UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

A PROPOSED STREAMFLOW DATA PROGRAM FOR WISCONSIN

By

Roy E. Campbell

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Open-file report

Madison, Wisconsin

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ABSTRACT

An evaluation of the streamflow data available in Wisconsin was made to provide guidelines for planning future programs. The basic steps in the evaluation procedure were (1) definition of the long-term goals of the streamflow data program, (2) examination and analysis of all available data to determine which goals have already been met, and (3) consideration of alternate programs and techniques to meet the remaining objectives. A streamflow data program based on these guidelines is proposed for the future.

Streamflow data collected at gaging stations were classified according to the type of use or purpose. Recommendations were made as to whether a station should be included in the proposed network or whether it had met the objective for which it was operated and could be discontinued.

The historical data acquired and the new data to be collected form the basis for analytical and interpretive reports. Recommendations were made as to expanding or initiating such studies. Streamflow data collection should be a continuing effort, reoriented as necessary to meet the changing needs.

INTRODUCTION

The U.S. Geological Survey-State cooperative surface-water data program in Wisconsin started with the Wisconsin Railroad Commission and continued with its successors, the Public Service Commission of Wisconsin and, later, the Wisconsin Department of Natural Resources. The program has continued without interruption since its beginning in 1913 and has sustained a methodical and continuous collection of streamflow data that constitutes an invaluable measure of Wisconsin's water resources.

Prior to the cooperative program, a few flow measurements were made by General Gouverneur Warren in 1867, shortly after the Civil War, mostly of the Wisconsin River and its principal tributaries. Early records of flow were also collected on the Chippewa River at Chippewa Falls (1888), the Fox River at Rapide Croche (1896), the Wolf River at New London (1896), and the Fox River at Berlin (1898).

In recent years, as the needs for streamflow information increased, other agencies have participated in the cooperative studies. At the present time programs are in progress in cooperation with the Wisconsin Department of Natural Resources, the Wisconsin Department of Transportation, University Extension--the University of Wisconsin Geological and Natural History Survey, and the Southeastern Wisconsin Regional Planning Commission. Other agencies or organizations providing funds for streamflow-measurement work include the U.S. Army Corps of Engineers; U.S. Department of Agriculture, Soil Conservation Service; U.S. Department of the Interior, Fish and Wildlife Service; Wisconsin Valley Improvement Company; and several power companies (Federal Power Commission licensees). Since its inception the stream-gaging program has made possible the collection of records of more than 10 years at 122 sites (table A-1).

Streamflow data are needed for the evaluation of flooding, diversion of water for irrigation, protection of fish and wildlife, water quality, pollution, and erosion. As a result, the scope of the surface-water data program has been broadened to include special studies, such as, low-flow characteristics, flood-flow characteristics, and the collection of water-level data on many Wisconsin lakes. A study to define the regional flood-frequency relationships and particularly their extension to streams of small drainage areas was started in 1956 in cooperation with the State Highway Commission of Wisconsin, now the Wisconsin Department of Transportation. There are now 135 gages established for this purpose.

A regional low-flow study was initiated in 1961 as part of the cooperative program with the Public Service Commission of Wisconsin, now the Wisconsin Department of Natural Resources. Low-flow data have been collected at about 300 sites throughout the State.

PURPOSE OF EVALUATION

The need for a greater variety of hydrologic information made it imperative that a systematic evaluation of the streamflow data program be made to determine how to apply funds and manpower available in order to best serve State and Federal interests.

The purpose of this study is to evaluate the current streamflow data program and to design a program that will produce the data needed to meet the varied concerns of the State. The basic steps of this evaluation are (1) define the long-term objectives of the streamflow data program, (2) analyze all available data to determine which objectives have been met, (3) consider alternate means of meeting the remaining objectives, and (4) prepare recommendations for a proposed program of data collection and analysis to meet all objectives. The concepts and procedures used in this study are described by Carter and Benson (1970).

HYDROLOGIC SETTING

Wisconsin is in two major drainage systems. About 30 percent of the State, 17,500 square miles, drains to the St. Lawrence River through Lakes Superior and Michigan. The remaining 70 percent, about 38,600 square miles, drains to the Mississippi River. The major river systems are the Wisconsin, Chippewa, Fox-Wolf, St. Croix, Menominee, and Rock. About 5,100 lakes have surface areas greater than 20 acres.

The annual surface runoff within the State varies from 6 to 20 inches, generally increasing to the north. The year-to-year variation in the annual runoff is much less than for most north-central states. Maximum annual runoff is generally less than twice the long-term average. Minimum annual runoff is generally greater than one-half the long-term average.

Average annual precipitation varies from a minimum of about 27 inches in the east-central and northwestern regions to 34 inches in the southwest and north-central regions. Temperature and evapotranspiration decrease to the north. Annual snowfall ranges from about 20 inches in the south to more than 100 inches in the north near Lake Superior, with wide variation from year to year. Snowmelt runoff frequently contributes to peak discharges of rivers, especially when the ground is frozen. The snowmelt and rainfall also recharge ground-water reservoirs, which in turn maintain base flow of the streams.

Differences in streamflow from basin to basin are influenced by topography, geology, and soils, as well as climate.

The southwestern area of the State is characterized by rugged, unglaciated topography, deeply incised streams, steep hillslopes, and sparse forest cover. Streams in the southern part of this area are most subject to high flood peaks.

The south-central area is a flat region characterized by end moraines, ground moraines, outwash, and numerous wetlands. Flood peaks of streams in this area are generally low. Average annual runoff is among the lowest in the State.

The central sand plain area is generally level and consists of glacial outwash and lake deposits. Precipitation is quickly absorbed in the thick, permeable materials, and streams in this area have high base flows and relatively low flood peaks. About 90 percent of the average annual runoff of the Little Plover River from 1960 to 1962 was ground-water inflow.

Eastern Wisconsin is an area of varied topography, much of which is gently rolling. However, the Kettle moraine part of this area has fairly rugged terrain consisting of knobs, kettles, and land-locked lakes. Average annual runoff is low. The streams generally have low gradients and are not flashy.

The northern highland area extends in a broad band south of Lake Superior. The area which is largely forested contains the headwaters of most of the major river systems. Numerous reservoirs and lakes stabilize the flow of several rivers. Glacial drift covers most of the area, and where drift is thin, ground-water storage is small and surface runoff is large.

In the extreme northern part of the State, streams have a steep gradient to Lake Superior. Flood runoff is rapid, and annual runoff is generally high. Relatively impermeable lake clay covers the lower part of the basin.

CONCEPTS AND PROCEDURES USED IN THIS STUDY

The principal concept of this study is that streamflow information may be needed at any point on any stream in Wisconsin and that the program must be designed to accommodate this need. This information can be provided by a combination of data collection and hydrologic studies that generalize the data obtained at gaging sites.

Another important concept is that the goals of the program, including accuracy goals, should be identified and put in quantitative form whenever possible. This permits evaluation of existing data to determine which goals have been attained and how the program should be modified.

The procedures used in this study correspond to the general framework for design of a data collection program shown by table 1 (Carter and Benson, 1970). Streamflow data are classified into four types: (1) data for current use, (2) data for planning and design, (3) data to define long-term trends, and (4) data on the stream environment. For planning and design type of data, streams are classified as natural or regulated, and each of these classifications is further subdivided into principal or minor, with the separation occurring at a drainage area of 500 square miles or greater.

In the initial phase of the study, program goals were established for each type of data. All available data were then examined and analyzed. Streamflow information was compared with the program goals in order to consider elements that should be included in the future program.

Table 1.—*Framework for design of data collection program*

Type of data	Current use	Planning and Design				Long-term trends	Stream environment
		Natural Flow		Regulated Flow			
		Minor streams	Principal streams	Minor streams	Principal streams		
Goals	To provide current data on streamflow needed for day-by-day decisions on water management as required.	To provide information on statistical characteristics of flow at any site on any stream to the specified accuracy.				To provide a long-term data base of homogeneous records on natural-flow streams.	To describe the hydrologic environment of stream channels and drainage basins.
Drainage area limits	Full range	Less than 500* sq mi.	Greater than 500* sq mi.	Less than 500* sq mi.	Greater than 500* sq mi.	Full range	Full range
Accuracy goal	As required	Equivalent to 10 years of record.	Equivalent to 25 years of record.	Equivalent to 10 years of record.	Equivalent to 25 years of record.	Highest obtainable	As required
Approach	Operate gaging stations as required to provide specific information needed.	Relate flow characteristics to drainage basin characteristics using data for gaged basins.	Operate gaging stations to obtain 25 years of record (or the equivalent by correlation) at a network of points on principal streams; interpolate between points.	Develop generalized relations that account for the effect of storage, diversion or regulation on natural flow characteristics.	Utilize analytical model of stream system with observed data as input to compute homogeneous records for both natural flow conditions and present conditions of development.	Operate a number of carefully selected gaging stations indefinitely.	Observe and publish information on stream environment.
Evaluate available data	Identify stations where data is used currently and code the specific use of data.	Develop relationship for each flow characteristic and compare standard error with accuracy goal. Evaluate sample.	Lay out network of points on principal streams and compare data available at these points with goal.	Appraise type of regulation, data available, and areas where relationships are needed.	Identify stream systems that should be studied using model approach and determine data requirements.	Select two stations in each WRC subregion to operate indefinitely for this purpose.	Evaluate information available in relation to goals.
Design future program		Identify goals that have not been attained. Consider alternate means of attaining goals. Identify elements of future program.					

*May be varied with terrain and hydrologic conditions.

Data for Current Use

Current information on streamflow is needed at many sites for day-to-day decisions on water management, for assessment of current water availability, for the management of water quality, for the forecast of water hazards, and for the surveillance necessary to comply with legal requirements. Sites at which the needed data are collected are termed "current-purpose" streamflow stations.

Data for current use are obtained by operating gaging stations specifically for water-management purposes. Current-purpose data stations are identified separately because justification can be related to specific needs. In addition, the locations of the stations, the accuracy requirements, and the period of operation are often specified by the user of the data, who usually provides the financing.

This part of the program is not subject to design but changes in response to the needs for water-management data. However, the data obtained at current-purpose stations may have general hydrologic significance and may be useful as statistical data in planning and design.

Data for Planning and Design

Streamflow records form the principal basis for the planning and design of water-related activities and facilities. Past hydrologic experiences, however, are never precisely duplicated in the future. The exact sequence of wet and dry years probably will not occur again. This is one reason why designers and planners use statistical characteristics of streamflow rather than the records of flow at specific times. It is assumed that the probability of occurrence of a flow of given magnitude, or other statistical parameter, in the future can be approximated from the frequency of such occurrence in the past. Typical statistical characteristics are the mean flow, the standard deviation of mean flow, the flood of 50-year recurrence interval, and the minimum 7-day flow of 20-year recurrence interval.

A long record of streamflow at the specific site is desirable for defining statistical characteristics of streamflow. Although it is not feasible to collect a long continuous streamflow record at every site where it may be needed, a number of such stations are required to provide information that can be transferred to ungaged sites or to sites where little streamflow information is available.

Natural-Flow Streams

Information on natural-flow streams is transferred through regression techniques by relating flow characteristics to basin characteristics, such as mean annual flow to drainage area, topography, and climate; by relating, through correlation techniques, a short record to a longer one; or by interpolating between gaged points on a stream channel.

To evaluate the statistical characteristics of streamflow, the streams in Wisconsin were identified as having either natural- or regulated-flow conditions. For this study, streams under each of the above categories were also defined as being minor streams (drainage area less than 500 sq mi), or principal streams (drainage area greater than 500 sq mi). The principal-stream network was further defined by identifying stream gaging sites in the headwaters where drainage areas are about 500 square miles, and then identifying successive downstream sites on each stream where the drainage areas approximately doubled in downstream progression.

Regulated-Flow Streams

The natural-flow regimen of many streams is altered by the operation of storage reservoirs and the diversion of water that significantly affect streamflow. These alterations increase the scope of both the data collection and the analysis that is required to provide information on flow characteristics.

To be useful in statistical prediction, streamflow regulation should be homogeneous in time. Frequently, however, it is not possible to obtain a long record under one condition of development before changes occur.

Definition of flow characteristics at any point on any stream is also much more difficult under conditions of regulation. The procedures of regression and correlation used for natural streams cannot be applied, and the use of interpolation is limited.

For regulated streams, a systems approach is the most efficient way of providing meaningful information on the statistical characteristics of flow. This approach requires an analytical model of the stream system. Such models are simple in concept and generally consist of water-budget and flow-storage equations. However, in many instances a digital computer is required for complex equations or large volumes of data. A computer program can be tailored to the individual system.

Development of such a model requires information on stage-capacity curves of reservoirs, stage-discharge curves at the outlets, operating-rule curves for the release of water, losses due to evaporation and seepage, data on storage in the form of perched ice in late winter, the geometry of the stream channel, and records of diversions and return flow. Information on streamflow at points on regulated streams and data on unregulated inflow also are needed as input to the model and to verify the output. Possibly, aquifer characteristics and ground-water pumpage should be considered.

The model and the associated data can be used to derive homogeneous data for the natural and regulated conditions. All historical streamflow records for both natural and regulated flows could be used as input to the model. Furthermore, data could also be derived for ungaged sites in the stream system.

Accuracy Goals

In using historic hydrologic data to appraise the probability of future occurrences, some error is inherent. Natural streamflow varies in time and space. For this study, streamflow is considered generally random in occurrence. Statistical techniques used in the analysis of random events, therefore, are considered applicable. Variability of annual mean flow and other streamflow characteristics with time are determined from the historical streamflow data. The principal measure of the accuracy with which a particular streamflow characteristic can be determined is the statistical measure of error, "standard error of estimate". It is expressed in this report as a percentage of the average value of the characteristic. The standard error is the estimated limit above and below the average within which about 67 percent of future values of the characteristics are expected to fall. Conversely, there is only one chance in three that future values will differ from the average by more than one standard error.

In general, the longer the record, the more reliable are the estimates of probable future occurrences. However, even with a record of 50-100 years or more, it is not possible to determine with great precision the probability of certain flow characteristics such as floods of a given magnitude. The standard error of various streamflow parameters decreases with the years of available record but at a decreasing rate; typical examples are shown in figure 1. The economic value of additional years of record beyond a reasonable limit in the planning and design of projects is under study, but no usable guidelines are available.

Accuracy goals for streamflow characteristics are expressed as the accuracy equivalent of an arbitrary number of years of record. These goals are the same for natural and regulated flows; that is, accuracy equivalent to that which would be obtained from 10 years of record at the site for minor streams and accuracy equivalent to that which would be obtained from 25 years of record for principal streams.

