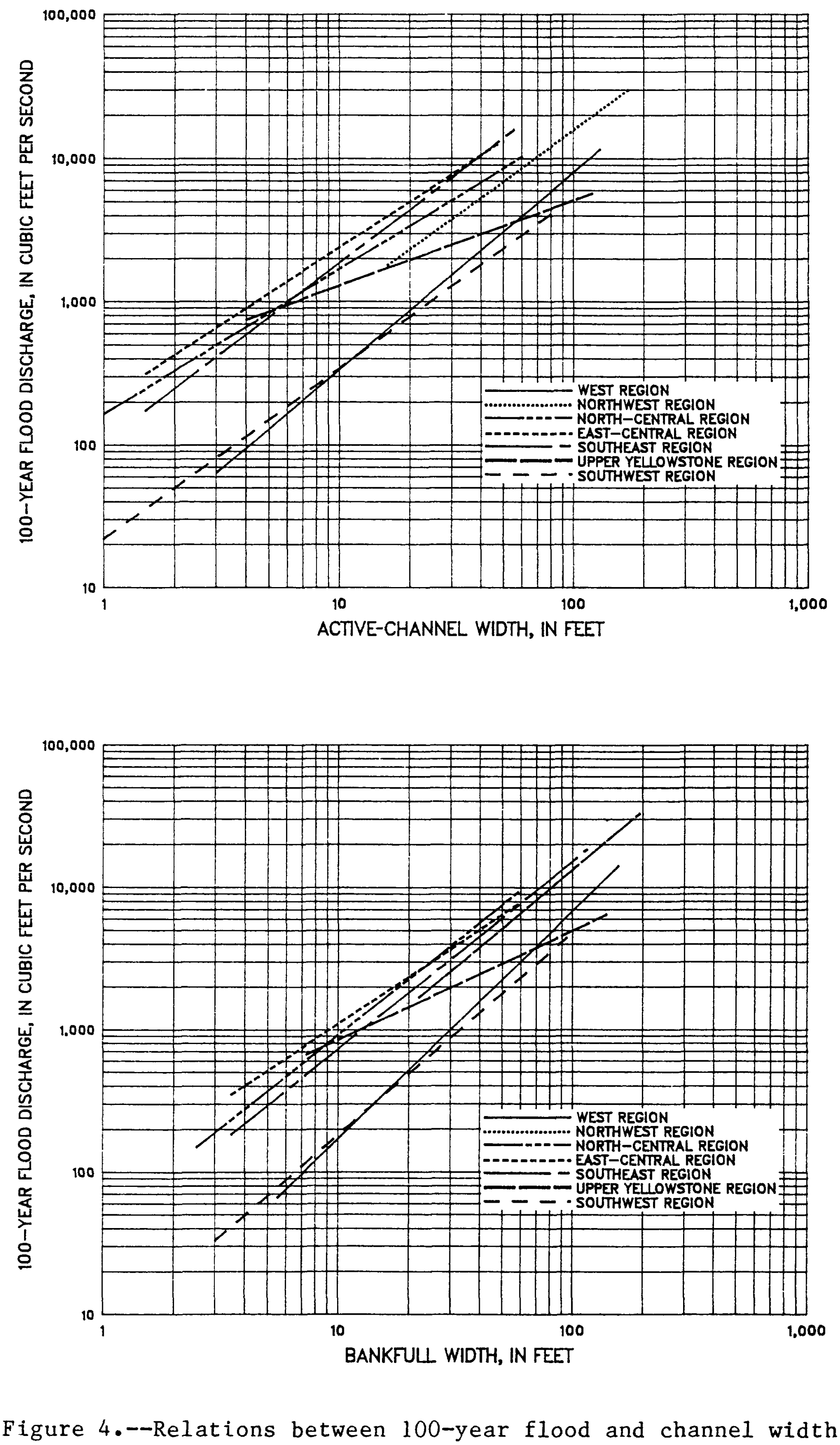


Figure 4.--Relations between 100-year flood and channel width.

Comparison With Previous Studies

Because of changes in regional boundaries, the equations developed for the Upper Yellowstone and East-Central Regions are not comparable to channel-geometry equations previously developed. The other regions are virtually the same as those used by Omang and others (1983) and by Parrett and others (1983); the newly developed equations for those regions together with the equations previously developed are given in table 2. The standard errors for the new equations are generally larger than the standard errors for the old equations in the Northwest Region. Conversely, the standard errors of the new equations are generally smaller than the standard errors of the old equations in the other regions. In the West Region, the standard errors of the new equations are about the same as those of the old equations. Although the new equations do not fit the data as well as the old equations in the Northwest Region, the new equations are believed to be more reliable because several different, more representative, gage sites were used in the present study. In the other regions listed in table 2, the new equations are considered to be substantially more reliable than the old equations because of the generally smaller standard errors as well as the larger data base and longer period of record.

The percentage differences in predicted discharge between the old and new equations are illustrated in figures 5 through 7. In the West Region, the new equations yield larger estimates of peak discharge for all widths and for all recurrence intervals (fig. 5). In the Northwest Region, the new equations yield larger estimates of peak discharge for all recurrence intervals for active-channel widths less than about 55 feet and for bankfull widths less than about 85 feet. For widths larger than these, the new equations for predicting peak discharges of 5- and 25-year recurrence intervals yield smaller values than the old equations. For the 100-year peak discharge, the equation using bankfull width gives larger results than the old equation for all widths, and the equation using active-channel width gives larger results for widths less than about 115 feet.

In the North-Central and Southeast Regions, the new equations provide larger predicted values of discharge for some recurrence intervals and widths and smaller predicted values of discharge for other recurrence intervals and widths (fig. 6). Overall, the new equations tend to predict larger values of discharge than the old equations in the North-Central Region and smaller values of discharge in the Southeast Region.

In the Southwest Region, the new equations yield slightly larger estimates of discharge for most recurrence intervals and widths (fig. 7). However, the percentage differences between the new and old equations are substantially smaller in this region than in any of the others.

Limitations and Reliability

Because regression analyses do not define actual physical relationships among variables, regression equations may not provide reliable results when the channel widths are outside the range of values used to develop the equations. For this study, the range of active-channel widths and bankfull widths used in each region is given in table 3. In particular, the reader is cautioned that using widths smaller than the minimum limits shown for the Northwest Region may lead to erroneous results. Smaller streams in the Northwest Region may not be affected so much

Table 2.--*Comparison between old and new regression equations*

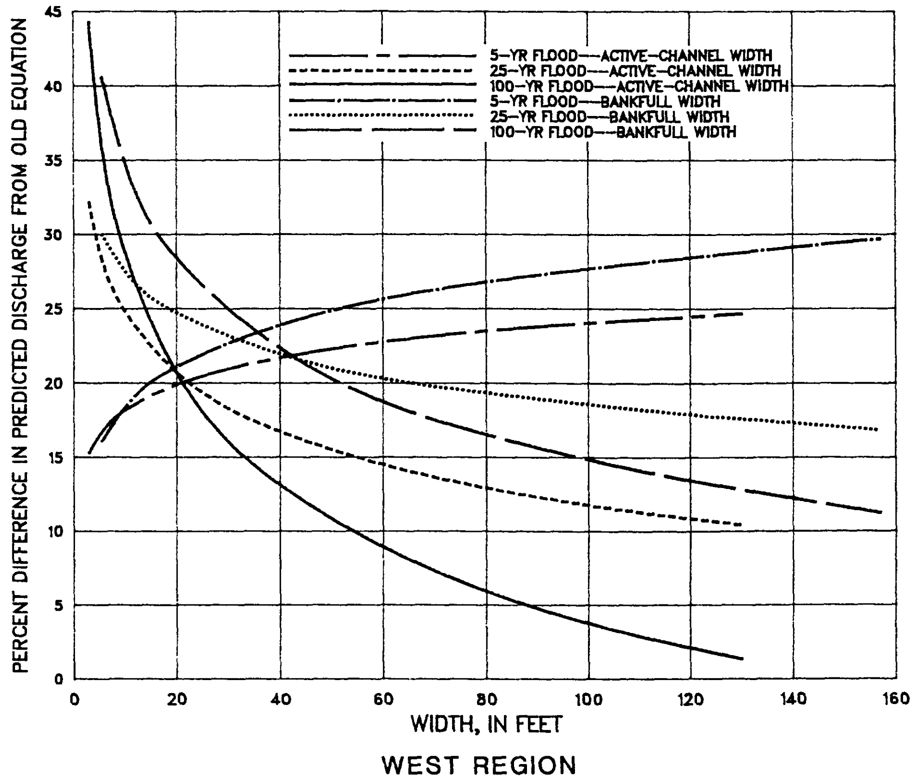
[Q, peak discharge, in cubic feet per second, for a given recurrence interval, in years; W_{AC}, active-channel width; W_{BF}, bankfull width]

