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GEOLOGICAL SURVEY
W. C. Mendenhall, Director

Water-Supply Paper 771

FLOODS IN THE UNITED STATES

MAGNITUDE AND FREQUENCY

BY
CLARENCE S. JARVIS AND OTHERS

Prepared in collaboration with the Water Planning Committee of the National Resources Board and its predecessor the Mississippi Valley Committee

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FOREWORD

"The ideal river, which would have a uniform flow, does not exist in nature." *

From time immemorial floods have transformed beneficent river waters into a menace to humanity. Man's progress toward economic stability has been repeatedly halted or even thrown backward by the interruption of his efforts to make effective use of rivers and of valley lands. This handicap is not imposed by the destructiveness of large rivers alone, or of rivers in widely separated areas, for there are few if any streams, brooks, or rivulets that are not subject to flows beyond their channel capacities. Yet, though man for ages has suffered seriously from recurring floods, he has not been deterred from continuing to extend his activities in areas that are virtually foredoomed to flood damage.

Today in the United States serious floods may occur in any section in any year, and even, in some regions, several times a year. Many of these floods leave behind them the tragedy of death and disease and of property irreparably damaged. The aggregate direct property damage caused by floods in this country has been estimated roughly to average $35,000,000 a year. In addition there are serious indirect and intangible losses of great but not precisely calculable magnitude.

The persistent recurrence of flood damages in our country, and, indeed, their tendency to increase, have given birth to the mistaken notion that floods are increasing in size and frequency. The rising damage totals are not attributable to greater or more frequent floods, however; rather they are the result of increasing occupation of river banks and river valleys by cities, towns, industrial plants, bridges, railroads, and highways and the increasing use of rivers as a source of water supplies for municipalities and industries and for power, irrigation, navigation, and recreation.

Safety of life and reduction of both direct and indirect losses from floods may be promoted by the adoption of measures for protection and control. It should be borne clearly in mind, however, that probably no single method of flood control will insure the protection of a large

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* Mississippi Valley Committee Report, 2d ed., p. 3, 1934.

drainage basin. "The improvement of natural channels; the building of reservoirs - sometimes well adapted for purposes of irrigation and power; the construction of levees, such as now exist along the lower Mississippi; reforestation and a change in certain areas from tilled crops to grass crops, may all play a part in slowing down the rush of water to the sea, or in keeping it away from cities, towns, and valuable lands." *

"Consideration of a national flood-control policy must necessarily recognize that the flood-control aspects of a project, be it a major purpose or an incidental one, must be evaluated in the light of a broad study which takes into account all other purposes or possibilities involved. Among such other purposes may be power, navigation, irrigation; may be low-water control, water supply, sewage, or waste disposal. Wherever more than one purpose is indicated, each must be considered in its full relation to all the others. Only by such procedure can a well-coordinated project be evolved." **

In planning public works for the control of floods, and in relating such works to effective utilization of river waters for the various purposes enumerated above, two basic requirements are (1) accurate and reliable records of the stage and discharge of past floods, and (2) development of methods for the analysis of such data, to determine the frequency of floods heretofore experienced and to estimate the magnitude and frequency of future floods. It is the purpose of this study to present for certain rivers in the United States much of the basic information of this sort now available. Engineers generally agree that a large part of the flood destruction in this country could have been prevented by control measures and by an adjustment of human activities on the basis of a greater knowledge of the characteristics of our waterways. For some rivers the characteristics relating to stages and flows of floods are compiled and analyzed herein for the first time.

The need for a more complete and systematic knowledge of floods was impressed upon the Mississippi Valley Committee early in its consideration of public works projects involving river utilization and control.

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* Mississippi Valley Committee Report, 2d ed., p. 3, 1934.
** Idem, p. 27.

Records now available for over 225 rivers of our country show daily flow for 20 years or longer - a sufficient length of time to afford reliable information of flood characteristics as a basis for planning. With the necessity clearly apparent and the data available, this study was undertaken. It was authorized and directed by the Mississippi Valley Committee, now the Water Planning Committee of the National Resources Board, and the work was done by the United States Geological Survey. The Committee on Flood Protection Data of the American Society of Civil Engineers has rendered invaluable service by review of procedures for flood-flow analyses, advice as to the conduct of studies, and suggestions regarding the form and contents of this report.

The objective has been to review the technique and procedure of estimating expected floods and to compile, in a form suited for ready reference, flood statistics for streams where long-time records are available. The results of the study here presented are a substantial contribution to this end.

The Mississippi Valley Committee also found it desirable to make a study of the relations of rainfall, run-off, and related factors, and, as a project, that study was combined with the study of floods. Both investigations have been carried forward concurrently with unified control and supervision, yet with the requisite independence of approach to call forth the best efforts of the separate groups at work. The results of the rainfall and run-off studies are contained in another report to be published as Water-Supply Paper 772.

Harlan H. Barrows
Herbert S. Crocker
Glen E. Edgerton
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Water Planning Committee of the National Resources Board
formerly Mississippi Valley Committee of the
Federal Emergency Administration of Public Works.

FLOODS IN THE UNITED STATES - MAGNITUDE AND FREQUENCY

By Clarence S. Jarvis and others

AUTHORIZATION

The Mississippi Valley Committee, in February 1934, obtained an allotment of funds under the Public Works Administration for carrying on in collaboration with the Geological Survey two separate but related investigations dealing (a) with rainfall and run-off and (b) with floods - occurrence, magnitude, and frequency. This work was continued after October 1, 1934, under the direction of the Water Planning Committee of the National Resources Board, successor to the Mississippi Valley Committee.

Funds were transferred to the Geological Survey for carrying on this work under the specific authority of the allotments, the general authority of its organic law, and the language of appropriation bills passed by Congress as follows:

"For gaging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources."

ADMINISTRATION AND PERSONNEL

The beginning of the organization of the personnel for these studies was made by the United States Geological Survey in March 1934, and the studies have been conducted continuously since that date under the general administrative supervision of N. C. Grover, chief hydraulic engineer, and the direct supervision of R. W. Davenport, chief of the division of water utilization. Mr. Davenport's experience and familiarity with the hydrologic field, together with his free cooperation, have been so helpful and constructive as to amount practically to joint authorship of certain chapters, besides giving valuable suggestions in relation to all other parts of this report.

The persons employed on this project were drawn in part from the regular rolls of the Geological Survey or other governmental departments as occasion required. Others were appointed by the Secretary of the

Interior from lists of eligible applicants under the Public Works Administration. Thorough cooperation was given by the various members and branches of the Geological Survey at every stage of the proceeding, so that the present report is in a large sense a product of the organization with the unnamed participants more numerous than those specifically mentioned, but nevertheless the aggregate of their occasional and timely contributions forms a very substantial element of this report.

Acknowledgments

Special acknowledgment should be made to H. Alden Foster, for his preliminary studies and report on methods for estimating floods, now appearing in revised and extended form as a chapter of this paper; to Gordon R. Williams, for directing the compilation and checking of all flood data listed herein; and to Merrill M. Bernard, whose assignment related largely to the development of the unit-hydrograph method of showing relationship between rainfall and run-off.

Acknowledgment is also expressed for the helpful advice, active participation, and cooperation of Prof. Thorndike Saville, of New York University, employed originally as part-time consultant and after October 1, 1934, as executive engineer for the Water Planning Committee of the National Resources Board. In the selection and testing of various methods of sampling flood records, plotting of the data, analysis of results, and interpretation and evaluation of such findings, the technical knowledge and experience of Professor Saville and his associate, Prof. J. J. Slade, Jr., of Rutgers University, were used to advantage, and their studies have contributed in an important way to this report. Besides devoting much individual thought and effort in research dealing directly with flood studies, procedures, and related problems, they directed various groups of employees under the Federal Emergency Relief Administration in New York City. These groups did much of the computing, plotting, and compiling of data used in the exploratory and later work relating to tests and comparison of methods widely used in analysis and interpretation of flood records.

In addition to his activities in an advisory capacity, as noted on the following page, Robert E. Horton has contributed a special chapter dealing with hydrologic phases of Tennessee River flood records at Chattanooga, Tennessee. His paper illustrates the application of advanced thought and methods in the evaluation and analysis of flood data.

The responsibility for final checking of Geological Survey data was placed on the district engineers, because of their familiarity with local conditions and records for their respective districts. Many of them undertook extensive reviews requiring extra work far beyond first estimates, in order to make necessary revisions, to correct occasional errors that had long escaped detection, and to supply some data not previously published.

Many whose names appear only in the bibliography or in other reference to some specific writing related to the text have contributed directly or indirectly to the plan and substance of this report. Many others who have contributed notably to this report in one way or another but whose names do not appear herein were employed for only short periods or at detail computations, listing, and other processes necessary for the preparation of a report of this nature. The importance of these contributions is fully appreciated and acknowledged.

COOPERATION

Cooperation from American Society of Civil Engineers

The Committee on Flood Protection Data appointed by the American Society of Civil Engineers, at the request of the Mississippi Valley Committee, to act in an advisory capacity, has assisted materially in defining the scope and policies of the flood studies from the beginning of this project and has reviewed the procedure and results. The following list shows the membership of this committee:

Gerard H. Matthes (chairman), principal engineer, Mississippi River Commission, Vicksburg, Miss.

Frederick H. Fowler, consulting engineer, San Francisco, Calif.

Robert E. Horton, consulting engineer, Voorheesville, N. Y.