At sites on natural-flow streams, where streamflow records are not available, the desired streamflow characteristics may be defined by means of the relation between the streamflow parameter and the characteristics of the drainage basin. This definition is accomplished by multiple regression analysis, a statistical method of handling sample data that relates a streamflow characteristic to topographic and climatic characteristics that affect streamflow. This analysis produces a regression equation that can be used to compute the flow characteristics at any point on natural streams. The standard

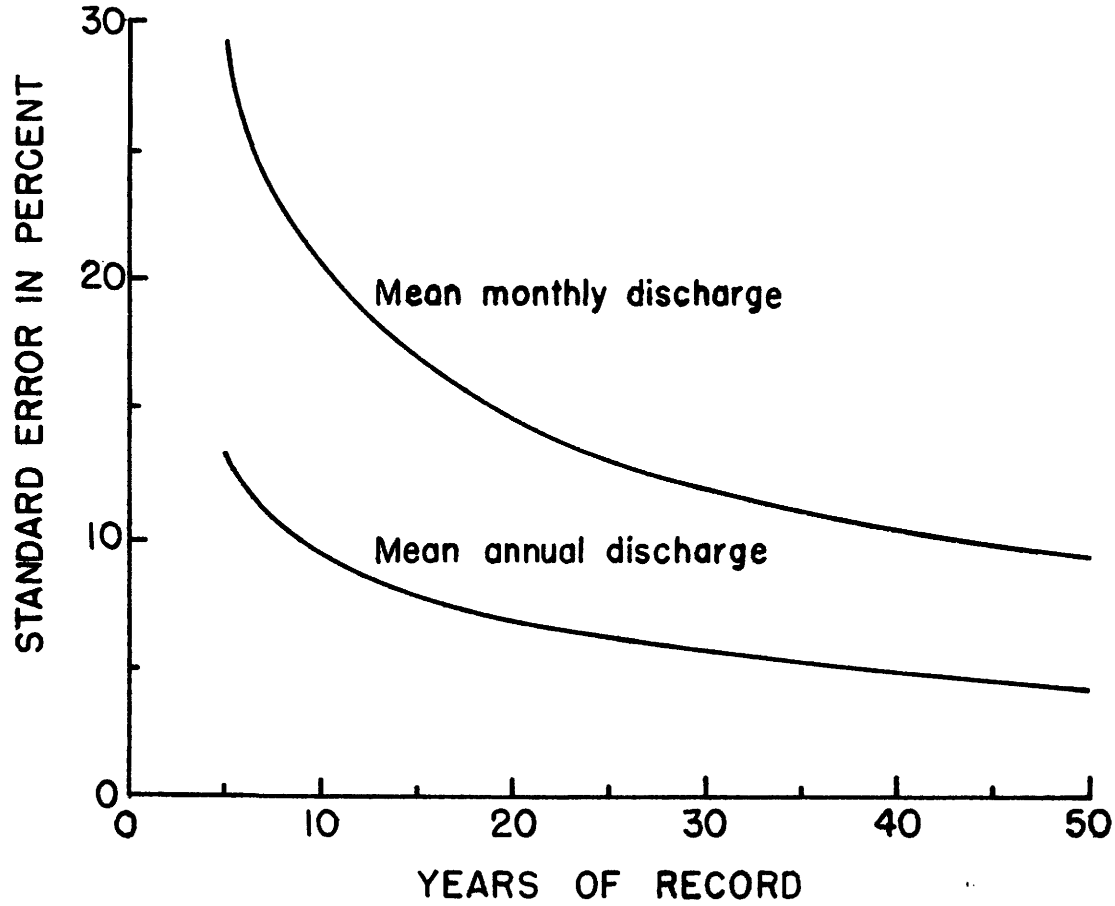

Figure 1.— Curve showing relation of standard error to years of record.

error of a regression equation measures the accuracy of an estimated discharge using the regression equation at an ungaged site. That error may be compared with the error associated with the same characteristic defined from a given number of years of record to determine whether the accuracy objective has been met.

Data to Define Long-Term Trends

Characteristics of streamflow derived from gaging-station records are used to estimate future-flow characteristics, on the assumption that the observed record represents the long-term stream flows. To affirm this assumption, or to better define the ways in which the flow characteristics change with time, selected gaging stations on natural streams should be operated indefinitely.

Data on Stream Environment

Environmental data describe the physical environment in which the water exists, especially those features that relate to the use of water for recreation, waste disposal, conjunctive surface water-ground water supply, and the preservation of the esthetic character of water. The types of stream environment data include the following:

1. The geologic and hydraulic properties of the stream-aquifer systems.
2. Time of travel of solutes in stream channels.
3. Definition of flood profiles along stream channels.
4. Identification of flood plains for floods of different frequencies.
5. Definition of stream and stream-channel properties, such as velocities, depths, bank vegetation, bed material, water temperature, water quality, and accessibility.
6. Definition of the effects of manmade changes in the environment on the quality and quantity of streamflow.
7. Character of the drainage basin, including area, vegetation, land and channel slopes, geology, and topography.

8. Climatic factors influencing the water supply.

GOALS OF THE WISCONSIN STREAMFLOW DATA PROGRAM

The objective of the Wisconsin streamflow data program is to provide information on flow at any point on any stream. Within this general objective specific goals are set for each of the four types of data that represent the particular information that is needed.

Data for Current Use

The program goal for current-use data is to provide the particular information needed at specific sites. Continuous record may not be required to meet each objective, such as determining streamflow for miscellaneous water quality samples. Accuracy goals at a given site, as specified by the data user, can be met by intensive observation or by more sophisticated instrumentation.

Data for Planning and Design

The goal for this type of data is to define, within the given accuracy, various statistical flow characteristics. This definition applies not only to all streams with natural flow but also to those streams that are affected by regulation and diversion. The most significant characteristics and their accuracy goals are listed in table 2. The accuracy goals shown for each flow characteristic are equivalent to 10 years of record for minor streams and 25 years of record for pincipal streams. The standard errors were calculated from a theoretical relation of standard error to index of variability (for Wisconsin streams) and number of years of record.

Data to Define Long-Term Trends

The goal for this type of data is to operate indefinitely a small network of gaging stations on streams that are expected to be relatively free from manmade changes. One or two stations should be

Table 2.--Accuracy goals

Streamflow characteristics	Standard error (percent)	
	10 years	25 years
Mean flow--annual discharge- - - - - - -	10	6
Flow variability--standard deviation of annual discharge- - - - - - - - - - -	22	14
Mean flow--monthly discharge (average) -	20	13
Flow variability--standard deviation of monthly discharges (average) - - - - - -	22	14
Flood peak--50-year flood- - - - - - - -	35	20
Flood volume--7-day, 50-year high flow -	30	20
Low flow--7-day, 2-year- - - - - - - - - -	12	8
Low flow--7-day, 20-year - - - - - - - - -	18	12

located in each major drainage area in the State, and stations should be located on streams that differ in physical characteristics.

Data on Stream Environment

Environmental data describe the flow and the stream channel in terms that will be valuable in planning the use of the stream for purposes such as recreation, waste disposal, conjunctive surface water-ground water supply, and in guarding against hazards from flooding. The long-range goals for this type of data in Wisconsin are given below.

1. Hydrologic studies of stream-aquifer systems.
2. Surveys of time and travel of solutes in stream channels.
3. Definition of flood profiles along stream channels.
4. Identification of flood plains for floods of different frequencies.
5. Reconnaissance surveys of streamflow and stream channel parameters that are related to the use of the stream for recreation, such as velocities, depths, bank vegetation, bed material, water temperature, water quality, and accessibility.
6. Research studies of the effect of manmade changes in the environment on streamflow.

EVALUATION OF EXISTING DATA IN WISCONSIN

In this evaluation all available data are considered and analyzed in relation to program objectives (table A-1). A separate evaluation is made for each of the four types of data.

Data for Current Use

More than one-half of the 105 gaging stations (fig. 2) in Wisconsin are operated to provide data for current use. It is assumed that the need for this type of data is being met, and that this part of the program can be modified as requirements change. The 60 gaging stations and the principal uses of the data are identified in table A-2.

Definitions of current purposes are given in table A-2.

Data for Planning and Design

The statistical characteristics of streamflow can be defined by sample gaging, analytical methods of regionalization, systems studies, or any combination of the three. The following discussion of the evaluation of this type of data follows the framework shown in table 1.

Evaluation of the Natural-Flow Systems

The purpose of the evaluation is to determine how accurately the statistical characteristics listed as goals can be defined by regionalization of the data available.

A most effective method for defining statistical streamflow characteristics on a broad scale is to relate the streamflow characteristics to basin characteristics in equations developed by use of multiple-regression techniques. Once the equation and its constants are defined, streamflow characteristics for a specific site can be computed by substituting the appropriate values of the drainage basin characteristics in the formulas.

Streamflow data from 116 gaging stations on streams in Wisconsin and in adjoining states having at least 10 years of mostly unregulated flow were used in the regression analysis to define all streamflow characteristics except flood peaks. The complete record of gaging stations for Wisconsin is given in figure 2 and table A-1.

The analysis for flood peaks was based on most of the 116 records, several other records with slightly less than 10 years, a number of records on regulated streams where regulation did not significantly affect peaks, and 115 crest-stage partial records, most of which were 7-11 years in length. The locations of the crest-gage partial record stations are shown in figure 3.

Streamflow characteristics.--The following streamflow characteristics defined at gaging stations include the full range of flow and represent those required for planning and design (table A-4).

a. Mean-flow characteristics are described by the mean of the annual means, Q_a, and by the means of record for each calendar month, q_n, where the subscript n, refers to the numerical order of the month beginning with January as 1.

b. Flow-variability characteristics are represented by the standard deviations of the annual and monthly means. The symbols used are, respectively, SD_a and SD_n, where the subscript n refers to the numerical order of months beginning with January as 1.

c. Flood-peak characteristics are represented by discharges from the annual flood-frequency curve at recurrence intervals of 2, 5, 10, 25, and 50 years. In this report peak-flow rates are noted as Q_2, Q_5, etc. The frequency curves were prepared as described by the U.S. Water Resources Council (1967).

d. Flood-volume characteristics represent the annual highest average flow for 1-day, 3-day, 7-day, and 15-day periods at recurrence intervals of 2, 10, and 50 years. These characteristics are noted symbolically in this report as $V_{1,2}$, $V_{1,10}$, $V_{1,50}$, $V_{3,2}$, $V_{3,10}$, $V_{3,50}$, $V_{7,2}$, etc. They were determined from frequency curves prepared as described by the U.S. Water Resources Council (1967).

e. Low-flow characteristics are the annual minimum 7 and 30 consecutive day mean flows at 2-year, 10-year, and 20-year recurrence intervals ($M_{7,2}$, $M_{7,10}$, $M_{7,20}$, $M_{30,2}$, $M_{30,10}$, and $M_{30,20}$). These characteristics were determined from graphical low-flow frequency curves.

f. Flow-duration characteristics are the flows exceeded 10, 50, and 95 percent of the time. These characteristics are noted as D_{10}, D_{50}, and D_{95}.

Drainage-basin characteristics.--Drainage-basin characteristics defined for this study are (table A-3):

a. Drainage area (A), in square miles, as shown in the latest U.S. Geological Survey streamflow reports.

b. Main-channel slope (S), in feet per mile, determined from elevations at points 10 percent and 85 percent of the distance along the channel from the gaging station to the divide. This index was described and used by Benson (1962, 1964).

c. Main-channel length (L), in miles, from the gaging station to the basin divide, as measured with a template graduated in 0.1-mile units.

d. Basin storage (St), expressed as percent of the drainage area, includes lakes, ponds, and wetlands, determined from U.S. Geological Survey maps and U.S. Soil Conservation Service data. To avoid zero values a constant of 1 percent was added to each parameter value before it was used in the regression equation.

e. Mean basin elevation (E), in feet above mean sea level, measured on U.S. Geological Survey 1:62,500 and Army Map Service 1:250,000 maps by laying a grid over the map, determining the elevation at each grid intersection, and averaging those elevations. The grid spacing was selected to give at least 20 intersections within the basin boundary.

f. Forest cover (F), expressed as percent of the drainage area as shown on U.S. Geological Survey maps, determined by the grid method and data from the U.S. Soil Conservation Service. A constant of 1 percent is added to each value used in the regression equation.

g. Mean annual precipitation (P), in inches, determined from an isohyetal map published in the U.S. Weather Bureau series (Climates of the States, 1960). A constant of 20 was subtracted from each value used in the regression equation.

h. The maximum 24-hour rainfall having a recurrence interval of 2 years (2-year rainfall, 24-hour), expressed in inches. These values were determined from U.S. Weather Bureau maps (Hershfield, 1961).

i. Mean minimum January temperature (T_1) in degrees Fahrenheit, was determined from maps published in the U.S. Weather Bureau series (Climates of the States, 1960).

j. Mean annual snowfall (Sn), in inches, was determined from a U.S. Weather Bureau isohyetal map. A constant of 20 was subtracted from each value used in the regression equation.

k. Soil index (Si), in inches, is an index of soil infiltration capacity calculated by the U.S. Soil Conservation Service (personal communication, 1969).

l. Average frost depth on February 28 (Fr), in inches, determined from data of the Wisconsin State Climatologist (personal communication, 1969).

m. Average snow depth on February 28 (So), in inches, determined from data of the Wisconsin State Climatologist (personal communication, 1969).

Regression analysis.--The next step was to relate each of the streamflow characteristics to basin and climatic characteristics in equations developed by using multiple regression techniques. The equation form is $Y=aA^{b_1}S^{b_2}P^{b_3}$ . . ., where Y is a statistical streamflow characteristic; A, S, and P are topographic or climatic characteristics; a is the regression constant; and b_1, b_2, and b_3 are coefficients obtained by regression (table A-4). This method was described by Benson (1962). In this study drainage area, main-channel slope, main-channel length, basin storage, forest cover, mean basin elevation, mean annual precipitation, 2-year, 24-hour rainfall, mean minimum January temperature, mean annual snowfall, soil index, and the average frost depth on February 28 were used in each regression. An additional variable, average snow depth on February 28, was used in the regression involving annual flood peaks. The computer calculated the regression equation, the standard error of estimate, and the significance of each basin parameter. Automatically, then, the computer repeated the calculation omitting the least significant basin parameter in each calculation until only the most significant parameter remained. After relations for a given streamflow characteristic were computed, the entire computation process was repeated using another streamflow characteristic and the same set of basin characteristics.

Table 3 illustrates the output of the regression analyses of mean annual flow. On the basis of this analysis, the equation for determining mean annual discharge at ungaged sites in Wisconsin, which includes all statistically significant variables is:

$$Q_a = 0.147\ A^{1.02}\ F^{0.12}\ P^{0.81}\ I^{-1.21}\ Si^{0.19}$$

Table 3.--Example of regression analyses

Streamflow characteristic	Regression coefficients for independent variables a/						Standard error of estimate	
	Drainage area	Forest cover	Mean annual precipitation	2-year, 24-hour rainfall	Soil index	Regression constant	Percent	Percent change b/
Mean flow--annual discharge	1.02	0.12	0.81	-1.21	0.19	0.147	17.3	----
	1.01	.15	.76	-1.18	----	.192	18.0	+0.7
	1.01	.22	.67	-----	----	.0619	19.5	+1.5
	.99	.22	----	-----	----	.334	22.3	+2.8
	1.02	----	----	-----	----	.591	30.8	+8.5

a/ Significant at one percent level.

b/ Percent change when least significant variable is dropped, as indicated by dashed line in column.

where Q_a is mean annual discharge, in cubic feet per second; A is drainage area, in square miles; F is forest cover in percent of drainage area, plus 1; P is mean annual precipitation, in inches (minus 20); I is precipitation intensity for 2-year, 24-hour rainfall, in inches; and Si is the soil index of the basin, in inches.

Table A-4 shows, for each of 45 streamflow characteristics, the regression constant, the regression coefficient (exponent) for all statistically significant basin characteristics, and the standard error of estimate. No meaningful equations were derived for low flow or for flow duration exceeding 95 percent of the time.

The standard errors in table A-4 should be compared with the corresponding values in table 2 to determine whether the accuracy goals have been met. A detailed discussion of this comparison will be deferred to a later section of this report, but the regression results do not meet the accuracy goals for minor streams (the equivalent of 10 years of record) or for the principal streams (the equivalent of 25 years of record).

Statistical values of streamflow characteristics computed using the regression equation were compared to the observed value. The ratio between observed and computed statistical values are the basin residuals, which are plotted on State maps to visually determine areal significance. Residuals for selected streamflow characteristics are shown on figures 5 through 10.

If the plotted basin residuals are found to be greater than one in an area but less than one in another area, an areal bias relation is indicated. If the basin residual plot shows a random scatter, it can be assumed that an unbiased relation exists.

Principal streams.--The goals for this category can be met only by gaging station operation because the accuracy objective, equivalent of 25 years of record, cannot be achieved by techniques of regionalization. The study for this category consisted of the identification of principal-streams network and evaluation of length of record available at these sites.