Previous studies[1]			This study		
Equation	Number of stations	Standard error (percent)	Equation	Number of stations	Standard error (percent)
West Region					
$Q_5 = 2.45\ W_{AC}^{1.639}$	54	48	$Q_5 = 2.76\ W_{AC}^{1.66}$	78	46
$Q_5 = 0.677\ W_{BF}^{1.857}$	52	48	$Q_5 = 0.743\ W_{BF}^{1.89}$	73	41
$Q_{25} = 5.38\ W_{AC}^{1.538}$	54	50	$Q_{25} = 7.50\ W_{AC}^{1.49}$	78	54
$Q_{25} = 1.61\ W_{BF}^{1.742}$	52	48	$Q_{25} = 2.21\ W_{BF}^{1.71}$	73	43
$Q_{100} = 8.75\ W_{AC}^{1.474}$	54	55	$Q_{100} = 14.0\ W_{AC}^{1.38}$	78	63
$Q_{100} = 2.74\ W_{BF}^{1.670}$	52	52	$Q_{100} = 4.34\ W_{BF}^{1.60}$	73	54
Northwest Region					
$Q_5 = 1.68\ W_{AC}^{1.763}$	22	39	$Q_5 = 6.40\ W_{AC}^{1.43}$	21	45
$Q_5 = 0.449\ W_{BF}^{1.958}$	21	36	$Q_5 = 2.11\ W_{BF}^{1.61}$	20	42
$Q_{25} = 5.46\ W_{AC}^{1.608}$	22	35	$Q_{25} = 21.4\ W_{AC}^{1.28}$	21	51
$Q_{25} = 1.63\ W_{BF}^{1.784}$	21	39	$Q_{25} = 7.57\ W_{BF}^{1.45}$	20	47
$Q_{100} = 16.9\ W_{AC}^{1.476}$	22	43	$Q_{100} = 66.0\ W_{AC}^{1.19}$	21	58
$Q_{100} = 5.48\ W_{BF}^{1.636}$	21	50	$Q_{100} = 24.4\ W_{BF}^{1.37}$	20	54
North-Central Region					
$Q_5 = 17.5\ W_{AC}^{1.238}$	40	72	$Q_5 = 17.3\ W_{AC}^{1.19}$	50	60
$Q_5 = 3.99\ W_{BF}^{1.504}$	33	77	$Q_5 = 4.28\ W_{BF}^{1.49}$	49	63
$Q_{25} = 84.0\ W_{AC}^{1.045}$	40	68	$Q_{25} = 66.1\ W_{AC}^{1.10}$	50	57

Table 2.--*Comparison between old and new regression equations*--Continued

Previous studies[1]			This study		
Equation	Number of stations	Standard error (percent)	Equation	Number of stations	Standard error (percent)
		North-Central Region--Continued			
$Q_{25} = 22.6\ W_{BF}^{1.277}$	33	72	$Q_{25} = 16.9\ W_{BF}^{1.41}$	49	57
$Q_{100} = 226\ W_{AC}^{0.919}$	40	77	$Q_{100} = 165\ W_{AC}^{1.01}$	50	75
$Q_{100} = 68.6\ W_{BF}^{1.125}$	33	79	$Q_{100} = 45.3\ W_{BF}^{1.31}$	49	72
		Southeast Region			
$Q_5 = 12.2\ W_{AC}^{1.48}$	28	76	$Q_5 = 20.3\ W_{AC}^{1.25}$	46	60
$Q_5 = 5.95\ W_{BF}^{1.46}$	28	56	$Q_5 = 5.85\ W_{BF}^{1.38}$	46	57
$Q_{25} = 39.9\ W_{AC}^{1.36}$	28	98	$Q_{25} = 56.8\ W_{AC}^{1.25}$	46	60
$Q_{25} = 24.5\ W_{BF}^{1.30}$	28	70	$Q_{25} = 17.8\ W_{BF}^{1.35}$	46	63
$Q_{100} = 85.9\ W_{AC}^{1.29}$	28	115	$Q_{100} = 105\ W_{AC}^{1.25}$	46	72
$Q_{100} = 60.1\ W_{BF}^{1.20}$	28	78	$Q_{100} = 35.2\ W_{BF}^{1.32}$	46	82
		Southwest Region			
$Q_5 = 2.74\ W_{AC}^{1.555}$	47	48	$Q_5 = 2.89\ W_{AC}^{1.55}$	61	49
$Q_5 = 0.768\ W_{BF}^{1.778}$	40	55	$Q_5 = 0.722\ W_{BF}^{1.82}$	59	49
$Q_{25} = 9.59\ W_{AC}^{1.334}$	47	63	$Q_{25} = 9.90\ W_{AC}^{1.33}$	61	51
$Q_{25} = 3.30\ W_{BF}^{1.519}$	40	70	$Q_{25} = 2.94\ W_{BF}^{1.57}$	59	49
$Q_{100} = 21.2\ W_{AC}^{1.193}$	47	79	$Q_{100} = 21.6\ W_{AC}^{1.20}$	61	60
$Q_{100} = 8.36\ W_{BF}^{1.353}$	40	85	$Q_{100} = 7.02\ W_{BF}^{1.42}$	59	57

[1]Omang and others (1983) and Parrett and others (1983).