Ivan E. Houk, senior engineer, United States Bureau of Reclamation, Denver, Colo.

Charles W. Sherman, consulting engineer, Boston, Mass.

C. W. Kutz, brigadier-general, U. S. Army, retired, Washington, D. C.

Daniel C. Walser, vice-president, Charles B. Hawley Engineering Corporation, Washington, D. C.

Considerable advantage has been realized from the earlier work of a similar committee, called the "Special Committee on Flood Protection Data," of which N. C. Grover was chairman and G. H. Matthes was secretary during the period covered by its official reports, 1922 to 1928. This committee performed very important preliminary or explanatory work in selecting such records as would be of most practical use, such forms as would be most helpful for their presentation, and such methods of analysis as would elicit the desired generalized information. After reaching a conclusion as to the significant data to be listed regarding flood events, represented by either the maximum daily average flow or the corresponding peak discharge, and then devising convenient forms for listing these data, testing their usefulness by transcribing several station records, and adopting the simplest, most direct method of plotting and analyzing the information, the special committee recognized that one phase of the work had been completed. It appeared inadvisable for the committee to continue its organized effort under the handicaps imposed by limitations of its work to the spare time of members who had but scant leisure. The project seemed to call for full-time effort of qualified investigators, working with advisory as well as cooperating agencies for collecting, compiling, interpreting, and publishing the desired data on flood protection. After it became apparent that such a project could not be financed, activities of the special committee were necessarily interrupted. The foundation that was laid by this special committee has contributed much to progress in the present project. For a detailed progress report by the Committee on Flood Protection Data which includes a review of the work by its predecessor, see Am. Soc. Civil Eng. Proc., vol. 61, pp. 333-340, 1935.

It is more than a coincidence that the present investigation, proceeding critically and impartially to review available data together with methods of listing, plotting, and analysis, arrived at aubstantially the same conclusions on all the fundamental problems, such as the selection of flood events and effective methods of treatment and presentation. Furthermore, this judgment has been confirmed by special mathematical and statistical approaches, in which Saville and Slade were associated in the interests of this flood study.

Cooperation from American Geophysical Union

A committee appointed by the Section of Hydrology of the American Geophysical Union in May 1934, has been acting in an advisory capacity for the studies of rainfall and run-off relations conducted under the same general supervision as the project described herein. Owing to the cloee relationship between the flood studies and those dealing with rainfall and run-off, there has been of necessity an interchange and comparison of ideas and material included in both studies. Such correspondence and conferences have extended to both groups employed on the two projects, and also to both advisory committees as occasion required, with resulting benefit to both projects. The personnel of the American Geophysical Union committee is as follows:

Wesley W. Horner (chairman), consulting engineer, St. Louis, Mo.

Jacob A. Harmon, consulting engineer, Peoria, Ill.

Robert E. Horton, consulting engineer, Voorheesville, N. Y. (appointed January 1935).

Adolph F. Meyer, consulting engineer, Minneapolis, Minn.

G. W. Pickels, professor, University of Illinois, Urbana, Ill.

Leroy K. Sherman, president Randolph-Perkins Co., Chicago, Ill.

Ray Towl, mayor, Omaha, Nebr.

J. W. Woerman, senior civil engineer, U. S. Engineer Office, Chicago, Ill.

Cooperation from other sources

In addition to those mentioned above, numerous members of the engineering profession, in Federal, State, or private service, have actively contributed to the substance and tenor of this report. For example, the authors of certain methods for estimating floods have gone to considerable length to bring the descriptions of their methods into acceptable summarized form and have provided some of their later unpublished ideas.

Reference to the various chapters of this report, particularly those relating to methods for estimating floods and examples of procedure, and the extensive bibliography of technical literature dealing with flood phenomena, will show how widespread an interest has been manifested in this subject during the greater part of the past century. The variety of flood events recorded and the diverse opinions regarding the best methods for flood protection and control have continued to the present day. Some progress has been made, however, toward unifying of opinions as to the most effective practical methods to be applied. It has been recognized almost universally that each river presents its own problems and that the treatment accorded to one stream or system may or may not be applicable to another. One of the primary considerations has to do with previously demonstrated habits of run-off, especially as to the volume and frequency of their extreme phases. With this in view, the main objective of this report has been to furnish the most reliable significant data for a large number of streams and, so far as practicable, to present records at two or more widely separated stations on the same stream. Thereby, the trends and variations within each drainage area may be traced, and estimates made for intervening or outlying adjacent stations.

At best, in the brief period allotted the limited personnel could be expected to achieve only a few steps forward in a field so filled with problems, uncertainties, and data of various grades of reliability. One of the early problems had to deal with orientation - to find the most profitable and logical direction of approach to various phases of the study. The wide range of consultants and advisory committees and supervisors provided the necessary safeguards against individual prejudices or preferences, and therefore the presentation may properly be said to represent the coordinated efforts of a large group rather than of a few individuals. Exceptions to a certain extent are provided by the four chapters contributed by Profs. Thorndike Saville and J. J. Slade, Jr., and Messrs. Robert E. Horton and Merrill M. Bernard. Inasmuch as they have dealt with phases of the investigation representing advanced thought and methods which necessarily have yet to stand the test of time and diverse application, it is well to regard these chapters as representative of the thought and expression of specialists who have done much constructive work in their respective fields.

DESCRIPTIVE, GENERAL, AND HISTORICAL NOTES

The investigation of floods in the United States which has resulted in this report represents a phase of the broadening national consciousness of public interest and joint responsibility shared by the Federal Government in the larger problems of control, development, and utilization of water resources. It is appropriate to mention, as examples of the national legislative and administrative acts that express this concept, those early authorizations for control of the upper Mississippi River by large storage projects; the Reclamation Act and the application of the conservation policy, both initiated about 20 years later, during the early years of this century; the Federal Water Power Act of 1920; and the authorization of January 1927 for the survey of some 70 important river systems (69th Cong., 1st sess., H. Doc. 308).

Recent notable treatments of the subject of the utilization and control of the country's water resources are the report of the President's Committee on Water Flow, entitled "Development of the rivers of the United States" (73d Cong., 2d sess., H. Doc. 395); reports on some 70 river systems by the Corps of Engineers under H. Doc. 308, 69 Cong., 1st sess.; a report of the Mississippi Valley Committee of the Public Works Administration, October 1, 1934; a report of the National Resources Board, December 1, 1934, especially part 3, the report of the Water Planning Committee, "National power survey interim report, Power Series no. 1," by the Federal Power Commission; and "Potential water power sites, summarized from reports by the Corps of Engineers to the Congress," March 1935. There have been almost numberless other evidences, of varying degrees of importance, of the gradually broadening national consciousness with respect to water resources, to which only bare reference can be made here.

The need of organized effort in the investigation of the flood flow of streams has long been recognized. As a consequence there have been organized from time to time numerous governmental and private agencies, which have proceeded in their respective ways to make such investigations of the subject as were required for the solution of their particular problems or as lay within the fields selected for their activities. Throughout the United States, particularly in recent decades, there have been numerous earnest and competent efforts at furthering the systematic knowledge of the flood characteristics of streams, for the solution of specific problems for certain localities and for contributing sounder bases of analysis for the solution of flood problems in general. It is not practicable to cite at this place even the more notable of such investigations, but references to many of the reports are included in the bibliography (pp. 468 to 487).

Many of the earlier studies have involved an aggregate effort much in excess of that which was possible under the present project and have produced very notable results. The detailed and voluminous reports concerning some of the special investigations for flood-control districts, for example, and several years of preliminary and continuing study while the projects were developing or under construction, cannot be duplicated under the present authorization for studies of floods in the United States. The most that can be reasonably expected is a single volume, designed to be one of a possible series if activity in this field is continued.

In addition to the limitations of time and personnel available, the broad scope of the investigations underlying this report should be mentioned. Unlike studies pertaining to single districts or limited regions, the present project was intended to encompass the entire country and to include the compilation of correspondingly comprehensive flood data and the development of pertinent correlations and comparisons. As the work progressed it was found necessary to give priority to the compilations of data, and to defer the earlier plan of making some sort of correlation of results.

It is fully realized that such merit as may be claimed for any part of this report should be credited largely to preceding investigations and assembled records. It is hoped that this report may facilitate further studies by placing observed data in convenient form for reference and use, by showing relative advantages and disadvantages of various methods and avenues of approach or treatment of data, and by recognition of the limitation of even the best of devices or methods of analysis in comparison with carefully observed and recorded physical data.

One of the prime objectives of the present study was to review in a fundamental way the existing methods and technique of estimating and analyzing floods. Therefore, the first steps in the investigation involved (1) a compilation and review of the literature treating this subject and the subject of flood occurrences in general and (2) a review of methods of estimating floods and the preparation of a manual for guiding the application of such methods as seemed to be required. The results are presented in the bibliography (pp. 468 to 487) and in the chapters entitled "Methods for estimating floods" (pp. 28 to 67) and "Examples of procedure" (pp. 68 to 89).

In the early stages of the present flood study it was recognized that many phases of the selection, plotting, and interpretation of flood data should be reviewed before adopting a definite procedure from among the several that have been proposed or used to a notable extent. The group engaged on this project therefore considered as many different lines of approach as seemed promising and undertook to conduct independent tests of results to be derived from them.