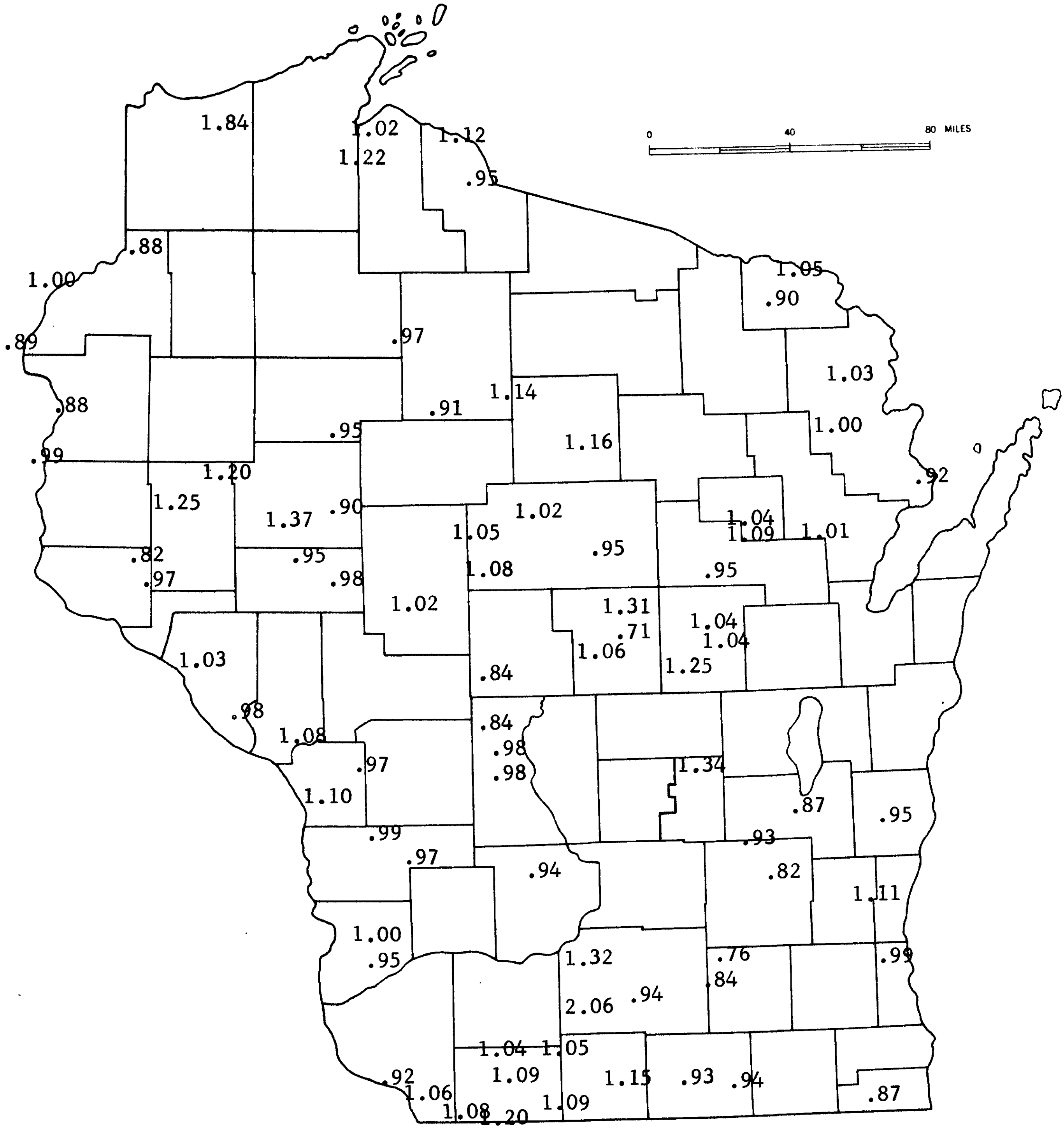

Figure 5.--Basin residuals, ratio of observed to computed, of mean annual flow, Q_a.

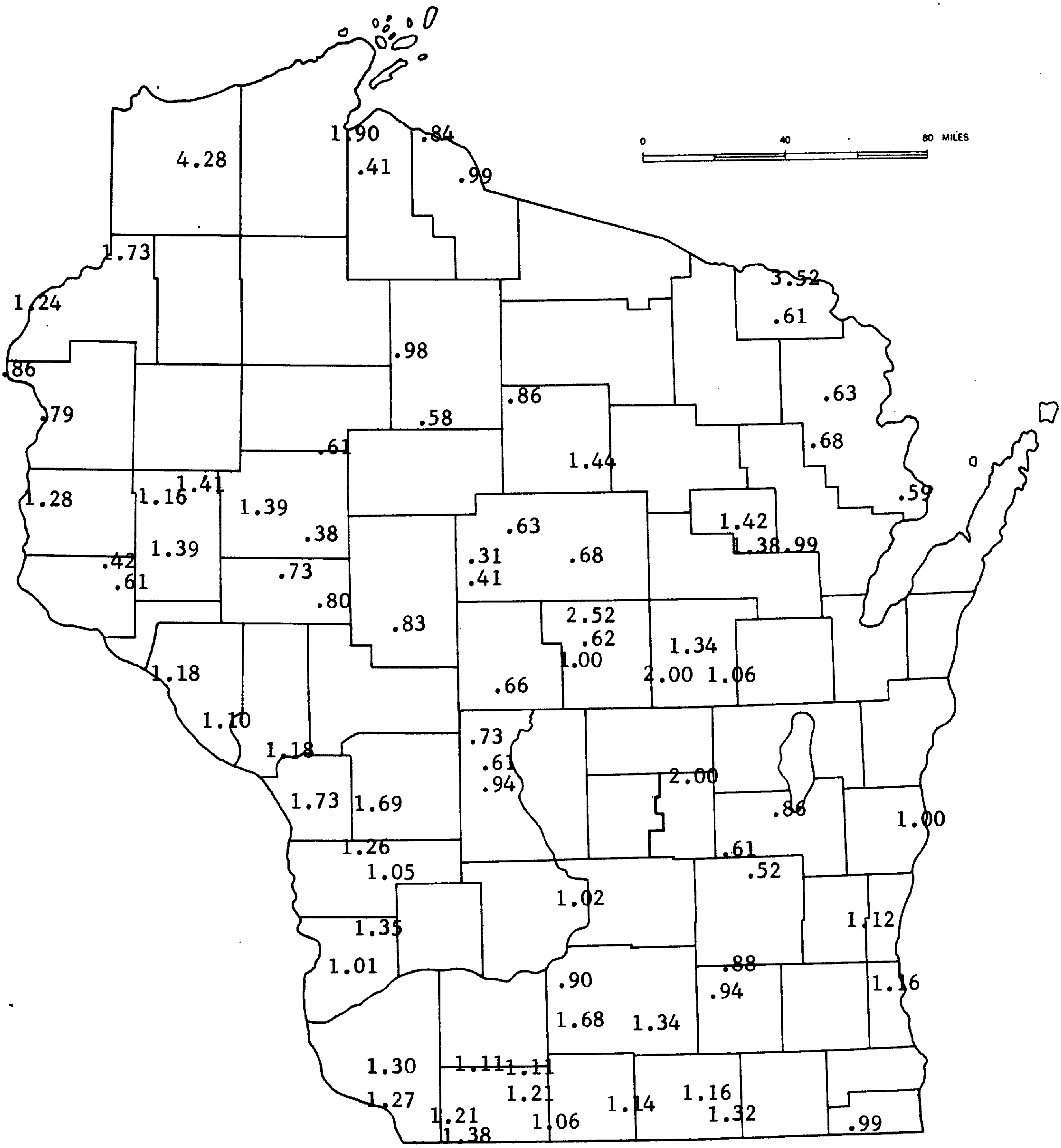

Figure 6.--Basin residuals, ratio of observed to computed, of February mean flow, q_2.

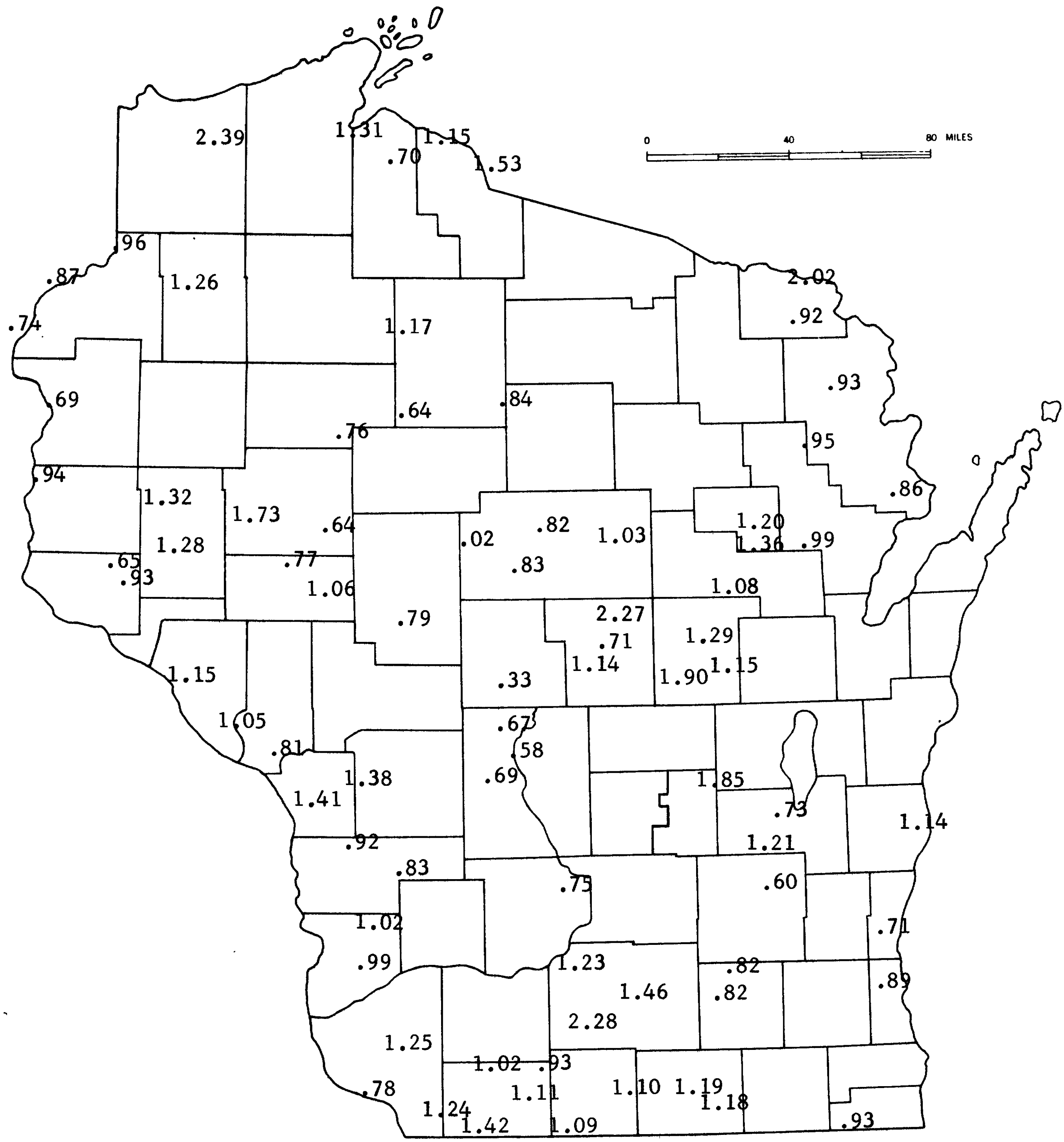

Figure 7.--Basin residuals, ratio of observed to computed, of August mean flow, q_8.

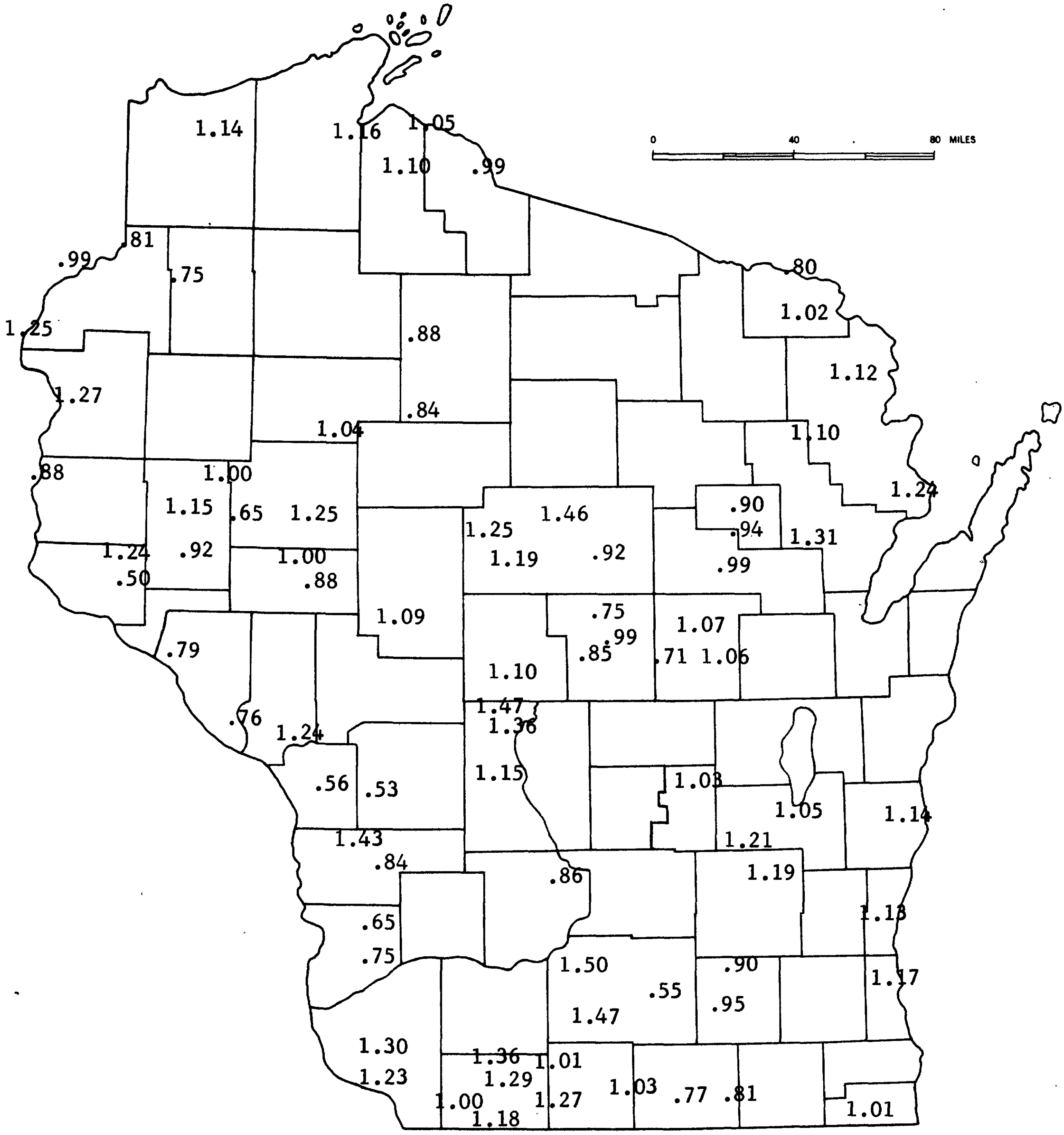

Figure 8.--Basin residuals, ratio of observed to computed, of flow variability, annual standard deviation, SD_a.