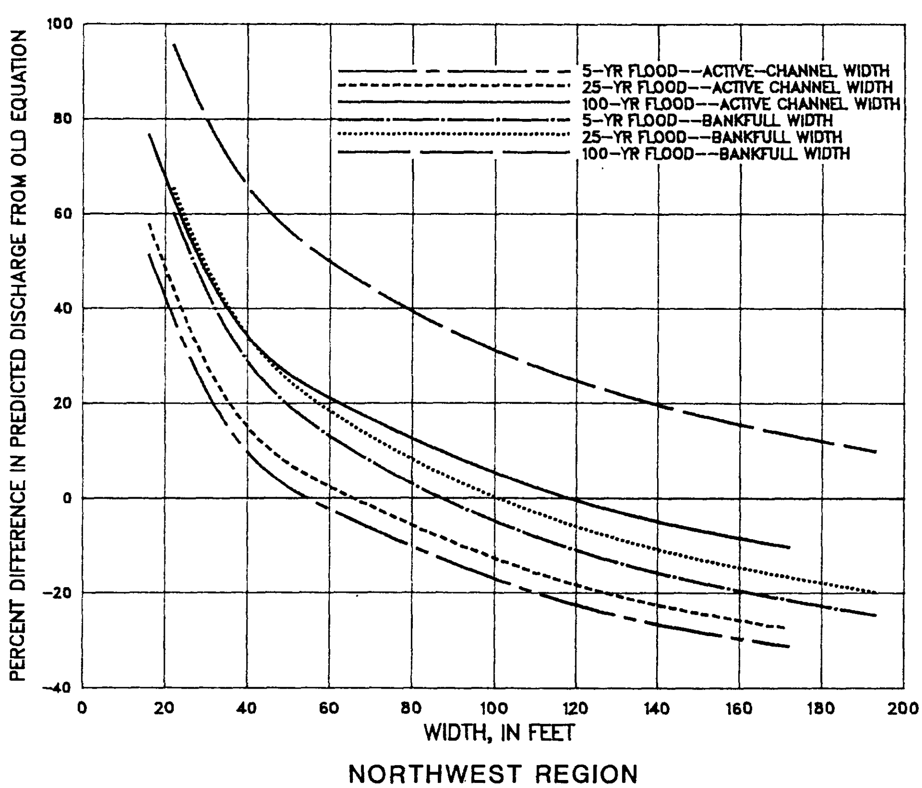
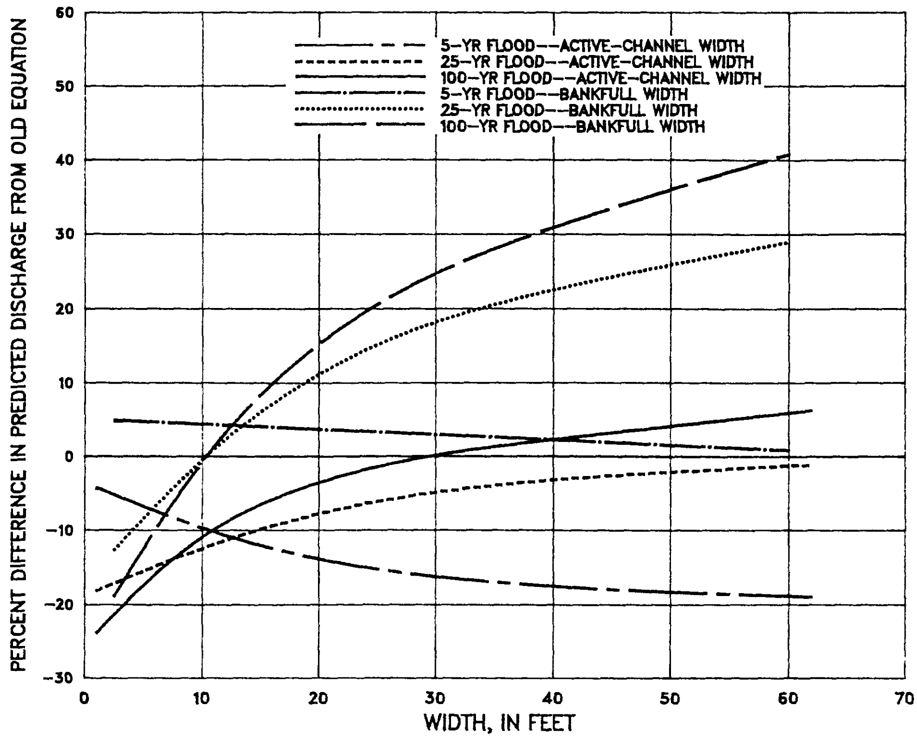
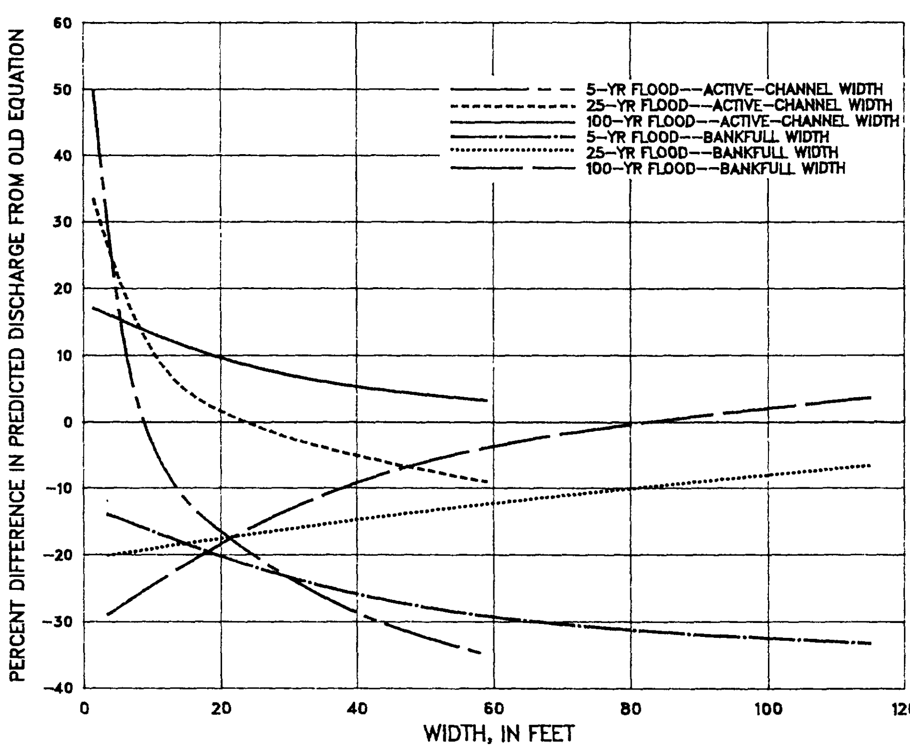


Figure 5.--Comparison between old and new prediction equations in the West and Northwest Regions.



NORTH-CENTRAL REGION



SOUTHEAST REGION

Figure 6.--Comparison between old and new prediction equations in the North-Central and Southeast Regions.

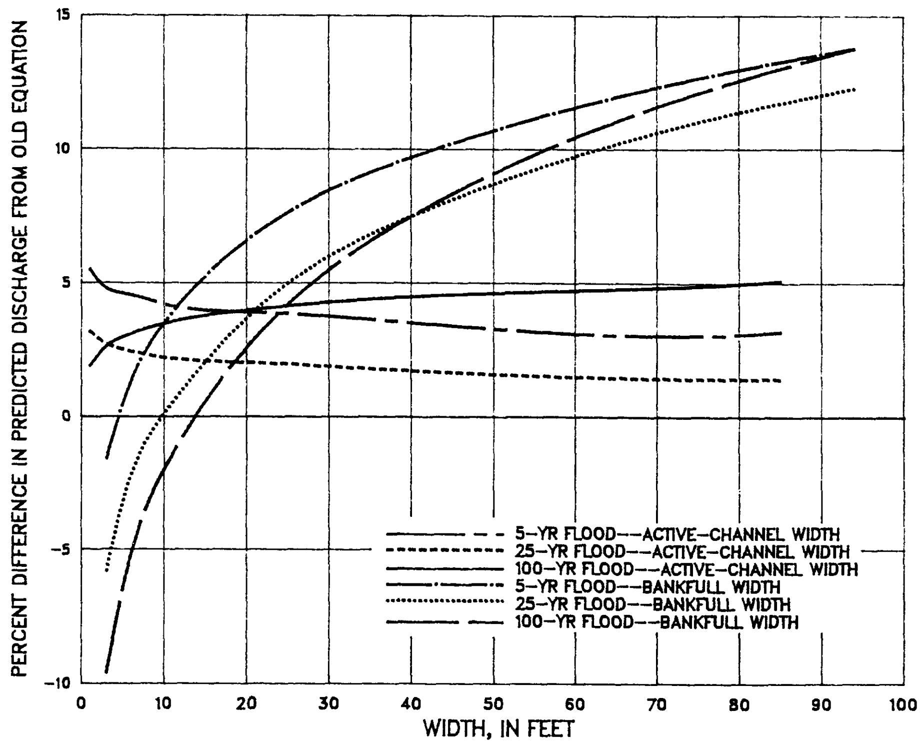


Figure 7.--Comparison between old and new prediction equations in the Southwest Region.

by the large-scale frontal rainstorms as are the larger streams. Thus, flood-frequency curves for smaller streams in this region may be much flatter than for the larger streams, and the equations developed for the West Region may be more applicable in these instances than equations for the Northwest Region.

Similarly, the equations developed for the Upper Yellowstone Region may yield erroneous results for small streams (active-channel widths less than about 15 feet) located in the mountainous areas near the Wyoming border and south and north of Livingston, Montana. None of the small-stream gaging sites used in the analysis were located in the more rugged, mountainous parts of this region, and the equations for the Southwest Region probably provide more accurate results for the smaller streams in these areas than equations for the Upper Yellowstone Region.

Meaningful relationships between channel width and discharge require stable conditions so that the channel is fully adjusted to the prevailing conditions of water and sediment discharge. The equations developed in this study thus may not be applicable to stream reaches having the following conditions:

1. Braided channels or channels with unstable banks.
2. Small streams that are entirely vegetated and have poorly defined channels.
3. Channels having exposed bedrock in the bed or banks.
4. Reaches having long pools or steep inclines.
5. Channels that have been widened by recent floods or otherwise altered by human activities.
6. Streams that have recently undergone changes in the streamflow regimen, such as the construction of upstream diversion or regulation structures.

Table 3.--*Range of active-channel and bankfull widths used in regression analysis*

Region	Range of active-channel widths, in feet	Range of bankfull widths, in feet
West	3.0 - 130	5.5 - 157
Northwest	16.0 - 172	22.0 - 193
North-Central	1.0 - 62.0	2.5 - 60.0
East-Central	1.5 - 47.0	3.5 - 59.0
Southeast	1.5 - 59.0	3.5 - 115
Upper Yellowstone	4.0 - 120	7.3 - 140
Southwest	1.0 - 85.0	3.0 - 94.0

An additional constraint on the use of channel-geometry equations to estimate discharge is the requirement that the site be visited and the channel width measured. Properly identifying active-channel width or bankfull width requires training and experience. Even among individuals experienced in making channel-geometry measurements, the variability in measured widths can be large. Based on a test in Wyoming, Wahl (1977) reported that the standard error in computed discharge that could be attributed solely to measurement error could be as large as 30 percent. A comparison between independent measurements of active-channel width made by the authors and by Hammer (1981) of the U.S. Forest Service at 11 sites in the West Region indicates a similar measurement variability. In this instance, the standard error of computed 100-year discharge resulting from measurement error alone was 32 percent (0.137 log unit). As discussed by Wahl (1984), a truer indication of the total standard error, in log units, of estimated discharge at a specific site is the square root of the sums of the squares of the errors due to calibration (regression) and measurement. Using the standard error for the West Region for Q_{100} and active-channel width (table 2), the

$$\text{true standard error} = \sqrt{(0.253)^2 + (0.137)^2} = 0.288 \qquad (3)$$

This corresponds to 74 percent compared to the regression error alone of 63 percent. The standard error due to measurement variability is expected to be somewhat larger in the regions in eastern Montana where streamflows are more erratic and channel features consequently are not so well defined as in the West Region.