As explained in some detail under appropriate headings elsewhere n this report, flood data may be collected on the basis either of maximum daily average discharge or of momentary peak discharge for each flood rise, but in practice the former is generally used, because of its uniform availability. Furthermore, these data may be distributed with regard to time as annual floods, monthly floods, daily flood peaks of flood events, or complete series of average daily flows above some arbitrarily adopted base flow, commonly coincident with the minimum annual flood for the period of record. (For definitions of terms as used in this report see pages 462 to 467).

Floods caused primarily by ice obstructions, dam failures, high tides, and gales are intended to be excluded from the tabulations. Such flood conditions are not necessarily indicative of high natural rates of run-off but frequently occur at times when stream flow would normally not have exceeded bank-full stages. Backwater caused by ice jams and the movement of large masses of ice have inflicted annually much damage in norther sections of the United States - in some localities more damage than is caused by unimpeded storm run-off.

Flood data having been listed to conform with each of the several methods above mentioned, for more than 20 widely separated stations, the next step was to plot the data on the various types of cross-section charts, including arithmetic probability paper, logarithmic probability paper, log-log cross-section paper, semi-log charts, and ordinary cross-section paper. After the data were plotted the lines or curves of average trend corresponding to the plotted points were drawn and then extended to magnitudes and frequencies outside the range of observation. In this manner it was possible to compare the results derived for various periodicities - for example, 1 year, 10 years, and, by extrapolation, 100 years or more, as well as for any desired intermediate periods.

By way of comparison, solutions were made by the mathematical processes devised to fit curves to series of observed data, on such arrays as were strictly time series and thus amenable to such analysis. Likewise, various well-known formulas for estimation of rarely exceeded floods or floods corresponding to designated periodicity were compared with results derived from graphic or mathematical analysis.

The results thus obtained were found to vary throughout a considerable range but not more widely than should be normally expected, in view of the inherent differences in methods of selection and plotting of records. The mathematical or statistical treatment for fitting curves to plotted data usually resulted in fairly close agreement with the curves derived by strictly graphic processes. Many of the widest divergences, as might be expected, resulted from the use of general formulas. One of the misleading aspects of the use of formulas is the close agreement occasionally attained, in contrast with the usual wide differences either above or below results obtained by the graphic processes.

After consideration of the availability and significance of the various kinds of data, the labor involved in their listing and analysis, the probable uses to which they may be applied, and the kind of information usually desired, it was decided that flood events or rises generally afford very satisfactory basic items for such a study - in other words, for each flood rise the highest average flow for a calendar day ("daily flood peak") and the "momentary" flood peaks, either or both as available, chronologically listed as shown on pages 120 to 397.

This view was confirmed by independent research in mathematical and statistical fields by Prof. J. J. Slade. Quoting from his letter of July 25, 1934, addressed to Prof. Thorndike Saville:

"Flood peaks present the most satisfactory statistical population in a record of stream flow. . . Daily flood flows are not independent events - that is, a high flow implies high flows preceding and following it."

Other pertinent tests and analyses of flood data by graphic means were made as described on pages 74 to 87, by comparing trends derived from total records. In the category of investigation of fundamental technique and methods fall also studies and researches by Professors Saville and Slade. Professor Saville has contributed a study of the application of methods of estimating flood flows to records of the Tennessee River at Chattanooga, Tenn., which appears on pages 398 to 420. This is presented as an example of statistical and mathematical approach and treatment and a comparison of results derived from the separate methods. It is not intended as an endorsement or recommendation for any particular method of analysis, but rather as a clear exposition of the application of such devices. A digest of Professor Slade's studies appears on pages 421 to 432.

Studies by Merrill M. Bernard in the application of the unit-hydrograph method are described in the report on the associated study of relations of rainfall and run-off (Water-Supply Paper 772). A digest of these studies as they relate to the application of the method to the investigation of floods from excessively heavy rainfall appears on pages 451 to 461 of this report.

The most important feature of the investigation has been the compilation of flood records on representative streams. The effort has been made to insure that these flood data should be as authentic and reliable as possible.

The desirability of procuring long-period records of rainfall and run-off has been recognized in many notable investigations, wherein many short records were combined or laid end to end, so to speak, for analysis as a single composite record. Thereby composite records totaling several hundred years or even running into thousands of years have been brought together for consideration and analysis. However, the question arises as to the comparability of composite records with those based on observations at single stations for like periods.

Among the rivers in the United States for which most promising long-period records of stage are available, the Delaware, the Susquehanna, the Potomac, the James, and the Roanoke all cross the Fall Line marking the boundary between the Coastal Plain and the Piedmont belt, where there are durable rock dikes or other resistant ledges capable of maintaining the channel section with little change for hundreds of years. Fortunately, some of the river-stage records were obtained at or somewhat upstream from such permanent controls, and therefore they show the most notable flood occurrences on some of those rivers for 200 years or more, with continuous records during recent decades. Where the river channel is not so nearly permanent, as on the Ohio River at Pittsburgh or Wheeling and on the Mississippi River at St. Paul or St. Louis, and where the channel material is notably unstable, as throughout the lower Mississippi Valley, the records of stage are less capable of satisfactory transformation into corresponding discharge. Despite such instability of channels, and the changes in stage-discharge relations wrought by levees, contraction works, channel rectification and stabilization, and drainage and reclamation projects, the long records of maximum annual river stages in the lower Mississippi Valley, for example, are still regarded as of considerable interest and historic value and as worthy of space in this report. Naturally, such records are listed as gage readings only, even though approximations to corresponding discharges are available for recent years and for a few others more or less irregularly distributed. It has been observed at several stations along the lower Mississippi River, for instance, that the stage-discharge relation is affected materially by the phase of flood and by the manner of succession of flood rises, so that the usual procedures for converting gage readings into corresponding discharge quantities are not applicable. It is conceivable that a thorough coordination of all available data regarding stages and discharges of the main river and its tributaries, together with a consideration of channel and valley storage, may yet be accomplished, to permit estimates of river discharge for the floods of record. The labor involved in such a coordination program is clearly beyond the scope of the present investigation.

An interesting incident of the initial exploratory studies was a more or less brief examination of the available long-time records of floods on foreign streams. It was the hope that this examination would, by reason of the long experience represented by such records, disclose some of the characteristics of floods with respect to their magnitude and frequency and thus furnish a desirable adjunct to this investigation. It has seemed inappropriate to present the detailed results in this paper, but a digest of some of the more important features follows:

There are no systematic records of discharge on any river in any country extending back more than 50 or 60 years. For many of the rivers of Europe there are records of flood heights for several hundred years, though generally they incorporate only the notably high floods of earlier centuries. For several French rivers the records extend back into the sixth and seventh centuries and therefore afford fragmentary data covering more than 1,000 years.

Records of greater length but with less certainty regarding altitude of reference points have been kept in Mesopotamia, India, and China. Unfortunately, little is known regarding the comparative channel cross sections and the tendencies of the rivers either to erode or to deposit bed loads in the vicinity of the gages. It follows that equal gage readings many years or centuries apart may not indicate even approximately equal flood discharges. By far the longest available records with fixed datum planes are those made in the neighborhood of the second Nile cataract, in upper Egypt. Some of the inscriptions on canyon walls date back to 1800 B. C. or earlier. With allowance for the weathering and erosion of river banks and channel bed, these records lead to the conclusion that not only in magnitude but also in frequency and irregularity of occurrence the notably high Nile floods of those early days closely resembled those of recent centuries.

The longest continuous record of annual flood heights now available was made at the Roda gage, on the Nile at Cairo, at the apex of the delta. Although the structure containing the graduated masonry column used as a nilometer has every appearance of stability, it is known that many changes have taken place along the channel during the 13 centuries covered by the record and that these changes must have affected the stability of the stage-discharge relation for this point. Among them are changes in the number and position of outlet channels to the Mediterranean and Red Seas and in the number of branches and canals for diverting flood waters from the river in that vicinity; the construction of protection dikes and other improvements along the banks; the deposition of silt, which accounts for a fairly uniform aggradation of land surface within the flood plains amounting to a rise of 5 or 6 inches to the century; the opening and closing of dikes, canal headgates, and flood channels, either as regulatory measures or in consequence of devastating inundations; and attempts at barrage construction. Furthermore, considerable variations in magnitude and duration of flood stages were attributable to changes in the amount of natural and artificial storage within the drainage basin during the period of record.

The available records pertaining to the Roda gage, comprising what purport to be maximum annual flood stages for nearly 1,200 years during the last 13 centuries, have been plotted on a single chart together with the corresponding low-water stages for some 1,100 years within the same period of record. This chart, together with a somewhat detailed discussion of long-period river records with special reference to floods, is in process of publication* at the time of this writing. What is perhaps the most significant observation concerning the nilometer record at Roda is similar to the conclusion expressed above regarding the longer period of fragmentary records at the second cataract and is applicable in some degree to all other long-period river-stage records investigated under this project - namely, that the variations in river stages from year to year and from century to century show no well-defined or progressive changes from the earliest periods of record to the present day except as may be explained by sedimentation, erosion, or regulation. However, it is readily apparent by reference to the Roda gage record about 1000 A. D., for example, that analysis of that part of the record would result in a graph or curve of quite different trend from those derived from the record for other centuries, and notably for the period from 1831 to 1930, during which permanent barrages and storage reservoirs have been constructed and perennial irrigation for lower Egypt has been accomplished.

