

TECHNIQUES FOR ESTIMATING PEAK-FLOW FREQUENCY RELATIONS  
FOR NORTH DAKOTA STREAMS

By Tara Williams-Sether

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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 92-4020

Prepared in cooperation with  
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION



Bismarck, North Dakota

1992

U.S. DEPARTMENT OF THE INTERIOR

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## CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
cubic foot per second (ft <sup>3</sup> /s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per mile (ft/mi)	0.1894	meter per kilometer
inch (in.)	25.4	millimeter
inch per hour (in/hr)	25.4	millimeter per hour
mile (mi)	1.609	kilometer
square mile (mi <sup>2</sup> )	2.590	square kilometer

To convert degrees Fahrenheit (°F) to degrees Celsius (°C), use the following formula: °C = 5/9 x (°F-32).

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

This report presents techniques for estimating peak-flow frequency relations for North Dakota streams. In addition, a generalized skew coefficient analysis was completed for North Dakota to test the validity of using the generalized skew coefficient map in Bulletin 17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data, 1982, "Guidelines for Determining Flood Flow Frequency." The analysis indicates that the generalized skew coefficient map in Bulletin 17B provides accurate estimates of generalized skew coefficient values for natural-flow streams in North Dakota.

Peak-flow records through 1988 for 192 continuous- and partial-record streamflow gaging stations that had 10 or more years of record were used in a generalized least-squares regression analysis that relates peak flows for selected recurrence intervals to selected basin characteristics. Peak-flow equations were developed for recurrence intervals of 2, 10, 15, 25, 50, 100, and 500 years for three hydrologic regions in North Dakota. The peak-flow equations are applicable to natural-flow streams that have drainage areas of less than or equal to 1,000 square miles. The standard error of estimate for the three hydrologic regions ranges from 60 to 70 percent for the 100-year peak-flow equations.

Methods are presented for transferring peak-flow data from gaging stations to ungaged sites on the same stream and for determining peak flows for ungaged sites on ungaged streams. Peak-flow relations, weighted estimates of peak flow, and selected basin characteristics are tabulated for the 192 gaging stations used in the generalized skew coefficient and regression analyses. Peak-flow relations also are provided for 63 additional gaging stations that were not used in the generalized skew coefficient and regression analyses. These 63 gaging stations generally represent streams that are significantly controlled by regulation and those that have drainage areas greater than 1,000 square miles.

## INTRODUCTION

The size of highway structures, such as bridges and culverts, is determined largely by the hydraulic properties necessary to convey peak streamflow without causing significant damage to upstream property or to the structures. Underdesign of a structure could cause disruption of service, costly maintenance, and loss of life. Overdesign of a structure could result in excessive construction costs. Thus, accurate estimates of peak streamflow for recurrence intervals such as the 15-, 25-, 50-, 100-, and 500-year peak flows are needed.

Estimates of peak flows for selected recurrence intervals for streamflow gaging stations commonly are determined by fitting a probability distribution function or a frequency relation to a series of annual peak flows. Estimates for ungaged sites commonly are made by transferring the data from gaging stations using regression techniques that relate peak flow for selected recurrence intervals to basin and climatic characteristics. Accuracy of the estimates for the ungaged sites depends on the accuracy of peak flows for the gaging stations for selected recurrence intervals, the accuracy of the basin and climatic characteristics, and the accuracy of the equations that relate peak flow to basin and climatic characteristics.

This report was prepared by the U.S. Geological Survey in cooperation with the North Dakota Department of Transportation. Engineering analyses performed by the North Dakota Department of Transportation require current peak-flow estimates, particularly for the 15- to 500-year recurrence intervals. These peak-flow requirements have created a need for updating the flood-frequency analysis by Crosby (1975). Crosby's analysis only used data through 1973 and did not include peak-flow equations for the 15-, 100-, and 500-year recurrence intervals. Because the accuracy of peak-flow estimates for selected recurrence intervals is sensitive to the value of the generalized skew coefficient, the generalized skew coefficient values presently being used in North Dakota also need to be evaluated.

All Federal agencies and many State agencies and local consultants use the log-Pearson Type III distribution when determining frequency relations for gaging stations and follow the procedures described in Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" (Hydrology Subcommittee of the Interagency Advisory Committee on Water Data, 1982). In this report, this reference will be referred to as Bulletin 17B. The procedures described in Bulletin 17B were used to determine frequencies in this report.

### Purpose and Scope

The purpose of this report is: (1) To test the validity of using the generalized skew coefficient map from Bulletin 17B for North Dakota and, if necessary, develop a new procedure for estimating the generalized skew coefficient for North Dakota streams; (2) to publish peak-flow frequency relations for selected recurrence intervals from 2 to 500 years for gaging stations with 10 or more years of record; (3) to present a procedure for computing peak-flow frequency relations for ungaged sites near a gaging station on a gaged stream; and (4) to develop regression equations for

estimating peak flows for ungaged sites on ungaged natural-flow streams that have drainage areas of 1,000 mi<sup>2</sup> or less.

The generalized skew coefficient and regression analyses were based on data for 192 continuous- and partial-record streamflow gaging stations that had 10 or more years of record. Of these stations, 146 are in North Dakota, 14 are in Minnesota, 16 are in Montana, 13 are in South Dakota, 2 are in Manitoba, Canada, and 1 is in Saskatchewan, Canada. The locations of the 192 gaging stations are shown in figure 1. Log-Pearson Type III distribution was used to compute peak-flow frequency relations for the 192 gaging stations. The generalized least-squares (GLS) regression technique (Tasker and Stedinger, 1989) was used to compute weighted peak-flow frequency relations for the 192 stations and to develop equations that can be used to estimate peak-flow frequency relations for ungaged sites. A drainage-area ratio method was used to demonstrate how to estimate peak flow for ungaged sites near a gaging station on a gaged stream.

### Previous Studies

McCabe and Crosby (1959) used all data available through 1955 and completed a study of the magnitude and frequency of floods in North Dakota and South Dakota. Patterson (1966) used data through 1961 and Patterson and Gamble (1968) used data through 1963 to complete part of a series of reports on the magnitude and frequency of floods in the United States. However, their reports contained little information on flood frequencies and magnitudes for small drainage basins in North Dakota. Crosby (1970) included a limited analysis of magnitude and frequency of floods when he evaluated the streamflow data program for North Dakota. Crosby (1975) used data available through 1973 to complete a study of the magnitude and frequency of floods for small drainage basins of 100 mi<sup>2</sup> or less; however, he did not develop equations for estimating the 15-, 100-, and 500-year recurrence interval floods. Miller and Frink (1984) completed a study to determine whether any changes in flood response because of changes in land use could be documented for the Red River of the North.

### General Physical and Hydrologic Description of Study Area

The North Dakota landscape varies from flat plains to rugged badlands. Elevations range from 750 ft above sea level at Pembina in the extreme northeast corner of the State to 3,506 ft above sea level at White Butte near Bowman in the southwest corner. North Dakota commonly is divided into two major physiographic provinces, the Central Lowland and the Great Plains (Fenneman, 1946; fig. 2). The division between the provinces is along the easterly boundary of the Coteau du Missouri. The Central Lowland Province consists of the Red River Valley and the Drift Prairie. The Red River Valley is a flat area characterized by lake-bottom sediments near the Red River of the North and beach ridges and scarps farther west (Bluemle, 1977), and the Drift Prairie generally consists of a gently rolling area of glacial deposits. The Great Plains Province is a rolling to hilly area, the result of erosion of generally flat-lying, easily eroded sedimentary rocks. The Coteau du Missouri is a hummocky area over which glacial stagnation occurred. In the southwestern part of the State, badlands topography has developed near some

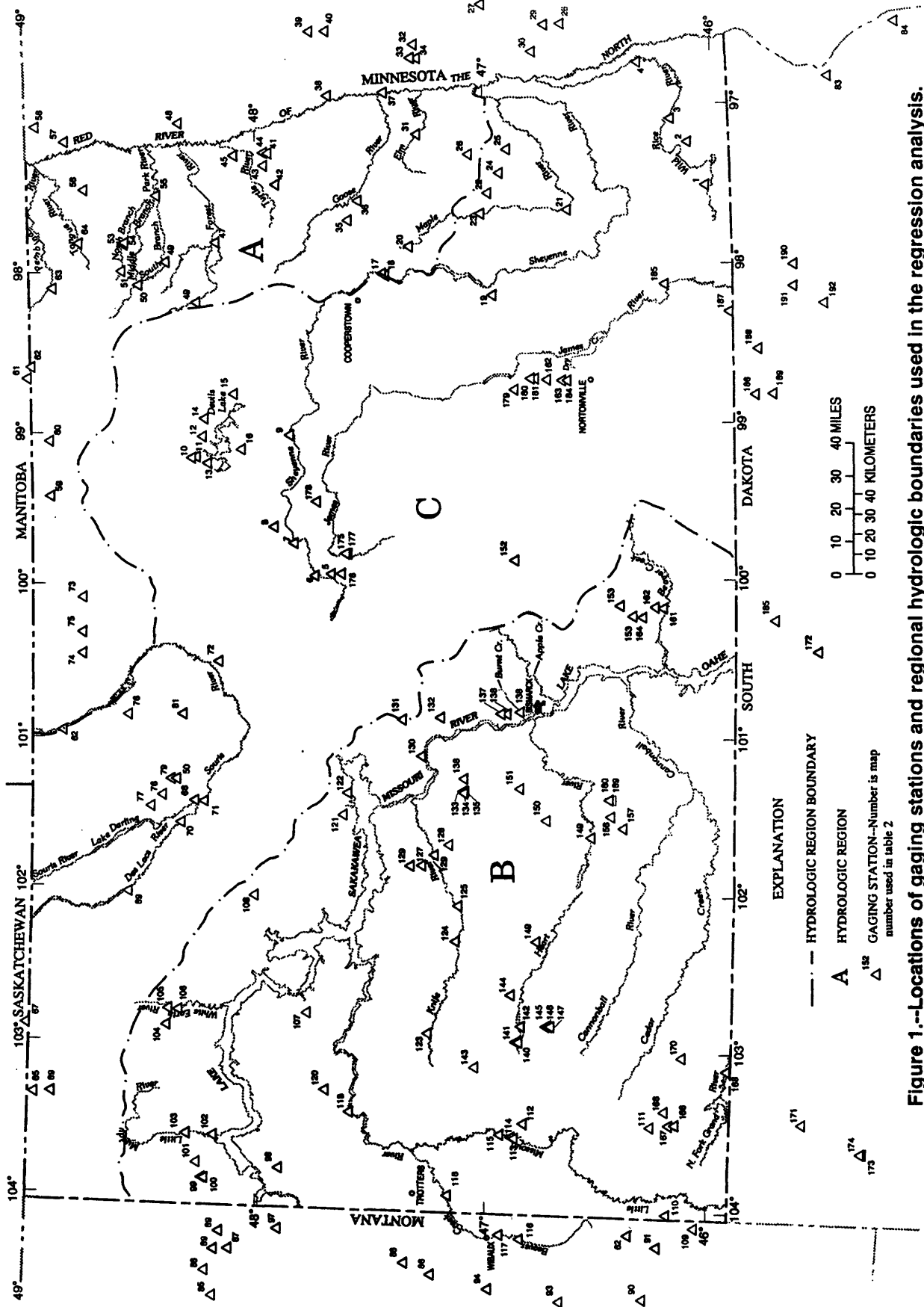


Figure 1.--Locations of gaging stations and regional hydrologic boundaries used in the regression analysis.



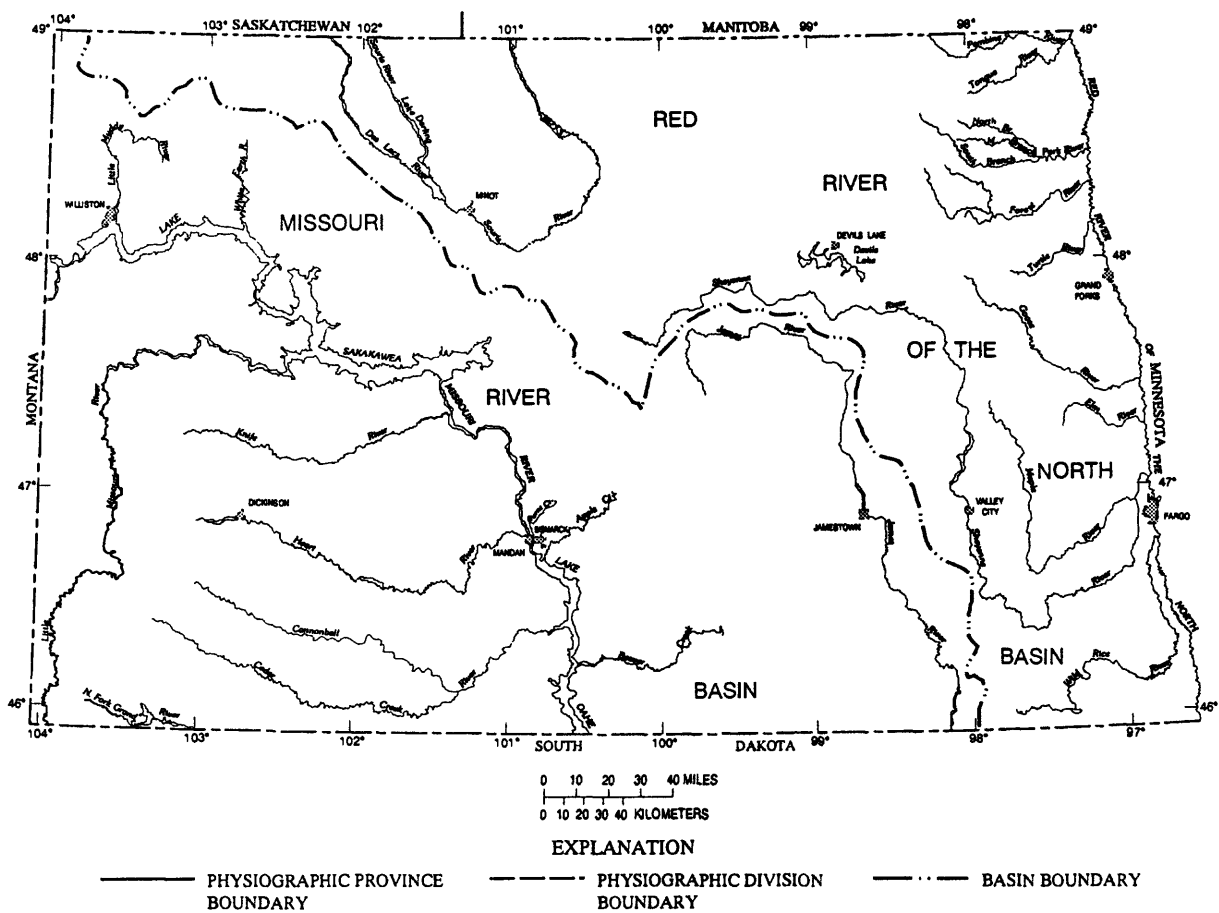
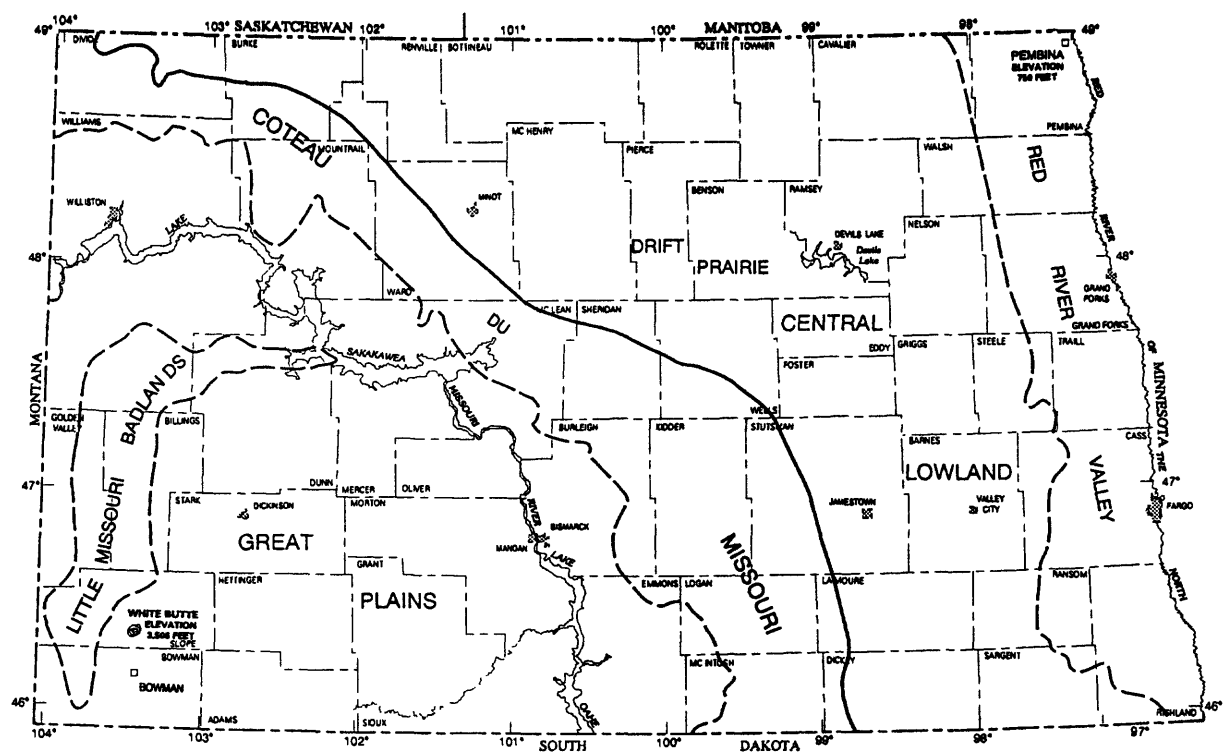