Despite the limitations associated with the channel-geometry equations, the equations described in this report are considered to be as reliable as the equations recently developed by Omang and others (1986) using basin and climatic variables. Although the error of measurement may be larger for channel width than for mapped basin or climatic variables, the site visits needed to measure channel width commonly indicate hydrologic or geologic anomalies of the stream that would invalidate the application of basin equations. In this respect, the requirement for a site visit is a positive feature of the channel-geometry equations.

An additional advantage to having estimating equations based on channel geometry as well as estimating equations based on basin and climatic variables is that each technique is presumed to be independent from the other. Each technique thus can be used to check results from the other, and results from each technique can be weighted inversely proportional to their variances and averaged to yield a single estimate that should be more reliable than either individual estimate. According to the U.S. Water Resources Council (1981), a weighted average of two independent estimates can be obtained from the following:

$$z = \frac{x \cdot (SE_y)^2 + y \cdot (SE_x)^2}{(SE_x)^2 + (SE_y)^2} \qquad (4)$$

where z is the weighted average estimate, x and y are the estimates made from two independent techniques, and SE_x and SE_y are the standard errors of the two independent techniques expressed in log units. The standard error of the weighted average estimate (SE_z) can be determined as follows:

$$SE_z = \sqrt{\frac{(SE_x)^2 \cdot (SE_y)^2}{(SE_x)^2 + (SE_y)^2}} \qquad (5)$$

SUMMARY

Because of a substantially expanded data base, additional period of record at data sites used in previous analyses, and revised flood-frequency curves, new regression equations that relate channel width to flood peaks were developed for seven regions in Montana. Five of the regions are virtually identical with regions used in the previous studies. The new regression equations that use active-channel width as the independent variable have standard errors of estimate ranging from 30 to 87 percent. The new equations that use bankfull width as the independent variable have standard errors of estimate ranging from 34 to 92 percent. The prediction equations for the 2-year flood, 5-year flood, and the 10-year flood generally had the smallest standard errors, whereas the prediction equations for the 100-year flood had the largest standard errors. Equations for those regions composed of the mountainous areas of the State (West, Northwest, Upper Yellowstone, and Southwest) generally had smaller standard errors than equations for the flatter, plains areas of the State (North-Central, East-Central, and Southeast Regions). For any given recurrence interval and channel width, the equations for the West and Southwest Regions yielded smaller peak discharges than equations for any other region.

Compared with equations previously developed, the new equations had substantially smaller standard errors in three regions and substantially larger standard errors in one region. In one region, the standard errors for the new equations are about the same as for the old equations. Comparisons could not be made in the two regions where boundaries were different from those used in previous studies. In the two regions where the standard errors of the new equations are the same or larger (West and Northwest Regions), the new equations yield substantially larger peak discharges for most recurrence intervals and widths. In the other regions, the new equations yield larger discharges for some recurrence intervals and widths and smaller discharges for other recurrence intervals and widths, compared to the old equations. In all regions, the new equations are considered to be more reliable than the old equations, largely because of the larger data base and longer period of record.

The standard error of prediction at a specific site is greater than the standard error of the estimating equation because of uncertainty in defining channel width at the site. The standard error of width measurements has been shown to be about 32 percent for streams in the West region. Combining this with a typical standard error of the estimating equation of 63 percent gives a total standard error of prediction of 74 percent.

The equations for predicting peak discharge using channel width are considered to be as reliable as the equations using basin and climatic variables because the site visits needed for the channel-geometry method commonly indicate hydrologic or geologic anomalies that may significantly affect discharge. Because the estimates from equations based on channel width are presumed to be independent from those based on basin and climatic variables, the two can be weighted inversely proportional to their variances and averaged to yield a weighted estimate that should be more reliable than either individual estimate.

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Table 4.--*Peak discharges and channel widths at selected gaging stations*

[Stations are in Montana unless identified otherwise. Abbreviations: Ab, above; bdy, boundary; bl, below; Cr, creek; int, international; nr, near; R, river; res, reservoir; trib, tributary; BC, British Columbia; N Dak, North Dakota; S Dak, South Dakota; Sask, Saskatchewan; Wyo, Wyoming]

Station number	Station name	Peak discharge, in cubic feet per second, for selected recurrence intervals, in years: 2	5	10	25	50	100	Active-channel width, in feet	Bankfull width, in feet
	WEST REGION								
12300400	Cayuse Cr nr Trego	53.5	95.0	126	169	202	237	11	--
12300500	Fortine Cr nr Trego	775	1100	1330	1610	1830	2040	22	29
12300800	Deep Cr nr Fortine	135	182	211	247	272	297	16	18
12301300	Tobacco R nr Eureka	1560	2050	2350	2720	2980	3230	48	58
12301800	Gold Cr nr Rexford	65.3	112	148	200	244	291	9.0	14
12301810	Big Cr nr Rexford	1330	2360	3090	4040	4750	5440	44	55
12301997	Richards Cr nr Libby	24.2	51.7	74.2	106	132	159	6.8	11
12302400	Shaughnessy Cr nr Libby	11.5	30.3	50.4	87.1	124	171	7.5	12
12302500	Granite Cr nr Libby	603	878	1080	1370	1610	1870	32	--
12303100	Flower Cr nr Libby	228	320	383	465	528	592	17	24
12303400	Ross Cr nr Troy	900	1600	2100	2900	3400	4000	37	47
12303440	Camp Cr nr Troy	249	388	489	628	737	853	19	--
12303500	Lake Cr nr Troy	2540	3180	3610	4160	4580	5000	65	79
12304060	Blacktail Cr nr Yaak	74.0	131	174	233	281	331	12	16
12304120	Zulu Cr nr Yaak	40.7	69.5	92.9	128	158	191	8.5	13
12304300	Cyclone Cr nr Yaak	135	184	218	261	294	328	10	22
12304400	Fourth of July Cr nr Yaak	174	245	288	338	372	404	13	21
12305500	Boulder Cr nr Leonia, Idaho	1250	1680	1950	2450	3000	4100	36	45
12306500	Moyie R at Eastport, Idaho	5410	7010	7900	8870	9500	10100	112	138
12307500	Moyie R at Eileen, Idaho	6530	8130	9080	10200	11000	11700	98	132
12310800	Trail Cr at Naples, Idaho	160	252	328	443	544	660	12	20
12316800	Mission Cr nr Copeland, Idaho	340	420	471	532	577	620	25	32
12321000	Smith Cr nr Porthill, Idaho	1910	2500	2880	3370	3720	4080	58	79
12321500	Boundary Cr nr Porthill, Idaho	1930	2480	2840	3270	3600	3920	53	63
12323300	Smith Cr nr Silver Bow	18.0	41.7	63.6	98.4	130	165	3.0	5.5
12323500	German Gulch nr Ramsay	186	285	357	454	531	612	22	27
12324100	Racetrack Cr bl Granite Cr, nr Anaconda	367	485	554	632	685	733	26	28
12324590	Little Blackfoot R nr Garrison	1370	2920	4260	6320	8100	10100	60	77
12324700	Clark Fork trib nr Drummond	45.0	89.8	127	183	230	282	4.0	10
12330000	Boulder Cr at Maxville	395	596	741	938	1090	1250	28	32
12331700	Edwards Gulch at Drummond	10.1	35.9	70.4	145	233	357	3.0	7.0
12332000	Middle Fork Rock Cr nr Philipsburg	948	1250	1420	1600	1720	1820	56	71
12335500	Nevada Cr ab res nr Finn	528	968	1320	1830	2250	2710	21	33
12338600	Monture Cr at Forest Service bdy, nr Ovando	1390	1710	1910	2160	2340	2520	36	--
12338690	Monture Cr nr Ovando	1540	1920	2140	2400	2570	2730	52	68
12339300	Deer Cr nr Seeley Lake	272	353	403	463	506	547	23	30
12339900	West Twin Cr nr Bonner	95.4	160	208	273	324	378	15	21
12341000	Rattlesnake Cr at Missoula	1300	1720	1980	2290	2510	2720	39	48
12342950	Trapper Cr nr Conner	495	734	896	1100	1250	1410	22	31
12343400	East Fork Bitterroot R nr Conner	1930	2820	3380	4050	4530	5000	75	90
12345800	Camas Cr nr Hamilton	149	209	246	290	320	348	15	20
12345850	Sleeping Child Cr nr Hamilton	581	846	1020	1250	1410	1570	33	37
12346500	Skalkho Cr nr Hamilton	667	857	962	1080	1150	1220	34	44
12347500	Blodgett Cr nr Corvallis	636	773	854	948	1010	1070	34	38
12350000	Bear Cr nr Victor	694	893	1020	1160	1270	1370	41	47
12350200	Gash Cr nr Victor	110	159	189	225	251	274	11	16
12351000	Burnt Fork Bitterroot R nr Stevensville	341	507	617	754	853	951	20	28
12352000	Lolo Cr ab Sleemen Cr, nr Lolo	1490	1810	2000	2250	2420	2590	51	60
12352200	Hayes Cr nr Missoula	11.1	26.3	39.8	60.2	77.5	96.4	4.0	8.0
12353250	Ninemile Cr nr Alberton	530	783	958	1190	1360	1540	40	--
12353280	Ninemile Cr nr Huson	1120	1450	1640	1850	1990	2120	48	60
12353400	Negro Gulch nr Alberton	30.2	68.7	102	152	195	241	8.0	13
12353800	Thompson Cr nr Superior	67.8	118	153	200	234	269	9.0	14
12353850	East Fork Timber Cr nr Haugan	39.6	60.0	73.2	89.2	101	112	8.0	12
12354000	St Regis R nr St Regis	4200	6690	8620	11400	13700	16200	130	136