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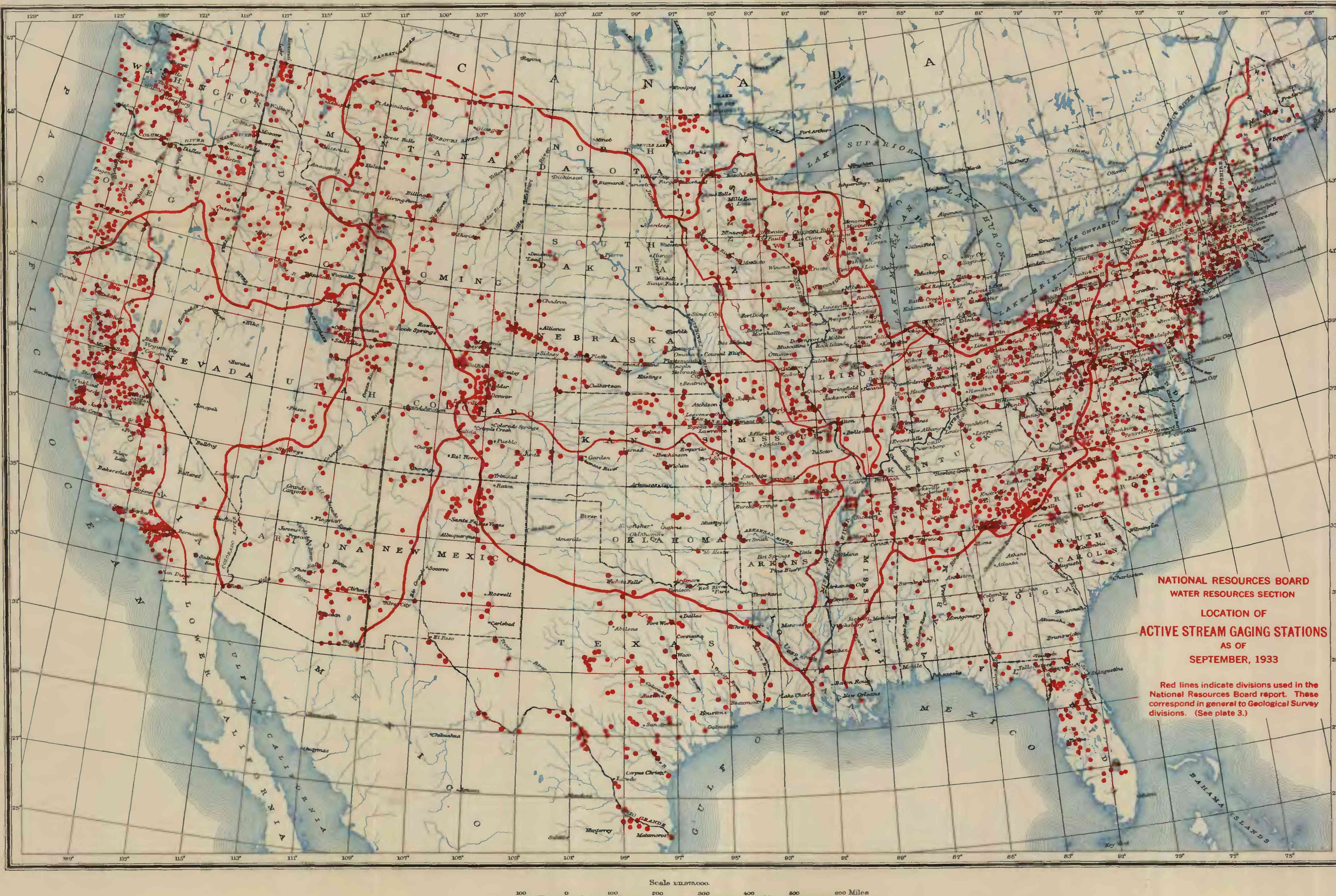
* Jarvis, C.S., Flood stage records of the Nile River; Am. Soc. Civil Eng. Proc., vol. 61, p. 803, August, 1935.


NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
LOCATION OF
ACTIVE STREAM GAGING STATIONS
AS OF
SEPTEMBER, 1933
Red lines indicate divisions used in the National Resources Board report. These correspond in general to Geological Survey divisions. (See plate 3.)
PACIFIC OCEAN
GULF OF MEXICO
CANADA
MEXICO
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
ILLINOIS
KENTUCKY
GEORGIA
SOUTH CAROLINA
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
BAHAMA ISLANDS
LOWER CALIFORNIA
GULF OF CALIFORNIA
Scale 1:11,875,000.
100 0 100 200 300 400 500 600 Miles

It appears to be the consensus of opinion that there is an attractive field for further studies of various aspects of floods, both those treated in this report and others, which will give results of great public value and may appropriately be carried on by a governmental agency or agencies. For example, there is opportunity for profitable research in relation to great floods of the past, with a view to making available for guidance of present development the most authentic possible records of such critical events. It is believed that careful search in a variety of sources of record would yield information which at present is at least not generally or readily available. There is opportunity for a beneficial study of total volumes of floods as contrasted with their rates of flow, for consideration in projects involving limited availability of storage and appropriate spillway design. Studies of the flood-producing capacities of drainage basins as revealed by an analysis of meteorologic and hydrologic factors may be advanced with advantage. The list of profitable projects of flood investigation is long. The present and many previous investigations have fallen far short of covering the field in an adequate way.

As illustrative of recent progress and the present status of stream measurements in this country, which provide basic information for such studies as the present one and also for those mentioned in the foregoing discussion, plate 1 is presented herewith. This map was reproduced from page 304 of the report of the National Resources Board, dated December 1, 1934. This map shows the locations of all the active stream-gaging stations reported by the United States Geological Survey on September 30, 1933, a total of nearly 3,000. This represents approximately one-half the total number of stations for which records have been published by the Geological Survey and other agencies since the beginning of stream gaging in this country.

METHODS FOR ESTIMATING FLOODS

The purpose of the study embodied in this chapter is to make a compilation of various methods representing the principal bases of approach thus far proposed for estimating the rate of flood flow to be expected on any given stream, together with a brief analysis of the several methods and a comparison of their relative advantages and disadvantages. No particular attempt is made to select the best methods for use, except as advantages and limitations of particular methods are inherently apparent.

As different lines of reasoning have been followed in estimating floods, and engineers have not reached agreement as to which methods are most desirable under given conditions, it is essential that any study of flood problems be based on an adequate understanding of the various theories and of their relation to one another.

Historical Review

River stages have been regarded as important items of historical records for thousands of years along the Nile, and for more than a thousand years on other foreign river systems, but apparently no successful attempts were made toward translating gage heights into corresponding discharge quantities until the last century or so. The uncertainties or lack of information regarding channel roughness, changes in cross section and gradient, stability of reference datum, and other elements affecting stage-discharge relations prevent satisfactory evaluations of flood flows from most of the recorded river stages, both ancient and modern; and some uncertainty extends to periods after the beginning of reliable discharge measurements.

Among the longest river-stage records available for American streams, extending intermittently over a period of about 200 years, only the later records are capable of satisfactory translation into discharge. Such later records, if they cover a period of adequate length, constitute by far the most reliable bases for flood estimates. A large part of this report is devoted to the presentation of data of flood flows that have been experienced at gaging stations where records of considerable length are available. However, the data now being collected by some governmental and private agencies are gage-height records, with no direct reference to stage-discharge relations. Analysis of available flood data must therefore include gage readings, with or without the corresponding rates of discharge, if the treatment is to be comprehensive in scope.

The need for determination of flood discharge where records are lacking, as they have been more often than not, has led to various efforts to express the rate of flow in terms of known or assumed factors, or some function thereof. Thus, discharge measurements of different rivers may be compared and rates of flood discharge may be found to vary either directly with the size of the drainage area or with some fractional power thereof. The influence of intensity and manner of occurrence of rainfall, or of physical characteristics of the drainage basin may also be evaluated and related to the rates of discharge. Indeed, Hayford* found that 23 factors or coefficients entered into the determination of the discharge of a stream.

Such efforts on the part of hydrologists and engineers during the past century have resulted in several formulas designed to express the observed relationships, some of them distinguished by their simplicity and others by their complexity of structure and symbols. The defect most commonly shared by flood-flow formulas is their restricted applicability, which is due to their being based on local phenomena observed during relatively short periods. It is believed that a general review of some of the representative types of formulas may promote their more intelligent use and possibly prepare the way for other forward steps in this field of study. The preliminary work dealing with this subject has confirmed the view commonly held by modern hydrologists - that at best a general formula is only a temporary substitute for observed or logically derived flood information and should be superseded by or amended in accordance with authentic physical data as they become available. A general expression for extremes of run-off rates is comparable with pioneer equipment for bridging ravines or scaling cliffs, which provides means for preliminary reconnaissance and thus assists the later operations looking toward a trustworthy structure for all reasonable purposes. Any proposed formula should therefore be used with due precautions and restricted to fields in which its applicability has been tested.

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* Hayford, J. F., and Folse, J. A., A new method of estimating stream flow: Carnegie Inst. Washington Pub. 400, 1929.

The earlier efforts at estimating flood flows were in general rather crude, because authentic records of rates of flow on streams were very scanty and the attainable accuracy was below later-approved standards. Practically all such studies were based on observations of flow in small areas or on single streams and were commonly summarized as formulas giving the rate of flood flow expected as a function of the drainage area. Some investigators added other variables, such as length and average width of drainage basin, depth of rainfall, and slope of river, also factors taking into account the soil texture, vegetative cover, and other physical characteristics. As stream-flow data became more numerous, the records of individual floods also increased in number, and tabulations of maximum observed floods on various rivers were made, to be used as guides in estimating future flow from those or other river basins.