Figure 2.--Main topographic areas in North Dakota.  
(Modified from Fenneman, 1946; Bluemle, 1977.)

streams and rivers and is especially prominent along the Little Missouri River (Bluemle, 1977, p. 2). The two major drainage basins within North Dakota are the Red River of the North basin and the Missouri River basin (fig. 2).

North Dakota's climate has a great deal of variability compared to some states. Jensen (no date, p. 1) stated that "\*\*\*\*because of location, the climate of the state is characterized by large annual, daily and day-to-day temperature changes, light to moderate precipitation which tends to be irregular in time and coverage, low relative humidity, plentiful sunshine, and nearly continuous air movement." Mean annual precipitation ranges from about 14 in. in the northwest part of the State to about 21.5 in. in the extreme southeast part of the State (Dr. J. W.ENZ, North Dakota State Climatologist, written commun., 1988).

Peak flows in North Dakota result from both rainfall and snowmelt. About 75 percent of the precipitation occurs between April and September, and local high-intensity thunderstorms are common. Winter precipitation is minimal and generally in the form of snow (Jensen, no date). A comparison between the number of annual peak flows resulting from rainfall and the number of annual peak flows resulting from snowmelt for gaging stations located in the western part of the State indicated that peak flows resulting from snowmelt were more prevalent than those resulting from high-intensity rainfall (Emerson, 1988). A cursory comparison of annual peak flows made for gaging stations that were used in this peak-flow frequency analysis for the eastern part of the State indicated that the number of annual peak flows resulting from high-intensity rainfall and those resulting from snowmelt are about equal. No attempt was made to separate the peak flows resulting from rainfall from those resulting from snowmelt for this study because of the difficulty in distinguishing snowmelt peak flows that were not affected by rainfall. Also, such a separation could lead to an inadequate data base because 60 percent of the data base consists of record lengths of less than 20 years.

## BASIN AND CLIMATIC CHARACTERISTICS CONSIDERED IN THE GENERALIZED SKEW COEFFICIENT AND REGRESSION ANALYSES

Basin and climatic characteristics were used in the analysis of generalized skew coefficients and in the development of regression equations for estimating flood characteristics for ungaged sites. Basin and climatic characteristics used in these analyses were obtained from the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE) (Dempster, 1983). The characteristics were chosen on the basis of the results from previous studies and the availability of existing data. Methods for determining basin and climatic characteristics are discussed in more detail in Benson (1962) and Benson and Carter (1973). Climatological information for 1931-60 is available in Jensen (no date). The basin and climatic characteristics considered are:

1. Drainage area,  $A$ , in square miles--total area from gaging station to basin divide including noncontributing area.
2. Contributing drainage area,  $CA$ , in square miles--drainage area that contributes overland flow to the station in question.

3. Main-channel slope,  $S$ , in feet per mile--as computed by the elevation difference between points located 10- and 85-percent of the distance along the longest water course from the gaging station to the basin divide and divided by 0.75 of the longest water course length. Main-channel slope is further described by Benson (1962, p. B26-B28).

4. Stream length,  $L$ , in miles--measured along the longest water course from the gaging station to the basin divide including the main channel and appropriate upstream tributaries.

5. Mean basin elevation,  $E$ , in feet above sea level--measured from topographic maps by the transparent-grid sampling method; an average of 20 to 80 sample points in the basin.

6. Soil infiltration index,  $SI$ , in inches per hour--a relative measure of potential infiltration. Information on soil infiltration indices can be obtained from the Soil Conservation Service.

7. Mean annual precipitation,  $P$ , in inches.

8. Precipitation intensity,  $I$ , 2-year, 24-hour rainfall, in inches per 24 hours--estimated from the U.S. Weather Bureau (1961).

9. Mean annual snowfall,  $SF$ , in inches.

10. Mean maximum March air temperature,  $M$ , in degrees Fahrenheit.

#### ANALYSIS OF GENERALIZED SKEW COEFFICIENT

An analysis was undertaken to test the validity of using the generalized skew coefficient map from Bulletin 17B for North Dakota and to determine if an improved estimate of generalized skew could be obtained. The skew coefficient for the gaging-station record of annual peak flow is sensitive to extreme events; thus, it is difficult to obtain accurate gaging-station skew coefficient estimates from small samples of peak flow. The accuracy of the estimated gaging-station skew coefficient can be improved by weighting the gaging-station skew coefficient with a generalized skew coefficient estimated by considering information from nearby sites, as described in Bulletin 17B. The procedure for developing generalized skew coefficients requires the use of at least 40 gaging stations with 25 or more years of record for each station. The criteria of 25 or more years of record was relaxed to 10 or more years of record for this study in order to enlarge the available data base. Data for 192 gaging stations (fig. 1) were used in the analysis and the three methods described in Bulletin 17B were considered: (1) Lines of equal values of the skew coefficient drawn on a statewide map; (2) regression equations that relate skew coefficients to selected basin and climatic characteristics; and (3) the means of the gaging-station skew coefficient values for major river basins. Conditional probability adjustments (Appendix 5, Bulletin 17B) for low outliers and zero peak-flow records were applied to the station-record statistics. No adjustments were made for high outliers or historic peaks due to the paucity of historical information.

For method 1, each gaging-station skew coefficient value was plotted on a map of North Dakota at the centroid of the drainage basin, and the map was examined to determine whether any geographic or topographic trends were apparent. Very little relation to geography or topography was apparent, so this method was not considered further.

For method 2, plots of gaging-station skew coefficient values versus selected basin and climatic characteristics were generated. Development of regression equations was attempted using all of the skew coefficient data for the 192 gaging stations, using only data for gaging stations located in the Red River of the North basin, and using only data for gaging stations located in the Missouri River basin. The regression equations that relate gaging-station skew coefficient values to basin and climatic characteristics were not well defined and, consequently, this method was not considered further.

For method 3, gaging-station skew coefficient values were derived for each gaging station for three categories; stations with 10 or more years of record, stations with 10 to 19 years of record, and stations with 20 or more years of record. A mean skew coefficient value, the generalized skew coefficient, was computed for each category using all of the 192 gaging stations, those in the Red River of the North basin, and those in the Missouri River basin. The mean-squared-error (MSE) value associated with the nine computed generalized skew coefficients was compared with the MSE value of 0.302 for the generalized skew coefficient map in Bulletin 17B. Improvement in MSE was most noticeable for gaging stations that have 20 or more years of data, particularly for the data set that represents only the Red River of the North basin and for the data set that represents all of the 192 stations (table 1). However, the change in MSE was not considered to be significant enough to change the common procedure of using the generalized skew coefficient map in Bulletin 17B for North Dakota streams. Thus, it was determined that the generalized skew coefficient map in Bulletin 17B provides accurate estimates of generalized skew coefficient values for natural-flow streams in North Dakota. The generalized skew coefficient map mean of -0.4 (Bulletin 17B) is considered representative for North Dakota as an average. Values obtained from the generalized skew coefficient map in Bulletin 17B are considered more accurate for individual stations, especially in the southwestern corner of the State.

#### PEAK-FLOW FREQUENCY RELATIONS FOR GAGING STATIONS

Peak-flow frequency relations for 192 gaging stations on streams that have drainage areas of less than or equal to 1,000 mi<sup>2</sup> are listed in table 2 (at the back of report). The first-line values listed in table 2 are the gaging-station peak-flow frequency data. These frequency data were determined using the procedures outlined in Bulletin 17B. The second line values are the weighted peak-flow frequency values that were determined using the gaging-station peak-flow frequency data and an estimate of peak-flow frequency from regional regression equations (discussed later). The weighted value is considered to be the best estimate of the peak-flow frequency relation for a gaging station on an unregulated stream because the weighted estimate reduces the time-sampling error associated with short periods of record.

Peak-flow frequency relations for 63 additional gaging stations that were not used in analysis of the generalized skew coefficient or for developing regression equations for computing peak-flow frequencies at ungaged sites are listed in table 3 (at the back of report). These stations generally represent streams that are significantly controlled by regulation and those with

Table 1.--Mean and variance of station skew data and mean squared error  
computed for the differences between station skew and the  
generalized skew coefficient map in Bulletin 17B

Record length for stations (years)	Number of stations	Mean of station skew	Variance of station skew	Mean-squared error of the difference between station skew and Bulletin 17B skew
<u>All 192 stations</u>				
10 or more	192	-0.378	0.358	0.353
10 to 19	108	-.324	.393	.388
20 or more	84	-.483	.296	.301
<u>Missouri River basin stations only</u>				
10 or more	108	-0.269	0.382	0.387
10 to 19	72	-.191	.385	.411
20 or more	36	-.425	.349	.338
<u>Red River of the North basin stations only</u>				
10 or more	84	-0.517	0.297	0.310
10 to 19	36	-.536	.394	.402
20 or more	48	-.515	.231	.244

drainage areas greater than 1,000 mi<sup>2</sup>. Locations of these gaging stations are shown in figure 3 (at the back of report).

It is good practice to coordinate any work related to peak-flow frequency with other government agencies and appropriate consulting firms. This is especially important for sites along state borders and on the larger rivers for which other agencies and consulting firms may have determined peak-flow values while completing flood-plain information or flood-insurance or flood-frequency studies. Also, coordinating the peak-flow frequency values with the respective agencies is needed to determine whether the operating rules for regulating the streams have been consistent throughout the period of record used to determine the peak-flow frequency values listed in table 3. The North Dakota State Water Commission, U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Soil Conservation Service, U.S. Bureau of Reclamation, and U.S. Bureau of Land Management are agencies that commonly develop peak-flow

information for selected parts of the State. The peak-flow values listed in table 3 were coordinated with the North Dakota State Water Commission and the U.S. Army Corps of Engineers (K. L. Lindskov, U.S. Geological Survey, written commun., 1991).

The weighting procedure used to determine weighted peak flow in this report is part of the GLS regression and network analysis program GLSNET (G. D. Tasker and others, written commun., 1987). The following equation was used to calculate the weighted peak flows for each gaging station in table 2:

$$Q_{TW} = \frac{n Q_{TS} + en Q_{TR}}{n + en}, \quad (1)$$

where

$Q_{TW}$  = weighted peak flow, in cubic feet per second, for recurrence interval of  $T$ -years;

$n$  = number of years of station data used to compute  $Q_{TS}$ ;

$Q_{TS}$  = station peak flow, in cubic feet per second, for recurrence interval of  $T$ -years;

$en$  = equivalent years of record for  $Q_{TR}$ ; and

$Q_{TR}$  = peak flow from regional regression equation that relates peak flow to basin characteristics, in cubic feet per second, for recurrence interval of  $T$ -years.

The equivalent years of record,  $en$ , is a measure of the accuracy of prediction in terms of the number of years of record that is required for each gaging station to achieve results of equal accuracy to that of the regional regression equation. A further explanation on how the equivalent years of record is calculated is given by Hardison (1971).

## PEAK-FLOW FREQUENCY RELATIONS FOR UNGAGED SITES

The procedure for determining peak flow for a selected recurrence interval for a specific ungaged site depends on whether the site is located near a gaging station on the same stream or is an ungaged site on an ungaged stream. For an ungaged site near a gaging station on the same stream, a drainage-area ratio method should be used to estimate the  $T$ -year peak flow. For ungaged sites on ungaged streams, the regional regression equations developed during this study that relate peak flow for selected recurrence intervals to basin characteristics should be used.

### Ungaged Sites Near a Gaging Station on the Same Stream

The following equation can be used to determine  $T$ -year peak-flow values for an ungaged site located near a gaging station on the same stream. This equation should be used only when the contributing drainage area for the ungaged site is from 75 to 150 percent of the contributing drainage area for the gaged site (otherwise the regional regression equations discussed later in this report should be used):

$$Q_T(u) = Q_{TW}(g) (CA_u/CA_g)^x, \quad (2)$$

where

- $Q_T(u)$  = peak flow, in cubic feet per second, for the ungaged site for a recurrence interval of  $T$ -years;
- $Q_{TW}(g)$  = weighted peak flow, in cubic feet per second, for the gaging station for a recurrence interval of  $T$ -years;
- $CA_u$  = contributing drainage area, in square miles, for the ungaged site;
- $CA_g$  = contributing drainage area, in square miles, for the gaging station; and
- $x$  = mean exponent for the appropriate hydrologic region.