Table 4.--*Peak discharges and channel widths at selected gaging stations*--Continued

Station number	Station name	Peak discharge, in cubic feet per second, for selected recurrence intervals, in years: 2	5	10	25	50	100	Active-channel width, in feet	Bankfull width, in feet
				WEST REGION--Continued					
12354100	North Fork Little Joe Cr nr St Regis	184	239	268	299	319	335	16	21
12355000	Flathead R at Flathead, BC	7400	10100	11800	13800	15300	16800	120	145
12355350	Big Cr at Forest Service bdy, nr Columbia Falls	1200	1530	1750	2030	2240	2460	43	50
12364000	Logan Cr at Tally Lake, nr Whitefish	468	879	1190	1620	1960	2310	47	67
12365000	Stillwater R nr Whitefish	1570	2450	3000	3650	4100	4520	70	85
12370500	Dayton Cr nr Proctor	39.4	69.5	91.9	122	146	170	11	14
12370900	Teepee Cr nr Polson	9.80	20.7	31.3	49.5	67.3	89.3	6.0	10
12371100	Hell Roaring Cr nr Polson	30.1	61.8	88.2	127	159	194	10	14
12374300	Mill Cr nr Niarada	93.0	167	219	287	338	388	13	21
12375700	Garden Cr nr Hot Springs	26.0	48.9	66.5	90.8	110	130	8.0	12
12378000	Mission Cr nr St Ignatius	455	714	909	1180	1400	1640	22	24
12390700	Prospect Cr at Thompson Falls	1760	2470	2950	3550	4000	4460	49	67
12391100	White Pine Cr nr Trout Creek	222	356	453	584	687	794	23	30
12391200	Canyon Cr nr Trout Creek	160	216	248	284	308	330	17	22
12391525	Snake Cr nr Noxon	46.9	87.7	118	159	191	223	11	15
12391550	Bull R nr Noxon	2130	2910	3410	4020	4460	4890	63	68
12392100	Trapper Cr nr Clark Fork, Idaho	44.7	125	231	470	769	1220	5.0	10
12392300	Pack R nr Colborn, Idaho	2470	3290	3860	4610	5190	5790	67	77
12411000	Coeur d'Alene R ab Shoshone Cr, nr Prichard, Idaho	7030	10100	12300	15300	17600	20100	117	157
12413100	Boulder Cr at Mullen, Idaho	99.8	143	173	215	247	281	11	17
12413140	Placer Cr at Wallace, Idaho	394	733	1030	1490	1900	2380	21	27
12413200	Montgomery Cr nr Kellogg, Idaho	71.8	121	160	218	268	324	12	16
13336850	Wier Cr nr Powell Ranger Station, Idaho	264	415	526	677	796	922	22	29
				NORTHWEST REGION					
05010000	Belly R at int bdy	1950	2680	3210	4800	9200	16700	133	158
05014500	Swiftcurrent Cr at Many Glacier, Glacier National Park	1010	1310	1510	1900	3300	6700	45	62
05015000	Canyon Cr nr Many Glacier, Glacier National Park	195	310	400	620	1000	1800	22	27
06073000	Dearborn R nr Clemons	1140	2000	2750	4300	6200	10500	54	84
06078500	North Fork Sun R nr Augusta	3100	4000	4650	6200	10500	17500	86	93
06079600	Beaver Cr at Gibson Dam, nr Augusta	119	276	450	800	1350	2500	17	24
06080000	Sun R nr Augusta	6400	9600	12000	17100	24500	38000	160	193
06081500	Willow Cr nr Augusta	150	350	540	890	1250	1470	20	35
06084500	Elk Cr at Augusta	868	2080	3240	5180	6980	9100	43	57
06092000	Two Medicine R nr Browning	3600	5200	6700	9900	15500	29000	164	155
06102500	Teton R nr Farmington	1400	2650	3900	6400	10000	17500	41	70
06132200	South Fork Milk R nr Browning	380	790	1200	2100	3400	6200	22	27
12335000	Blackfoot R nr Helmville	2100	3670	4900	6640	8080	9620	100	120
12356000	Skyland Cr nr Essex	160	225	275	380	620	1100	18	26
12356500	Bear Cr nr Essex	410	620	800	1040	1560	2350	25	36
12357000	Middle Fork Flathead R at Essex	9800	14000	17000	22000	27000	34500	172	192
12357300	Moccasin Cr nr West Glacier	130	235	335	515	820	1400	16	22
12359500	Spotted Bear R nr Hungry Horse	3700	4450	4900	5500	6000	6900	105	--
12360000	Twin Cr nr Hungry Horse	1400	1950	2310	2890	3050	4100	41	59
12361000	Sullivan Cr nr Hungry Horse	1860	2430	2800	3210	3600	4100	63	78
12361500	Graves Cr nr Hungry Horse	1230	1840	2340	3120	3800	4590	40	60
				NORTH-CENTRAL REGION					
06071200	Lyons Cr nr Wolf Creek	93.0	228	381	677	1000	1440	11	17
06071400	Dog Cr nr Craig	58.0	205	428	989	1750	2990	11	16
06071600	Wegner Cr nr Craig	114	292	504	940	1440	2140	18	18
06073600	Black Rock Cr nr Augusta	183	322	445	641	821	1030	3.8	7.2
06077300	Trout Cr nr Eden	45.5	129	239	493	815	1310	6.0	9.0

Table 4.--*Peak discharges and channel widths at selected gaging stations*--Continued