One of the earliest extensive investigations in the United States was made by Emil Kuichling and described in the report of the New York State Barge Canal for 1901, which contains a table of floods on American and foreign streams and lists flood formulas that had been proposed by American and European engineers. Kuichling also gives flood formulas of his own, which recognize the two general classifications with respect to periodicity as "rare" and "frequent."

The first comprehensive and scientific approach in the United States toward a study of rainfall and run-off phenomena, with floods necessarily representing the plotted peaks in the hydrographs, appears to be that of George W. Rafter*. On pages 68 and 69 of his paper are forms of duration curves, representing yearly depths of rainfall and evaporation on the Lake Cochituate Basin, Mass. This was followed, in 1905, by his 883-page volume on the hydrology of the State of New York, in which the results of several earlier and related papers and investigations were incorporated, with such revisions of views as had developed during his more recent studies. In this volume frequency of floods was considered briefly, with reference to such rivers as the Tiber and the Seine. However, the dearth of long-period records on American rivers at that time hindered the further application of periodicity investigation.

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* Relation of rainfall to run-off: U. S. Geol. Survey Water-Supply and Irrigation Paper 80, 1903.

A brief paper by Robert E. Horton* discusses earlier applications of the Gaussian principles of probability to rainfall and flood phenomena.

The first really comprehensive study of statistical methods applied to floods in this country was a paper by Weston E. Fuller** presented at the meeting of the American Society of Civil Engineers in October 1913. Fuller was the first to publish a formula introducing the concept of a flood magnitude-frequency relationship into the problem, in this respect following a line of reasoning that was introduced into studies of river flow about the same time by Allen Hazen. Hazen's application of statistical methods to engineering studies and Fuller's adaptation of these methods to flood prediction have had an important influence on engineering developments since that time.

Further extensions and variations of Hazen's and Fuller's ideas have been made by several writers. In addition, various attempts have been made to develop empirical formulas for estimating the magnitude of very large floods on a more logical basis than the older formulas of this type. As stream-flow records have become more extensive and reliable, the tabulations of extreme floods have increased in value and have provided the basis for more comprehensive studies and approaches to general formulas covering more adequately the practical range of flood phenomena.

An entirely distinct line of study has been made in recent years by dealing with rainfall and its relation to run-off, by so-called "rational" methods, which involve attempts to determine stream run-off by analysis of rainfall records and corresponding hydrographs, with due consideration of the influence of ground water, evaporation, transpiration, shape of drainage area, et cetera. Related to such procedures are studies of frequency of intense rainfall and its distribution over large areas, the most notable of which are those published by the Miami Conservancy District, whose report on "Storm rainfall of eastern United States" is a classic in this field.

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* Frequency of recurrence of Hudson River floods: U. S. Weather Bureau, Bull. Z, pp. 109-112, 1913.
** Flood flows: Am. Soc. Civil Eng. Trans., vol. 77, pp. 564-617, 1914.

In the following pages the various methods, including the formulas suited for use where flow records are sparse and also the devices for analyzing observed flows where data are more ample, will be classified as to broad general types. An effort will also be made to show their distinctive features and to clarify certain points that have been confusing and have led some investigators into difficulties.

Classification of methods

The various methods of estimating floods may be grouped into the following classification:

- A. Extreme-flood formulas.
- B. Flood-frequency formulas.
  - 1. Formulas with frequency relation implied.
    - a. Formulas involving only drainage area.
    - b. Formulas involving length or width of drainage basin.
    - c. Formulas involving rainfall plus other factors.
    - d. Formulas involving total flood run-off.
  - 2. Formulas with frequency relation expressed.
- C. Statistical (or probability) methods.
  - 1. Theoretical probability curves.
  - 2. The duration-curve method.
- D. Methods dependent on relation of rainfall to run-off.
  - 1. "Rational" methods. Under this heading would come the methods for determining the frequency of rainfall of various intensities.
  - 2. The unit-hydrograph method.
- E. Method for estimating peak flow from 24-hour average flow.

A. Extreme-flood formulas

The fundamental relation that has been most often employed in extreme-flood formulas is that between rate of flow and some power or other function of the drainage area. The best handbooks and treatises on engineering hydraulics list a large number of such expressions, with the powers of drainage areas ranging from about 0.5 to 0.8, and some of them introduce other factors. Limitations of space as well as inherent restrictions in their significance preclude a complete listing and consideration of these formulas. It is proposed, therefore, to discuss in detail only such formulas as make use of the periodicity or frequency, probability, rainfall, or similar relations, which mark the later trends of scientific investigation in the hydrologic field. Some formulas that are about equally representative of extreme-flood and flood-frequency concepts are thus given consideration, even though such concepts were somewhat vague in the early attempts at developing the idea of frequency or of periodicity. Precautions against inexperienced or ill-considered use are particularly applicable to such formulas and in varying degree to all similar expressions.

B. Flood-frequency formulas

1. Formulas with frequency relations implied

a. Formulas involving only drainage area

The simplest type of rare-flood formula is that relating the maximum expected flood to the drainage area. A large group of formulas are of the type

$$\text{Flood flow} = Q = CA^n$$

where C is a coefficient, A the drainage area, and n a constant. The value of n is chosen by the investigator so as best to suit the flood records which the formula is to represent or to envelop, and has been given variously, from 0.5 to 0.8 or even as high as 1.0. The coefficient, C, must vary to suit local conditions, combining the rainfall and run-off characteristics of the drainage area under consideration, the season of the year, and the probable frequency of occurrence.

A formula of this type is the "modified Myer formula" (Am. Soc. Civil Eng. Trans., vol. 89, p. 994, 1926):

$$Q = 10{,}000\ p\sqrt{M}$$

where Q is the flow in c.f.s., M the drainage area in square miles, and p a variable percentage coefficient expressing the ratio of the maximum flood for the given stream to an assumed extreme maximum of all streams.

Kuichling (op. cit., p. 844) gives several formulas of this type, mostly based on rivers in India. In other formulas the area enters as a more complicated factor. Two of Kuichling's formulas are as follows:

$$(1)\quad q = \frac{44{,}000}{M + 170} + 20 \text{ (for frequent floods)}$$

$$(2)\quad q = \frac{127{,}000}{M + 370} + 7.4 \text{ (for rare floods)}$$

where q is the maximum flood in c.s.m. (c.f.s. per square mile) and M is the area in square miles. To convert the units into flood discharge rate in c.f.s., both members of the equations must be multiplied by M. The first expression applies to all but exceptionally heavy spring freshets; the second is exceeded only in cloudbursts or under a very rare combination of favoring circumstances. Where M is 1,000, the rare flood as thus derived is about 170 percent of the frequent flood; where M is 10,000, the percentage is 124. Thus Kuichling made some attempt to consider the frequency of the floods. Similar formulas quoted by Kuichling are the Ganguillet formula (for Swiss streams), the Italian formulas, and the O'Connell formula (English), all apparently intended to represent the rate of discharge to be attained at rare intervals.

The "culvert formulas" used in railroad work (such as those of E. T. D. Myer, A. N. Talbot, and J. T. Fanning) and the storm-sewer formulas (such as that of R. McMath) are also of this type. (See Merriman, American civil engineers' handbook, 5th ed., pp. 2009-2010, 1930.)

In all formulas of this type, if the numerical coefficients are given, the formula should be restricted in use to the region for which it was prepared and perhaps to comparable regions elsewhere; otherwise the coefficients must be newly determined to suit the stream under consideration, which will probably require considerable study of existing records.

b. Length and width formulas

A group of rare- or high-flood formulas involves the length or average width of the drainage basin.

Kuichling quotes the Craig formula, based on Indian records (Inst. Civil Eng. Proc., vol. 27, p. 217, 1868):

$$Q = 440\ nB\ (\text{hyperbolic log } \frac{8L^2}{B})$$

where L = length of basin, in miles.

B = average width of basin, in miles.

n ranges from less than 1 to more than 2, with rainfall and topography.

For any assumed rates of rainfall, the resulting floods should fall into corresponding classifications, as frequent or rare, with due regard to such factors as seasonal influence, soil moisture, and vegetation. The Craig formula was apparently the first to include the shape of drainage area as a factor.

The Dredge or Burge formula (based on Indian records) is

$$Q = 1{,}300 \frac{M}{L^{2/3}}$$

Inasmuch as area (M) equals average width times length (W L), this expression is evidently reducible to the form $Q = 1{,}300\ W\ L^{1/3}$ and thus may be accorded a place among formulas based essentially on width or length or shape of drainage basin.

c. Formulas involving rainfall

Some formulas include a rainfall factor, together with the drainage area or other factors.

1. Kuichling quotes the Burkli-Ziegler, Possenti, and Cramer formulas, which are of this type. He gives the Iszkowski formula as developed in Austria (Am. Soc. Civil Eng. Trans., vol. 77, p. 648, 1914).