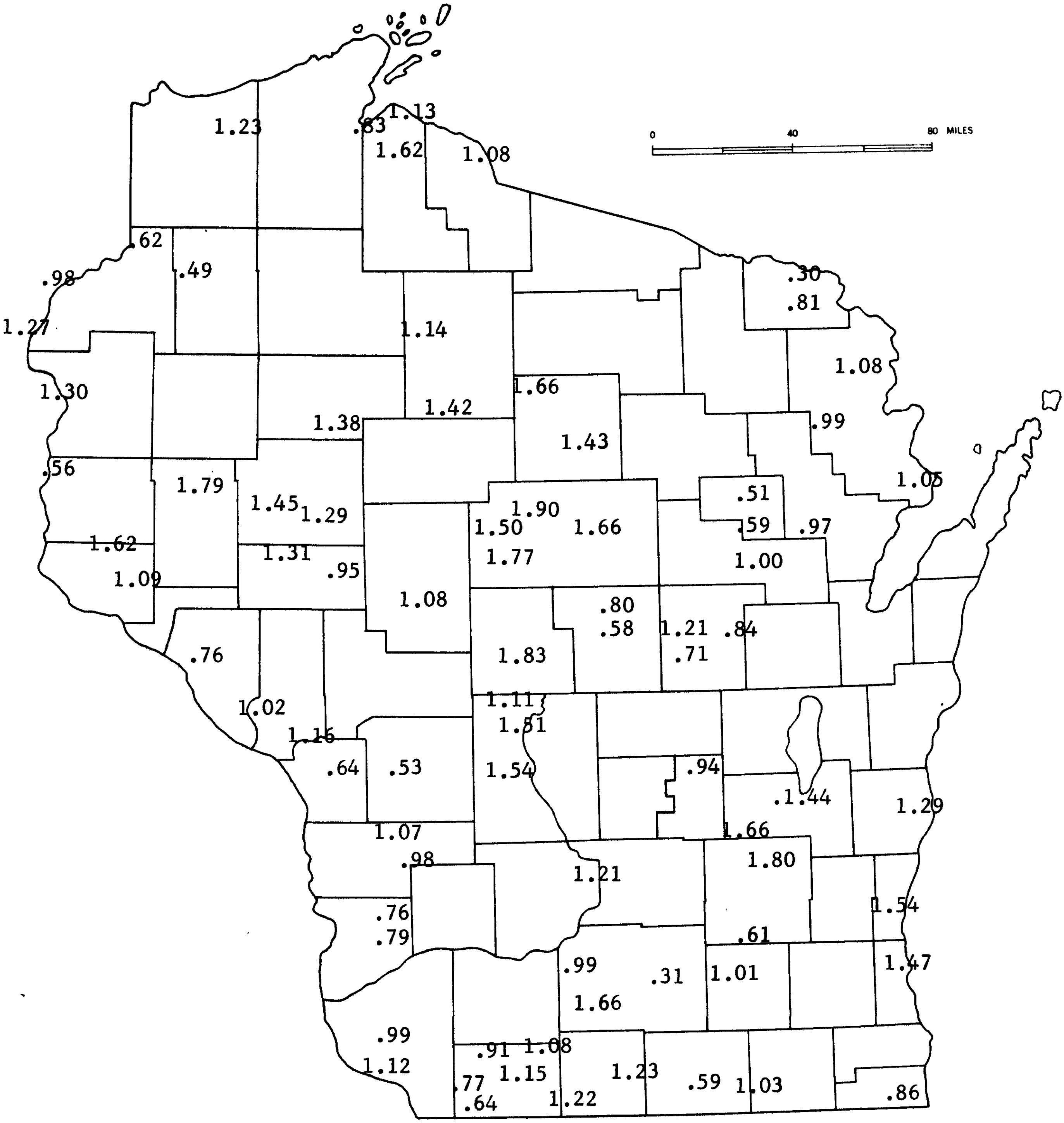

Figure 9.--Basin residuals, ratio of observed to computed, of 7-day flood volume, 10-year recurrence interval, $V_{7,10}$.

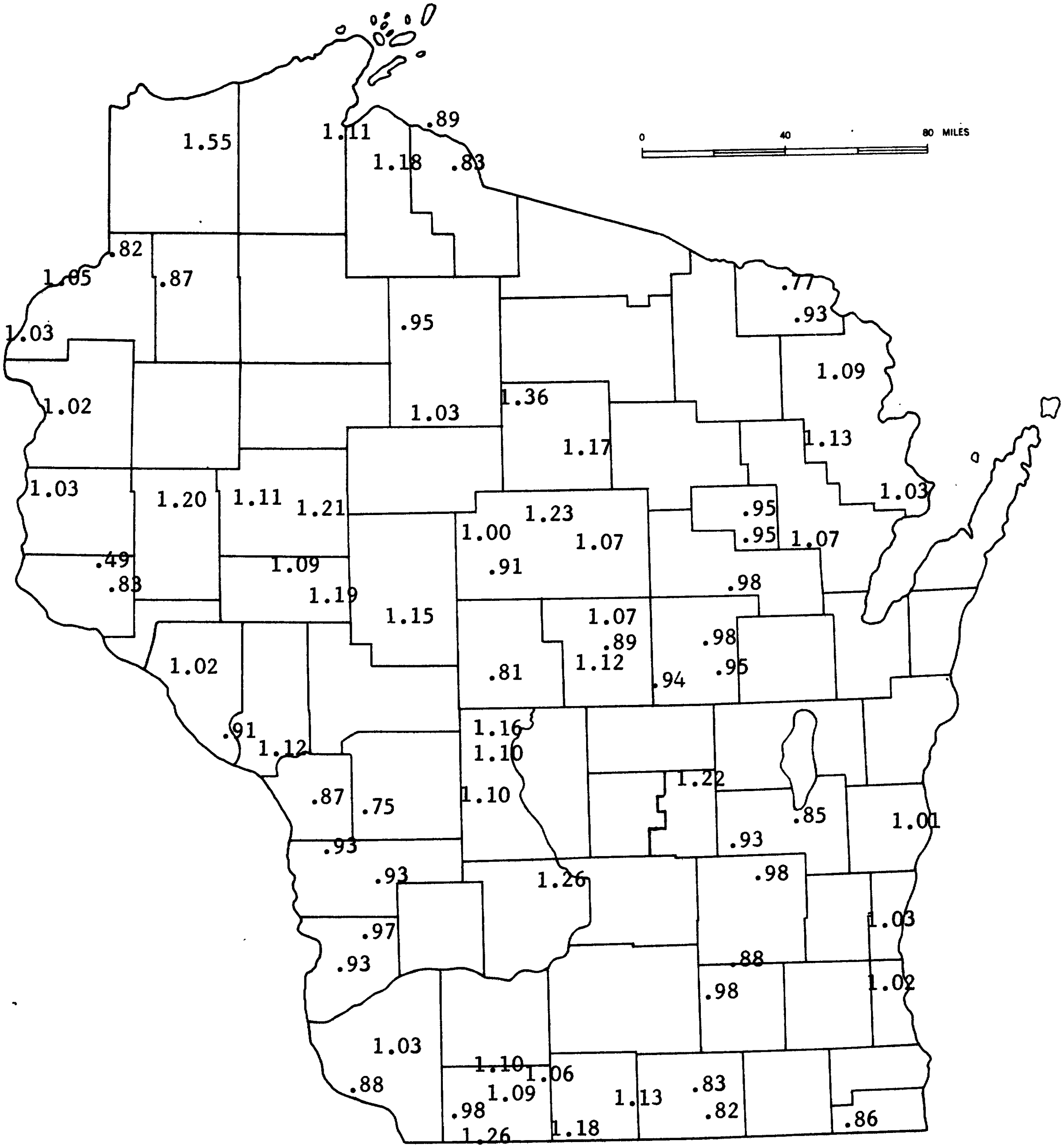

Figure 10.--Basin residuals, ratio of observed to computed, of 10 percent flow duration, D_{10}.

The principal-streams network for Wisconsin includes 50 sites on unregulated streams, with at least 25 years of record collected at 39 of these sites.

Evaluation of the Regulated-Flow Systems

The goals for regulated streams are more difficult to attain because the technique of regionalization does not apply, the streamflow characteristics are changing with variations in the regulation, and a meaningful correlation seldom exists between flows at two sites if at least one of the flows is regulated. A systems approach may be used to define the characteristics of regulated streamflow under different patterns of regulation or under the condition of natural flow. Systems studies for all of the regulated-stream systems in Wisconsin will require a major effort. Therefore, the present evaluation is limited to identifying the regulated streams and describing, briefly, a regulated system.

The stream systems in Wisconsin materially affected by regulation are: Menominee River; Fox River, from Lake Winnebago downstream; Chippewa River (including its regulated tributaries, Flambeau and Red Cedar Rivers); Wisconsin River (including the regulated Tomahawk River); and Yahara River. Reservoirs on the first four rivers have been in operation about as long as streamflow records have been collected. Bear Lake Reservoir, which affects the Chippewa River, has been regulated since 1880. The flow of the Chippewa River where it is measured at the gaging station at Chippewa Falls has been regulated for the period of record. The Menominee River is an interstate stream and a systems study would involve both Michigan and Wisconsin. Although the Yahara River has no regulation, the chain of lakes are regulated.

Streamflow data and records of reservoir contents will be very useful in systems studies. Streamflow records for sites on Wisconsin regulated stream systems and records of daily contents for all major reservoirs are available.

A river system in Wisconsin affected by regulation might be described generally by using the Wisconsin River basin as an example.

Data available includes (1) reservoir records of storage and release, (2) streamflow records of regulated and unregulated tributaries, (3) streamflow records at sites on the mainstem, (4) information on reservoir and power dam operation procedures, (5) precipitation records, (6) records of water use at powerplants and paper mills.

Of the 21 reservoirs in the upper Wisconsin River basin, 15 have been in operation since before 1910. Records of month-end content since 1920 are published. Two large reservoirs were completed in the lower part of the basin in 1950.

Streamflow records varying in length from 5 to 50 years are available for 22 tributaries unaffected by regulation. There are also over 25 years of streamflow records on several tributaries affected by regulation.

Streamflow records varying in length up to 68 years are available for 11 sites on the mainstem of the Wisconsin River.

The 21 upper reservoirs are owned and operated by the Wisconsin Valley Improvement Company. The usable capacity of the reservoirs is limited by the Wisconsin Department of Natural Resources. There are occasional changes in capacity and in minimum drawdown levels.

The U.S. Weather Bureau publishes precipitation data for many sites within the basin. Collection of most of the data began before 1900.

Many of the approximately 25 powerplants and paper mills on the Wisconsin River and its tributaries keep daily operational logs with hourly entries of water use and spillage. Some logs are in units of discharge (cubic feet per second) and some are in units of power generation (Kilowatt hours). Most computations are based on theoretical ratings but some have been checked by current-meter measurements.

Only a few years of streamflow record at one gaging station are available for the mainstem of the Wisconsin River prior to regulation. Therefore, any flow characteristics for unregulated conditions would have to be computed from the above data or possibly by the regression equations developed in this report for natural flow conditions of drainage areas of less than 500 square miles.

Statistical flow-characteristics under regulated conditions could be computed from the data available. In the lower part of the basin, flow characteristics could be computed for conditions of flow when 21 reservoirs were in operation and also for the last 20 years when the Castle Rock and Petenwell reservoirs were in operation.

Data to Define Long-Term Trends

At present one gaging station, Popple River near Fence, is designated as a long-term station for indefinite operation. No stations on regulated streams are now so designated.

Data on Stream Environment

Many basin characteristics were considered for 116 drainage basins for the present study, particularly drainage area, main-channel length, main-channel slope, forest cover, mean basin elevation, basin storage area, mean average annual precipitation, mean annual snowfall, soil index, rainfall intensity, and average frost depth.

Flood-prone areas have been outlined on 174 topographic quadrangle maps and flood profiles defined for selected streams. Areas inundated by floods having a magnitude equal to 100-year recurrence interval have been delineated for about 55 miles of the Rock River above Janesville. Detailed channel surveys have been made at five gaging stations. Channel surveys have been made at many sites in connection with indirect determinations of peak flows for unusual floods. Channel geometry can be determined from depth observations made at almost 200 gaging stations.

DISCUSSION OF THE EVALUATION

Of the three data categories used in this study, only one, data for planning and designing of water projects, is clearly subject to design. The requirements for other types of data are established in response to specific needs, or are defined by hydrologic judgment.

Application of the regression equations do not provide estimates of flow characteristics within the accuracy objectives. For example, the accuracy goal for mean annual flow is 10 percent (accuracy obtainable with 10 years continuous record), whereas the standard error resulting from use of the regression equation for mean annual flow is 17 percent.

In attempting to improve the standard error of estimate, a subsequent regression was made using selected records. The standard error of the regression equation for mean annual flow from selected records was 12 percent, a significant improvement. The improvement in the standard error is attributed to the selection of gaging station records. Of the 34 records from adjacent states, only 15 were used in this regression. The 19 station records excluded had no drainage area in Wisconsin. Five Wisconsin records were also excluded because of hydrologic inconsistencies. Data from this regression, however, is incomplete and the coefficients computed for the limited number of independent variables were not all significant. Therefore, none of the equations from this run are given in this report.

Further regression analyses for this report could not be made because of a time limitation. However, a regression equation for mean annual flow might be obtained that would meet the goal. Basin residuals (fig. 5-10) indicate a definite possibility of correlating with geologic factors.

The conclusions derived from the evaluation of streamflow data (116 stations) by regression analysis and based on the standard errors shown in tables 2 and A-4 are as follows:

1. For natural flows, application of the regression equations will not provide flow characteristics of Wisconsin streams within the accuracy goals. Additional independent variables, probably geologic, might make possible a regression equation to compute mean annual discharge, standard deviation of mean annual discharge and possibly 50-year frequency flood volumes and flood peaks within the goals.

2. Flow-variability of mean monthly discharge, standard deviation of mean monthly discharge, flood volumes and flood peaks of frequencies of 2 to 25 years cannot be accurately estimated by regression.
3. Low-flow characteristics at ungaged sites on natural-flow streams, minor and principal, cannot be estimated accurately by regression. Thus, accurate estimates of low-flow characteristics at a site will require a few measurements of low flow correlated with concurrent flows at a suitable continuous-record index station where similar hydrologic conditions prevail.
4. Regression equations are not defined for any of the stream-flow characteristics for streams having drainage areas of less than about 50 square miles. Continuous-record or partial-record stations must be operated to define the streamflow characteristics for small drainage areas.
5. The objectives established for identifying the principal-streams network included sites with drainage areas of about 500 square miles on the most upstream segment of the stream and, proceeding downstream, sites where the drainage area is approximately double that of the previous site. The accuracy objective is 25 years of record, or equivalent. One station must remain in operation for a short period of time and 6 stations need to be established.

THE PROPOSED PROGRAM

The information developed in different segments of this study has been merged and applied in planning a streamflow-information program that would eventually attain as many of the remaining goals as possible within the limits of reasonable funding. For the optimum program, a balance must be maintained between data collection and interpretation, as continuous interaction between the two is needed, not only to gain a better understanding of the hydrologic system, but also to guide future evaluation of the program in meeting ever-changing needs and in adapting to changing technology.

Data Collection

Data for Current Purpose

Operation of the 60 stations, identified as meeting the needs for current-purpose data (table A-2), should be continued. The changing needs will be assessed periodically, and the data-collection network will be modified by adding or discontinuing stations as needs change for current-purpose data. Also the needs for this type of data will be examined for each site, and a determination made as to whether a continuous record or daily discharge is required or whether measurement of specific flow characteristics, such as peak flow or instantaneous flow, would suffice.

Data for Planning and Design

Some of the objectives, although not yet attained, appear to be attainable. However, continued operation of certain stations to obtain either continuous-record or partial-record data is necessary.

Flood-peak characteristics at recurrence intervals of 100 years are often estimated for project design. Although the objective of this study includes only the 50-year flood, it would be desirable to continue collecting flood-peak data at selected sites indefinitely. For each streamflow station proposed for discontinuance, consideration will be given to the continued collection of peak-flow data. This data can be obtained at little cost by operating the station as a partial-record station.