The peak flow,  $Q_{TW}(g)$ , is the weighted value in table 2 that was determined using equation 1. The exponent,  $x$ , was determined by relating the seven separate regression equations for  $T$ -year peak flows ( $T = 2, 10, 15, 25, 50, 100, 500$  years) to the independent drainage-area variable for each hydrologic region and computing the mean of the exponents for the seven equations for each region. The mean exponent for region A was 0.55, the mean exponent for region B was 0.58, and the mean exponent for region C was 0.57. The determination of the hydrologic regions and development of the regional regression equations are discussed in the section "Ungaged Sites on Ungaged Streams."

### Ungaged Sites on Ungaged Streams

#### Development of Regression Equations

Equations that relate peak-flow values for selected recurrence intervals to basin characteristics were developed using a GLS regression procedure instead of using the conventional ordinary least-squares (OLS) regression procedure. The GLS regression procedure takes into consideration the time-sampling error in the dependent variable and the cross correlation between sites. When available peak-flow data for gaging stations are for different and widely varying lengths of record and concurrent peak flows at different sites are cross correlated, the GLS regression procedure provides more accurate estimates of the regression coefficients. The GLS regression procedure also provides better estimates of the predictive accuracy of peak-flow values that are computed by the regression equations and almost unbiased estimates of the variance of the underlying regression model error (Stedinger and Tasker, 1985).

The conventional OLS regression procedure, such as that used by Crosby (1975), only provides an estimate of the model error, and the assumption is made that peak flows for selected recurrence intervals are independent from site to site and that site-to-site variance (time-sampling error) is identical. The OLS procedure, however, was used in this study to tentatively choose the basin and climatic characteristics that would be statistically significant at the 5-percent level. Both dependent and independent variables were transformed to base 10 logarithms for the regression analyses. The transformation to base 10 logarithms was made to linearize the relation between the dependent and one or more independent variables.

The basic regression model using the GLS procedure can be represented by the following linear equation:

$$\underline{Y} = \underline{X} \underline{B} + \underline{u}, \quad (3)$$

where

$\underline{Y}$  = ( $nx1$ ) vector of  $T$ -year flood events (dependent variable),  
 $\underline{X}$  = ( $nxp$ ) matrix of basin characteristics (independent variables),  
 $\underline{B}$  = ( $px1$ ) vector to be estimated (regression coefficients), and  
 $\underline{u}$  = ( $nx1$ ) random vector (errors).

The best linear unbiased estimator ( $\underline{b}$ ) of the parameter vector  $\underline{B}$  for the  $T$ -year event is:

$$\underline{b} = (\underline{X}^T \underline{\Lambda}^{-1} \underline{X})^{-1} \underline{X}^T \underline{\Lambda}^{-1} \underline{Y},$$

where

$\underline{\Lambda}$  = the unknown covariance (weighting) matrix.

Further details on the GLS procedure and the methods used to determine the unknown matrix are discussed in Stedinger and Tasker (1985) and in Tasker and Stedinger (1989). The computer program GLSNET (G. D. Tasker and others, written commun., 1987) was used to develop the  $T$ -year peak-flow regional regression equations for North Dakota.

An evaluation of residuals from preliminary regression runs showed that the State should be divided into the same three hydrologic regions (fig. 1) that were used in the previous study by Crosby (1975). The boundaries of the hydrologic regions generally conform to three primary types of topography: Region A is a flat plain area, region B is a rolling to hilly plain area, and region C is a prairie pothole area.

Regression equations for recurrence intervals of 2, 10, 15, 25, 50, 100, and 500 years were developed for hydrologic regions A, B, and C. The characteristics used in the final regional regression equations that are significant at the 5-percent level are contributing drainage area and main-channel slope. The regional regression equations and the associated standard error of estimate, standard error of prediction, and equivalent years of record for each equation are listed in table 4. The standard error of estimate is the square root of the average model error variance in the GLS analysis. The model error variance is a measure of the error inherent in the regression model that cannot be changed by collecting more data. The standard error of prediction is the square root of the sum of the average sampling error variance and the average model error variance and is the measure of the accuracy with which the regression model can estimate the  $T$ -year flood at an ungaged site. The equivalent years of record indicates the number of years of streamflow record that provides an estimate equal in accuracy to the standard error of prediction. The regression equations developed for regions A, B, and C may be used to determine peak flows for ungaged sites on ungaged streams. Examples of the use of the regional regression equations to compute peak-flow values for ungaged sites on ungaged streams are given in the section "Examples of Using Regression Equations to Compute Peak-Flow Frequency Data for Ungaged Sites on Ungaged Streams."



Table 4.--Regional regression equations that relate peak flow for selected recurrence intervals  
to selected basin characteristics

[ $Q$ , peak flow, in cubic feet per second;  $CA$ , contributing drainage area, in square miles;  
 $S$ , main-channel slope, in feet per mile]

Recurrence interval (years)	Equation	Number of stations used in analysis	Standard error of estimate (percent)	Standard error of prediction (percent)	Equivalent years of record (years)
<u>Region A</u>					
2	$Q = 24.9 CA^{0.543} S^{0.094}$	41	60	64	3.1
10	$Q = 62.2 CA^{0.600} S^{0.168}$	41	55	60	5.0
15	$Q = 70.9 CA^{0.609} S^{0.181}$	41	56	60	5.6
25	$Q = 81.6 CA^{0.619} S^{0.197}$	41	57	61	6.3
50	$Q = 95.9 CA^{0.631} S^{0.217}$	41	58	64	7.1
100	$Q = 110 CA^{0.640} S^{0.234}$	41	60	66	7.8
500	$Q = 142 CA^{0.656} S^{0.268}$	41	67	73	8.7
<u>Region B</u>					
2	$Q = 7.68 CA^{0.697} S^{0.299}$	88	83	88	2.3
10	$Q = 32.7 CA^{0.716} S^{0.294}$	88	60	64	5.9
15	$Q = 41.6 CA^{0.717} S^{0.286}$	88	60	67	6.7
25	$Q = 55.1 CA^{0.716} S^{0.276}$	88	61	66	7.5
50	$Q = 76.4 CA^{0.715} S^{0.262}$	88	65	70	8.2
100	$Q = 101 CA^{0.713} S^{0.249}$	88	70	76	8.5
500	$Q = 171 CA^{0.708} S^{0.229}$	88	84	91	8.6
<u>Region C</u>					
2	$Q = 4.08 CA^{0.638} S^{0.348}$	58	98	104	2.0
10	$Q = 22.3 CA^{0.665} S^{0.275}$	58	66	71	5.2
15	$Q = 29.4 CA^{0.668} S^{0.263}$	58	64	77	6.3
25	$Q = 39.7 CA^{0.670} S^{0.249}$	58	62	68	7.5
50	$Q = 56.3 CA^{0.671} S^{0.232}$	58	62	68	9.0
100	$Q = 75.6 CA^{0.672} S^{0.219}$	58	63	69	10.2
500	$Q = 129 CA^{0.676} S^{0.196}$	58	67	75	12.0

## Limitations on Use of the Regression Equations

The following limitations should be considered when using the regression equations to compute peak-flow frequency relations for North Dakota streams: (1) The equations apply to streams that are located in rural watersheds and should not be applied to watersheds significantly affected by urbanization; (2) the equations should not be used where dams, flood-detention structures, and other manmade works exist that significantly affect the annual peak flows; and (3) the equations generally should be used only for streams that have drainage areas of less than or equal to 1,000 mi<sup>2</sup> and for streams that have drainage areas and basin characteristics that are within the range of characteristics used to develop the regression equations. The ranges of the characteristics for the gaging stations used to develop the regression equations are given in table 5.

Table 5.--Range of basin characteristics used to develop the regression equations

Region	Contributing drainage area (square miles) (CA)	Main-channel slope (feet per mile) (S)
A	0.08 - 959	1.0 - 300
B	0.06 - 775	2.1 - 198
C	0.13 - 796	2.1 - 270

## EXAMPLES OF ESTIMATING PEAK-FLOW FREQUENCY DATA FOR GAGING STATIONS AND FOR UNGAGED SITES

### Example for Determining Weighted Peak-Flow Frequency Data for Gaging Stations

The procedure used to determine the weighted peak flow (eq. 1) for the 100-year recurrence interval for station 05056950, Sheyenne River tributary no. 2 near Cooperstown, N.Dak. (table 2, map number 18), is shown in the following example.

Station 05056950,  
 $n = 15$  years,  
 $Q_{TS} = 98 \text{ ft}^3/\text{s}$ ,  
 $CA = 0.08 \text{ mi}^2$ , and  
 $S = 300 \text{ ft/mi}$ .

The gaging station is located in region A, and the 100-year regression equation from table 4 is

$$Q_{100} = 110 CA^{0.640} S^{0.234}; \text{ thus,}$$

$$Q_{TR} = Q_{100} = 110 (0.08)^{0.640} (300)^{0.234} = 83.$$

The equivalent years of record,  $en$ , for this station for the 100-year equation is 3.8 years. Using equation 1,

$$Q_{TW} = \frac{15(98) + 3.8(83)}{15 + 3.8} = 95 \text{ ft}^3/\text{s}.$$

### Example for Determining Peak-Flow Frequency Data for an Ungaged Site

#### Near a Gaging Station on the Same Stream

The following is an example of how to use the drainage-area ratio method (eq. 2) to determine peak flow for an ungaged site near a gaging station on the same stream. To estimate the 100-year peak flow for an ungaged site on Burnt Creek, locate the site in figure 1. The site is located downstream of a gaging station on the same stream (station 06342450, Burnt Creek near Bismarck, N.Dak.). Contributing drainage area ( $CA_U$ ) for the ungaged site is  $114 \text{ mi}^2$ , and the contributing drainage area ( $CA_g$ ) for the gaging station (table 2, map number 139) is  $108 \text{ mi}^2$ . Both the ungaged site and the gaging station are located in region B. Determine if the drainage-area ratio ( $CA_U/CA_g$ ) is between 0.75 and 1.50:

$$CA_U/CA_g = 114/108 = 1.06,$$

which meets the drainage-area ratio requirement. Thus, the following relation is used:

$$Q_{100}(u) = Q_{100}(g) (CA_U/CA_g)^{0.58},$$

where

$Q_{100}(g) = 7,790 \text{ ft}^3/\text{s}$ , the weighted peak flow for the gaging station (table 2);

$CA_U = 114 \text{ mi}^2$ ; and

$CA_g = 108 \text{ mi}^2$ .

Therefore,

$$Q_{100}(u) = 7,790 (114/108)^{0.58} = 8,040 \text{ ft}^3/\text{s}.$$

## Examples for Determining Peak-Flow Frequency Data for an Ungaged Site

### Between Two Gaging Stations on the Same Stream

An ungaged site for which a peak-flow calculation is desired sometimes may be between two gaging stations on the same stream. If the contributing drainage area for the ungaged site is within 75 to 150 percent of the contributing drainage area for both of the gaging stations, the drainage-area ratio method (eq. 2) should be applied to determine peak flow ( $Q_T(u)$ ) for the ungaged site using data from each of the gaging stations. The resulting two peak-flow values then are averaged in log units. The peak flow ( $Q_T(u)$ ) also can be determined by interpolating in log units between both of the gaging stations.

The following examples illustrate how to use equation 2 and interpolation to determine a 100-year peak flow for an ungaged site that is between two gaging stations on the same stream. The gaging stations are station 06336500, Beaver Creek at Wibaux, Mont. (table 2, map number 117), and station 06336600, Beaver Creek near Trotters, N.Dak. (table 2, map number 118). Contributing drainage area ( $CA_u$ ) for the ungaged site is 500 mi<sup>2</sup>, contributing drainage area ( $CA_g$ ) for gaging station 06336500 is 351 mi<sup>2</sup>, and contributing drainage area ( $CA_g$ ) for gaging station 06336600 is 616 mi<sup>2</sup>. The ungaged site and the gaging stations are located in region B.

Determine if the drainage-area ratio ( $CA_u/CA_g$ ) for the ungaged site and each gaging station is between 0.75 and 1.50:

1. Station 06336500,  
 $CA_g = 351 \text{ mi}^2$ ,  
 $CA_u = 500 \text{ mi}^2$ ,  
 $CA_u/CA_g = 500/351 = 1.42$ .
2. Station 06336600,  
 $CA_g = 616 \text{ mi}^2$ ,  
 $CA_u = 500 \text{ mi}^2$ ,  
 $CA_u/CA_g = 500/616 = 0.81$ .

The drainage-area ratio requirement has been met for both situations. Thus, equation 2 is applied for the ungaged site using data from both gaging stations, and the results are averaged in log units.

1. Station 06336500,  
 $Q_{100}(g) = 10,200 \text{ ft}^3/\text{s}$ , weighted peak flow for the gaging station (table 2);  
 $Q_{100}(u) = 10,200 (500/351)^{0.58} = 12,500 \text{ ft}^3/\text{s}$ .
2. Station 06336600,  
 $Q_{100}(g) = 11,700 \text{ ft}^3/\text{s}$ , weighted peak flow for the gaging station (table 2);  
 $Q_{100}(u) = 11,700 (500/616)^{0.58} = 10,400 \text{ ft}^3/\text{s}$ .

Logarithmic average:

$$\frac{\log(12,500) + \log(10,400)}{2} = \frac{4.097 + 4.017}{2} = 4.057,$$

$$Q_{100}(u) = \text{antilog}(4.057) = 11,400 \text{ ft}^3/\text{s}.$$

The peak flow for the ungaged site determined by interpolation between the two gaging stations is shown below:

$$\log Q_{100}(u) = \log Q_{100}(06336600) - \frac{\log CA_{06336600} - \log CA_u}{\log CA_{06336600} - \log CA_{06336500}} \times [\log Q_{100}(06336600) - \log Q_{100}(06336500)]$$

$$\log Q_{100}(u) = \log(11,700) - \frac{\log(616) - \log(500)}{\log(616) - \log(351)} [\log(11,700) - \log(10,200)]$$

$$\log Q_{100}(u) = 4.068 - \frac{2.789 - 2.699}{2.789 - 2.545} (4.068 - 4.009) = 4.046$$

$$Q_{100}(u) = \text{antilog}(4.046) = 11,100 \text{ ft}^3/\text{s}.$$

#### Examples of Using Regression Equations to Compute Peak-Flow Frequency Data for Ungaged Sites on Ungaged Streams

Depending on the location of the ungaged site and its relation to the hydrologic region boundaries, one of two procedures can be used to compute peak-flow values. Procedure 1 should be used when the stream drainage area is within a single region. Procedure 2 should be used when the stream drainage area is part of more than one region.

Use procedure 1 to determine the 100-year peak flow for an ungaged site on Dry Creek near Nortonville, N.Dak. The site is located in region C (fig. 1). The basin characteristics that were computed from a U.S. Geological Survey 7.5-minute topographic map are:

$$CA = 8.0 \text{ mi}^2 \text{ and} \\ S = 4.2 \text{ ft/mi}.$$

The indicated peak flow for a recurrence interval of 100 years is

$$Q_{100} = 75.6 (8.0)^{0.672} (4.2)^{0.219} = 419 \text{ ft}^3/\text{s}.$$

Procedure 2 is similar to procedure 1 except 7-year regional regression equations would be solved for each of the associated regions and the results would be averaged or apportioned according to the fraction of the contributing

drainage area that is in each region. Because the boundaries for the three hydrologic regions A, B, and C were delineated generally along drainage divides of major streams, few streams cross these regional boundaries.