2. C. E. Grunsky (Am. Soc. Civil Eng. Trans., vol. 85, pp. 66-136, 1922) proposed a formula based on California records, in which the frequency relation is expressed in the intensity-duration measure of the rainfall:

$$I = \frac{C}{t^{\frac{1}{2}}}$$

where t is the critical time, in minutes, during the continuance of a rainstorm for the area under consideration, within which the rain will produce the maximum rate of run-off (table is given in Military Engineer, May-June 1931, p. 226); I is the rainfall intensity, in inches per hour, throughout the entire drainage basin; and C must be determined from local records of rainfall. The maximum rainfall in one hour is expressed as

$$R \text{ (inches)} = 0.129\ C$$

The maximum stream flow from large areas is

$$q = 413\ aI, \text{ in c.f.s. per sq. mi.}$$

or $$q = \frac{3{,}200\ a\ R}{t^{\frac{1}{2}}}$$

where $$a = \frac{60}{60 + C \cdot \sqrt[3]{t}}$$

C ranges from 0.5 for impervious areas to 250 for sandy regions.

3. G. E. Lillie (Inst. Civil Eng. Minutes of Proc., vol. 217, pp. 295-332, 1924) proposed a formula involving both rainfall and shape of basin:

$$Q = VR\lambda\Sigma(\theta L)$$

where Q = peak discharge, in c.f.s., representing the potential maximum.

V = standard mean velocity of river in flood.

$R = 2 + \frac{\text{annual rainfall}}{15}$ (for areas less than 10 square miles, $R = 4.0$).

$\lambda = 1.1 + \log_{10}L'$.

L' = length of drainage basin in miles.

L = length of the several sectors of drainage basin in miles.

θ = angle of the several sectors of the drainage basin, in degrees.

The drainage basin is divided into a number of sectors, centering at the gaging point. The expression $\Sigma(\theta L)$ is proportional to the width of the drainage basin, the reduction factor 57.3 being applied to convert degrees into units of circular measure. This formula relates to rivers in India. For small rivers it was proposed as giving a flood that may be realized only once in a "lifetime"; for larger rivers, a discharge only slightly greater than an ordinary heavy flood. The "standard velocity" of a river generally will not vary to any great extent from source to mouth, according to Lillie's assumption.

4. C. R. Pettis (A new theory of river flood flow, published privately, 1927) proposed this formula:

$$Q = CPW^{1.25}$$

or, as modified in Engineering News-Record, June 21, 1934, p. 804, $Q = C(PW)^{1.25}$

where Q = peak flood discharge in c.f.s. (presumably the 100-year maximum flood).

C = a mensuration factor, or coefficient representing the combined influence of other factors, such as regional and drainage-basin characteristics.

W = average width of drainage basin = $\frac{\text{drainage area}}{\text{length of main stream}}$

P = a rainfall coefficient.

For the recently modified expression P is the probable 100-year maximum 1-day rainfall, in inches. As originally proposed, it was the 100-year pluvial index of a 6-day storm, from "Storm rainfall in eastern

United States," Miami Conservancy District reports, 1917, part 5. Therein it is disclosed that, practically without exception, the 1-day pluvial index is more than half of the 6-day index.

For the rivers originally studied (northern United States, Ohio to Connecticut), when P is based on 100-year 6-day rainfall, C = 328; when P is based on 100-year 1-day rainfall, C = 480. For the expression as modified in June 1934, based on P representing 100-year 1-day rainfall, the numerical value of C will range in different regions from 310 in humid areas to 40 in desert areas, such as central Nevada.

The Pettis formula is based on several assumptions, including the consideration of a single storm covering the entire width of the drainage area, when the soil moisture content is high initially, and the average channel slopes and stream velocities are fairly uniform at all controlling cross sections. Limitations of the Pettis formula are summarized as follows:

(a) The "width formula" should be limited generally to drainage areas between 1,000 and 10,000 square miles, although it may be applicable in some areas outside these limits.

(b) There must be no extensive lakes or artificial storage in the drainage area.

(c) The drainage area must be of fairly uniform width throughout its length. If wider at its lower end, the formula gives too small a flood; if wider near its upper end, the formula gives too large a flood. Corrections of 10 to 13 percent may be required owing to variations in width.

5. F. S. Besson (Military Engineer, September-October 1933, p. 424) proposed a generalized formula:

$$Q_m = P_m \, T \, G_m \, A^x$$

where Q_m = maximum flood flow.

P_m = maximum precipitation during the period of the flood.

T = factor representing influence of topography.

G_m = factor representing influence of ground surface conditions for maximum run-off.

A = drainage area.

x = an exponent to be determined for each drainage area.

Subscript r being used to indicate factors representing recorded flood conditions,

$$\frac{Q_m}{Q_r} = \frac{P_m G_m}{P_r G_r}$$

If ground conditions for the recorded flood are the same as for the maximum flood,

$$Q_m = \frac{P_m}{P_r} Q_r$$

P_r is obtained from the rainfall record of the given storm. P_m is estimated by a study of storm records.

The comparison of factors as employed by this method results in cancelation of such coefficients or reduction factors as are common to numerator and denominator, thus permitting the use of any desired units of drainage area, rainfall depth, and stream discharge. Besson recommends the use of factors of safety, selected according to local conditions, to be applied to the probable future maximum flood estimated as shown above. This method depends on the possibility of properly estimating the maximum expected rainfall, in which the element of probability may enter to some extent. Its accuracy also depends on whether the recorded flood occurred with ground conditions most favorable to the production of floods.

6. F. G. Switzer and H. G. Miller (Floods: Cornell Univ. Eng. Exper. Sta., Bull. 13, Dec. 15, 1929), from a study of 47 rivers in different parts of the United States, propose the following formula:

$$Q = P_c C W^n$$

where Q = 24-hour average flood discharge, in c.f.s.

P_c = rainfall factor.

W = mean width of drainage basin, in miles.

C and n are empirical constants (average values, $C = 80$, $n = 1.5$).

The rainfall factor, P_c, is based on the Miami Conservancy District chart of maximum 1-day rainfall expected to be equaled or exceeded once in 100 years, at single stations, adjusted to allow for time of concentration and for area of drainage basin (by methods of Hazen and Creager). The resulting "corrected rainfall factor" gives the total rainfall over the entire drainage area that would be expected to produce a maximum flood. This formula is similar to the Pettis formula, except that Pettis used the Miami Conservancy District rainfall factors without correction for length of storm or distribution over drainage area. The Pettis formula gives peak flow; Switzer and Miller's formula gives the 24-hour average flood discharge.

d. Total run-off formulas

The Boston Society of Civil Engineers proposed a formula based on a study of floods in New England (Report of committee on floods: Boston Soc. Civil Eng. Jour., September 1930, pp. 297, 376-407):

$$Q = C_F R \sqrt{A}$$

where Q = peak flow, in c.f.s.

C_F = a coefficient, which is a measure of drainage-area characteristics.

R = total flood run-off, in inches on the drainage basin.

A = drainage area, in square miles.

Let T = total flood period in hours (base of triangle representing flood hydrograph); then $C_F = \frac{1290\sqrt{A}}{T}$; therefore $Q = \frac{1290\ R}{T} A$.

Let q = the peak flow in c.f.s. per square mile, or c.s.m.; then $Q = qA$, and accordingly, $q = \frac{1290\ R}{T}$.

The maximum suggested for New England streams is $C_F = 1{,}000$, with $R = 8$, equivalent to 80 percent on the Myer scale mentioned above.

Total estimated run-off depths from severe storms: for occasional floods (about 50-year frequency), 3 inches; for rare floods (50- to 200-year frequency), 6 inches; for maximum flood (200 years or more), 8 inches.

The idea of a fairly constant base for hydrographs of storm run-off at a given station, with the peak discharge varying with the magnitude of that portion of the rainfall appearing as direct surface run-off during a prescribed period, expressed or implied in connection with the presentation of this formula, is one of the fundamentals underlying some of the most valuable recent contributions to the science of hydrology. These have to do with the unit hydrograph and distribution graphs and related methods of analysis, discussed on pages 65, 451-461.

The effect of pondage is to reduce the peak flow in the direct ratio that the volume of pondage bears to the total flood run-off.

The frequency of occurrence of a flood is involved to some extent, through selection of the magnitude of R, though on a somewhat arbitrary basis, evidently intended to represent a fair estimate of broad experience in this field. The principal difference between this Boston Society formula and most other formulas is the introduction of the term R, which affords a unit of measure independent of area, thus making it possible to compare floods on different drainage basins. A somewhat similar or related factor appears in the Pettis formulas as P, the rainfall coefficient or pluvial index, indicating the total precipitation expected to occur once in 100 years at any rain-measurement station during a storm of given duration, ranging from 1 to 6 days. From the known relations of rainfall to run-off, it is apparent that R should represent varying percentages of the average rainfall over the drainage basin, up to 100 percent as a limit, except in the event of released storage or melting snow and ice, when R might occasionally exceed the average rainfall. On an equal area of a neighboring river system the total run-off from a single storm might be considerably greater or less, and the coefficient for such a drainage basin might vary so as either to balance or to magnify such differences in rate of discharge; yet these facts or estimates would be readily shown by this formula.

The foregoing formulas with implied frequency relations all give maximum rates of discharge for a short interval of time (except Switzer and Miller's formula, which is for a 24-hour flood). To summarize some of Hazen's comments relating to his collection of data and their analysis by such formulas (Flood flows, pp. 117, 123, 1930): All the data treated represent peak rates of discharge; 1-day average floods are not used. This is a difference that is important and is greatest for small areas. The length of time in the record period does not enter this picture. Many of the floods considered are isolated occurrences on streams that are not ordinarily gaged. There is no basis for comparing them with the mean flood of the same stream. Most of the items are not very accurate. The methods above described may be the best to use in regions where local data are meager. They also serve as a basis for roughly checking estimates by other methods. There is no question that there have been a few enormously high rates of run-off from small areas that apparently do not fall in line with other methods of estimating floods.