Natural-flow, minor streams.--As application of the regression equations for flow characteristics will not give results within the accuracy goals for minor streams, no stations identified solely with this category of data should be discontinued until at least 20 years of record, or its equivalent, is obtained. Regression equations are not defined for any streamflow characteristics for areas of less than about 50 square miles. Eleven continuous-record stations with drainage areas of less than 100 square miles and not included in this study because of insufficient length of record will provide data for this lack of definition. Four additional records with drainage areas of just over 100 square miles will also be available.

The following stations are not recommended for inclusion in the future program:

4-0300	Montreal River near Saxon
4-0665	Pike River at Amberg
4-0865	Cedar Creek at Cedarburg
5-4155	East Fork Galena River at Council Hill
5-4230	West Branch Rock River near Waupun
5-4240	East Branch Rock River near Mayville
5-4315	Turtle Creek near Clinton
5-4325	Pecatonica River at Darlington
5-4330	East Branch Pecatonica River near Blanchardville

No new gaging stations on natural-flow minor streams are recommended.

Low-flow characteristics at ungaged sites cannot be estimated by regression methods within the goals. For this reason, 6 to 10 discharge measurements should be obtained in the next 3 to 5 years on all streams with drainage areas of about 50 square miles or larger. However, information on low-flow characteristics has been collected at about 300 sites with drainage areas generally less than 50 square miles throughout the State, under a program begun in 1962. This information, together with data available from the regulated stream-gaging network, will provide a data base from which reasonable estimates of low-flow characteristics can be made at most ungaged sites, but accuracy cannot be qualified. Additional data are needed at about 150 of the presently operated low-flow partial-record sites to sample the full range of low flow. All sites will be continued in operation although some will be measured only when extremely low base-flow conditions occur. Another project, begun in 1968 will provide 2 or 3 measurements of base flow made over a 1 or 2 year period at numerous sites in selected small drainage basins.

Low-flow measurements made at a site during a variety of base-flow conditions can be correlated with concurrent flow data at a suitable continuous-record station where similar hydrologic conditions prevail. Low-flow measurements should be obtained as the need develops, or as anticipated at specific ungaged sites.

To improve the definition of flood-peak characteristics for the smaller drainage areas, a program was begun in 1959 to establish a peak-flow partial-record station network. The 135 stations (fig. 3, in pocket) now operated for less than 10 years should be continued. These stations provide a sample of peak-flow data from drainage areas generally ranging from a fraction of a square mile to nearly 100 square miles. An open-file report, "Floods in Wisconsin - Magnitude and Frequency," will be updated in 1970. This report will give flood frequencies up to a 50-year recurrence interval for all sizes of drainage areas.

Natural-flow, principal streams.--The accuracy objective of 25 years of record, or equivalent, has been met at 39 of 50 sites identified in this category of data. Nine of the 39 stations are not recommended for continuation, and the remainder are needed for other purposes. Five stations identified solely in this category will be continued until 25 years of record has been obtained. It is recommended that six stations be established to fill gaps in the principal-streams network.

The following stations in the natural-flow, principal-streams network are not recommended for inclusion in the program:

4-0785	Embarrass River near Embarrass
4-0800	Little Wolf River at Royalton
5-3325	Namekagon River near Trego
5-3360	St. Croix River near Grantsburg
5-3415	Apple River near Somerset
5-3794	Trempealeau River at Arcadia
5-3830	LaCrosse River near West Salem

5-4105	Kickapoo River at Steuben
5-4255	Rock River at Watertown

It is recommended that the following stations be established to fill gaps in the principal-streams network to sample increments of drainage area on the streams.

St. Lawrence River basin - Part 4:

Fox River near Montello

Manitowoc River near Manitowoc

Upper Mississippi River basin - Part 5:

St. Croix River near Dairyland

Black River near Greenwood

Rock River near Hustisford

Fox River near Burlington

Regulated-flow, minor streams.--No streams in Wisconsin were identified with this category of data; therefore, no data collection on streams in this category is proposed at this time. Many minor streams have relatively large reservoirs and a few have minor diversions. Most of these reservoirs are part of a principal regulated stream system. Data collection on some of these streams may be necessary as needs require.

Regulated-flow, principal streams.--For purposes of the study, consideration of this category of data was limited only to identifying the regulated-streams systems. In Wisconsin these are: Menominee River; Fox River from Lake Winnebago downstream; Chippewa River (including its regulated tributaries, Flambeau and Red Cedar Rivers); Wisconsin River (including the regulated Tomahawk River); and the Yahara River. The upper reaches of the Menominee River are gaged by the Michigan District as well as those tributaries whose drainage areas are in Michigan. The manipulation of the flow of the Rock River at Horicon from Horicon Marsh was not considered as regulated flow. No new gaging stations are recommended for inclusion and none are recommended for discontinuance.

The proposed program should include provisions to collect records of inflow, outflow, reservoir contents, diversions, operation schedules, and other pertinent hydrologic data at the major reservoirs in the regulated-streams systems described above. Many of these records are now being reported by the companies that operate the reservoirs.

Data to Define Long-Term Trends in Streamflow

Fifteen additional stations have been classified as long-term trend stations and should be continued indefinitely. These records already average 40 years in length and will provide a long-term sample reflecting areal coverage of the State, a range of drainage-area size, and a variety of climatic and physiographic characteristics. These 16 gaging stations and their drainage areas and periods of record are listed below:

Station number	Station name	Drainage area (sq mi)	Period of Record
4-0255	Bois Brule River at Brule	113	1942-
4-0637	Popple River near Fence	131	1963-
4-0710	Oconto River near Gillett	678	1906-9, 1913-
4-0735	Fox River at Berlin	1,430	1898-
4-0860	Sheboygan River at Sheboygan	432	1916-24, 1950-
5-3335	St. Croix River near Danbury	1,588	1914-
5-3620	Jump River at Sheldon	574	1915-
5-3680	Hay River at Wheeler	426	1950-
5-3810	Black River at Neillsville	756	1905-9, 1913-
5-3945	Prairie River near Merrill	181	1914-31, 1939-
5-3995	Big Eau Pleine River near Stratford	224	1914-25, 1937-
5-4015.35	Big Roche a Cri Creek near Adams	54	1963-
5-4050	Baraboo River near Baraboo	600	1913-22, 1942-
5-4135	Grant River near Burton	267	1934-
5-4260	Crawfish River at Milford	732	1931-
5-4365	Sugar River near Brodhead	527	1914-

Summary of Data Collection Phase

The data-collection phase of the proposed program is summarized in table A-5. The table includes all streamflow stations now in operation and those proposed for establishment. Recommendations are made as to whether the station should be included in the proposed network or whether it has met the objective for which it was operated and could be discontinued. Each station is identified as to type of data. Data collected at most current-purpose gaging stations may also be used for planning and design. The locations of gaging stations included in the proposed program and the purpose of data to be collected are shown in figure 4.

Data Analysis

The streamflow-data network operated through the years is a base for analytical and interpretive reports. Some aspects of data analyses are of a continuing nature, with the data collection effort continuing, reoriented as necessary to fill gaps or eliminate deficiencies, and to provide data for continuing future analyses.

The proposed program of data analyses for Wisconsin streams may be described as those based on data collected to date, and those for which additional data will be required. Streamflow data are being analyzed and interpreted for the following current studies:

1. A study of magnitude and frequency of floods in Wisconsin has been expanded to adequately define flood frequencies up to 25-year recurrence interval for all drainage areas and up to 100-year recurrence interval for larger size areas. A progress report will be available in 1970. When sufficient length of record has been obtained at most of the peak-flow partial-record stations for areas generally less than 50 square miles, these data should be merged with those from continuous-record stations to provide better definition of flood frequencies up to 50-year recurrence interval.

2. A study of low-flow frequency of Wisconsin streams is now in progress and a preliminary report will be published in 1970. Studies of the Rock River and the Chippewa-Flambeau River basins are in progress. The remaining basins in the State will be studied to complete the low-flow analysis of the State.
3. Statistics of mean-annual and mean-monthly flows and duration of Wisconsin Streams are being analyzed to imppove knowledge of flow characteristics.

Utilizing available data and the collection of additional data specifically required, the following studies should be expanded or initiated as a part of the proposed streamflow data program:

1. Time of travel and dispersion of solutes in Wisconsin streams, such as the Fox River below Lake Winnebago, Wisconsin River, Fox River (Illinois River basin), Rock River, and tributaries to Lake Michigan.
2. Develop model for regulated-streams systems, such as Wisconsin River, Menominee River, lower Fox River, and Yahara River.
3. Stream-aquifer flow systems in selected basins.
4. Delineation of areas inundated by floodwaters and the preparation of flood profiles.
5. Determine gains and losses of flow of selected streams.
6. Effect of urbanization on streamflow.
7. Effect of small reservoirs and ponds on streamflow characteristics.
8. Water quality changes as related to streamflow.
9. Study of isolated rainfall-runoff event.

These are only a few of the data analyses and hydrologic studies that could be made in Wisconsin. Changing needs for streamflow information and changes in technology in water-related fields should stimulate data analyses under the streamflow data program for Wisconsin.

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APPENDIX

TABLES

Table A-1.--Current and discontinued continuous-record gaging stations in Wisconsin and adjacent areas

Station number	Station name	Period of record	Total drainage area (square miles)
4-0255	Bois Brule River at Brule, Wis.	1942-	113
0260	Bois Brule River near Brule, Wis.	1914-17	153
0263	Sioux River near Washburn, Wis.	1964-66	17.5
0265	Bad River at Mellen, Wis.	1948-55	101
0270	Bad River near Odanah, Wis.	1914-22, 1948-	611
0275	White River near Ashland, Wis.	1948-	269
0285	Montreal River near Kimball, Wis.	1924-25	109
0290	West Branch Montreal River at Gile	1918-25, 1942-47	a 78
0295	West Branch Montreal River near Kimball, Wis.	1924-25	a 96
0300	Montreal River near Saxon, Wis.	1938-	262
0630	Menominee River near Florence, Wis.	1914-	1,780
0637	Popple River near Fence, Wis.	1963-	131
0640	Pine River near Florence, Wis.	1913-23	500
0645	Pine River at Pine River powerplant, near Florence, Wis.	1923-	528
0660	Menominee River near Pembine, Wis.	1949-	a3,240
0665	Pike River at Amberg, Wis.	1914-	253
0670	Menominee River below Koss, Mich.	1907-9, 1913-	a3,790
0675	Menominee River near McAllister, Wis.	1945-61	a4,020
0680	Peshtigo River at High Falls, near Crivitz, Wis.	1912-57	554
0695	Peshtigo River at Peshtigo, Wis.	1953-	1,124
0710	Oconto River near Gillet, Wis.	1906-9, 1913-	678
0720	Suamico River at Suamico, Wis.	1951-52	57.0
0727.5	Lawrence Creek near Westfield, Wis.	1967-	-
0730.5	Grand River near Kingston, Wis.	1968-	73.7
0734.05	West Branch White River near Wautoma, Wis.	1963-65	a 43
0735	Fox River at Berlin, Wis.	1898-	1,430
0749.5	Wolf River at Langlade, Wis.	1966-	460
0750	Wolf River near White Lake, Wis.	1935-37	482
0752	Evergreen Creek near Langlade, Wis.	1964-	a 8.0
0755	Wolf River above West Branch Wolf River, Wis.	1927-62	633
0760	West Branch Wolf River at Neopit, Wis.	1911-17	108
0765	West Branch Wolf River near Keshena, Wis.	1928-31	170
0770	Wolf River at Keshena Falls, Wis.	1907-9, 1910-	812
0785	Embarrass River near Embarrass, Wis.	1919-	395
0790	Wolf River at New London, Wis.	1896-	2,240
0797	Spaulding Creek near Big Falls, Wis.	1964-66	a 4.9
0800	Little Wolf River at Royalton, Wis.	1914-	514
0809.5	Emmons Creek near Rural, Wis.	1968-	27
0810	Waupaca River near Waupaca, Wis.	1916-66	272
0830	West Branch Fond du Lac River at Fond du Lac, Wis.	1939-54	84.5
0835	East Branch Fond du Lac River near Fond du Lac, Wis.	1939-54	77.9
0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis.	1896-	a6,150
0852	Kewaunee River near Kewaunee, Wis.	1964-	129
0860	Sheboygan River at Sheboygan, Wis.	1916-24, 1950-	432
0861.5	Milwaukee River at Kewauskum, Wis.	1968-	a 134
0862	East Branch Milwaukee River near New Fane, Wis.	1968-	a 46
0863.4	North Branch Milwaukee River near Fillmore, Wis.	1968-	a 95
0863.6	Milwaukee River at Waubeka, Wis.	1968-	a 428
0865	Cedar Creek near Cedarburg, Wis.	1930-	121
0870	Milwaukee River at Milwaukee, Wis.	1914-	686
0871.2	Menomonee River at Wauwatosa, Wis.	1961-	123
0872.04	Oak Creek at South Milwaukee, Wis.	1963-	25.0
0872.2	Root River near Franklin, Wis.	1963-	49.3
0872.33	Root River Canal near Franklin, Wis.	1963-	57.2
0872.4	Root River at Racine, Wis.	1963-	187
5-3320	Namekagon River at Trego, Wis.	1914-27	a 460
3325	Namekagon River near Trego, Wis.	1927-	503
3335	St. Croix River near Danbury, Wis.	1914-	1,588
3353.8	Bashaw Brook near Shell Lake, Wis.	1964-66	28.2
3355	Clam River near Webster, Wis.	1940-42	364
3360	St. Croix River near Grantsburg, Wis.	1923-	a2,820
3390	Wood River near Grantsburg, Wis.	1939	a 190

Table A-1.--Current and discontinued continuous-record gaging stations in Wisconsin and adjacent areas.--Continued