## NEED FOR ADDITIONAL STREAMFLOW DATA AND FOR UPDATING THE BASIN AND CLIMATIC CHARACTERISTICS FILE

Future peak-flow frequency studies for North Dakota could be improved if additional gaging stations were established or previously discontinued gaging stations were reestablished on natural-flow streams, especially for sites on streams with drainage areas of less than 200 mi<sup>2</sup>. Most of the gaging stations operated in 1990 are on larger streams and are not operated primarily for defining natural variations in hydrologic characteristics. In addition, the basin and climatic characteristics file needs to be updated.

Descriptions of the history of the streamflow-data program for North Dakota appear in Crosby (1970) and Ryan (1985, 1989). During 1954-73, as many as 92 crest-stage gages were operated to determine peak-flow frequency for sites on streams with small drainage areas (Crosby, 1975; Crosby and Pewe, 1972); and, at times during 1977-83, about 50 continuous-record gaging stations were operated to define hydrologic characteristics in the coal areas of North Dakota (Haffield, 1981). Currently (1990), 94 gaging stations for which annual peak flow is determined are operated in North Dakota; however, many of these 94 stations are on regulated streams. Additional stations need to be operated for defining natural variations in hydrologic characteristics, such as for determining peak-flow frequency at ungaged sites. The peak-flow information could be obtained by operating continuous-record gaging stations and (or) crest-stage gages for at least 25 years, an adequate record length for estimating the 100-year peak flow. The GLS procedure could be used to perform a network analysis that would yield a relation between the effect of adding or deleting stations to an operating budget. The GLS procedure also would relate the standard error (at site or regional) to record length with the idea of achieving a certain standard error (at site or regional).

Accurate and up-to-date data for basin and climatic characteristics also are an important part of defining relations for transferring peak-flow values from gaged to ungaged sites. Many U.S. Geological Survey 7.5-minute topographic maps have been completed since the basin and climatic characteristics were calculated for the study by Crosby (1970). Thus, the basin and climatic characteristics file for North Dakota needs to be updated and, in many cases, additional basin and climatic characteristics (beyond contributing drainage area and main-channel slope) need to be determined for gaging stations that were established after 1970.

## SUMMARY

The generalized skew coefficient for North Dakota in Bulletin 17B of the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data, 1982, "Guidelines for Determining Flood Flow Frequency" was evaluated for applicability by using the three recommended procedures: (1) Lines of equal skew coefficient drawn on a statewide map, (2) regression equations that relate skew coefficient to selected basin and climatic characteristics, and (3) mean values of skew coefficient for major river basins or hydrologic regions. Data for 192 continuous- and partial-record streamflow gaging stations that had 10 or more years of record were used to evaluate the use of the generalized skew coefficient map in Bulletin 17B and to compute peak-flow frequency relations. Of these gaging stations, 146 are in North Dakota, 14 in Minnesota, 16 in Montana, 13 in South Dakota, 2 in Manitoba, Canada, and 1 in Saskatchewan, Canada. The gaging stations were restricted to those on natural-flow streams not significantly affected by regulation that have drainage areas of less than or equal to 1,000 square miles. Interpretation of the data indicates that the generalized skew coefficient map for North Dakota in Bulletin 17B could not be improved significantly. Thus, it was determined that the generalized skew map provides accurate estimates of generalized skew coefficient values for natural-flow streams in North Dakota.

Peak-flow frequency relations for the 192 gaging stations used in the regression analysis were updated using data through 1988. The frequency relations are tabulated along with selected basin characteristics. The selected basin characteristics used to develop the peak-flow frequency relations and the generalized least-squares regression equations are contributing drainage area and main-channel slope. Weighted peak flows based on gaging-station data and the regional regression equations for selected recurrence intervals also are provided for each gaging station. The weighted value is considered to be the most reliable estimate of peak flow for a gaging station on an unregulated stream because of the reduction in time-sampling error associated with short periods of record. Peak-flow relations are provided for 63 additional gaging stations. These 63 stations generally represent streams that are significantly controlled by regulation and those with drainage areas greater than 1,000 square miles.

The generalized least-squares regression method was used to develop regression equations for three hydrologic regions in North Dakota by relating peak flows for recurrence intervals of 2, 10, 15, 25, 50, 100, and 500 years to basin characteristics. The standard error of estimate ranges from 60 to 70 percent for the 100-year peak-flow equations.

Examples are given for (1) determining weighted peak-flow frequency data for gaging stations and (2) using the drainage-area ratio method for determining peak-flow frequency data for ungaged sites near a gaging station on the same stream and ungaged sites between two gaging stations on the same stream. Also, two procedures are given for determining peak-flow values for ungaged sites on ungaged streams using the regional regression equations.

Future peak-flow frequency studies for North Dakota could be improved if additional gaging stations were established on natural-flow streams. Additional peak-flow frequency data are needed, especially for sites on streams with drainage areas of less than 200 square miles. The basin characteristics file needs to be updated and additional basin and climatic characteristics need to be determined for gaging stations that were established after 1970.

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Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses

[Period of record: First line represents water years; second line, in parentheses, represents number of years of station record. Drainage area: First line represents total drainage area; second line, in parentheses, represents contributing drainage area. Peak flow: First line represents log-Pearson type III estimates for gaging-station data; second line, in parentheses, represents weighted values computed by using equation 1. --, indicates no data]

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Main-channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)							
						Recurrence intervals (years)							
						2	10	15	25	50	100	500	Maximum of record
1 (C)	05051600	Wild Rice River near Rutland, N.Dak.	1960-76, 1978-80, 1982-88 (27)	2.1	546 (250)	106 (110)	523 (596)	670 (786)	883 (1,070)	1,220 (1,520)	1,610 (2,060)	2,730 (3,610)	1,270
2 (C)	05051800	Grass Lake tributary near Lidgerwood, N.Dak.	1958-73 (16)	10.0 (.61)	.61 (.61)	8 (8)	30 (30)	36 (37)	45 (46)	57 (60)	70 (76)	101 (117)	36
3 (C)	05051900	Wild Rice River tributary near Mantador, N.Dak.	1958-73 (16)	24.0	65.0 (4.20)	6 (7)	55 (67)	81 (99)	129 (153)	227 (252)	381 (387)	1,110 (898)	210
4 (C)	05052500	Antelope Creek at Dwight, N.Dak.	1944-47, 1949-73, 1975 (30)	3.4	293 (278)	430 (411)	2,670 (2,370)	3,520 (3,060)	4,760 (4,050)	6,730 (5,600)	9,050 (7,380)	15,700 (12,500)	9,000
5 (C)	05054500	Shenenne River above Harvey, N.Dak.	1956-88 (33)	3.0	424 (154)	120 (122)	430 (478)	525 (601)	653 (776)	843 (1,050)	1,050 (1,360)	1,600 (2,210)	1,000

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Main-channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)						
						Recurrence intervals (years)						
						2	10	15	25	50	100	Maximum of record
6 (C)	05055000	Shenoyne River near Harvey, N.Dak.	1943, 1946-56 (12)	2.7	534 (173)	342 (303)	1,090 (1,030)	1,320 (1,270)	1,620 (1,620)	2,080 (2,160)	2,580 (2,780)	3,920 (4,510)
7 (C)	05055100	North Fork Shenoyne River near Wellsburg, N.Dak.	1958-67 (10)	4.0	693 (203)	65 (79)	229 (417)	279 (561)	346 (777)	446 (1,130)	556 (1,530)	846 (2,670)
8 (C)	05055200	Big Coulee near Maddock, N.Dak.	1957-67, 1969-73 (16)	3.3	140 (97.0)	162 (155)	599 (612)	730 (765)	907 (980)	1,160 (1,310)	1,440 (1,690)	2,140 (2,720)
9 (C)	05055520	Big Coulee near Fort Totten, N.Dak.	1966-75 (10)	19.0	23.2 (7.70)	65 (60)	231 (219)	278 (268)	341 (335)	431 (436)	525 (547)	756 (841)
10 (C)	05056020	Mauvais Coulee tributary near Bisbee, N.Dak.	1955-73 (19)	9.0	8.90 (8.90)	18 (19)	140 (147)	198 (204)	292 (293)	464 (444)	700 (634)	1,580 (1,250)
11 (C)	05056040	Mauvais Coulee tributary no. 2 near Cando, N.Dak.	1955-73 (19)	7.1	17.1 (17.1)	55 (55)	314 (299)	404 (383)	530 (501)	723 (682)	937 (885)	1,510 (1,430)
12 (C)	05056060	Mauvais Coulee tributary no. 3 near Cando, N.Dak.	1955-73 (19)	11.0	129 (60.2)	154 (151)	985 (892)	1,320 (1,160)	1,810 (1,550)	2,630 (2,170)	3,630 (2,880)	6,720 (4,960)

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro-logic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main-channel slope (feet per mile)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
13 (C)	05056080	Mauvais Coulee tributary no. 4 near Bisbee, N.Dak.	1955-73 (19)	59.6 (53.0)	10.0	69 (73)	596 (594)	824 (805)	1,170 (1,110)	1,760 (1,610)	2,500 (2,190)	4,770 (3,850)	1,100	
14 (C)	05056100	Mauvais Coulee near Cando, N.Dak.	1957-88 (32)	387 (377)	5.1	230 (234)	1,580 (1,610)	2,090 (2,140)	2,840 (2,910)	4,010 (4,120)	5,360 (5,520)	9,110 (9,440)	2,660	
15 (C)	05056200	Edmore Coulee near Edmore, N.Dak.	1956-88 (33)	382 (282)	3.5	211 (212)	1,050 (1,090)	1,320 (1,390)	1,680 (1,810)	2,210 (2,440)	2,770 (3,150)	4,140 (5,020)	1,110	
16 (C)	05056300	Little Coulee at Leeds, N.Dak.	1956-67, 1969-73 (17)	280 (140)	4.2	51 (60)	445 (551)	613 (766)	866 (1,090)	1,290 (1,620)	1,800 (2,250)	3,340 (4,080)	590	
17 (A)	05056900	Shenenne River tributary near Cooperstown, N.Dak.	1959-73 (15)	15.2 (15.2)	29.0	290 (261)	929 (824)	1,090 (969)	1,300 (1,160)	1,580 (1,420)	1,850 (1,680)	2,450 (2,330)	1,000	
18 (A)	05056950	Shenenne River tributary no. 2 near Cooperstown, N.Dak.	1959-73 (15)	.08 (.08)	300	6 (6)	28 (29)	37 (38)	50 (50)	72 (71)	98 (95)	186 (170)	59	
19 (C)	05057200	Baldhill Creek near Dazey, N.Dak.	1956-88 (33)	691 (351)	3.0	286 (284)	1,710 (1,670)	2,300 (2,230)	3,210 (3,080)	4,780 (4,490)	6,810 (6,260)	13,800 (12,000)	9,000	
20 (A)	05059600	Maple River near Hope, N.Dak.	1965-88 (24)	20.2 (17.4)	11.0	196 (190)	648 (624)	783 (751)	966 (923)	1,240 (1,180)	1,540 (1,450)	2,330 (2,170)	900	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
21 (C)	05059700	Maple River near Enderlin, N.Dak.	1956-88 (33)	3.0	843 (796)	692 (670)	3,900 (3,640)	5,150 (4,750)	7,000 (6,380)	10,100 (9,020)	13,900 (12,200)	25,800 (21,900)	7,610	
22 (C)	05059800	Swan Creek near Absaraka, N.Dak.	1955-73 (19)	12.0	28.9 (28.9)	102 (100)	389 (394)	487 (498)	628 (648)	854 (887)	1,120 (1,170)	1,940 (1,980)	670	
23 (C)	05059850	Swan Creek tributary near Ayr, N.Dak.	1955, 1957-73, (18)	12.9	4.00 (4.00)	19 (20)	94 (98)	120 (125)	156 (164)	212 (225)	276 (295)	451 (487)	120	
24 (C)	05059900	Swan Creek near Casselton, N.Dak.	1955-62, 1964-73 (18)	10.5	14.0 (14.0)	265 (227)	826 (634)	1,000 (749)	1,240 (906)	1,620 (1,150)	2,050 (1,430)	3,280 (2,230)	2,000	
25 (C)	05059950	Swan Creek tributary near Casselton, N.Dak.	1955-73 (19)	7.7	56.6 (14.1)	47 (47)	210 (214)	264 (271)	339 (352)	452 (476)	578 (618)	918 (1,010)	225	
26 (A)	05060500	Rush River at Amenia, N.Dak.	1947-88 (42)	3.5	116 (116)	295 (300)	1,270 (1,270)	1,600 (1,600)	2,070 (2,060)	2,800 (2,760)	3,650 (3,560)	6,100 (5,800)	3,490	
27 (A)	05060800	Buffalo River near Callaway, Minn.	1960-89 (30)	6.0	94.5 (94.5)	245 (254)	486 (564)	538 (644)	600 (748)	681 (893)	756 (1,040)	919 (1,370)	635	
28 (C)	05061200	Whiskey Creek at Barnesville, Minn.	1961-87 (27)	18.6	62.5 (25.3)	150 (145)	400 (404)	470 (484)	566 (595)	705 (764)	857 (953)	1,270 (1,460)	660	