One of the important features of methods utilizing the maximum recorded discharge is the use of tabulated records of floods on numerous rivers, in which the length of record period provides a first approximation to the probable frequency. The most recent extensive table of floods hitherto published is given in Am. Soc. Civil Eng. Trans., vol. 89, pp. 1003-1029, 1926. Other published tabulations are as follows:

Emil Kuichling, Annual report on the Barge Canal, New York, 1901, p. 844.

Emil Kuichling, Am. Soc. Civil Eng. Trans., vol. 77, p. 650, 1914.

Weston E. Fuller, idem, p. 564.

H. P. Eddy, Am. Soc. Civil Eng. Trans., vol. 85, p. 1528, 1922.

Joel D. Justin, Am. Soc. Civil Eng. Trans., vol. 87, p. 135, 1924.

Practically all the extreme or rare flood formulas include an area factor. The shape of drainage basin is involved in the Craig, Dredge, Lillie, Pettis, and Switzer and Miller formulas. A rainfall factor is included in the Grunsky, Lillie, Pettis, Switzer and Miller, and several European formulas.

The formulas discussed under this heading do not involve primary consideration of probable frequency of floods; such conceptions in their beginnings were somewhat vague and were utilized only indirectly in the selection of the proper values of the coefficients to be applied in any particular formula.

2. Formulas with frequency relation expressed

A distinct group of methods for studying flood flows is that involving a primary consideration of the frequency with which floods of any given magnitude may be expected on a certain river. The following are the best-known formulas that have been proposed to express the direct relation between the intensity of flood flow and the expected frequency of its occurrence:

1. Weston E. Fuller (Am. Soc. Civil Eng. Trans., vol. 77, p. 564, 1914) is credited with the first published formula involving flood frequency. Robert E. Horton, in his discussion of Fuller's paper, states that the use of probability methods in run-off studies had been suggested to him in 1896 by George W. Rafter, with whom he was associated in the

preparation of "Hydrology of the State of New York." Horton had made numerous plottings of flood-frequency records on logarithmic paper, prior to 1908. (See notes below on Horton's formulas.) Fuller's formulas are:

$$Q_{ave} = CA^{0.8}$$

$$Q = Q_{ave}\,(1 + 0.8 \log_{10} T)$$

$$Q_{max} = Q\,(1 + 2A^{-0.3})$$

where Q_{ave} = the average of the annual floods (24-hour), in c.f.s.

Q = the probable greatest average rate of flow in c.f.s. for 24 consecutive hours during a period of years (T), (maximum 1-day flood).

Q_{max} = the maximum rate of discharge of a flood, in c.f.s.

A = drainage area, in square miles.

T = the number of years in the period considered.

C = a coefficient, which is assumed to be constant for the river at the point of observation.

The formula for Q_{max} is an approximate relation and was based on only 26 available records of the maximum flood and the 24-hour flood. The maximum flood does not necessarily occur on the same day as the 24-hour flood.

The formula for Q is intended to give the "average maximum flood" as compared with "the flood to be equaled or exceeded" as used in other methods. For a given record, Q is determined by the following procedure:

1. From each year's record, obtain the maximum daily flow. The average of these maxima for all the years of record is the "average yearly flood," or Q_{ave}.

2. List all such annual floods in order of magnitude and number them serially.

3. Compute ratio of each flood to the average annual flood, Q_{ave}.

4. Sum up all the floods equal to or exceeding the flood concerned; that is, the one corresponding to any given serial number.

5. Divide item 4 by the serial number of the flood concerned to obtain Q_{ave} for that portion of the record.

6. Divide total number of years represented in record by the

serial number of the flood concerned to find the corresponding period of years.

Item 5 represents the average of the floods that occur in the period of years found by item 6; that is, item 5 derives Q for the years (T) found by item 6.

The "flood to be equaled or exceeded" as used by Hazen and others, for any given serial number in the order of flood magnitudes, is given by item 3, for the period of years in item 6.

Comments on Fuller's formula: Q_{ave} is the same as the "average 1-day flood" as used by Hazen. For the whole period of record Fuller's Q_{max} is the same numerically as Hazen's "maximum 1-day flood"; but Fuller regards it as the average maximum for the period in which such floods recur, whereas Hazen treated it as a magnitude to be equaled or exceeded. For smaller numbers of years (T) the Fuller and Hazen methods give different results, those from the Hazen method usually being smaller. The influence of storage, slopes, shape of drainage basin, etc., is included in the value assigned to the coefficient, C. The proper value to be adopted for T depends on the chance to be taken, the hazard varying inversely with the length of the time interval.

Compared with other formulas, Fuller's gives considerably higher rates of flood for very small and very large drainage areas. It was based on records of a large number of American and some foreign rivers. An application of the Fuller method to flood data on the Tennesee River at Chattanooga has been contributed by Thorndike Saville, pages 398 to 403.

2. Robert E. Horton* (Am. Soc. Civil Eng. Trans., vol. 77, p. 665, 1914) gives a formula suitable for eastern Pennsylvania streams (records of 1885-94), which may be rendered in the following form, to agree with the usual nomenclature,

$$q = 4021.5 \frac{T^{0.25}}{A}$$

in which A = drainage area in square miles.

q = flood "equaled or exceeded" in an average interval of T years, in c.f.s. per square mile.

Horton gives the following general formula, which involves the assumption that there is a certain maximum finite rate of flood discharge (Am. Soc. Civil Eng. Trans., vol. 89, p. 1086, 1926):

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* Details regarding further development and use of the Horton formula may be found on p. 437.

$$R = R_g \left(1 - e^{-kt^n}\right)$$

where R = ratio of magnitude of the event to its average magnitude.

t = average "exceedance" interval of an event of magnitude R.

e = base of the Naperian (or hyperbolic) logarithms.

R_g = true maximum or limiting value of the magnitude of the flood or other phenomenon.

k, n = constants.

Values of k, n, and R_g may be determined from the lower definitely located portion of the "exceedance" interval curve. For Connecticut River records (1843-1917), Horton gives:

$$R = 1.82 \left(1 - e^{-0.255\, t^{0.54}}\right)$$

3. E. W. Lane (Am. Soc. Civil Eng. Trans., vol. 89, p. 1051, 1926) derived an expression to represent the average interval between floods of various magnitudes for New England rivers as

$$Q = K(\log I + B)$$

"in which Q is the discharge in second-feet per square mile, which would be equaled or exceeded on the average once in I years; K is a constant for the station in question; and B is a constant for New England streams and probably nearly constant for much larger area."

This expression was later shown to be capable of transformation to a form similar to that of Fuller,

$$Q = C\, A^{0.8} (1 + 0.8 \log T)$$

4. S. L. Moyer has proposed a method for plotting a frequency curve of floods, rainfall, or other hydrologic data (The rainfall hazard, private manuscript, about 1929. See also Am. Soc. Civil Eng. Trans., vol. 93, pp. 907-919, 1929). His general frequency formula is

$$F = \frac{a}{b-N}$$

where $a = T + 2\frac{T-1}{J-2} - 1$

$b = T + \frac{T-1}{J-2}$

c = a constant, to be evaluated for each problem.

$d = \frac{2}{3F} + \frac{20}{F+59}$

$J = T + \frac{14T}{T+13}$

Also $Q = (c-d)\ e$ magnitude of flood,

where ce = upper limit, when $F = \infty$.

$(c-1)\ e$ = lower limit, when $F = 1$.

e = difference between upper and lower limits.

$d = \frac{3}{10\ F} + \frac{35}{F + 49}$, for rainfall and similar studies.

In these formulas,

T = total number of items in the record series.

N = numerical order of any item, arranged in order of increasing magnitude.

J = "basis of frequency distribution, or the average interval in the count of opportunities in the sum total of the chances, between events exceeding the maximum of T observations."

F = frequency or average interval between events of given or exceeding magnitude.

$P = \frac{1}{F}$ = probability or proportion of the total events exceeding the magnitude of the given event.

5. W. P. Creager (Hydroelectric handbook, p. 55, 1927) proposes the following formula:

$$Q = CA^{0.5} \left[\frac{2-e^{-0.04\ A^{0.3}}}{3} \left(1 - \frac{\log 0.1\ T}{3} \right) + \frac{\log 0.1\ T}{3} \right]$$

where Q = peak flood flow, in c.f.s.

A = drainage area, in square miles.

e = base of Naperian or hyperbolic logarithms.

T = frequency in years.

C = a coefficient depending on characteristics of the drainage basin; 6,000 for areas having characteristics most favorable to large floods.

Comments on flood-frequency formulas: The flood-frequency formulas are closely related to the statistical or probability methods, described under the next heading. The statistical methods as a rule do not attempt to set up general formulas of flood frequency applicable to any number of streams but are intended to be applied to the flow records of individual rivers in order to determine the probability of occurrence of floods of different magnitude as indicated by those particular records. The flood-frequency formulas, on the other hand, are attempts to generalize the probability expressions so as to cover a large group of streams, thereby eliminating the necessity for a detailed analysis of each flow record and being applicable especially to streams on which flow records are lacking or few in number.