Station number	Station name	Peak discharge, in cubic feet per second, for selected recurrence intervals, in years						Active-channel width, in feet	Bankfull width, in feet
		2	5	10	25	50	100		
	NORTH-CENTRAL REGION--Continued								
06077700	Smith R trib nr Eden	2.8	10.8	24.6	64.0	124	233	1.0	2.5
06077800	Goodman Coulee nr Eden	86.1	219	379	714	1110	1670	5.5	11
06088500	Muddy Cr at Vaughn	648	1300	2010	3370	4870	6930	43	60
06089300	Sun R trib nr Great Falls	74.0	274	542	1120	1780	2710	10	18
06090500	Belt Cr nr Monarch	1610	3020	4370	6710	9000	11900	62	--
06090550	Little Otter Cr nr Raynesford	42.0	113	194	356	532	771	7.0	9.3
06090810	Ninemile Coulee nr Fort Benton	150	540	1100	2300	3400	5100	9.2	18
06098700	Powell Coulee nr Browning	19.5	96.1	234	633	1230	2290	5.5	11
06099700	Middle Fork Dry Fork of Marias R nr Dupuyer	71.9	261	552	1300	2340	4050	7.5	24
06100200	Heines Coulee trib nr Valier	6.2	23.4	51.5	129	244	446	1.0	4.0
06101800	Sixmile Coulee nr Chester	18.1	95.3	211	468	760	1150	4.0	7.0
06101900	Dead Indian Coulee nr Fort Benton	6.7	61.6	180	533	1040	1850	4.8	8.5
06102100	Dry Fork Coulee trib nr Loma	18.6	63.7	118	225	338	483	3.5	6.5
06105800	Bruce Coulee trib nr Choteau	56.9	138	228	400	584	830	3.4	14
06108200	Kinley Coulee nr Dutton	66.0	170	340	700	1500	3000	4.3	8.0
06109560	Alkali Creek trib nr Big Sandy	9.2	25.5	43.8	78.6	115	162	3.5	6.2
06109800	South Fork Judith R nr Utica	268	634	1030	1790	2600	3680	20	22
06111700	Mill Cr nr Lewistown	13.6	35.9	57.8	94.1	127	166	2.8	5.0
06112100	Cottonwood Cr nr Moore	370	868	1340	2100	2800	3610	29	30
06112800	Bull Cr trib nr Hilger	20.5	43.3	62.8	91.9	117	144	2.7	3.5
06114900	Taffy Cr trib nr Winifred	58.1	129	192	285	365	453	4.7	10
06115300	Duval Cr nr Landusky	58.2	157	259	434	600	800	8.0	14
06124600	East Fork Roberts Cr trib nr Judith Gap	27.3	60.8	91.6	141	185	236	3.0	6.0
06128400	South Fork Bear Cr nr Grassrange	252	672	1110	1900	2670	3630	14	21
06129200	Alkali Cr nr Heath	25.5	103	208	433	690	1040	5.0	9.0
06129500	McDonald Cr at Winnett	343	726	1040	1470	1820	2190	26	43
06132400	Dry Fork Milk R nr Babb	185	600	1160	2200	3200	4700	10	12
06133500	North Fork Milk R ab St Mary Canal, nr Browning	267	695	1180	2120	3140	4500	23	31
06134800	Van Cleeve Coulee nr Sunburst	33.8	84.1	134	217	295	388	3.0	5.5
06138800	Spring Coulee nr Havre	30.2	178	394	838	1300	1870	12	21
06140400	Bullhook Cr nr Havre	102	295	483	783	1040	1330	12	18
06144350	Middle Cr nr Alberta bdy, Alberta	257	842	1420	2310	3060	3850	17	25
06145000	McRae Coulee nr int bdy, Alberta	274	646	933	1310	1580	1840	5.3	13
06148000	Battle Cr ab Cypress Lake inflow canal, nr West Plains, Sask	557	1110	1550	2160	2650	3170	20	28
06150500	East Fork Battle Cr nr int bdy	322	853	1330	2040	2630	3250	17	30
06151000	Lyons Cr at int bdy	203	533	813	1200	1500	1800	16	23
06154400	Peoples Cr nr Hays	316	1200	2310	4490	6780	9700	28	53
06154410	Little Peoples Cr nr Hays	51.7	163	287	515	742	1020	15	19
06155100	Black Coulee nr Malta	74.2	144	199	277	340	405	4.7	9.0
06155200	Alkali Cr nr Malta	148	561	1030	1830	2580	3420	26	36
06155300	Disjardin Coulee nr Malta	28.9	71.9	118	201	287	396	4.0	9.0
06155400	Taylor Coulee nr Malta	8.4	52.5	119	255	397	571	4.0	10
06155600	Murray Coulee nr Hogeland	56.9	173	300	526	748	1020	7.3	13
06156000	Whitewater Cr nr int bdy	177	947	2030	4210	6460	9240	22	28
06164600	Beaver Cr trib nr Zortman	86.8	195	287	422	534	654	3.3	6.2
	EAST-CENTRAL REGION								
06117800	Big Coulee trib nr Martinsdale	58.0	160	290	500	720	1050	2.0	6.0
06118500	South Fork Musselshell R ab Martinsdale	746	1340	1900	2830	3720	4830	47	58
06120700	Antelope Cr trib nr mouth, nr Harlowton	36.0	128	240	462	696	1000	2.5	5.0
06122000	American Fork bl Lebo Cr, nr Harlowton	344	690	991	1460	1870	2330	24	32
06125700	Big Coulee nr Lavina	109	382	743	1520	2430	3700	16	26

Table 4.--*Peak discharges and channel widths at selected gaging stations*--Continued

Station number	Station name	Peak discharge, in cubic feet per second, for selected recurrence intervals, in years: 2	5	10	25	50	100	Active-channel width, in feet	Bankfull width, in feet
	EAST-CENTRAL REGION--Continued								
06126300	Currant Cr nr Roundup	136	436	796	1510	2270	3280	13	27
06127100	South Willow Cr trib nr Roundup	69.7	185	307	522	733	992	3.0	6.8
06127200	Musselshell R trib nr Musselshell	47.8	137	228	379	518	677	2.8	7.0
06127520	Home Cr nr Sumatra	53.9	95.3	126	167	198	231	2.7	5.5
06127570	Butts Coulee nr Melstone	89.3	195	288	429	550	684	4.3	8.7
06128900	Box Elder Cr trib nr Winnett	127	281	417	625	805	1010	10	14
06129700	Gorman Coulee nr Cat Creek	88.8	275	467	790	1080	1420	--	8.3
06129800	Gorman Coulee trib nr Cat Creek	35.9	114	206	384	570	810	2.8	5.0
06130600	Cat Cr nr Cat Creek	95.8	217	324	489	631	788	6.7	12
06130610	Bair Coulee nr Mosby	53.3	162	287	525	771	1090	3.0	9.3
06130850	Second Cr trib 2 nr Jordan	31.0	100	182	337	498	704	3.0	8.0
06131100	Terry Cr trib nr Van Norman	32.0	82.6	129	201	262	328	3.0	6.3
06131300	McGuire Cr trib nr Van Norman	76.3	161	227	316	385	454	3.0	4.2
06169000	Horse Cr at int bdy	299	731	1090	1610	2020	2440	7.0	11
06169500	Rock Cr bl Horse Cr, nr int bdy	1100	2360	3310	4580	5520	6440	29	41
06170000	McEachern Cr nr int bdy	695	1970	3050	4520	5620	6680	25	36
06172300	Uuger Coulee nr Vandalia	82.0	428	950	2120	3470	5320	6.3	10
06172350	Mooney Coulee nr Tampico	38.3	180	355	669	962	1300	4.0	--
06173300	Willow Cr trib nr Glasgow	62.2	241	453	840	1220	1670	2.3	7.8
06174600	Snow Coulee nr Opheim	30.9	120	224	414	596	812	2.8	7.0
06175550	East Fork Sand Cr nr Vida	185	460	727	1170	1580	2060	8.0	17
06175700	East Fork Wolf Cr nr Lustre	50.4	247	503	981	1440	1990	4.0	8.0
06175900	Wolf Cr trib 2 nr Wolf Point	88.6	395	784	1520	2240	3110	4.5	9.0
06176500	Wolf Cr nr Wolf Point	423	1990	4190	8850	14000	20700	32	50
06177050	East Fork Duck Cr nr Brockway	98.6	271	428	663	857	1060	6.0	17
06177100	Duck Cr nr Brockway	164	596	1060	1830	2520	3270	10	34
06177150	Redwater R at Brockway	520	1340	2050	3070	3870	4690	14	54
06177200	Tusler Cr nr Brockway	139	340	505	731	905	1080	12	35
06177250	Tusler Cr trib nr Brockway	6.3	62.9	179	491	888	1460	5.0	12
06177400	McCune Cr nr Circle	75.0	308	603	1180	1770	2510	13	22
06177500	Redwater R at Circle	850	2500	4070	6520	8590	10800	16	27
06177700	Cow Cr trib nr Vida	68.8	242	436	781	1110	1500	2.5	11
06177800	Wolf Cr trib nr Vida	42.0	205	490	1150	1950	3100	3.0	7.0
06178000	Poplar R at int bdy	759	2180	3780	6770	9850	13800	19	32
06178500	East Poplar R at int bdy	557	1800	2980	4720	6110	7530	23	59
06179500	West Fork Poplar R nr Opheim	218	959	1950	3950	6070	8790	30	--
06180000	West Fork Poplar R nr Richland	589	1490	2320	3610	4710	5930	21	31
06181200	Missouri R trib 2 nr Brockton	52.7	117	173	260	335	418	3.0	5.8
06182500	Big Muddy Cr nr Daleview	1060	2590	3920	5880	7490	9190	16	33
06182700	Middle Fork Big Muddy Cr nr Flaxville	36.0	111	186	308	416	537	1.5	3.5
06183100	Box Elder Cr nr Plentywood	93.1	191	266	369	447	527	6.0	11
06183300	Spring Cr nr Plentywood	30.4	84.5	140	236	326	434	4.0	10
06183400	Spring Cr at Highway 16, nr Plentywood	83.3	365	740	1500	2300	3320	6.0	
06185100	Big Muddy Cr trib nr Culbertson	45.9	171	328	637	964	1380	5.0	10
06185200	Missouri R trib 3 nr Culbertson	13.6	89.3	231	623	1170	2030	5.3	8.2
06185300	Missouri R trib 4 nr Bainville	324	633	874	1210	1470	1740	4.0	8.0
06185400	Missouri R trib 5 nr Culbertson	43.5	188	376	750	1140	1630	4.0	8.0
06217700	Crooked Cr trib nr Shepherd	100	410	870	1850	2800	4500	8.0	13
06294900	Middle Fork Froze to Death Cr trib nr Ingomar	72.6	143	206	304	392	493	4.3	8.0
06295020	Short Cr nr Forsyth	138	399	679	1170	1660	2240	7.3	15
06296115	Reservation Cr nr Miles City	224	607	971	1550	2050	2610	5.7	12
06309040	Dry House Cr nr Angela	137	462	833	1510	2170	2980	19	25
06309060	North Fork Sunday Cr nr Angela	53.3	108	156	227	289	359	3.3	8.3
06326550	Cherry Cr trib nr Terry	104	188	253	346	422	503	3.5	8.0
06326950	Yellowstone R trib 5 nr Marsh	22.2	84.9	160	297	431	593	2.5	9.0