Station number	Station name	Period of record	Total drainage area (square miles)
5-3395	St. Croix River near Rush City, Minn.	1923-61	a5,120
3405	St. Croix River at St. Croix Falls, Wis.	1902-	a5,930
3415	Apple River near Somerset, Wis.	1901-	555
3420	Kinnickinnic River near River Falls, Wis.	1916-21	167
3445	Mississippi River at Prescott, Wis.	1928-	a44,800
3555	West Fork Chippewa River at Lessards, near Winter, Wis.	1911-16	577
3560	Chippewa River at Bishops Bridge, near Winter, Wis.	1912-	787
3565	Chippewa River near Bruce, Wis.	1914-	a1,630
3575	Flambeau River at Flambeau Flowage, Wis.	1927-61	666
3580	Flambeau River near Butternut, Wis.	1914-38	737
3585	Flambeau River at Babb's Island, near Winter, Wis.	1929-	1,000
3595	South Fork Flambeau River near Phillips, Wis.	1929-	615
3596	Price Creek near Phillips, Wis.	1964-66	14.7
3600	Flambeau River near Ladysmith, Wis.	1903-6, 1914-61	1,823
3605	Flambeau River near Bruce, Wis.	1951-	1,897
3610	Chippewa River near Holcombe, Wis.	1944-49	a3,790
3615	South Fork Jump River near Ogema, Wis.	1944-54	328
3620	Jump River at Sheldon, Wis.	1915-	574
3625	Chippewa River at Holcombe, Wis.	1942-49	a4,700
3630	Fisher River at Holcombe, Wis.	1944-45	a 76
3635	O'Neil Creek near Chippewa Falls, Wis.	1944-45	67.1
3637	Yellow River near Hanibal, Wis.	1962-63	91.2
3640	Yellow River at Cadott, Wis.	1942-61	351
3645	Duncan Creek at Bloomer, Wis.	1943-51	49.2
3650	Duncan Creek at Chippewa Falls, Wis.	1942-55	114
3655	Chippewa River at Chippewa Falls, Wis.	1888-	a5,600
3660	Eau Claire River near Augusta, Wis.	1914-26	a 500
3665	Eau Claire River near Fall Creek, Wis.	1942-55	758
3670	Chippewa River at Eau Claire, Wis.	1902-9, 1944-54	a6,630
3674.25	Red Cedar River near Cameron, Wis.	1966-	450
3675	Red Cedar River near Colfax, Wis.	1914-61	a1,100
3680	Hay River at Wheeler, Wis.	1950-	426
3690	Red Cedar River at Menomonie, Wis.	1907-8, 1913-	a1,760
3695	Chippewa River at Durand, Wis.	1928-	a9,010
3700	Eau Galle River at Spring Valley, Wis.	1944-	64.8
3705	Eau Galle River at Elmwood, Wis.	1942-53	91.9
3720	Buffalo River near Tell, Wis.	1932-51	406
3725	Mississippi River at Alma, Wis.	1930-31	a57,100
3780	Mississippi River near Fountain City, Wis.	1930-31	a58,800
3794	Trempealeau River at Arcadia, Wis.	1960-	552
3795	Trempealeau River at Dodge, Wis.	1913-19, 1934	643
3800	Trempealeau River near Trempealeau, Wis.	1931-34	722
3809	Poplar River near Owen, Wis.	1964-66	159
3810	Black River at Neillsville, Wis.	1905-9, 1913	756
3820	Black River near Galesville, Wis.	1931-	a2,120
3825	Little La Crosse River near Leon, Wis.	1934-61	77.1
3830	La Crosse River near West Salem, Wis.	1913-	398
3835	Mississippi River at La Crosse, Wis.	1929-55	a62,800
3865	Coon Creek at Coon Valley, Wis.	1934-40	77.2
3870	Coon Creek near Stoddard, Wis.	1934-40	119
3871	North Fork Bad Axe River near Genoa, Wis.	1964-66	80.7
3901.8	Wisconsin River at Conover, Wis.	1966-	176
3910	Wisconsin River at Rainbow Lake, near Lake Tomahawk, Wis.	1936-	750
3920	Wisconsin River at Whirlpool Rapids, near Rhinelander, Wis.	1905-61	a1,200
3923.5	Bearskin Creek near Harshaw, Wis.	1964-66	32.4
3924	Tomahawk River near Bradley, Wis.	1914-27, 1928-29	422
3930	Tomahawk River at Bradley, Wis.	1930-	545
3935	Spirit River at Spirit Falls, Wis.	1942-	a 82
3940	New Wood River near Merrill, Wis.	1952-61	a 83
3945	Prairie River near Merrill, Wis.	1914-31, 1939-	181

Table A-1.--Current and discontinued continuous-record gaging stations in Wisconsin and adjacent areas.--Continued

Station number	Station name	Period of record	Total drainage area (square miles)
5-3950	Wisconsin River at Merrill, Wis.	1902-	a2,780
3960	Rib River at Rib Falls, Wis.	1925-57	309
3965	Little Rib River near Wausau, Wis.	1914-16	a 76
3970	Eau Claire River near Antigo, Wis.	1949-55	a 75
3975	Eau Claire River at Kelly, Wis.	1914-26, 1939-	326
3980	Wisconsin River at Rothschild, Wis.	1944-	a4,000
3985	Bull Creek Jr. near Rothschild, Wis.	1944-51	26.4
3990	Big Eau Pleine River near Colby, Wis.	1941-54	a 79
3995	Big Eau Pleine River near Stratford, Wis.	1914-25, 1937-	224
4000	Wisconsin River at Knowlton, Wis.	1920-42	a4,520
4005	Plover River near Stevens Point, Wis.	1914-19, 1944-51	136
4006	Little Plover River near Arnott, Wis.	1959-	-
4006.5	Little Plover River at Plover, Wis.	1959-	a 15
4008	Wisconsin River at Wisconsin Rapids, Wis.	1914-50, 1957-	a5,400
4008.53	Buena Vista Creek near Kellner, Wis.	1964-67	a 44
4008.7	Fourmile Creek near Kellner, Wis.	1964-67	a 51
4010.2	Tenmile Creek Ditch 5, near Bancroft, Wis.	1964-	a 8.8
4010.5	Tenmile Creek near Nekoosa, Wis.	1964-	-
4011	Fourteenmile Creek near New Rome, Wis.	1964-	a 77
4015	Wisconsin River near Necedah, Wis.	1902-14, 1944-50	a5,860
4015.1	Big Roche a Cri Creek near Hancock, Wis.	1963-67	a 9.5
4015.35	Big Roche a Cri Creek near Adams, Wis.	1963-	a 54
4020	Yellow River at Babcock, Wis.	1944-	223
4025	Yellow River at Sprague, Wis.	1926-40	a 420
4030	Yellow River at Necedah, Wis.	1940-57	526
4035	Lemonweir River at New Lisbon, Wis.	1944-	a 500
4037	Dell Creek near Lake Delton, Wis.	1957-65	44.9
4040	Wisconsin River near Wisconsin Dells, Wis.	1934-	a7,830
4042	Narrows Creek at Loganville, Wis.	1964-66	40.0
4050	Baraboo River near Baraboo, Wis.	1913-22, 1942-	600
4060	Wisconsin River at Prairie du Sac, Wis.	1946-53	a8,950
4065	Black Earth Creek at Black Earth, Wis.	1954-	49.5
4066.4	Otter Creek near Highland; Wis.	1968-	a 12.4
4070	Wisconsin River at Muscoda, Wis.	1902-3, 1913-	a10,300
4075	Kickapoo River at Ontario, Wis.	1938-39	151
4080	Kickapoo River at La Farge, Wis.	1938-	266
4085	Knapp Creek near Bloomingdale, Wis.	1954-69	8.47
4090	West Fork Kickapoo River near Readstown, Wis.	1938-39	106
4095	Kickapoo River at Soldiers Grove, Wis.	1938-39	530
4098.3	North Fork Nederlo Creek near Gays Mills, Wis.	1968-	2.4
4098.6	South Fork Nederlo Creek near Gays Mills, Wis.	1968-	4.1
4098.7	Nederlo Creek near Gays Mills, Wis.	1968-	6.8
4098.8	Tributary to Nederlo Creek near Gays Mills, Wis.	1968-	a 0.2
4098.9	Nederlo Creek near Gays Mills, Wis.	1968-	9.8
4100	Kickapoo River at Gays Mills, Wis.	1914-34, 1964-	616
4105	Kickapoo River at Steuben, Wis.	1933-	690
4134	Pigeon Creek near Lancaster, Wis.	1964-66	6.90
4135	Grant River at Burton, Wis.	1934-	267
4140	Platte River near Rockville, Wis.	1934-	139
4150	Galena River at Buncombe, Wis.	1939-	128
4155	East Fork Galena River at Council Hill, Ill.	1939-	a 20.1
4230	West Branch Rock River near Waupun, Wis.	1949-	41.4
4235	South Branch Rock River at Waupun, Wis.	1948-69	62.8
4240	East Branch Rock River near Mayville, Wis.	1949-	179
4255	Rock River at Watertown, Wis.	1931-	971
4260	Crawfish River at Milford, Wis.	1931-	732
4265	Whitewater Creek near Whitewater, Wis.	1926-28, 1946-54	a 7.2
4270	Whitewater Creek at Whitewater, Wis.	1926-28, 1946-54	16.7
4278	Token Creek near Madison, Wis.	1964-66	24.4
4295	Yahara River near McFarland, Wis.	1930-	351
4300	Yahara River near Edgerton, Wis.	1916-17	459

Table A-1.--Current and discontinued continuous-record gaging stations in Wisconsin and adjacent areas.--Continued

Station number	Station name	Period of record	Total drainage area (square miles)
5-4301	Badfish Creek near Stoughton, Wis.	1956-66	43.5
4305	Rock River at Afton, Wis.	1914-	a3,300
4315	Turtle Creek near Clinton, Wis.	1939-	186
4325	Pecatonica River at Darlington, Wis.	1939-	274
4330	East Branch Pecatonica River near Blanchardville, Wis.	1939-	221
4335	Yellowstone River near Blanchardville, Wis.	1954-65	29.1
4340	Pecatonica River at Dill, Wis.	1914-19	951
4345	Pecatonica River at Martintown, Wis.	1939-	a1,040
4360	Mount Vernon Creek near Mount Vernon, Wis.	1954-65	16.1
4365	Sugar River near Brodhead, Wis.	1914-	527
5438.3	Fox River at Waukesha, Wis.	1963-	127
5440	Fox River near Mukwonago, Wis.	1927-30	231
5453	White River near Burlington, Wis.	1964-66	105
5465	Fox River at Wilmot, Wis.	1939-	880

a Approximate area.

Table A-2.--Current-purpose gaging stations in Wisconsin

Station number	Station name	Purpose*				
		Accounting	Operation	Forecasting	Compact or legal	Research or special studies
4-0270	Bad River near Odanah	X	--	--	--	--
4-0645	Pine River near Florence	--	--	--	X	--
4-0660	Menominee River near Pembine	--	--	--	X	--
4-0670	Menominee River below Koss	X	--	--	X	--
4-0695	Peshtigo River at Peshtigo	X	--	--	--	--
4-0710	Oconto River near Gillett	X	--	--	--	--
4-0727.5	Lawrence Creek near Westfield	--	X	--	--	--
4-0735	Fox River at Berlin	--	X	X	--	--
4-0749.5	Wolf River at Langlade	--	--	--	X	--
4-0770	Wolf River at Keshena Falls	--	--	--	X	--
4-0790	Wolf River at New London	--	X	X	--	--
4-0845	Fox River near Wrightstown	X	X	--	X	--
4-0860	Sheboygan River at Sheboygan	X	--	--	--	--
4-0870	Milwaukee River at Milwaukee	X	--	--	--	--
5-3405	St. Croix River at St. Croix Falls	X	--	X	--	--
5-3560	Chippewa River near Winter	--	--	--	X	--
5-3565	Chippewa River near Bruce	--	--	--	X	--
5-3585	Flambeau River near Winter	--	--	--	X	--
5-3595	South Fork Flambeau River near Phillips	--	--	--	--	X
5-3605	Flambeau River near Bruce	--	--	--	X	--
5-3620	Jump River at Sheldon	X	--	--	X	--
5-3655	Chippewa River at Chippewa Falls	--	--	--	--	X
5-3674.25	Red Cedar River near Cameron	--	--	--	X	--
5-3690	Red Cedar River at Menomonie	--	--	--	X	--
5-3695	Chippewa River at Durand	X	X	X	--	--
5-3700	Eau Galle River at Spring Valley	--	X	--	--	--
5-3795	Trempealeau River at Dodge	--	X	X	--	--
5-3820	Black River near Galesville	--	X	X	--	--
5-3901.8	Wisconsin River at Conover	--	--	--	--	X
5-3910	Wisconsin River near Lake Tomahawk	--	X	--	X	--
5-3930	Tomahawk River at Bradley	--	X	--	X	--
5-3935	Spirit River at Spirit Falls	--	X	--	--	--
5-3945	Prairie River near Merrill	--	X	--	X	--
5-3950	Wisconsin River at Merrill	--	X	X	X	--
5-3975	Eau Claire River at Kelly	--	X	--	--	--
5-3980	Wisconsin River at Rothschild	--	X	--	X	--
5-3995	Big Eau Pleine River near Stratford	--	X	--	X	--
5-4006	Little Plover River near Arnott	--	--	--	--	X
5-4006.5	Little Plover River at Plover	--	--	--	--	X
5-4008	Wisconsin River at Wisconsin Rapids	--	X	--	X	--

Table A-2.--Current-purpose gaging stations in Wisconsin--Continued

Station number	Station name	Purpose* Accounting	Operation	Forecasting	Compact or legal	Research or special studies
5-4020	Yellow River at Babcock	----------	---------	-----------	-------	X
5-4035	Lemonweir River at New Lisbon	----------	---------	-----------	-------	X
5-4040	Wisconsin River near Wisconsin Dells	----------	---------	-----------	-------	X
5-4065	Black Earth Creek at Black Earth	----------	---------	-----------	-------	X
5-4066.4	Otter Creek near Highland	----------	---------	-----------	-------	X
5-4070	Wisconsin River at Muscoda	X	---------	X	-------	-------
5-4080	Kickapoo River at LaFarge	----------	---------	X	-------	X
5-4098.3	North Fork Nederlo Creek near Gays Mills	----------	---------	-----------	-------	X
5-4098.6	South Fork Nederlo Creek near Gays Mills	----------	---------	-----------	-------	X
5-4098.7	Nederlo Creek near Gays Mills	----------	---------	-----------	-------	X
5-4098.8	Tributary to Nederlo Creek near Gays Mills	----------	---------	-----------	-------	X
5-4098.9	Nederlo Creek near Gays Mills	----------	---------	-----------	-------	X
5-4100	Kickapoo Creek at Gays Mills	----------	---------	-----------	-------	X
5-4135	Grant River near Burton	----------	X	X	-------	-------
5-4140	Platte River near Rockville	----------	X	-----------	-------	-------
5-4150	Galena River at Buncombe	----------	X	-----------	-------	-------
5-4295	Yahara River near McFarland	----------	---------	-----------	-------	X
5-4305	Rock River at Afton	X	---------	X	-------	-------
5-4345	Pecatonica River at Martintown	X	---------	X	-------	-------
5-5465	Fox River at Wilmot	X	X	X	-------	-------

* Accounting - Refers to streamflow gaging stations used for assessment of current water conditions, such as the monthly Water Resources Review.

Operation - Refers to stations such as those used for water management, powerplant operation.

Forecasting - Refers to stations such as those used for flood forecasting.

Compact or legal - Refers to stations used to meet compact or legal requirements, such as Federal Power Commission licensees.

Research or special studies - Refers to stations used in active projects.