Table 2.---Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
29 (C)	05061400	Hay Creek above Downer, Minn.	1961-87 (27)	16.0	5.81 (5.81)	50 (48)	316 (284)	442 (384)	654 (540)	1,060 (817)	1,660 (1,190)	4,220 (2,640)	1,460	
30 (C)	05061500	South Branch Buffalo River at Sabin, Minn.	1945-87 (43)	13.8	522 (522)	1,220 (1,180)	4,010 (3,860)	4,860 (4,690)	6,010 (5,840)	7,740 (7,580)	9,670 (9,540)	14,900 (14,900)	8,500	
31 (A)	05062200	Elm River near Kelso, N.Dak.	1956-73, 1981-86 (24)	5.5	194 (194)	157 (183)	1,250 (1,360)	1,660 (1,790)	2,220 (2,390)	3,060 (3,290)	3,980 (4,260)	6,240 (6,680)	1,000	
32 (A)	05062500	Wild Rice River at Twin Valley, Minn.	1909-17, 1931-87 (66)	7.2	888 (888)	1,300 (1,290)	3,750 (3,840)	4,420 (4,570)	5,300 (5,530)	6,560 (6,920)	7,870 (8,400)	11,200 (12,100)	9,200	
33 (A)	05062700	Wild Rice River tributary near Twin Valley, Minn.	1961-85 (25)	17.9	4.72 (4.72)	91 (89)	235 (238)	270 (276)	314 (325)	372 (392)	429 (460)	555 (622)	324	
34 (A)	05062800	Coon Creek near Twin Valley, Minn.	1962-84 (23)	15.2	50.8 (50.8)	575 (524)	1,590 (1,470)	1,860 (1,720)	2,200 (2,050)	2,680 (2,510)	3,160 (3,000)	4,340 (4,220)	2,700	
35 (A)	05064900	Beaver Creek near Finley, N.Dak.	1965-88 (24)	5.9	160 (160)	378 (388)	1,320 (1,390)	1,580 (1,690)	1,930 (2,080)	2,410 (2,650)	2,900 (3,240)	4,070 (4,700)	1,900	
36 (A)	05065500	Goose River near Portland, N.Dak.	1940-76, 1982-88 (44)	7.0	517 (407)	690 (697)	2,760 (2,810)	3,450 (3,510)	4,420 (4,490)	5,920 (6,010)	7,650 (7,730)	12,600 (12,600)	8,530	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main- channel slope (feet per mile)	Peak flow (cubic feet per second)							
						Recurrence intervals (years)							
						2	10	15	25	50	100	500	Maximum of record
37 (A)	05067500	Marsh River near Shelly, Minn.	1944-87 (44)	151 (151)	3.2	1,020 (958)	3,170 (2,930)	3,750 (3,440)	4,490 (4,100)	5,510 (5,020)	6,550 (5,960)	9,000 (8,200)	4,880
38 (A)	05069000	Sand Hill River at Climax, Minn.	1943-87 (45)	426 (426)	7.2	1,060 (1,030)	3,080 (3,100)	3,630 (3,680)	4,370 (4,470)	5,420 (5,600)	6,530 (6,810)	9,330 (9,880)	4,560
39 (A)	05076000	Thief River near Thief River Falls, Minn.	1909-17, 1919-26, 1929-87 (76)	959 (959)	1.0	1,450 (1,420)	3,430 (3,460)	3,850 (3,910)	4,330 (4,450)	4,930 (5,160)	5,470 (5,820)	6,520 (7,220)	5,610
40 (A)	05076600	Red Lake River tributary near Thief River Falls, Minn.	1962-81 (20)	2.33 (2.33)	5.7	74 (70)	155 (152)	175 (173)	202 (200)	239 (239)	279 (280)	379 (382)	200
41 (A)	05082600	English Coulee tributary near Grand Forks, N.Dak.	1955-73, 1984 (20)	4.70 (4.70)	3.4	52 (54)	132 (141)	152 (163)	177 (193)	211 (234)	245 (275)	324 (374)	164
42 (A)	05082680	Saltwater Coulee tributary near Emerado, N.Dak.	1955-67, 1969-73 (18)	22.0 (22.0)	17.0	113 (120)	467 (499)	565 (609)	687 (755)	853 (960)	1,020 (1,170)	1,360 (1,680)	290
43 (A)	05082700	Saltwater Coulee near Emerado, N.Dak.	1950, 1955-73 (20)	110 (110)	12.0	224 (244)	1,080 (1,180)	1,370 (1,490)	1,770 (1,930)	2,380 (2,590)	3,050 (3,320)	4,840 (5,250)	3,500

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main-channel slope (feet per mile)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
44 (A)	05082900	Freshwater Coulee near Emerado, N.Dak.	1955-73 (19)	31.0 (31.0)	6.4	282 (267)	1,140 (1,020)	1,390 (1,220)	1,710 (1,490)	2,150 (1,860)	2,610 (2,230)	3,660 (3,130)	1,180	
45 (A)	05083000	Turtle River at Manvel, N.Dak.	1946-70, 1972-73, 1980 (28)	613 (556)	7.8	828 (840)	4,580 (4,450)	6,170 (5,900)	8,690 (8,110)	13,200 (11,900)	19,300 (16,800)	41,700 (33,700)	28,000	
46 (A)	05083600	Middle Branch Forest River near Whitman, N.Dak.	1961-88 (28)	47.7 (38.6)	4.5	105 (112)	581 (599)	747 (765)	981 (996)	1,340 (1,340)	1,740 (1,720)	2,820 (2,720)	984	
47 (A)	05084000	Forest River near Fordville, N.Dak.	1940-88 (49)	456 (336)	11.0	1,050 (1,020)	5,030 (4,780)	6,480 (6,100)	8,570 (7,980)	11,900 (11,000)	16,000 (14,500)	28,100 (24,800)	16,400	
48 (A)	05087500	Middle River at Argyle, Minn.	1945, 1950-87 (39)	265 (265)	7.5	861 (837)	2,470 (2,470)	2,860 (2,890)	3,350 (3,430)	4,000 (4,180)	4,630 (4,940)	6,000 (6,690)	4,260	
49 (A)	05088000	South Branch Park River near Park River, N.Dak.	1940-50 (11)	214 (214)	8.3	1,100 (937)	5,980 (4,280)	7,910 (5,390)	10,900 (6,970)	15,900 (9,460)	22,200 (12,400)	43,400 (21,400)	11,000	
50 (A)	05089100	Middle Branch Park River near Union, N.Dak.	1966-86 (21)	15.3 (15.3)	21.0	197 (190)	626 (607)	760 (736)	949 (915)	1,240 (1,190)	1,570 (1,500)	2,540 (2,360)	960	



Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Main-channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
51 (A)	05089200	North Branch Park River at Gardar, N.Dak.	1955-74 (20)	19.0	51.8 (51.8)	384 (367)	1,480 (1,390)	1,790 (1,680)	2,180 (2,050)	2,740 (2,590)	3,300 (3,140)	4,580 (4,500)	1,200	
52 (A)	05089500	Cart Creek at Mountain, N.Dak.	1954-84 (31)	58.0	16.9 (16.9)	204 (201)	710 (704)	858 (854)	1,060 (1,060)	1,350 (1,360)	1,660 (1,680)	2,460 (2,520)	1,300	
53 (A)	05089700	Cart Creek at Crystal, N.Dak.	1955-74 (20)	12.0	74.0 (74.0)	570 (525)	3,160 (2,600)	4,000 (3,200)	5,110 (3,990)	6,710 (5,100)	8,370 (6,230)	12,300 (8,970)	2,950	
54 (A)	05089800	Cart Creek tributary near Crystal, N.Dak.	1955-73 (19)	6.4	3.80 (3.80)	52 (53)	120 (130)	137 (151)	160 (179)	191 (218)	223 (259)	301 (359)	187	
55 (A)	05090000	Park River at Grafton, N.Dak.	1897, 1916, 1932-88 (59)	6.5	695 (695)	1,170 (1,160)	5,460 (5,340)	6,860 (6,690)	8,780 (8,550)	11,700 (11,300)	14,800 (14,400)	23,100 (22,400)	12,600	
56 (A)	05092200	Pembina County drain 20 near Glasston, N.Dak.	1972-86 (15)	5.3	80.0 (80.0)	96 (119)	303 (428)	373 (538)	474 (696)	637 (940)	835 (1,220)	1,470 (2,010)	940	
57 (A)	05095500	Two Rivers below Hallock, Minn.	1945-55 (11)	5.4	644 (644)	967 (971)	2,370 (2,840)	2,760 (3,430)	3,280 (4,220)	4,040 (5,400)	4,870 (6,670)	7,090 (9,910)	3,690	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro-logic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main-channel slope (feet per mile)	Peak flow (cubic feet per second)								
						Recurrence intervals (years)								Maximum of record
						2	10	15	25	50	100	500		
58 (A)	05096000	North Branch Two Rivers near Lancaster, Minn.	1930-38, 1941-55 (24)	32.0 (32.0)	4.8	83 (91)	426 (457)	546 (583)	716 (760)	980 (1,030)	1,280 (1,330)	2,120 (2,130)	912	
59 (A)	05098700	Hidden Island Coulee near Hansboro, N.Dak.	1962-88 (27)	26.2 (23.4)	8.6	170 (170)	645 (637)	799 (784)	1,010 (987)	1,340 (1,290)	1,720 (1,630)	2,770 (2,570)	1,200	
60 (A)	05098800	Cypress Creek near Saries, N.Dak.	1962-88 (27)	57.2 (51.2)	1.0	323 (310)	1,480 (1,320)	1,880 (1,640)	2,430 (2,060)	3,270 (2,680)	4,230 (3,370)	6,890 (5,180)	2,000	
61 (A)	05099100	Snowflake Creek near Snowflake, Manitoba	1961-88 (28)	377 (94.4)	--	139 (153)	711 (--)	916 (--)	1,210 (--)	1,680 (--)	2,230 (--)	3,820 (--)	1,130	
62 (A)	05099150	Mowbray Creek near Mowbray, Manitoba	1962-88 (27)	101 (65.7)	--	212 (219)	791 (--)	956 (--)	1,170 (--)	1,470 (--)	1,790 (--)	2,520 (--)	943	
63 (A)	05099400	Little Pembina River near Waltham, N.Dak.	1956-82 (27)	182 (172)	11.6	1,090 (1,000)	4,860 (4,200)	6,160 (5,230)	8,020 (6,660)	10,900 (8,850)	14,300 (11,300)	24,200 (18,400)	6,600	
64 (A)	05101000	Tongue River at Akra, N.Dak.	1939-46, 1948-54 (15)	160 (160)	21.7	572 (564)	2,490 (2,410)	3,240 (3,090)	4,400 (4,100)	6,420 (5,790)	9,080 (7,890)	18,600 (14,900)	11,800	
65 (C)	05113450	Long Creek tributary no. 2 near Crosby, N.Dak.	1960-73 (14)	6.70 (5.60)	15.0	36 (36)	166 (162)	213 (206)	282 (270)	393 (371)	528 (489)	944 (830)	260	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)							Maximum of record
						Recurrence intervals (years)							
						2	10	15	25	50	100	500	
66 (C)	05113520	Long Creek tributary near Crosby, N.Dak.	1960-70, 1972-73 (13)	18.0	.40 (.40)	13 (12)	37 (34)	44 (41)	52 (50)	65 (63)	79 (78)	116 (119)	65
67 (C)	05113800	Short Creek below international boundary near Roche Percee, Saskatchewan	1960-77, 1979-88 (29)	--	466 (125)	207 (--)	1,170 (--)	1,560 (--)	2,150 (--)	3,160 (--)	4,440 (--)	8,710 (--)	1,700
68 (C)	05116100	Souris River tributary near Burlington, N.Dak.	1959-73 (15)		.13 (.13)	7 (7)	39 (37)	50 (46)	64 (58)	84 (75)	106 (94)	159 (138)	30
69 (C)	05116200	Des Lacs River tributary near Donnybrook, N.Dak.	1956-73 (18)		3.82 (3.82)	53 (53)	165 (171)	198 (208)	242 (258)	306 (334)	375 (417)	558 (638)	210
70 (C)	05116550	Fuller Coulee at Foxholm, N.Dak.	1955-73 (19)	49.0	5.90 (5.90)	62 (61)	232 (228)	286 (282)	362 (357)	478 (472)	609 (602)	979 (959)	280
71 (C)	05117200	Souris River tributary no. 2 near Burlington, N.Dak.	1960-73 (14)	60.0	2.04 (2.04)	33 (32)	145 (136)	185 (172)	245 (222)	342 (301)	460 (393)	830 (656)	300

<sup>1</sup>Records not used in regression analysis; used in skew analysis.

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
72 (C)	05120500	Wintering River near Karlsruhe, N.Dak.	1937-88 (52)	3.7	705 (285)	135 (138)	694 (747)	916 (999)	1,260 (1,390)	1,850 (2,050)	2,600 (2,880)	5,210 (5,610)	3,000	
73 (A)	05122500	Willow Creek at Dunseith, N.Dak.	1954-73 (20)	36.4	142 (91.0)	95 (115)	400 (534)	505 (690)	655 (916)	891 (1,280)	1,170 (1,690)	1,980 (2,870)	476	
74 (A)	05123300	Oak Creek tributary near Bottineau, N.Dak.	1955, 1959-73 (16)	58.3	3.10 (3.10)	128 (118)	491 (427)	611 (522)	780 (652)	1,040 (849)	1,350 (1,070)	2,240 (1,700)	851	
75 (A)	05123350	Oak Creek tributary no. 5 near Bottineau, N.Dak.	1959-73 (15)	135	.56 (.56)	39 (37)	109 (107)	126 (125)	149 (149)	178 (182)	208 (216)	274 (299)	118	
176 (C)	05123510	Deep River near Upham, N.Dak.	1951, 1958-80, 1985-88 (28)	2.4	975 (369)	105 (--)	3,240 (--)	5,380 (--)	9,330 (--)	17,500 (--)	29,900 (--)	80,100 (--)	6,760	
77 (C)	05123520	Egg Creek near Glenburn, N.Dak.	1955-73 (19)	4.4	20.9 (7.00)	22 (22)	194 (177)	266 (237)	372 (323)	546 (458)	750 (611)	1,330 (1,030)	300	
78 (C)	05123540	Egg Creek near Ruthville, N.Dak.	1955-73 (19)	5.2	108 (26.0)	175 (158)	592 (514)	724 (624)	908 (778)	1,190 (1,020)	1,510 (1,290)	2,440 (2,080)	1,400	

<sup>1</sup>Records not used in regression analysis; used in skew analysis.

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
79 (C)	05123560	Egg Creek tributary near Deering, N.Dak.	1955-73 (19)	6.0	4.25 (4.25)	4 (4)	19 (26)	24 (35)	32 (49)	44 (72)	57 (99)	96 (178)	26	
80 (C)	05123580	Egg Creek near Deering, N.Dak.	1956-73 (18)	4.2	136 (43.6)	73 (73)	200 (236)	240 (297)	295 (387)	380 (530)	480 (694)	778 (1,150)	430	
81 (C)	05123600	Egg Creek near Granville, N.Dak.	1957-81 (25)	3.6	289 (143)	139 (140)	927 (912)	1,230 (1,200)	1,670 (1,630)	2,380 (2,300)	3,210 (3,080)	5,600 (5,300)	1,710	
82 (A)	05123900	Boundary Creek near Landa, N.Dak.	1958-81, 1985-88 (28)	5.9	230 (170)	283 (300)	1,680 (1,700)	2,240 (2,240)	3,100 (3,030)	4,560 (4,330)	6,400 (5,900)	12,500 (10,800)	3,580	
83 (C)	05290000	Little Minnesota River near Peever, S.Dak.	1940-81 (42)	3.2	447 (447)	793 (754)	2,970 (2,780)	3,670 (3,430)	4,640 (4,340)	6,130 (5,740)	7,810 (7,340)	12,500 (11,900)	4,730	
84 (C)	05291000	Whetstone River near Big Stone City, S.Dak.	1910-12, 1931-87 (60)	10.9	389 (389)	1,190 (1,150)	4,680 (4,380)	5,700 (5,320)	7,040 (6,570)	8,960 (8,360)	11,000 (10,300)	15,700 (15,100)	6,870	
85 (B)	06181200	Missouri River tributary no. 2 near Brockton, Mont.	1962-76 (15)	86.9	1.60 (1.60)	52 (50)	176 (174)	216 (214)	271 (269)	357 (353)	457 (448)	744 (716)	313	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)							
						Recurrence intervals (years)							Maximum of record
						2	10	15	25	50	100	500	
86 (B)	06185100	Big Muddy Creek tributary near Culbertson, Mont.	1963-77 (15)	34.5	7.38 (7.38)	44 (49)	336 (350)	468 (473)	682 (657)	1,070 (964)	1,590 (1,350)	3,510 (2,620)	676
87 (B)	06185200	Missouri River tributary no. 3 near Culbertson, Mont.	1963-77 (15)	82.8	1.23 (1.23)	14 (--)	313 (--)	526 (--)	951 (--)	1,940 (--)	3,680 (--)	13,400 (--)	2,570
88 (B)	06185300	Missouri River tributary no. 4 near Culbertson, Mont.	1963-77 (15)	41.7	11.6 (11.6)	337 (294)	835 (740)	978 (875)	1,170 (1,060)	1,460 (1,340)	1,780 (1,660)	2,680 (2,530)	1,670
89 (B)	06185400	Missouri River tributary no. 5 near Culbertson, Mont.	1963-88 (26)	119	3.67 (3.67)	37 (39)	297 (304)	418 (418)	615 (594)	973 (896)	1,460 (1,280)	3,250 (2,620)	1,320
90 (B)	06326650	O'Fallon Creek tributary near Ismay, Mont.	1962-76 (15)	198	.16 (.16)	31 (27)	67 (60)	76 (69)	87 (80)	103 (96)	118 (113)	156 (156)	61
91 (B)	06326700	Deep Creek near Baker, Mont.	1962-76, 1978 (16)	52.9	3.79 (3.79)	114 (107)	207 (222)	229 (256)	258 (301)	299 (364)	341 (430)	446 (586)	260

<sup>1</sup>Records not used in regression analysis; used in skew analysis.