Table 4.- *Peak discharges and channel widths at selected gaging stations*--Continued

Station number	Station name	Peak discharge, in cubic feet per second, for selected recurrence intervals, in years: 2	5	10	25	50	100	Active-channel width, in feet	Bankfull width, in feet
	EAST-CENTRAL REGION--Continued								
06328800	Indian Cr at Intake	12.5	40.6	74.0	139	207	296	1.8	3.5
06329200	Burns Cr nr Savage	301	1030	1810	3140	4370	5770	19	51
06329570	First Hay Cr nr Sidney	45.4	196	405	852	1350	2030	12	24
06329800	Painted Woods Cr nr Williston, N Dak	94.0	253	405	648	863	1100	7.3	14
06330100	Sand Cr at Williston, N Dak	134	455	814	1450	2070	2800	5.5	--
06331900	White Earth R trib nr Tioga, N Dak	71.0	192	309	497	662	848	4.0	6.5
	SOUTHEAST REGION								
06294600	East Cabin Cr trib nr Hardin	14.5	68.1	148	330	548	855	3.5	6.5
06294800	Unknown Cr nr Bighorn	149	533	992	1860	2750	3860	8.3	14
06294850	Buckingham Coulee nr Myers	27.8	84.9	149	269	391	545	4.3	7.0
06294930	Sarpy Cr trib nr Colstrip	17.3	67.0	138	304	511	818	3.0	6.0
06294940	Sarpy Cr nr Hysham	93.8	282	487	855	1220	1660	13	22
06294985	East Fork Armells Cr trib nr Colstrip	13.2	41.3	74.3	138	205	292	3.8	6.5
06295100	Rosebud Cr nr Kirby	86.4	203	314	495	662	857	6.7	11
06295200	Whitedirt Cr nr Lame Deer	8.5	24.7	42.2	73.0	103	139	2.7	4.5
06296100	Snell Cr nr Hathaway	106	222	323	475	606	750	6.0	15
06306900	Spring Cr nr Decker	83.0	313	621	1280	2040	3100	15	21
06306950	Leaf Rock Cr nr Kirby	19.6	105	236	526	859	1310	4.3	11
06307520	Canyon Cr nr Birney	48.0	170	460	1200	2200	3900	20	30
06307600	Hanging Woman Cr nr Birney	148	705	1550	3540	5960	9460	16	26
06307780	Stebbins Cr at mouth, nr Ashland	98.1	294	495	831	1140	1490	13	17
06307930	Jack Cr nr Volborg	195	309	381	467	527	583	7.3	14
06308100	Sixmile Cr trib nr Epsie	55.0	160	250	430	560	800	2.8	5.5
06308200	Basin Cr trib nr Volborg	10.8	37.4	70.1	135	205	297	1.8	4.0
06308300	Basin Cr nr Volborg	170	524	913	1610	2290	3130	7.0	13
06308330	Deer Cr trib nr Volborg	32.7	150	324	723	1200	1890	5.5	10
06308340	Lagrange Cr nr Volborg	43.6	117	194	325	452	604	3.8	7.0
06309080	Deep Cr nr Kinsey	422	1110	1740	2720	3550	4460	13	23
06325400	East Fork Little Powder R trib nr Hammond	46.7	82.7	111	153	188	227	3.0	6.0
06325700	Deep Cr nr Powderville	49.8	129	208	340	463	607	4.0	7.5
06325950	Cut Coulee nr Mizpah	94.8	175	233	309	366	423	7.0	13
06326400	Meyers Cr nr Locate	271	588	882	1360	1800	2320	9.0	22
06326510	Locate Cr trib nr Locate	14.3	61.6	122	241	362	512	2.0	5.5
06326700	Deep Cr nr Baker	116	169	205	250	284	318	4.5	11
06326800	Pennel Cr nr Baker	44.4	86.4	123	181	232	291	2.5	5.5
06326940	Spring Cr trib nr Fallon	32.1	85.0	138	225	306	401	2.3	5.0
06327700	Griffith Cr nr Glendive	117	368	682	1330	2070	3100	11	19
06327720	Griffith Cr trib nr Glendive	33.9	173	385	863	1420	2200	2.3	6.0
06328100	Yellowstone R trib 6 nr Glendive	32.2	139	271	520	763	1060	4.0	9.5
06334100	Wolf Cr nr Hammond	233	536	784	1130	1400	1670	13	31
06334200	Willow Cr nr Alzada	640	1170	1570	2120	2560	3010	14	66
06334610	Hawksnest Cr trib nr Albion	29.9	57.8	79.2	108	131	154	2.8	6.5
06334640	North Fork Coal Bank Cr nr Mill Iron	155	381	569	831	1030	1240	8.0	16
06334720	Soda Cr trib nr Webster	8.6	28.6	52.0	96.3	142	199	1.8	5.5
06335000	Little Beaver Cr nr Marmarth, N Dak	3310	5860	7630	9870	11500	13100	59	115
06335700	Deep Cr nr Bowman, N Dak	12.0	27.0	41.0	62.0	80.0	100	1.5	3.5
06336100	Sheep Cr trib 1 nr Medora, N Dak	25.0	47.0	64.0	99.0	124	154	1.5	4.0
06336200	Sheep Cr trib 2 nr Medora, N Dak	41.0	101	156	239	310	387	2.0	5.0
06336300	Little Missouri R trib nr Medora, N Dak	3.2	17.0	39.0	86.0	141	215	1.5	4.5
06336400	Jules Cr nr Medora, N Dak	175	401	596	885	1120	1380	4.5	10
06336450	Spring Cr nr Wibaux	66.9	156	235	353	454	563	4.0	15
06336500	Beaver Cr at Wibaux	745	2660	4780	8450	11800	15800	36	55
06358600	South Fork Moreau R trib nr Redig, S Dak	53.6	124	192	302	405	526	4.7	11

Table 4.--*Peak discharges and channel widths at selected gaging stations*--Continued