Table A-3.--Drainage basin characteristics for gaging stations in Wisconsin

Station number	Drainage basin characteristics												
	Drainage area (sq mi)	Main channel slope (ft/mi)	Main channel length (miles)	Basin storage (percent)	Mean basin elevation (feet)	Forest cover (percent)	Mean annual precipitation (inches)	2-year 24-hour rainfall (inches)	Mean minimum Jan. temp. (°F)	Mean annual snowfall (inches)	Soil index (inches)	Average frost depth Feb. 28 (inches)	Average snow depth Feb. 28 (inches)
4-0255	113	3.60	18.6	15.4	1,160	85.0	30.5	2.55	2	55	6.39	24	14
4-0270	611	18.8	46.4	9.7	1,360	80.0	32.4	2.52	3	70	6.67	13	18
4-0275	269	19.1	40.6	13.1	1,140	80.0	31.1	2.53	1	56	7.24	16	17
4-0290	78	17.1	19.4	19.2	1,620	83.0	34.5	2.50	5	85	6.39	10	21
4-0300	262	18.6	41.0	15.9	1,470	82.0	34.8	2.49	5	100	6.39	9	22
4-0310	200	21.4	16.4	8.1	1,510	93.7	35	2.40	6	60	3.0	8	22
4-0315	171	3.80	21.2	19.4	1,640	91.5	36	2.35	4	40	3.5	9	21
4-0320	261	6.30	38.8	14.9	1,580	93.2	36	2.35	5	55	3.5	8	22
4-0330	164	3.30	32.6	11.1	1,680	94.0	32	2.30	3	40	3.0	8	21
4-0350	272	14.0	55.0	17.4	1,270	86.5	34	2.25	4	40	6.0	8	20
4-0405	171	20.3	32.1	18.1	1,610	97.0	31	2.20	5	45	3.0	10	19
4-0425	162	8.20	25.3	3.5	1,020	93.8	34	2.20	5	55	5.0	8	21
4-0610	389	7.92	60.7	9.8	1,530	91	32	2.30	2	40	2.0	11	19
4-0645	528	8.78	62.0	22.0	1,560	89.0	30.2	2.40	3	65	6.67	14	17
4-0653	56.1	12.8	17.4	12.8	1,290	95.2	30	2.25	4	50	6.0	16	14
4-0655	237	10.3	39.6	10.1	1,220	95.8	30	2.25	6	50	3.0	17	16
4-0665	253	12.6	39.0	17.2	1,210	86.0	29.1	2.38	6	57	7.86	19	12
4-0680	554	6.53	73.0	19.3	1,440	87.0	29.4	2.39	5	54	7.86	19	12
4-0695	1,124	6.21	128	18.4	1,130	72.0	29.0	2.37	6	52	7.54	23	11
4-0710	678	7.50	96.0	16.8	1,080	88.0	29.4	2.41	6	48	6.67	26	10
4-0735	1,430	.84	104	12.6	900	22.0	29.5	2.65	8	40	3.51	30	8
4-0755	633	9.60	90.0	15.5	1,520	76.0	30.2	2.44	4	61	7.24	27	12
4-0770	812	9.51	94.0	13.9	1,270	69.0	30.2	2.44	5	60	6.95	28	11
4-0785	395	11.9	56.6	15.0	1,210	36.0	30.6	2.49	8	46	5.38	31	8
4-0790	2,240	5.80	174	14.6	1,080	43.0	29.8	2.46	7	57	5.15	29	9
4-0800	514	8.77	56.3	15.8	1,010	35.0	30.3	2.50	7	45	5.62	30	8
4-0810	272	10.0	45.0	6.2	1,070	26.0	30.4	2.53	7	45	5.38	31	8
4-0835	77.9	3.85	18.9	7.3	920	6.00	29.5	2.51	11	39	2.50	17	6
4-0860	432	4.63	86.2	9.6	930	13.0	29.7	2.47	12	41	2.99	24	5
4-0865	121	9.90	26.8	10.7	930	3.00	29.7	2.56	12	41	3.33	18	4
4-0870	686	5.32	87.5	9.9	940	12.0	29.6	2.52	13	41	3.70	20	4
5-2860	1,360	3.70	126	37	1,070	44.1	27.5	2.60	1	42	4.08	28	13
5-3325	503	6.05	76.0	17.3	1,260	78.1	31.2	2.59	1	48	9.23	26	13
5-3335	1,588	5.71	104	17.1	1,190	82.9	31.0	2.59	1	48	9.23	28	13
5-3360	2,820	4.65	133	17.9	1,350	72.7	29.7	2.61	1	46	9.23	27	13
5-3385	958	5.30	73.6	43	1,070	65	28.0	2.58	1	44	4.28	28	13
5-3395	5,120	4.24	158	20.5	1,240	70.2	29.4	2.61	1	45	8.87	27	13
5-3400	167	1.90	14.0	47	900	60	28.0	2.68	2	41	3.70	28	11
5-3405	5,930	3.64	187	20.4	1,100	68.0	29.1	2.65	1	45	8.87	27	12

Table A-3.--Drainage basin characteristics for gaging stations in Wisconsin--Continued

Station number	Drainage basin characteristics											
	Drainage area (sq mi)	Main channel slope (ft/mi)	Main channel length (miles)	Basin storage (percent)	Mean basin elevation (feet)	Forest cover (percent)	Mean annual precipitation (inches)	2-year 24-hour rainfall (inches)	Mean minimum Jan. temp. (°F)	Mean annual snowfall (inches)	Soil index (inches)	Average frost depth Feb. 28 (inches)	Average snow depth Feb. 28 (inches)
5-3415	555	6.02	67.5	12.3	1,150	42.0	27.8	2.70	2	42	4.49	25	11
5-3595	615	3.69	69.3	33.3	1,560	72.6	33.4	2.54	3	48	5.87	15	17
5-3615	328	9.68	41.0	18.5	1,560	65.0	33.9	2.57	3	44	5.38	19	12
5-3620	574	8.30	71.4	17.6	1,400	62.0	33.6	2.60	2	43	5.38	20	12
5-3640	351	5.96	70.3	14.1	1,250	63.0	32.7	2.63	2	41	5.38	21	9
5-3650	114	6.75	26.5	1.6	1,130	11.0	30.1	2.62	6	38	4.08	26	8
5-3660	500	7.40	50.3	5.7	1,140	45.0	32.6	2.69	2	43	3.89	22	9
5-3665	758	6.36	70.3	4.4	1,100	43.5	32.3	2.71	4	42	4.08	23	9
5-3675	1,100	4.17	86.5	7.8	1,110	38.7	29.0	2.68	3	42	4.49	28	11
5-3680	426	6.12	52.5	3.2	1,140	32.4	28.3	2.74	3	40	3.89	26	10
5-3690	1,760	4.33	113	6.0	1,100	35.0	28.5	2.70	3	40	4.28	28	11
5-3700	64.8	17.6	19.5	0.2	1,180	14.2	29.1	2.78	4	38	4.08	26	9
5-3705	91.9	15.7	26.2	0.2	1,170	14.3	29.2	2.79	4	38	3.89	26	9
5-3720	406	6.30	61.2	2.1	980	28.6	30.7	2.79	5	40	4.28	27	7
5-3765	76.8	22.3	22.4	0	990	7.8	28.5	2.90	6	40	3.33	28	7
5-3790	8.95	43.3	4.0	0	760	50	30.0	2.89	8	40	3.33	27	7
5-3795	643	3.64	79.0	1.4	960	25.8	31.0	2.82	5	45	4.28	27	7
5-3810	756	5.81	93.0	7.3	1,350	30.8	32.8	2.67	2	46	3.33	22	10
5-3820	2,120	5.51	172	8.2	1,100	43.7	31.7	2.75	3	50	3.89	23	9
5-3825	77.1	20.0	15.8	2.6	1,000	30.4	31.7	2.86	7	46	3.89	23	8
5-3830	398	6.98	41.0	3.1	980	31.9	31.6	2.85	6	48	4.70	24	8
5-3845	129	28.0	17.6	0	940	15	29.5	2.91	6	40	3.33	26	6
5-3850	1,270	6.50	99.6	0	950	10.2	30.0	2.94	5	40	3.33	27	6
5-3855	275	7.60	34.0	0	950	20	30.5	2.96	5.5	40	3.51	27	6
5-3860	1,560	6.40	103	0	950	12.5	30.0	2.94	5.5	40	3.33	27	6
5-3875	511	6.25	83.0	0	1,290	9.6	31.7	3.00	5	40	3.5	24	5
5-3885	42.8	29.5	14.0	0	1,140	15.2	32.8	3.00	5	40	3.9	20	5
5-3890	221	13.4	36.2	0	1,140	20.7	32.8	3.00	5	40	3.9	19	5
5-3935	82	12.5	18.7	17.2	1,650	51.5	33.0	2.57	3	46	5.38	22	12
5-3945	181	10.4	38.2	23.2	1,610	74.6	30.8	2.49	4	51	7.24	26	12
5-3960	309	11.8	35.5	6.8	1,490	55.4	33.3	2.59	4	47	5.87	25	11
5-3975	326	8.28	58.0	11.4	1,540	45.2	30.7	2.50	6	50	6.13	31	10
5-3990	79	9.29	18.5	3.8	1,380	17.4	33.3	2.61	5	49	2.99	26	11
5-3995	224	10.1	29.0	1.9	1,340	21.2	33.2	2.61	5	50	2.95	27	11
5-4005	136	5.64	45.3	18.9	1,300	40.7	31.4	2.52	6	49	6.13	32	8
5-4006	5.4	14.1	1.90	2.6	1,100	56.0	31.2	2.59	8	48	10.80	31	9
5-4006.5	12.0	10.7	4.20	1.5	1,100	26.5	31.2	2.59	8	48	8.87	31	9
5-4020	223	7.63	50.7	4.9	1,200	39.2	31.5	2.69	5	51	3.70	30	10
5-4025	420	6.81	62.7	7.6	1,130	45.0	31.0	2.70	5	50	3.89	29	10

Table A-3.--Drainage basin characteristics for gaging stations in Wisconsin--Continued

Station number	Drainage basin characteristics												
	Drainage area (sq mi)	Main channel slope (ft/mi)	Main channel length (miles)	Basin storage (percent)	Mean basin elevation (feet)	Forest cover (percent)	Mean annual precipitation (inches)	2-year 24-hour rainfall (inches)	Mean minimum Jan. temp. (°F)	Mean annual snowfall (inches)	Soil index (inches)	Average frost depth Feb. 28 (inches)	Average snow depth Feb. 28 (inches)
5-4030	526	6.07	75.7	9.4	1,100	48.7	30.8	2.70	5	49	4.08	28	9
5-4035	500	3.65	42.0	15.6	990	44.2	31.0	2.76	6	47	5.15	24	9
5-4050	600	2.02	76.0	0.6	1,050	28.8	31.8	2.82	9	43	3.89	24	8
5-4065	42.8	9.42	13.4	0.2	1,000	21.8	29.3	2.80	8	38	4.28	20	6
5-4080	266	9.13	30.5	0.1	1,140	34.0	31.8	2.86	7	46	4.08	22	8
5-4085	8.47	40.4	6.60	0	1,220	22.6	32.0	2.89	8	46	4.08	20	7
5-4100	616	5.20	58.0	0.2	1,090	35.6	32.5	2.89	8	43	4.08	21	7
5-4105	690	4.30	69.5	0.3	1,070	37.2	32.6	2.90	8	43	4.08	20	7
5-4125	1,545	5.58	112	0	1,080	16.6	32.3	3.00	6	40	3.60	18	5
5-4135	267	9.73	35.0	0	960	22.1	33.6	3.03	12	41	3.89	17	5
5-4140	139	11.5	26.0	0	990	22.3	33.6	3.02	11	39	3.89	17	5
5-4145	130	22.1	16.1	0	910	38.8	35.1	3.00	10	40	3.90	17	5
5-4150	128	12.6	28.2	0	970	4.10	33.7	3.02	12	36	3.89	17	5
5-4155	20.1	41.5	8.80	0	940	3.70	33.7	3.01	12	35	3.89	17	5
5-4170	305	8.10	31.9	0.1	1,080	8.5	32.7	3.10	8	37	3.20	17	5
5-4185	1,553	4.10	106	0	960	13.6	34.1	3.10	10	36	3.70	12	4
5-4190	244	10.9	36.9	0	880	10.4	33.0	3.00	13	33	2.70	12	4
5-4235	62.8	8.33	13.8	8.2	960	1.50	29.6	2.57	11	38	3.16	18	6
5-4240	179	3.21	41.8	3.8	1,030	10.6	30.5	2.54	13	40	3.70	18	4
5-4255	971	1.38	106.0	12.1	970	9.10	30.7	2.59	12	38	3.33	19	5
5-4260	732	2.50	64.0	11.1	870	7.40	30.5	2.67	12	38	3.70	22	6
5-4295	351	4.49	35.5	10.7	980	4.30	30.1	2.78	11	38	3.16	21	5
5-4305	3,300	1.28	171	11.4	1,120	7.90	30.9	2.70	12	37	3.33	20	5
5-4315	186	5.58	25.2	2.6	950	8.10	32.5	2.77	14	39	3.70	16	5
5-4325	274	8.25	36.6	0	1,060	11.7	33.2	2.97	10	38	4.08	17	5
5-4330	221	8.25	26.7	0.1	1,080	17.2	31.9	2.90	9	37	4.08	17	5
5-4335	28.5	26.4	11.8	0	1,020	7.00	32.6	2.94	10	35	4.08	17	5
5-4345	1,040	2.28	81.8	0.3	990	11.5	32.6	2.93	10	36	4.08	17	5
5-4350	1.29	40.9	2.1	0	960	0	32.9	3.00	12	32	4.10	16	5
5-4360	16.1	25.0	9.60	0	1,050	13.0	30.7	2.85	9	37	3.89	18	5
5-4365	527	3.90	51.3	0.9	970	12.0	31.0	2.85	9	36	4.08	17	5
5-4370	2,540	2.01	118.5	1.8	950	7.9	33.0	2.9	12	36	4.1	16	5
5-4375	6,290	.84	178.1	8.1	1,040	7.7	30.5	2.7	12	38	3.5	17	5
5-4385	525	4.59	41.3	12.4	880	2.5	32.7	2.8	15	31	4.1	13	5
5-5280	230	1.27	38.8	17.2	750	11.0	31.0	2.7	16	39	3.9	13	6
5-5465	868	1.42	75.0	7.8	860	10.0	31.6	2.68	13	41	3.51	16	5
5-5490	15.3	7.34	8.9	24.4	880	17.3	32.4	2.8	15	31	6.7	12	5
5-5500	1,364	.90	117.3	15.5	870	8.6	31.0	2.7	14	40	3.9	15	5

Table A-4.--Regression results relating streamflow characteristics to basin characteristics in Wisconsin

Equation form is $Y=aA^{b1}S^{b2}L^{b3}St^{b4}E^{b5}F^{b6}P^{b7}I^{b8}T_1^{b9}Sn^{b10}Si^{b11}Fr^{b12}So^{b13}$

Streamflow characteristic, Y	Regression constant, a	Exponent of drainage basin characteristics													Standard error of estimate	
		Drainage area A	Main channel slope S	Main channel length L	Basin storage plus 1 St	Mean basin elevation E	Forest cover plus 1 F	Mean annual precipitation minus 20 P	2-year 24-hour rainfall I	Mean minimum Jan. temp T_1	Mean annual snowfall minus 20 Sn	Soil index Si	Average frost depth Feb. 28 Fr	Average snow depth So	Logs	Percent
Mean flow																
Q_a	0.147	1.02	-----	-----	-----	-----	0.12	0.81	-1.21	-----	-----	0.19	-----	-----	0.075	17
q_1	4.36	1.05	-----	-----	-.13	-----	-----	-.86	-----	.24	-----	1.04	-.82	-----	.176	42
q_2	982	1.06	-----	-----	-.24	-.65	-----	-.95	-----	.26	-----	1.13	-1.00	-----	.185	44
q_3	.019	.83	-----	.35	-.05	-----	-.09	1.21	-----	.10	-----	-----	.33	-----	.104	24
q_4	.024	1.03	-----	-----	.09	.53	-----	.93	-2.73	-.12	.29	-.19	-----	-----	.110	26
q_5	.015	1.02	-----	-----	.10	.33	.22	.90	-1.48	-----	-----	-----	-----	-----	.088	20
q_6	$1.93x10^{-3}$	1.04	-----	-----	-----	.44	.22	.68	-----	-----	-----	.22	-----	-----	.112	26
q_7	$9.64x10^{-7}$	1.05	-----	-----	-.10	-----	.25	-----	-----	-----	-----	.46	-.29	-----	.130	30
q_8	.180	1.03	-----	-----	-.16	-----	.25	-----	-----	-----	-----	.60	-.26	-----	.146	34
q_9	$1.57x10^{-4}$	1.02	-----	-----	-.13	.97	.20	-----	-----	-----	-----	.46	-----	-----	.145	34
q_{10}	$9.53x10^{-4}$	1.01	-----	-----	-----	.64	.23	-----	-----	.17	-----	.39	-----	-----	.125	29
q_{11}	.772	1.02	-----	-----	-----	-----	.21	.71	-1.44	.14	-----	.38	-----	-----	.117	27
q_{12}	.553	1.02	-----	-----	-----	-----	.24	-.54	-----	.25	-----	.62	-.44	-----	.152	36
Mean of standard errors of regression equations of mean monthly discharges----------																31
Flow variability																
SD_a	$1.05x10^{-3}$	1.01	-----	-----	.14	.41	-.13	1.01	-----	-----	-----	-----	-----	-----	.115	27
SD_1	$8.43x10^{-5}$	1.02	-----	-----	.22	-----	-----	1.13	3.44	.60	-----	-----	-----	-----	.171	40
SD_2	$6.47x10^{-3}$	1.03	-----	-----	-----	-----	-.17	-----	3.87	.48	-----	.39	-.47	-----	.167	39
SD_3	$3.73x10^{-3}$	1.06	-----	-----	.09	-----	-.22	1.84	-----	-----	-----	-.45	.42	-----	.156	37
SD_4	$5.70x10^{-5}$	1.03	-----	-----	.12	1.41	-----	-----	-----	-----	-----	-.56	-----	-----	.184	44
SD_5	$1.32x10^{-4}$	1.04	-----	-----	.18	.89	-----	.98	-----	-----	-----	-----	-.33	-----	.174	41
SD_6	$7.13x10^{-3}$	1.03	-----	-----	.09	-----	-----	1.80	-----	-.29	-----	-----	-----	-----	.183	43
SD_7	.226	1.07	-----	-----	-----	-----	-----	.73	-----	-.23	-----	-----	-.47	-----	.151	35
SD_8	$3.21x10^{-5}$	1.06	-----	-----	-----	1.06	-.11	.66	-----	-----	-----	-----	-----	-----	.165	39
SD_9	$1.19x10^{-8}$	1.05	-----	-----	.16	1.47	-.18	2.08	-----	-----	-----	-----	.62	-----	.202	48
SD_{10}	$5.47x10^{-6}$	1.03	-----	-----	.22	.93	-----	1.45	-----	.20	-----	-----	-----	-----	.165	39
SD_{11}	$5.85x10^{-4}$	1.04	-----	-----	.27	-----	-.16	2.46	-----	-----	-----	-----	-----	-----	.181	43
SD_{12}	$8.57x10^{-3}$	1.00	-----	-----	.24	-----	-----	.88	-----	.26	-----	-----	-----	-----	.148	35
Mean of standard errors of regression equations of standard deviation of mean monthly discharges----------																40