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Main-channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								
						Recurrence Intervals (years)								Maximum of record
						2	10	15	25	50	100	500		
92 (B)	06326800	Pennel Creek near Baker, Mont.	1962-88 (27)	87.4	.86 (.86)	36 (36)	109 (109)	133 (134)	169 (169)	229 (227)	302 (297)	543 (522)	350	
93 (B)	06326940	Spring Creek tributary near Fallon, Mont.	1972-88 (17)	27.6	3.10 (3.10)	14 (16)	151 (162)	215 (223)	314 (313)	484 (457)	697 (627)	1,360 (1,120)	303	
94 (B)	06327700	Griffith Creek near Glendive, Mont.	1955-60, 1962-63, 1965-67 (11)	69.8	15.5 (15.5)	156 (160)	1,630 (1,280)	2,460 (1,770)	3,960 (2,540)	7,110 (3,960)	12,100 (5,980)	36,100 (14,400)	14,600	
95 (B)	06328800	Indian Creek at Intake, Mont.	1958-73 (16)	69.7	0.46 (.46)	13 (14)	85 (80)	116 (106)	166 (143)	253 (205)	370 (283)	790 (542)	150	
96 (B)	06329200	Burns Creek near Savage, Mont.	1958-67, 1975-84, 1986 (21)	27.2	233 (233)	311 (350)	1,830 (2,230)	2,390 (2,940)	3,210 (3,950)	4,500 (5,520)	6,020 (7,300)	10,400 (12,300)	2,100	
97 (B)	06329570	First Hay Creek near Sidney, Mont.	1963-88 (26)	11.3	30.0 (29.1)	31 (37)	405 (465)	605 (676)	945 (1,010)	1,590 (1,600)	2,500 (2,360)	5,990 (4,980)	950	
98 (B)	06329597	Charbonneau Creek near Charbonneau, N.Dak.	1967-81 (15)	9.0	149 (149)	1,110 (979)	5,240 (4,020)	6,610 (4,950)	8,520 (6,250)	11,400 (8,220)	14,700 (10,400)	23,400 (16,500)	6,300	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Main-channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
99 (B)	06329700	Painted Woods Creek tributary near Williston, N.Dak.	1955-73 (19)	80.0 (.37)		8 (8)	59 (59)	82 (80)	120 (112)	186 (165)	276 (233)	600 (459)	110	
100 (B)	06329800	Painted Woods Creek near Williston, N.Dak.	1955-73 (19)	35.0 (17.0)	17.0	83 (89)	442 (495)	597 (661)	844 (912)	1,290 (1,340)	1,910 (1,900)	4,310 (3,880)	1,200	
101 (B)	06329900	Painted Woods Creek tributary no. 2 near Williston, N.Dak.	1955-73 (19)	30.0 (8.30)	8.30	31 (34)	176 (215)	233 (287)	320 (392)	465 (560)	647 (761)	1,230 (1,360)	276	
102 (B)	06330100	Sand Creek near Williston, N.Dak.	1955-73 (19)	20.0 (38.0)	38.0	152 (160)	1,030 (1,040)	1,390 (1,380)	1,940 (1,860)	2,860 (2,650)	4,000 (3,590)	7,630 (6,410)	1,600	
103 (B)	06331000	Little Muddy Creek below Cow Creek near Williston, N.Dak.	1955-78 (24)	8.3 (775)	875	1,280 (1,300)	4,790 (5,250)	5,870 (6,550)	7,370 (8,320)	9,590 (11,000)	12,100 (13,900)	18,600 (21,600)	6,910	
104 (B)	06331900	White Earth River tributary near Tioga, N.Dak.	1960-73 (14)	29.0 (9.60)	9.60	65 (69)	332 (361)	440 (474)	607 (639)	900 (909)	1,280 (1,240)	2,640 (2,330)	1,120	
105 (B)	06332000	White Earth River at White Earth, N.Dak.	1955-81 (27)	7.4 (490)	780	589 (621)	2,360 (2,760)	2,950 (3,510)	3,800 (4,570)	5,140 (6,200)	6,700 (8,060)	11,300 (13,300)	5,200	



Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main-channel slope (feet per mile)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence Intervals (years)								
						2	10	15	25	50	100	500		
106 (B)	06332150	White Earth River tributary near White Earth, N.Dak.	1960-73 (14)	.32 (.32)	35.0	21 (20)	72 (63)	88 (76)	110 (94)	145 (123)	184 (155)	295 (247)	107	
107 (B)	06332515	Bear Den Creek near Mandaree, N.Dak.	1967-88 (22)	74.0 (74.0)	16.5	504 (485)	1,880 (1,810)	2,270 (2,210)	2,780 (2,730)	3,500 (3,500)	4,250 (4,310)	6,020 (6,350)	2,840	
108 (B)	06332520	Shell Creek near Parshall, N.Dak.	1966-81 (16)	465 (145)	2.6	449 (430)	1,730 (1,670)	2,140 (2,080)	2,720 (2,660)	3,620 (3,560)	4,640 (4,580)	7,510 (7,430)	2,400	
109 (B)	06334720	Soda Creek tributary near Webster, Mont.	1962-88 (27)	2.22 (2.22)	29.0	7 (8)	68 (80)	99 (115)	152 (171)	255 (271)	405 (407)	1,020 (909)	250	
110 (B)	06335000	Little Beaver Creek near Marmarth, N.Dak.	1939-79 (41)	587 (587)	11.4	3,270 (3,090)	7,710 (7,500)	8,780 (8,660)	10,100 (10,200)	12,000 (12,300)	13,800 (14,500)	18,000 (19,600)	12,700	
111 (B)	06335700	Deep Creek near Bowman, N.Dak.	1955-73 (19)	.29 (.20)	190	12 (12)	38 (39)	46 (48)	57 (61)	75 (80)	96 (102)	159 (164)	58	
112 (B)	06336100	Sheep Creek tributary near Medora, N.Dak.	1955-65, 1968-73 (17)	.29 (.29)	129	23 (22)	64 (62)	76 (75)	93 (91)	118 (116)	145 (144)	222 (220)	147	
113 (B)	06336200	Sheep Creek tributary no. 2 near Medora, N.Dak.	1958-73 (16)	.42 (.42)	91.0	34 (31)	238 (174)	312 (216)	413 (272)	566 (351)	731 (435)	1,140 (647)	210	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro-logic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main-channel slope (feet per mile)	Peak flow (cubic feet per second)										Maximum of record
						Recurrence intervals (years)										
						2	10	15	25	50	100	500				
114 (B)	06336300	Little Missouri River tributary near Medora, N.Dak.	1955-73 (19)	.32 (.32)	195	4 (4)	31 (37)	45 (53)	70 (78)	119 (123)	193 (184)	523 (424)	200			
115 (B)	06336400	Jules Creek near Medora, N.Dak.	1955-73 (19)	3.8 (3.8)	36.5	187 (165)	526 (443)	618 (519)	741 (620)	915 (769)	1,100 (933)	1,560 (1,360)	629			
116 (B)	06336450	Spring Creek near Wibaux, Mont.	1956-60, 1962-73 (17)	4.00 (4.00)	74.0	66 (67)	238 (254)	292 (315)	366 (398)	479 (523)	605 (662)	951 (1,040)	438			
117 (B)	06336500	Beaver Creek at Wibaux, Mont.	1938-44, 1946, 1948-67, 1969, 1979-83 (34)	351 (351)	5.0	706 (707)	3,810 (3,760)	4,820 (4,740)	6,160 (6,090)	8,100 (8,060)	10,100 (10,200)	15,000 (15,500)	3,780			
118 (B)	06336600	Beaver Creek near Trotters, N.Dak.	1978-88 (11)	616 (616)	5.7	385 (480)	2,420 (3,340)	3,240 (4,470)	4,500 (6,090)	6,630 (8,680)	9,300 (11,700)	18,000 (20,600)	2,720			
119 (B)	06336980	Little Missouri River tributary near Watford City, N.Dak.	1960-73 (14)	2.10 (2.10)	59.0	258 (204)	1,040 (651)	1,280 (762)	1,590 (907)	2,040 (1,120)	2,510 (1,340)	3,680 (1,930)	1,050			

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								
						Recurrence intervals (years)								Maximum of record
						2	10	15	25	50	100	500		
120 (B)	06337100	Spring Creek near Watford City, N.Dak.	1960-73 (14)	18.0	22.7 (22.7)	248 (231)	1,120 (969)	1,400 (1,200)	1,800 (1,520)	2,390 (1,990)	3,040 (2,520)	4,770 (3,940)	1,100	
121 (B)	06337600	East Branch Douglas Creek tributary near Garrison, N.Dak.	1957, 1959-73 (16)	53.0	1.39 (1.39)	28 (28)	74 (85)	86 (102)	101 (125)	122 (158)	144 (194)	195 (281)	76	
122 (B)	06337900	Snake Creek tributary near Garrison, N.Dak.	1959-73 (15)	17.0	1.22 (1.22)	15 (16)	54 (60)	67 (76)	86 (99)	116 (134)	152 (174)	262 (292)	92	
123 (B)	06339100	Knife River at Manning, N.Dak.	1968-88 (21)	7.2	205 (205)	1,150 (1,050)	2,640 (2,640)	2,960 (3,060)	3,350 (3,610)	3,850 (4,390)	4,320 (5,190)	5,280 (7,070)	2,940	
124 (B)	06339300	Knife River at Marshall, N.Dak.	1971-81 (11)	4.5	722 (722)	1,970 (1,770)	5,420 (5,520)	6,370 (6,700)	7,630 (8,330)	9,430 (10,700)	11,300 (13,300)	16,300 (20,000)	9,080	
125 (B)	06339490	Elm Creek near Golden Valley, N.Dak.	1968-81 (14)	7.3	82.0 (82.0)	409 (391)	2,140 (1,860)	2,880 (2,410)	4,040 (3,260)	6,150 (4,720)	9,010 (6,630)	19,900 (13,500)	10,000	
126 (B)	06339560	Brush Creek near Beulah, N.Dak.	1975-88 (14)	16.5	23.9 (23.9)	102 (110)	468 (534)	588 (680)	756 (883)	1,010 (1,190)	1,290 (1,530)	2,050 (2,440)	940	
127 (B)	06340000	Spring Creek at Zap, N.Dak.	1924, 1946-88 (44)	3.3	549 (549)	1,670 (1,600)	4,280 (4,270)	4,950 (5,020)	5,810 (6,000)	7,010 (7,400)	8,250 (8,870)	11,200 (12,500)	6,130	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
128 (B)	06340200	West Branch Otter Creek near Beulah, N.Dak.	1965-82 (18)	16.4	26.5 (26.5)	257 (246)	2,100 (1,620)	3,040 (2,210)	4,670 (3,140)	7,900 (4,890)	12,800 (7,390)	34,300 (17,800)	23,700	
129 (B)	06340528	West Branch Antelope Creek no. 4 near Zap, N.Dak.	1977-86 (10)	32.2	8.46 (8.46)	88 (89)	312 (348)	387 (436)	494 (559)	663 (748)	863 (963)	1,470 (1,570)	650	
130 (B)	06340905	Coal Lake Coulee near Hensler, N.Dak.	1978-88 (11)	32.9	70.5 (17.2)	140 (143)	601 (634)	756 (799)	976 (1,030)	1,320 (1,380)	1,710 (1,770)	2,820 (2,840)	926	
131 (B)	06341400	Turtle Creek near Turtle Lake, N.Dak.	1957-76 (20)	2.1	310 (115)	46 (55)	223 (332)	294 (449)	403 (622)	593 (904)	840 (1,250)	1,710 (2,340)	610	
132 (B)	06341800	Painted Woods Creek near Willton, N.Dak.	1958-81, 1983-88 (30)	3.5	427 (117)	319 (318)	1,470 (1,460)	1,840 (1,840)	2,350 (2,360)	3,120 (3,140)	3,960 (4,020)	6,160 (6,330)	4,050	
133 (B)	06342050	Square Butte Creek at Center, N.Dak.	1956-73 (18)	15.6	56.8 (56.8)	374 (363)	2,190 (1,910)	3,000 (2,530)	4,330 (3,480)	6,810 (5,190)	10,300 (7,490)	24,300 (16,300)	8,000	
134 (B)	06342100	Square Butte Creek tributary no. 2 near Center, N.Dak.	1955-72 (18)	28.0	13.0 (13.0)	217 (204)	858 (766)	1,090 (960)	1,440 (1,240)	2,020 (1,700)	2,750 (2,270)	5,170 (4,090)	2,500	
135 (B)	06342150	Square Butte Creek tributary near Center, N.Dak.	1955-73 (19)	158 (.19)	.19 (.19)	15 (15)	32 (34)	36 (39)	42 (47)	50 (57)	58 (68)	79 (97)	51	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
136 (B)	06342250	Square Butte Creek tributary no. 3 near Center, N.Dak.	1956-73 (18)	59.8	1.68 (1.68)	44 (43)	105 (115)	120 (135)	138 (162)	162 (199)	186 (239)	239 (334)	130	
137 (B)	06342300	Burnt Creek tributary near Baldwin, N.Dak.	1956-73 (18)	43.8	2.98 (2.98)	130 (118)	603 (476)	768 (588)	1,010 (744)	1,380 (985)	1,830 (1,260)	3,120 (2,080)	1,040	
138 (B)	06342350	Burnt Creek tributary no. 2 near Baldwin, N.Dak.	1956-73 (18)	67.9	2.12 (2.12)	92 (86)	457 (377)	585 (468)	768 (594)	1,060 (787)	1,390 (1,010)	2,330 (1,620)	652	
139 (B)	06342450	Burnt Creek near Bismarck, N.Dak.	1968-88 (21)	10.5	108 (108)	520 (506)	2,700 (2,470)	3,530 (3,170)	4,770 (4,180)	6,810 (5,820)	9,330 (7,790)	17,300 (13,800)	10,000	
140 (B)	06343000	Heart River near South Heart, N.Dak.	1947-72, 1978-84 (33)	3.1	315 (315)	1,570 (1,450)	4,810 (4,380)	5,640 (5,170)	6,670 (6,190)	8,060 (7,640)	9,430 (9,150)	12,500 (12,700)	8,080	
141 (B)	06343200	Heart River tributary near South Heart, N.Dak.	1955-73 (19)	148	.13 (.13)	13 (13)	43 (41)	52 (49)	64 (60)	81 (77)	101 (96)	155 (147)	62	
142 (B)	06344200	Heart River tributary near Dickinson, N.Dak.	1955-73 (19)	32.6	1.72 (1.72)	11 (12)	90 (99)	120 (131)	161 (175)	222 (242)	289 (316)	450 (503)	90	