Station number	Station name	Peak discharge, in cubic feet per second, for selected recurrence intervals, in years: 2	5	10	25	50	100	Active-channel width, in feet	Bankfull width, in feet
	UPPER YELLOWSTONE REGION								
06187500	Tower Cr at Tower Falls, Yellowstone National Park, Wyo	320	470	565	680	761	839	23	31
06191000	Gardner R nr Mammoth, Yellowstone National Park, Wyo	1120	1510	1760	2060	2270	2480	44	55
06193000	Shields R nr Wilsall	545	847	1090	1440	1730	2060	38	46
06193500	Shields R at Clyde Park	1060	1750	2320	3190	3950	4810	68	75
06194000	Brackett Cr nr Clyde Park	205	386	556	840	1110	1440	23	31
06197000	Big Timber Cr nr Big Timber	670	1210	1700	2510	3260	4180	42	65
06197500	Boulder R nr Contact	3720	4560	5110	5820	6360	6900	80	95
06200000	Boulder R at Big Timber	5860	7240	8140	9270	10100	11000	120	140
06200500	Sweet Grass Cr ab Melville	933	1360	1680	2150	2540	2960	52	--
06201000	Sweet Grass Cr bl Melville	937	1540	2030	2770	3410	4150	50	57
06201600	Bridger Cr nr Greycliff	131	496	1030	2270	3830	6200	24	32
06201650	Work Cr nr Reedpoint	95.8	369	752	1620	2670	4190	17	--
06201700	Hump Cr nr Reedpoint	35.4	116	221	448	716	1100	5.5	8.0
06204050	West Rosebud Cr nr Roscoe	789	1170	1440	1810	2100	2410	46	60
06204500	Rosebud Cr nr Absarokee	2300	3240	3910	4810	5520	6260	105	130
06205100	Allen Cr nr Park City	64.1	220	425	866	1380	2110	6.5	28
06206500	Sunlight Cr nr Painter, Wyo	1180	1480	1680	1920	2100	2280	50	56
06207800	Bluewater Cr nr Belfry	98.1	259	454	860	1330	2000	10	23
06209500	Rock Cr nr Red Lodge	1230	1710	2020	2420	2710	3000	64	77
06210000	West Fork Rock Cr bl Basin Cr, nr Red Lodge	528	798	995	1260	1480	1700	40	54
06211000	Red Lodge Cr ab Cooney Res, nr Boyd	579	1180	1720	2580	3360	4260	30	46
06211500	Willow Cr nr Boyd	252	562	883	1470	2070	2850	26	38
06215000	Pryor Cr nr Pryor	123	243	357	546	727	947	10	15
06216000	Pryor Cr at Pryor	161	297	423	629	823	1060	18	27
06216200	West Wets Cr nr Billings	91.8	209	323	515	697	917	7.0	12
06216300	West Buckeye Cr nr Billings	78.8	196	324	567	823	1160	8.0	16
06216500	Pryor Cr nr Billings	654	1290	1890	2930	3920	5160	41	58
06287500	Soap Cr nr St Xavier	406	931	1500	2600	3780	5360	19	23
06288000	Rotten Grass Cr nr St Xavier	409	762	1080	1590	2070	2630	21	24
06289000	Little Bighorn R at State line, nr Wyola	1050	1480	1780	2190	2500	2840	45	48
06290000	Pass Cr nr Wyola	306	591	869	1350	1830	2440	29	37
06290200	Little Bighorn R trib nr Wyola	12.1	56.3	129	321	583	1010	4.0	7.3
06290500	Little Bighorn R bl Pass Cr, nr Wyola	1280	2050	2700	3690	4580	5600	75	64
06291500	Lodgegrass Cr nr Wyola	435	624	760	945	1090	1250	31	39
06293300	Long Otter Cr nr Lodgegrass	39.5	95.3	154	263	375	519	5.0	8.8
06298000	Tongue R nr Dayton, Wyo	1670	2260	2630	3080	3390	3690	62	72
06298500	Little Tongue R nr Dayton, Wyo	123	228	316	448	564	693	14	18
06299500	Wolf Cr at Wolf, Wyo	302	486	637	865	1060	1290	24	30
06300500	East Fork Goose Cr nr Bighorn, Wyo	511	692	825	1010	1160	1320	34	40
	SOUTHWEST REGION								
06011000	Red Rock R at Kennedy Ranch, nr Lakeview	723	934	1050	1180	1260	1330	62	87
06011400	Long Cr nr Lakeview	132	256	379	597	816	1100	17	22
06011900	Red Rock R trib nr Monida	4.4	9.2	13.2	19.2	24.0	29.3	1.0	3.0
06013200	Traux Cr nr Lima	4.5	24.1	51.7	108	166	238	3.8	6.0
06013400	Muddy Cr nr Dell	61.8	109	142	184	214	244	5.5	10
06013500	Big Sheep Cr bl Muddy Cr, nr Dell	369	543	656	797	900	1000	27	33
06015430	Clark Canyon nr Dillon	73.1	143	198	276	338	403	9.0	14
06015500	Grasshopper Cr nr Dillon	399	682	878	1130	1310	1490	31	40
06017500	Blacktail Deer Cr nr Dillon	192	303	395	535	658	799	23	37
06019400	Sweetwater Cr nr Alder	96.4	200	284	403	500	601	9.0	13

Table 4.--*Peak discharges and channel widths at selected gaging stations*--Continued

Station number	Station name	Peak discharge, in cubic feet per second, for selected recurrence intervals, in years: 2	5	10	25	50	100	Active-channel width, in feet	Bankfull width, in feet
	SOUTHWEST REGION--Continued								
06019500	Ruby R ab res nr Alder	980	1100	1400	1800	2500	3200	44	53
06019800	Idaho Cr nr Alder	25.0	43.7	57.4	75.9	90.2	105	5.5	9.0
06024500	Trail Cr nr Wisdom	867	1030	1110	1210	1270	1330	35	48
06024590	Wise R nr Wise River	1790	2180	2400	2630	2780	2920	52	68
06025300	Moose Cr nr Divide	103	143	168	195	214	232	13	19
06027700	Fish Cr nr Silver Star	136	186	218	255	282	307	17	22
06030300	Jefferson R trib 2 nr Whitehall	8.2	34.1	70.5	151	244	376	7.0	11
06030500	Boulder R ab Rock Cr, nr Basin	180	337	468	666	838	1030	15	19
06031950	Cataract Cr nr Basin	280	510	700	1000	1200	1450	29	37
06033000	Boulder R nr Boulder	1130	1890	2490	3370	4130	4960	55	70
06035000	Willow Cr nr Harrison	229	352	441	560	654	752	23	28
06036600	Jefferson R trib 4 nr Sappington	2.4	8.4	16.7	36.1	60.3	96.6	3.8	7.7
06037500	Madison R nr West Yellowstone	1340	1620	1790	1960	2080	2190	85	94
06038550	Cabin Cr nr West Yellowstone	455	694	854	1060	1210	1350	34	46
06040300	Jack Cr nr Ennis	327	422	480	547	595	641	26	32
06043000	Taylor Cr nr Grayling	784	928	1010	1090	1150	1200	40	46
06043200	Squaw Cr nr Gallatin Gateway	265	396	492	621	723	830	25	31
06046500	Rocky Cr nr Bozeman	417	637	803	1040	1230	1430	28	37
06046700	Pitcher Cr nr Bozeman	15.6	33.9	52.4	85.5	119	162	4.5	10
06047000	Bear Canyon nr Bozeman	153	250	324	428	513	604	13	18
06048000	East Gallatin R at Bozeman	553	876	1130	1500	1800	2140	35	46
06048500	Bridger Cr nr Bozeman	303	505	667	908	1110	1340	22	28
06050000	Hyalite Cr at Hyalite Ranger Station, nr Bozeman	368	528	644	803	931	1070	33	42
06053050	Lost Cr nr Ringling	51.9	160	298	594	941	1440	9.3	--
06055500	Crow Cr nr Radersburg	537	848	1110	1500	1850	2260	30	38
06056200	Castle Cr trib nr Ringling	20.1	31.1	39.7	52.1	62.5	74.1	4.8	7.0
06056300	Cabin Cr nr Townsend	15.1	33.2	51.1	82.1	112	150	5.0	9.0
06056600	Deep Cr bl North Fork Deep Cr, nr Townsend	222	347	445	588	708	841	21	29
06061500	Prickly Pear Cr nr Clancy	266	480	715	1070	1400	1800	26	31
06061700	Jackson Cr nr East Helena	12.7	24.5	35.8	55.0	73.5	96.4	7.0	11
06061800	Crystal Cr nr East Helena	11.4	27.3	44.6	77.3	112	158	6.5	9.5
06061900	McClellan Cr at city diversion dam, nr East Helena	154	319	486	786	1090	1480	20	28
06062500	Tenmile Cr nr Rimini	210	420	610	1000	1360	1860	18	26
06062700	Little Porcupine Cr nr Helena	2.3	5.5	8.9	15.2	21.8	30.4	2.3	3.5
06063000	Tenmile Cr nr Helena	255	520	835	1360	1820	2440	24	33
06068500	Little Prickly Pear Cr nr Marysville	141	255	354	510	650	813	14	24
06074500	North Fork Smith R nr White Sulphur Springs	115	260	416	712	1030	1450	16	20
06076000	Newland Cr nr White Sulphur Springs	12.0	26.0	39.0	64.0	88.0	120	8.0	12
06076700	Sheep Cr nr Neihart	59.6	93.8	120	158	189	224	12	--
06076800	Nugget Cr nr Neihart	8.4	15.3	21.5	31.7	41.2	52.7	3.7	9.0
06077000	Sheep Cr nr White Sulphur Springs	208	304	378	484	571	667	27	36
06115500	North Fork Musselshell R nr Delpine	85.0	158	221	319	406	506	15	20
06117000	Checkerboard Cr nr Delpine	46.8	102	157	256	355	480	16	20
13038900	Targee Cr nr Macks Inn, Idaho	273	341	379	423	452	479	16	20
13108500	Camas Cr at Eightmile Shearing Corral, Idaho	870	1330	1640	2020	2310	2590	50	62
13113000	Beaver Cr at Spencer, Idaho	321	468	570	702	803	906	27	34
13116000	Medicine Lodge Cr at Ellis Ranch, nr Argora, Idaho	105	155	192	241	279	320	20	26
13117200	Main Fork nr Goldburg, Idaho	134	197	238	288	324	358	18	24
13117300	Sawmill Cr nr Goldburg, Idaho	364	538	650	788	888	985	28	35
13305700	Dahlonega Cr at Gibbonsville, Idaho	98.1	164	211	272	319	366	16	22
13305800	Hughes Cr nr North Fork, Idaho	138	208	256	320	368	417	14	20

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