Table A-4.--Regression results relating streamflow characteristics to basin characteristics in Wisconsin--Continued

Equation form is $Y=aA^{b1}S^{b2}L^{b3}St^{b4}E^{b5}F^{b6}P^{b7}I^{b8}T_1^{b9}Sn^{b10}Si^{b11}Fr^{b12}So^{b13}$

Exponent of drainage basin characteristics

Streamflow character-istic, Y	Regression constant, a	Drainage area A	Main channel slope S	Main channel length L	Basin storage plus 1 ST	Main basin eleva-tion E	Forest cover plus 1 F	Mean annual precipitat-tion minus 20 P	2-year 24-hour rainfall I	Mean minimum Jan. temp T_1	Mean annual snowfall minus 20 Sn	Soil index Si	Average frost depth Feb. 28 Fr	Average snow depth So	Standard error of estimate Logs	Standard error of estimate Percent
Flood peaks																
Q_2	0.668	0.88	0.44	-----	-.21	-----	-----	1.36	-----	-.15	-----	-.72	0.27	-----	0.194	46
Q_5	.506	.89	.53	-----	-.18	-----	-----	1.34	-----	-----	-----	-.82	.40	-----	.201	48
Q_{10}	.119	.90	.56	-----	-.21	-----	-----	1.35	-----	-----	-.42	-.92	.34	.40	.208	50
Q_{25}	.109	.84	.61	-----	-.24	-----	-----	1.77	-----	-----	-.62	-.78	.37	.47	.202	48
Q_{50}	63.4	.70	.62	-----	-.19	-----	-----	1.74	-----	-.29	-.82	-.68	-----	-----	.191	45
Flood volumes																
$V_{1,2}$	.263	.98	.34	-----	-.10	-----	-----	1.65	-----	-.20	-----	-.52	-----	-----	.181	43
$V_{1,10}$	.104	.97	.38	-----	-.14	-----	-----	1.45	-----	-.19	-----	-.68	-----	-----	.193	46
$V_{1,50}$	.134	.96	.39	-----	-.20	-----	-----	1.92	-----	-----	-----	-----	-----	-----	.210	50
$V_{3,2}$	1.93×10^{-4}	1.02	.26	-----	-----	.81	-----	1.61	-----	-----	-----	-.54	.28	-----	.171	40
$V_{3,10}$	.648	1.01	.34	-----	-----	-----	-----	1.38	-----	-.16	-----	-.73	-----	-----	.185	44
$V_{3,50}$	.050	1.07	.39	-----	-----	-----	-----	1.87	-----	-----	-----	-.36	-----	-----	.190	45
$V_{7,2}$	.174	1.02	.18	-----	-----	-----	-----	1.96	-1.99	-.17	-----	-.51	.31	-----	.155	36
$V_{7,10}$	.522	.83	.20	.32	-----	-----	-----	1.32	-----	-.20	-----	-.56	-----	-----	.164	39
$V_{7,50}$	.134	1.02	.23	-----	-----	-----	-----	1.51	-----	-----	-----	-----	-----	-----	.175	41
$V_{15,2}$	.288	.82	-----	.27	-----	-----	-----	1.48	-1.42	-.19	.32	-.38	-----	-----	.130	30
$V_{15,10}$	1.95	1.02	.14	-----	-----	-----	-----	1.16	-1.32	-.15	-----	-.45	-----	-----	.143	34
$V_{15,50}$	.318	.95	-----	-----	-----	-----	-----	1.44	-----	-.12	-----	-----	-----	-----	.156	37
Low flow																
$M_{7,2}$	No meaningful equation derived.														.362	94
$M_{7,10}$															.497	141
$M_{7,20}$															.556	166
$M_{30,2}$	No meaningful equation derived.														.345	88
$M_{30,10}$															.479	134
$M_{30,20}$															.504	144
Flow duration																
D_{10}	.071	1.05	-----	-----	.15	-----	-----	1.36	-1.54	-----	.18	-----	-----	-----	.088	20
D_{50}	1.60	1.07	-----	-----	-.16	-----	.35	-1.13	-----	.25	-----	.89	-.59	-----	.182	43
D_{95}	No meaningful equation derived.														.390	102

Table A-5.--Recommended streamflow station network in Wisconsin

Station number	Station name	Recommendations: Include in network	Recommendations: Not recommended for inclusion	Types of data: Current purpose	Types of data: Planning and design: Minor streams	Types of data: Planning and design: Principal streams	Types of data: Long-term trend
4-0255	Bois Brule River at Brule	X	---------	-------	-------	---------	X
4-0270	Bad River near Odanah	X	---------	X	-------	---------	-----
4-0275	White River near Ashland	X	---------	-------	-------	X	-----
4-0300	Montreal River near Saxon	-------	X	-------	-------	---------	-----
4-0637	Popple River near Fence	X	---------	-------	X	---------	X
4-0645	Pine River near Florence	X	---------	X	-------	---------	-----
4-0660	Menominee River near Pembine	X	---------	X	-------	---------	-----
4-0665	Pike River at Amberg	-------	X	-------	-------	---------	-----
4-0670	Menominee River below Koss	X	---------	X	-------	---------	-----
4-0695	Peshtigo River at Peshtigo	X	---------	X	-------	X	-----
4-0710	Oconto River near Gillett	X	---------	X	-------	---------	X
	FOX RIVER NEAR MONTELLO[a]	X	---------	-------	-------	X	-----
4-0727.5	Lawrence Creek near Westfield	X	---------	X	X	---------	-----
4-0730.5	Grand River near Kingston	X	---------	-------	X	---------	-----
4-0735	Fox River at Berlin	X	---------	X	-------	---------	X
4-0749.5	Wolf River at Langlade	X	---------	X	-------	X	-----
4-0752	Evergreen Creek near Langlade	X	---------	-------	X	---------	-----
4-0770	Wolf River at Keshena Falls	X	---------	X	-------	---------	-----
4-0785	Embarrass River near Embarrass	-------	X	-------	-------	---------	-----
4-0790	Wolf River at New London	X	---------	X	-------	---------	-----
4-0800	Little Wolf River at Royalton	-------	X	-------	-------	---------	-----
4-0809.5	Emmons Creek near Rural	X	---------	-------	X	---------	-----
4-0845	Fox River near Wrightstown	X	---------	X	-------	---------	-----
4-0852	Kewaunee River near Kewaunee	X	---------	-------	X	---------	-----
	MANITOWOC RIVER NEAR MANITOWOC[a]	X	---------	-------	-------	X	-----
4-0860	Sheboygan River at Sheboygan	X	---------	X	-------	---------	X
4-0861.5	Milwaukee River at Kewauskum	X	---------	-------	X	---------	-----
4-0862	East Branch Milwaukee River near New Fane	X	---------	-------	X	---------	-----
4-0863.4	North Branch Milwaukee River near Fillmore	X	---------	-------	X	---------	-----
4-0863.6	Milwaukee River at Waubeka	X	---------	-------	X	---------	-----
4-0865	Cedar Creek near Cedarburg	-------	X	-------	-------	---------	-----
4-0870	Milwaukee River at Milwaukee	X	---------	X	-------	---------	-----
4-0871.2	Menomonee River at Wauwatosa	X	---------	-------	X	---------	-----
4-0872.04	Oak Creek at South Milwaukee	X	---------	-------	X	---------	-----
4-0872.2	Root River near Franklin	X	---------	-------	X	---------	-----
4-0872.33	Root River Canal near Franklin	X	---------	-------	X	---------	-----
4-0872.4	Root River at Racine	X	---------	-------	X	---------	-----

Table A-5.--Recommended streamflow station network in Wisconsin--Continued

Station number	Station name	Recommendations		Types of data			
		Include in network	Not recommended for inclusion	Current purpose	Planning and design: Minor streams	Planning and design: Principal streams	Long-term trend
	ST. CROIX RIVER NEAR DAIRYLAND[a]	X	---------	-------	-------	X	-----
5-3325	Namekagon River near Trego	-------	X	-------	-------	--------	-----
5-3335	St. Croix River near Danbury	X	---------	-------	-------	--------	X
5-3360	St. Croix River near Grantsburg	-------	X	-------	-------	--------	-----
5-3405	St. Croix River at St. Croix Falls	X	---------	X	-------	--------	-----
5-3415	Apple River near Somerset	-------	X	-------	-------	--------	-----
5-3560	Chippewa River near Winter	X	---------	X	-------	--------	-----
5-3565	Chippewa River near Bruce	X	---------	X	-------	--------	-----
5-3585	Flambeau River near Winter	X	---------	X	-------	--------	-----
5-3595	South Fork Flambeau River near Phillips	X	---------	X	-------	--------	-----
5-3605	Flambeau River near Bruce	X	---------	X	-------	--------	-----
5-3620	Jump River at Sheldon	X	---------	X	-------	--------	X
5-3655	Chippewa River at Chippewa Falls	X	---------	X	-------	--------	-----
5-3674.25	Red Cedar River near Cameron	X	---------	X	-------	X	-----
5-3680	Hay River at Wheeler	X	---------	-------	-------	X	X
5-3690	Red Cedar River at Menomonie	X	---------	X	-------	--------	-----
5-3695	Chippewa River at Durand	X	---------	X	-------	--------	-----
5-3700	Eau Galle River at Spring Valley	X	---------	X	-------	--------	-----
5-3794	Trempealeau River at Arcadia	-------	X	-------	-------	--------	-----
5-3795	Trempealeau River at Dodge	X	---------	X	-------	--------	-----
	BLACK RIVER NEAR GREENWOOD[a]	X	---------	-------	-------	X	-----
5-3810	Black River at Neillsville	X	---------	-------	-------	--------	X
5-3820	Black River near Galesville	X	---------	X	-------	--------	-----
5-3830	LaCrosse River near West Salem	-------	X	-------	-------	--------	-----
5-3901.8	Wisconsin River at Conover	X	---------	X	-------	--------	-----
5-3910	Wisconsin River near Lake Tomahawk	X	---------	X	-------	--------	-----
5-3930	Tomahawk River at Bradley	X	---------	X	-------	--------	-----
5-3935	Spirit River at Spirit Falls	X	---------	X	-------	--------	-----
5-3945	Prairie River near Merrill	X	---------	X	-------	--------	X
5-3950	Wisconsin River at Merrill	X	---------	X	-------	--------	-----
5-3975	Eau Claire River at Kelly	X	---------	X	-------	--------	-----
5-3980	Wisconsin River at Rothschild	X	---------	X	-------	--------	-----
5-3995	Big Eau Pleine River near Stratford	X	---------	X	-------	--------	X
5-4006	Little Plover River near Arnott	X	---------	X	-------	--------	-----
5-4006.5	Little Plover River at Plover	X	---------	X	-------	--------	-----
5-4008	Wisconsin River at Wisconsin Rapids	X	---------	X	-------	--------	-----
5-4010.2	Tenmile Creek near Bancroft	X	---------	-------	X	--------	-----
5-4010.5	Tenmile Creek near Nekoosa	X	---------	-------	X	--------	-----

Table A-5.--Recommended streamflow station network in Wisconsin--Continued

Station number	Station name	Recommendations: Include in network	Recommendations: Not recommended for inclusion	Types of data: Current purpose	Types of data: Planning and design: Minor streams	Types of data: Planning and design: Principal streams	Types of data: Long-term trend
5-4011	Fourteenmile Creek near New Rome	X	---------	-------	X	---------	-----
5-4015.35	Big Roche a Cri Creek near Adams	X	---------	-------	X	---------	X
5-4020	Yellow River at Babcock	X	---------	X	-------	---------	-----
5-4035	Lemonweir River at New Lisbon	X	---------	X	-------	---------	-----
5-4040	Wisconsin River near Wisconsin Dells	X	---------	X	-------	---------	-----
5-4050	Baraboo River near Baraboo	X	---------	-------	-------	---------	X
5-4065	Black Earth Creek at Black Earth	X	---------	X	-------	---------	-----
5-4066.4	Otter Creek near Highland	X	---------	X	-------	---------	-----
5-4070	Wisconsin River at Muscoda	X	---------	X	-------	---------	-----
5-4080	Kickapoo River at LaFarge	X	---------	X	-------	---------	-----
5-4098.3	North Fork Nederlo Creek near Gays Mills	X	---------	X	-------	---------	-----
5-4098.6	South Fork Nederlo Creek near Gays Mills	X	---------	X	-------	---------	-----
5-4098.7	Nederlo Creek near Gays Mills	X	---------	X	-------	---------	-----
5-4098.8	Tributary to Nederlo Creek near Gays Mills	X	---------	X	-------	---------	-----
5-4098.9	Nederlo Creek near Gays Mills	X	---------	X	-------	---------	-----
5-4100	Kickapoo River at Gays Mills	X	---------	X	-------	---------	-----
5-4105	Kickapoo River at Steuben	-------	X	-------	-------	---------	-----
5-4135	Grant River near Burton	X	---------	X	-------	---------	X
5-4140	Platte River near Rockville	X	---------	X	-------	---------	-----
5-4150	Galena River at Buncombe	X	---------	X	-------	---------	-----
5-4155	East Fork Galena River at Council Hill, Ill.	-------	X	-------	-------	---------	-----
5-4230	West Branch Rock River near Waupun	-------	X	-------	-------	---------	-----
5-4240	East Branch Rock River near Mayville	-------	X	-------	-------	---------	-----
	ROCK RIVER NEAR HUSTIFORD[a]	X	---------	-------	-------	X	-----
5-4255	Rock River at Watertown	-------	X	-------	-------	---------	-----
5-4260	Crawfish River at Milford	X	---------	-------	-------	---------	X
5-4295	Yahara River near McFarland	X	---------	X	-------	---------	-----
5-4305	Rock River at Afton	X	---------	X	-------	---------	-----
5-4315	Turtle Creek near Clinton	-------	X	-------	-------	---------	-----
5-4325	Pecatonica River at Darlington	-------	X	-------	-------	---------	-----
5-4330	East Branch Pecatonica River near Blanchardville	-------	X	-------	-------	---------	-----
5-4345	Pecatonica River at Martintown	X	---------	X	-------	---------	-----
5-4365	Sugar River near Brodhead	X	---------	-------	-------	---------	X
5-5438.3	Fox River at Waukesha	X	---------	-------	X	---------	-----
	FOX RIVER NEAR BURLINGTON[a]	X	---------	-------	-------	X	-----
5-5465	Fox River at Wilmot	X	---------	X	-------	---------	-----

a Gaging stations to be established.