Table 2.---Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main- channel slope (feet per mile)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
143 (B)	06344600	Green River near New Hradec, N.Dak.	1964-88 (25)	152 (152)	6.8	1,150 (1,050)	2,630 (2,500)	2,990 (2,900)	3,440 (3,430)	4,050 (4,190)	4,660 (4,980)	6,090 (6,890)	4,120	
144 (B)	06345000	Green River near Gladstone, N.Dak.	1946-76 (31)	356 (356)	3.0	1,410 (1,320)	4,900 (4,480)	5,910 (5,420)	7,230 (6,680)	9,140 (8,530)	11,100 (10,500)	16,100 (15,700)	5,330	
145 (B)	06345100	Antelope Creek near Dickinson, N.Dak.	1955-73 (19)	69.2 (69.2)	15.0	537 (504)	4,320 (3,260)	5,920 (4,240)	8,350 (5,650)	12,400 (7,890)	17,400 (10,500)	32,900 (18,400)	6,100	
146 (B)	06345200	Antelope Creek tributary near New England, N.Dak.	1955-73 (19)	13.0 (13.0)	25.0	145 (141)	1,070 (895)	1,440 (1,160)	2,010 (1,550)	2,950 (2,160)	4,100 (2,870)	7,600 (4,950)	1,360	
147 (B)	06345300	Antelope Creek tributary no. 2 near New England, N.Dak.	1955-73 (19)	22.4 (22.4)	23.0	259 (246)	1,200 (1,070)	1,500 (1,320)	1,900 (1,660)	2,490 (2,160)	3,120 (2,700)	4,690 (4,100)	1,200	
148 (B)	06345700	Government Creek near Richardton, N.Dak.	1950, 1955-73 (20)	33.4 (33.4)	12.0	304 (288)	2,260 (1,770)	3,140 (2,320)	4,520 (3,160)	6,980 (4,580)	10,200 (6,380)	21,700 (12,400)	4,300	
149 (B)	06347000	Antelope Creek near Carson, N.Dak.	1943, 1949-76 (29)	221 (221)	5.2	959 (913)	5,360 (4,630)	7,090 (5,990)	9,700 (7,990)	14,100 (11,300)	19,600 (15,400)	37,400 (28,400)	11,100	
150 (B)	06347500	Muddy Creek near Almont, N.Dak.	1946-73 (28)	456 (456)	7.3	1,460 (1,420)	5,560 (5,370)	7,040 (6,780)	9,260 (8,850)	13,000 (12,300)	17,600 (16,500)	33,200 (30,200)	20,200	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
151 (B)	06348500	Sweetbriar Creek near Judson, N.Dak.	1950, 1952-63 (13)	8.7	157 (157)	1,290 (1,110)	3,220 (2,870)	3,780 (3,430)	4,540 (4,210)	5,690 (5,400)	6,980 (6,740)	10,600 (10,400)	5,910	
152 (C)	06349100	Dead Buffalo Lake tributary near Steele, N.Dak.	1960-73 (14)	17.0	5.90 (5.90)	30 (31)	67 (84)	76 (102)	89 (129)	107 (171)	127 (218)	178 (340)	116	
153 (B)	06349200	West Branch Long Lake Creek near Hazelton, N.Dak.	1955-58, 1960-73 (18)	14.6	16.5 (16.5)	49 (56)	618 (594)	885 (815)	1,300 (1,140)	2,000 (1,650)	2,850 (2,240)	5,390 (3,910)	798	
154 (B)	06350000	Cannonball River at Regent, N.Dak.	1950-88 (39)	4.5	580 (580)	1,970 (1,880)	8,070 (7,450)	10,000 (9,200)	12,700 (11,600)	16,700 (15,300)	21,100 (19,400)	32,900 (30,400)	20,300	
155 (B)	06351680	White Butte Fork Cedar Creek near Scranton, N.Dak.	1965-88 (24)	9.6	42.9 (42.9)	181 (183)	905 (911)	1,130 (1,140)	1,440 (1,460)	1,870 (1,920)	2,320 (2,420)	3,400 (3,680)	645	
156 (B)	06352000	Cedar Creek near Haynes, N.Dak.	1950-88 (39)	4.2	553 (553)	1,040 (1,030)	6,080 (5,820)	8,030 (7,590)	10,920 (10,200)	15,700 (14,400)	21,400 (19,400)	39,100 (34,700)	27,400	
157 (B)	06353600	Louise Creek tributary near Brisbane, N.Dak.	1955-73 (19)	64.6	.29 (.29)	9 (9)	24 (27)	28 (33)	33 (40)	41 (51)	49 (63)	72 (94)	31	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
158 (B)	06353700	Louise Creek tributary near Lark, N.Dak.	1956-73 (18)	62.2 (.76)		23 (23)	78 (81)	96 (99)	120 (125)	158 (165)	200 (209)	321 (333)	140	
159 (B)	06353800	Louise Creek tributary no. 2 near Lark, N.Dak.	1956-73 (18)	36.8 (7.70)	7.70 (7.70)	50 (53)	322 (342)	440 (457)	625 (630)	954 (917)	1,390 (1,270)	2,940 (2,440)	500	
160 (B)	06353900	Louise Creek above Flasher, N.Dak.	1955-73 (19)	16.2 (110)	110 (110)	227 (249)	1,150 (1,360)	1,480 (1,770)	1,940 (2,330)	2,670 (3,200)	3,510 (4,180)	5,870 (6,880)	1,300	
161 (B)	06354500	Beaver Creek at Linton, N.Dak.	1950-88 (39)	3.0 (617)	717 (617)	1,020 (1,010)	4,700 (4,670)	5,960 (5,920)	7,740 (7,680)	10,500 (10,400)	13,700 (13,500)	22,500 (22,300)	9,800	
162 (B)	06354700	Spring Creek near Linton, N.Dak.	1955-73 (19)	20.2 (22.9)	22.9 (22.9)	144 (147)	1,540 (1,290)	2,220 (1,760)	3,300 (2,440)	5,230 (3,590)	7,770 (4,990)	16,400 (9,400)	2,790	
163 (B)	06354750	Sand Creek tributary near Hazelton, N.Dak.	1960-73 (14)	24.0 (3.00)	3.00 (3.00)	18 (20)	59 (82)	72 (104)	90 (135)	117 (182)	149 (234)	238 (372)	115	
164 (B)	06354800	Sand Creek near Temvik, N.Dak.	1955-73 (19)	22.4 (23.3)	23.3 (23.3)	141 (145)	1,390 (1,190)	2,010 (1,630)	3,050 (2,300)	5,000 (3,450)	7,750 (4,960)	18,300 (10,200)	4,500	
165 (B)	06354860	Spring Creek near Herreid, S.Dak.	1963-86 (24)	4.7 (220)	440 (220)	217 (238)	1,210 (1,420)	1,580 (1,870)	2,110 (2,520)	2,960 (3,530)	3,970 (4,700)	6,910 (8,010)	1,340	



Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main- channel slope (feet per mile)	Peak flow (cubic feet per second)							
						Recurrence intervals (years)							Maximum of record
						2	10	15	25	50	100	500	
166 (B)	06354900	Spring Creek near Bowman, N.Dak.	1955-73 (19)	51.2 (51.2)	20.0	117 (132)	975 (1,060)	1,360 (1,450)	1,980 (2,020)	3,080 (2,980)	4,520 (4,140)	9,500 (7,820)	2,880
167 (B)	06354950	Spring Creek tributary near Bowman, N.Dak.	1955-73 (19)	11.4 (11.4)	20.0	54 (58)	285 (320)	375 (421)	513 (568)	745 (806)	1,040 (1,090)	2,010 (1,980)	488
168 (B)	06355000	North Fork Grand River at Haley, N.Dak.	1909, 1912-15, 1917, 1946-66 (27)	509 (509)	4.9	1,550 (1,480)	7,530 (6,760)	9,580 (8,504)	12,500 (11,000)	17,000 (14,800)	22,100 (19,100)	36,400 (31,200)	14,100
169 (B)	06355200	Buffalo Creek tributary near Buffalo Springs, N.Dak.	1955-73 (19)	3.39 (3.39)	15.0	35 (35)	260 (235)	375 (323)	572 (463)	965 (723)	1,560 (1,090)	4,250 (2,630)	1,320
170 (B)	06355310	Buffalo Creek tributary near Gascoyne, N.Dak.	1975-87 (13)	15.7 (15.4)	30.8	40 (48)	114 (195)	134 (246)	158 (314)	190 (414)	223 (520)	296 (781)	100
171 (B)	06356000	South Fork Grand River at Buffalo, S.Dak.	1956-87 (32)	148 (148)	17.8	659 (653)	1,770 (1,910)	2,060 (2,270)	2,430 (2,750)	2,950 (3,430)	3,480 (4,140)	4,760 (5,870)	2,780

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydrologic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main-channel slope (feet per mile)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
172 (B)	06358520	Deadman Creek tributary near Mobridge, S.Dak.	1956-80 (25)	.3 (.3)	158	17 (17)	72 (70)	92 (89)	122 (116)	172 (160)	234 (214)	439 (384)	180	
173 (B)	06358600	South Fork Moreau River tributary near Redig, S.Dak.	1956, 1958-80 (24)	2.33 (2.33)	12.6	55 (52)	186 (173)	230 (213)	294 (271)	398 (364)	524 (476)	921 (822)	450	
174 (B)	06358620	Sand Creek tributary near Redig, S.Dak.	1956, 1958-72 (16)	.06 (.06)	100	22 (19)	43 (36)	49 (40)	56 (46)	66 (55)	76 (65)	104 (92)	64	
175 (C)	06467600	James River near Manfred, N.Dak.	1955-88 (34)	253 (56.0)	6.4	153 (149)	662 (643)	834 (810)	1,080 (1,050)	1,450 (1,420)	1,890 (1,840)	3,110 (3,040)	2,000	
176 (C)	06467650	James River tributary near Manfred, N.Dak.	1955-61, 1963-73 (18)	90.2 (39.4)	4.4	16 (19)	193 (229)	282 (332)	427 (494)	688 (770)	1,040 (1,110)	2,230 (2,170)	375	
177 (C)	06467800	James River tributary no. 3 near Manfred, N.Dak.	1955-73 (19)	23.5 (20.6)	5.8	15 (17)	85 (112)	110 (151)	146 (209)	202 (304)	266 (417)	444 (737)	150	
178 (C)	06467900	Big Slough at Hamberg, N.Dak.	1958-68, 1970-75 (17)	60.0 (42.0)	3.1	10 (12)	141 (182)	208 (268)	314 (402)	504 (633)	748 (917)	1,540 (1,770)	170	

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro-logic region)	Station number	Station name	Period of record, water years (number of years)	Drainage area (square miles)	Main-channel slope (feet per mile)	Peak flow (cubic feet per second)							
						Recurrence intervals (years)							Maximum of record
						2	10	15	25	50	100	500	
179 (C)	06469400	Pipestem Creek near Pingree, N.Dak.	1974-88 (15)	700 (260)	2.5	502 (445)	1,740 (1,550)	2,130 (1,910)	2,670 (2,430)	3,490 (3,240)	4,420 (4,190)	7,050 (6,870)	2,520
180 (C)	06469500	Pipestem Creek near Buchanan, N.Dak.	1950-74 (25)	758 (298)	2.3	412 (389)	2,680 (2,300)	3,550 (2,990)	4,820 (3,960)	6,870 (5,480)	9,280 (7,240)	16,300 (12,200)	6,080
181 (C)	06469600	Minneapolis Flats Creek tributary near Eldridge, N.Dak.	1955-68, 1970-73 (18)	9.91 (9.91)	30.9	15 (17)	55 (80)	68 (104)	84 (139)	107 (194)	132 (257)	194 (428)	60
182 (C)	06470200	Beaver Creek tributary near Eldridge, N.Dak.	1955-73 (19)	0.19 (.19)	48.6	10 (10)	39 (36)	48 (43)	60 (53)	76 (67)	93 (82)	135 (119)	49
183 (C)	06470300	Beaver Creek near Sydney, N.Dak.	1955-73 (19)	224 (62.0)	14.1	114 (116)	909 (862)	1,220 (1,140)	1,680 (1,530)	2,400 (2,140)	3,240 (2,820)	5,520 (4,670)	1,010
184 (C)	06470400	Buffalo Creek tributary near Sydney, N.Dak.	1955-73 (19)	23.7 (11.3)	20.9	37 (38)	206 (215)	267 (280)	355 (374)	494 (520)	654 (687)	1,110 (1,150)	340
185 (C)	06470800	Bear Creek near Oakes, N.Dak.	1977-88 (12)	369 (114)	2.9	116 (116)	992 (886)	1,380 (1,190)	2,000 (1,640)	3,060 (2,370)	4,410 (3,240)	8,880 (5,810)	1,170
186 (C)	06471050	Elm River tributary near Leola, S.Dak.	1956-80 (25)	18.0 (18.0)	32.3	52 (54)	248 (268)	322 (352)	435 (477)	624 (682)	862 (931)	1,650 (1,700)	720

Table 2.--Selected basin characteristics, peak flow for selected recurrence intervals, and maximum peak flow of record for gaging stations used in the generalized skew coefficient and regression analyses--Continued

Map number (hydro- logic region)	Station number	Station name	Period of record, water years (number of years)	Main- channel slope (feet per mile)	Drainage area (square miles)	Peak flow (cubic feet per second)								Maximum of record
						Recurrence intervals (years)								
						2	10	15	25	50	100	500		
187 (C)	06471200	Maple River at North Dakota-South Dakota State line	1957-87 (31)	4.8	750 (480)	412 (408)	2,530 (2,450)	3,390 (3,240)	4,680 (4,420)	6,860 (6,350)	9,580 (8,680)	18,300 (15,800)	5,930	
188 (C)	06471350	Maple River at Frederick, S.Dak.	1956-69 (14)	4.1	822 (552)	299 (309)	2,620 (2,470)	3,770 (3,400)	5,660 (4,820)	9,230 (7,220)	14,300 (10,200)	33,900 (20,200)	6,000	
189 (C)	06471400	Willow Creek tributary near Leola, S.Dak.	1956-80 (25)	10.0	6.69 (6.69)	16 (17)	63 (73)	80 (96)	105 (130)	148 (187)	203 (258)	390 (476)	260	
190 (C)	06472200	Mud Creek tributary near Groton, S.Dak.	1960-69, 1974-80 (17)	20.4	65.5 (56.7)	31 (36)	212 (288)	290 (404)	412 (585)	626 (894)	905 (1,280)	1,870 (2,450)	250	
191 (C)	06472250	Mud Creek tributary no. 2 near Groton, S.Dak.	1960-80 (21)	19.4	84.6 (75.8)	38 (44)	233 (308)	311 (425)	429 (605)	626 (905)	871 (1,270)	1,650 (2,370)	310	
192 (C)	06472500	Mud Creek near Stratford, S.Dak.	1956-73, 1977 (19)	5.4	730 (460)	52 (65)	572 (791)	830 (1,170)	1,260 (1,770)	2,030 (2,840)	3,090 (4,190)	6,890 (8,540)	1,180	

Table 3.---Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses

[Period of record used: The period of record is represented in several ways; C represents the concurrent record for several stations on the same river; E represents the entire period of record; R represents regulated flow; and U represents unregulated flow. R,U indicates the period of record includes a combination of regulated and unregulated flow. It is not used to indicate that regulated flow was considered not significant. Drainage area: First line represents total drainage area; second line, in parentheses, represents contributing drainage area. Peak flow: Values represent log-Pearson type III estimates for gaging-station data for the period of record shown. --, indicates no data]

Map number	Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
					2	5	10	25	50	100	500
1a	05051500	Red River of the North at Wahpeton, N.Dak.	1942-90 C,E,R	4,010 (--)	2,610	4,850	6,530	8,770	10,500	12,300	16,400
2a	05052000	Wild Rice River near Mantador, N.Dak.	1944-73, 1975 E,R,U	1,360 (--)	245	618	1,000	1,670	2,330	3,130	5,720
3a	05053000	Wild Rice River near Abercrombie, N.Dak.	1933-90 E,R,U	2,080 (1,490)	902	2,680	4,380	7,040	9,300	11,700	17,900
4a	05054000	Red River of the North at Fargo, N.Dak.	<sup>1</sup> 1902-90 E,R,U 1942-90 C,R	6,800 (--)	3,040 4,530	6,830 9,470	10,300 13,800	16,000 20,300	21,100 26,000	27,000 32,300	44,300 49,800
5a	05056000	Sheneye River near Warwick, N.Dak.	1950-90 E,U	2,070 (760)	772	1,900	2,910	4,420	5,680	7,040	10,500
6a	05056239	Starkweather Coulee near Webster, N.Dak.	1980-90 E,U	310 (210)	162	312	424	572	685	799	1,060
7a	05056390	Little Coulee near Brinsmade, N.Dak.	1976-89 E,U	350 (190)	14	71	154	330	525	781	1,650

<sup>1</sup>See Miller and Frink, 1984 to evaluate the effects of period of record on peak flows for the Red River of the North.

Table 3.--Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses--Continued

Map number	Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
					2	5	10	25	50	100	500
8a	05056400	Big Coulee near Churchs Ferry, N.Dak.	1950-89 E,R	1,620 (1,460)	97	394	752	1,410	2,040	2,780	4,930
9a	05057000	Sheyenne River near Cooperstown, N.Dak.	1945-90 E,U	6,470 (1,270)	1,100	2,470	3,670	5,490	7,040	8,750	13,300
10a	05058000	Sheyenne River below Baldhill Dam, N.Dak.	1950-90 C,R	7,470 (1,910)	1,050	2,350	3,330	4,600	5,520	6,400	8,280
11a	05058500	Sheyenne River at Valley City, N.Dak.	1919, 1938-49 U 1950-75, 1981-90 R	7,810 (2,110)	1,170 1,200	2,350 2,230	3,280 2,940	4,580 3,830	5,620 4,460	6,710 5,070	9,380 6,360
12a	05058700	Sheyenne River at Lisbon, N.Dak.	1957-90 E,R	8,190 (2,490)	1,300	2,610	3,680	5,220	6,480	7,830	11,300
13a	05059000	Sheyenne River near Kindred, N.Dak.	1950-90 C,R	8,800 (3,020)	1,200	2,300	3,170	4,420	5,430	6,510	9,270
14a	05059500	Sheyenne River at West Fargo, N.Dak.	1903-06, 1919, 1930-49 U 1950-90 C,R	8,870 (3,090)	1,040 1,210	1,820 2,240	2,390 2,990	3,130 3,950	3,690 4,660	4,260 5,370	5,600 6,940
15a	05060000	Maple River near Mapleton, N.Dak.	1944-76 E,U	1,450 (1,380)	1,140	2,980	4,740	7,560	10,100	12,900	20,700
16a	05064500	Red River of the North at Halstad, Minn.	1942-90 C,R	21,800 (18,000)	10,800	20,100	27,200	36,900	44,500	52,400	71,500

Table 3.--Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses--Continued

Map number	Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
					2	5	10	25	50	100	500
17a	05066500	Goose River at Hillsboro, N.Dak.	1882, 1897, 1904, 1916, 1931-90 E,U	1,203 (1,090)	1,180	3,530	5,840	9,470	12,600	16,000	24,700
18a	05082500	Red River of the North at Grand Forks, N.Dak.	1882-1990 E,R,U 1942-90 C,R	30,100 (26,300)	14,900 20,100	29,400 35,200	41,000 46,200	57,100 60,900	70,000 72,100	83,600 83,600	117,000 111,000
19a	05085000	Forest River at Minto, N.Dak.	1882, 1897, 1907, 1916, 1944-90 E,U	740 (620)	1,080	2,920	4,770	7,880	10,800	14,200	24,200
20a	05089000	South Branch Park River below Homme Dam, N.Dak.	1950-90 E,R	226 (--)	658	2,370	4,260	7,510	10,500	13,900	23,200
21a	05092000	Red River of the North at Drayton, N.Dak.	1942-90 C,R	34,800 (31,000)	24,000	42,200	54,700	70,600	82,100	93,400	118,000
22a	05099000	Pembina River near Manitou, Manitoba	1921-23, 1925, 1927-57 E,U	2,300 (--)	732	1,550	2,240	3,270	4,150	5,100	7,650
23a	05099200	Pembina River near Kaleida, Manitoba	1958-69 E,U	2,870 (--)	935	2,380	3,900	6,680	9,480	13,000	25,000
24a	05099300	Pembina River near Windygates, Manitoba	1962-90 C,E,U	3,020 (--)	1,180	3,130	5,110	8,530	11,800	15,700	27,800

Table 3.--Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses--Continued

Map number	Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
					2	5	10	25	50	100	500
25a	05099600	Pembina River at Walhalla, N.Dak.	1940-90 E,U 1962-90 C,U	3,350 (--)	2,200 2,280	5,370 5,780	8,400 9,080	13,300 14,300	17,800 18,900	23,100 24,100	38,200 38,500
26a	05100000	Pembina River at Neche, N.Dak.	1904-08, 1910-15, 1919-90 E,U 1962-90 C,U	3,410 (--)	1,430 1,900	3,320 4,770	5,090 7,460	7,960 11,700	10,600 15,500	13,600 19,800	22,400 31,500
27a	05102500	Red River of the North at Emerson, Manitoba	1913-90 E,R,U 1942-90 C,R	40,200 (36,400)	20,200 25,800	36,100 44,000	48,000 56,400	63,900 71,700	76,400 82,700	89,100 93,200	120,000 116,000
28a	05113360	Long Creek at western crossing of international boundary, Saskatchewan	1959-90 E,U	1,320 (--)	494	1,950	3,600	6,430	9,000	11,900	19,500
29a	05113600	Long Creek near Noonan, N.Dak.	1960-90 E,U	1,790 (630)	603	2,370	4,410	7,980	11,300	15,100	25,400
30a	05114000	Souris River near Sherwood, N.Dak.	1930-90 E,R,U 1937-90 C,R,U	8,940 (3,040)	1,140 1,300	3,290 3,530	5,360 5,690	8,620 9,150	11,400 12,200	14,500 15,600	22,400 24,900
31a	05116000	Souris River near Foxholm, N.Dak.	1937-90 C,E,R	9,470 (3,270)	617	1,690	2,910	5,250	7,720	11,000	22,700
32a	05116500	Des Lacs River at Foxholm, N.Dak.	1946-90 E,R	939 (539)	503	1,270	1,960	3,010	3,890	4,850	7,300



Table 3.--Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses--Continued

Map number	Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
					2	5	10	25	50	100	500
33a	05117500	Souris River above Minot, N.Dak.	1904, 1906-90 E,R,U 1937-90 C,R	10,600 (3,900)	925	2,260	3,560	5,730	7,750	10,100	17,300
					871	2,110	3,370	5,570	7,710	10,300	18,800
34a	05120000	Souris River near Verendrye, N.Dak.	1937-90 C,E,R	11,300 (4,400)	1,150	2,520	3,700	5,500	7,050	8,760	13,400
35a	05122000	Souris River near Bantry, N.Dak.	1937-90 C,E,R	12,300 (4,700)	911	2,130	3,330	5,390	7,380	9,800	17,500
36a	05123400	Willow Creek near Willow City, N.Dak.	1957-90 E,U	1,160 (730)	313	1,160	2,160	4,000	5,800	7,980	14,500
37a	05123750	Cut Bank Creek at Upham, N.Dak.	1975-80, 1986-89 E,U	722 (272)	39	216	520	1,300	2,340	3,930	11,000
38a	05124000	Souris River near Westhope, N.Dak.	1930-90 E,R,U 1937-90 C,R	16,900 (6,600)	835	2,800	4,830	8,130	11,000	14,200	22,300
					947	3,210	5,490	9,060	12,100	15,300	23,100
39a	06185500	Missouri River near Culbertson, Mont.	1943-51, 1959-68, 1970-90 R	91,557 (--)	22,000	31,700	38,900	49,200	57,600	66,700	90,900
40a	06329500	Yellowstone River near Sidney, Mont.	1911-31, 1934-84, 1986-90 E,U	69,103 (--)	64,100	91,300	108,000	128,000	142,000	156,000	185,000
41a	06330000	Missouri River near Williston, N.Dak.	1943-65 R	164,500 (--)	88,900	132,000	163,000	203,000	233,000	265,000	342,000

Table 3.--Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses--Continued

Map Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
				2	5	10	25	50	100	500
42a	06334500 Little Missouri River at Camp Crook, S.Dak.	1956-90 E,U	1,970 (--)	2,560	5,090	6,910	9,240	10,900	12,600	16,100
43a	06335500 Little Missouri River at Marmarth, N.Dak.	1939-90 E,U	4,640 (--)	7,690	16,500	23,300	32,600	39,800	46,900	63,500
44a	06336000 Little Missouri River at Medora, N.Dak.	1904-12, 1914-16, 1924, 1929-34, 1946-76 E,U	6,190 (--)	9,830	20,000	28,600	41,600	52,800	65,300	99,300
45a	06337000 Little Missouri River near Watford City, N.Dak.	1935-90 E,U	8,310 (--)	12,400	25,000	34,900	48,900	60,000	71,600	100,000
46a	06338490 Missouri River at Garrison Dam, N.Dak.	1970-90 C,E,R	181,400 (--)	32,900	39,700	44,000	49,300	53,200	57,000	66,000
47a	06339500 Knife River near Golden Valley, N.Dak.	1943-90 E,U	1,230 (--)	2,570	5,560	8,020	11,500	14,300	17,200	24,400
48a	06340500 Knife River at Hazen, N.Dak.	1930-33, 1938-90 E,U	2,240 (--)	4,190	9,370	14,100	21,400	27,900	35,300	56,200
49a	06342260 Square Butte Creek below Center, N.Dak.	1968-90 R	146 (--)	568	2,180	3,910	6,680	9,040	11,500	17,600
50a	06342500 Missouri River at Bismarck, N.Dak.	1970-90 C,R	186,400 (--)	37,400	45,300	50,300	56,400	60,900	65,400	75,700

Table 3.--Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses--Continued

Map number	Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
					2	5	10	25	50	100	500
51a	06345500	Heart River near Richardton, N.Dak.	1905-21, 1938, 1943-49 U 1951-90 C,R	1,240 (--)	3,020 3,160	6,550 6,760	9,690 9,670	14,600 13,800	18,900 17,000	23,800 23,400	37,700 28,600
52a	06346500	Heart River below Heart Butte Dam, near Glen Ullin, N.Dak.	1951-72 R	1,710 (--)	1,410	3,050	4,380	6,270	7,790	9,370	13,200
53a	06348000	Heart River near Lark, N.Dak.	1951-90 C,R	2,750 (--)	2,960	7,810	12,500	20,100	26,900	34,600	56,200
54a	06349000	Heart River near Mandan, N.Dak.	1924, 1928-33, 1938-49 U 1951-90 C,R	3,310 (--)	5,620 3,810	11,200 10,300	15,900 16,500	22,900 26,200	28,900 34,700	35,400 44,000	52,900 69,000
55a	06349500	Apple Creek near Menoken, N.Dak.	1946-90 E,U	1,680 (1,180)	557	1,680	2,810	4,660	6,320	8,200	13,300
56a	06351000	Cannonball River below Bentley, N.Dak.	1943-81 E,U	1,140 (--)	3,080	7,800	12,000	18,400	23,600	29,300	43,500
57a	06352500	Cedar Creek near Pretty Rock, N.Dak.	1943-76 E,U	1,340 (--)	1,630	5,220	9,340	17,000	24,900	34,700	66,800
58a	06353000	Cedar Creek near Raleigh, N.Dak.	1939, 1962-90 E,U	1,750 (--)	1,750	4,250	6,620	10,500	13,900	18,000	29,500

Table 3.--Drainage area and peak flow for selected recurrence intervals for gaging stations not used in the generalized skew coefficient and regression analyses--Continued

Map number	Station number	Station name	Period of record used (water year)	Drainage area (square miles)	Peak flow (cubic feet per second) for selected recurrence intervals (years)						
					2	5	10	25	50	100	500
59a	06354000	Cannonball River at Breifen, N.Dak.	1906-08, 1912-18, 1922, 1924, 1928-90 E,U	4,100 (--)	4,570	10,900	16,900	26,900	36,100	47,000	79,400
60a	06468170	James River near Grace City, N.Dak.	1969-90 E,U	1,060 (410)	480	1,450	2,340	3,640	4,680	5,740	8,170
61a	06468500	James River near Pingree, N.Dak.	1953-68 E,U	1,670 (680)	146	342	534	860	1,170	1,540	2,710
62a	06470000	James River at Jamestown, N.Dak.	1928-33, 1938-39, 1943-53 U 1959-90 C,R	2,820 (1,170)	716 457	1,700 1,110	2,640 1,730	4,160 2,770	5,540 3,720	7,140 4,840	11,800 8,170
63a	06470500	James River at LaMoure, N.Dak.	1959-90 C,R	4,390 (1,790)	767	2,020	3,260	5,300	7,180	9,360	15,700