Fuller's formula is intended to give the "average maximum flood"; the others give the flood "to be equaled or exceeded." Fuller says on this point (Am. Soc. Civil Eng. Trans., vol. 89, p. 1078, 1926): "If it were desired to find the flood for which to design, so as to be quite sure that the structure would fail within a given period, then the flood that is equaled or exceeded in the period would be the proper one to use. The writer's view of the matter, however, is that for the design of the structure it is desired to ascertain the flood for which there is an even chance that it will not fail during the period, and for that reason he used the average flood. It really matters little which method is used, if the computer understands what he is doing." According to limited tests and observations, approximately the same results will be obtained by either method, provided the value of T used with the "equaled or exceeded" method is twice that used in Fuller's method.

Adolph F. Meyer (Elements of hydrology, p. 345, 1917) says: "When meteorological and hydrological data are entirely wanting, so that the cause of floods in the given stream cannot be studied, the use of such formulas as Fuller's may be justifiable, in that they serve as a rough guide."

The Fuller and Creager formulas for the flood to be expected contain as variables the drainage area and the time interval between floods. The characteristics of the drainage area are covered by the coefficient, C. Fuller's formula gives the 24-hour average expected flood, which must be adjusted to give the momentary peak; Creager's formula gives the momentary peak flow.

The Fuller and Creager formulas do not define or make use of an ultimate finite maximum flood. The Horton and Moyer formulas assume that there is such a maximum and proceed to use it. With the Horton formula the flood flow must be determined from the average flood (presumably the average of the annual floods). The ultimate maximum flood and the average flood must be estimated from records on the stream considered, or on similar streams. Thus the Horton and Moyer formulas involve the analysis of individual flood records to some extent.

See also comments under "Curves of average intervals between floods" (p. 58).

C. Statistical (or probability) methods

Under "statistical methods" have been included two general types of methods for estimating the probability of flood occurrence wherever sufficient data are available for their application:- (1) "theoretical probability curves," which are plotted from equations based more or less on the general mathematical theory of probability; (2) the "duration-curve method," which is a strictly graphic treatment of flood records by use of duration curves. Under some conditions the results of the second method may be expressed by an empirical formula.

1. Theoretical probability curves

The theoretical probability curves are all derived from some type of theoretical frequency curve and are more or less closely related to the "normal curve of error." The normal curve is symmetrical, however, whereas the frequency curves used in flood studies are generally asymmetrical or "skew" curves. Many skew frequency curves or families of curves have been proposed for statistical work, but only a few have been applied to any extent in hydrology. The better-known methods are listed below.

(a) Pearson's curves are a family of curves originally proposed by Karl Pearson, of London, and have had extensive use in statistical and actuarial work. They have been subdivided into seven types, of which type 2 is a special case of type 1, and type 7 is the "normal curve." Type 1 and type 3 have been put in a form convenient for use in hydraulic work, by H. Alden Foster (Am. Soc. Civil Eng. Trans., vol. 87, p. 142, 1924). An extension of Foster's tables is given in diagrammatic form by F. G. Switzer and H. G. Miller (Floods: Cornell Univ., Eng. Exper. Sta., Bull. 13, pp. 4-6, Dec. 15, 1929).

The process involved in applying these curves to a particular record consists in computing a "coefficient of variation" (CV) and "coefficient of skew" (CS) from the record, and from these coefficients, by using suitable tabulated factors, plotting the corresponding theoretical duration curve. The duration curve and the original data are plotted generally on "probability paper" (which was originally developed by Allen Hazen), and the theoretical curve is extended beyond the limits of the original record to obtain estimates of floods having any given probability of occurrence.

(b) Allen Hazen (Flood flows, p. 188, 1930) has developed a table of factors for computing a theoretical duration curve by means of the coefficients CV and CS. The table was obtained by empirical methods but gives results closely similar to the Pearson tables. Hazen used tables of this form in 1921 (Am. Soc. Civil Eng. Trans., vol. 84, p. 219). Hazen's and Foster's methods are practically equivalent, except as to the table of skew-curve factors to be used. Hazen's factors give somewhat higher values for the rare floods and hence are more conservative.

The Hazen method may be outlined as follows:

(1) Find the average of the annual floods, in c.f.s., and compute the "flood coefficient," which expresses the relation of the average flood to the size of the catchment area, by the following formula, in which A = drainage area, in square miles.

$$\text{Flood coefficient} = \frac{\text{mean flood}}{A^{0.8}}$$

Hazen's "flood coefficient" is the same as Fuller's C.

(2) Find the coefficient of variation (CV) and the coefficient of skew (CS) of the annual floods. If $d = \frac{\text{recorded value - mean}}{\text{mean}}$ and n = number of items in record,

$$CV = \sqrt{\frac{\sum d^2}{n-1}}$$

$$CS \text{ (computed)} = \frac{\sum d^3}{(n-1)\ (CV)^3}$$

The computed CS should be adjusted to allow for influence of the length of record, by multiplying by the factor $F = 1 + \frac{8.5}{n}$. (In using the Foster tables, $F = 1 + \frac{8.5}{n}$ for curves of type 3 and $F = 1 + \frac{6}{n}$ for curves of type 1.)

(3) Using CV and the adjusted CS, the theoretical curve which will represent the data is obtained by a set of factors, giving variations from the mean at certain percentages of time, the factors being multiplied by the CV to give the desired values.

(4) The theoretical flood curve (duration curve) so computed is plotted on probability paper, a logarithmic scale being generally used for ordinates. The abscissas show "percent of time" or probability of occurrence. The CV determines the general slope of the curve, and the CS controls the point where it reaches the ordinate of mean flood and determines the curvature of the line. In some cases, when the "adjusted CS" results in a curve that does not fit the recorded data very well, other values of CS are tried until a satisfactory fit is obtained. The one finally selected is called the "graphic CS." The latter method should always be used when the series of recorded values contains several zero items.

(5) In estimating floods from curves the ordinate of the flood duration curve at any given percent of time gives the flood magnitude corresponding to the same percent chance of its occurrence. The "1 percent chance flood" is a flow of water that will probably be exceeded on an average in 1 percent of a whole number of years - that is, once in 100 years or 10 times in 1,000 years. The "1 percent chance flood" is often called the "100-year flood." As discussed elsewhere in this report, the 100-year flood will be essentially related to the data on which its determination is based - annual floods, monthly floods, flood events, or other selected data.

Difference in coefficients.- There are great variations in the three coefficients obtained from records of several streams, even in one small part of the country, caused by (1) permanent conditions, depending on peculiarities in the various catchment areas and in their rainfall, climate, and storage, both natural and artificial; (2) temporary conditions, due to the shortness of the record periods and to the effect of chance, tending to decrease as the records become longer.

The flood coefficient is increased by mountainous areas, impervious soil, and high average rainfall and is decreased by storage, natural or artificial.

The CV is affected more nearly in the same degree by permanent and temporary conditions; the CS is affected mostly by temporary conditions.

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In estimating the coefficients for any given stream, the record of the stream itself, if available, should be considered, and also the records of other streams as near and as fairly comparable as can be found. Applications of the Fuller, Hazen, Foster, and Goodrich methods to flood records of the Tennessee River at Chattanooga are made by Thorndike Saville on pages 398 to 420.

(c) L. Standish Hall (Am. Soc. Civil Eng. Trans., vol. 84, p. 191, 1921) proposed a method of plotting duration curves on a special "hydraulic probability paper," in which the probability scale was obtained graphically from a duration curve representing yearly run-off on 35 California streams. In using this paper, any record is plotted as a duration curve, and a straight line is drawn through or close to the plotted points to give the theoretical duration curve. The paper was found to give satisfactory results for many streams, except that some having a high CV did not plot very well.

(d) R. D. Goodrich (Am. Soc. Civil Eng. Trans., vol. 91, p. 1, 1927) proposed a graphic method of plotting theoretical duration curves by use of a special skew-frequency paper. The records are made to plot as straight or approximately straight lines by adding or subtracting an arbitrary constant from the recorded values. (For further applications and refinements of this method see Harris, R. M., Straight line treatment of hydraulic duration curves: Univ. Washington, Eng. Exper. Sta., Bull. 65, May 1932.) Goodrich's method is based on a special equation for the theoretical duration curve. The use of the formula, however, is optional, as the curve itself is obtained by an entirely graphic process, and the constants of the formula are derived from the plotted curve. Advantages of Goodrich's method are:

(1) It may be applied entirely by graphic processes.

(2) It is particularly useful for plotting short-term records.

(3) It does not require extensive calculations, particularly for long-term records.

(4) It is applicable to different types of frequency or duration curves.

Among the disadvantages ascribed to this method are its indefiniteness and the flexibility of the resulting curves, which permit a closer fit to the plotted data than should be expected, or closer than is significant in view of inherent errors and uncertainties of the data.

Comments on theoretical probability curves: The methods noted above are those which have been specifically proposed for use in hydrologic studies. Many other types of frequency curves have been used in statistical work and could probably also be adapted to flood studies. J. J. Slade, Jr., of Rutgers University, has developed a formula that has interesting possibilities for engineering work; this was published in Am. Soc. Civil Eng. Proc., October 1934, p. 1119. Other references are:

Edgeworth, F. Y., Royal Statistical Soc. London Jour., vol. 69, pp. 497-530, 1906.

Saville, Thorndike, Rainfall data interpreted by laws of probability: Eng. News, vol. 76, p. 1208, 1916.

Fisher, Arne, The mathematical theory of probabilities.

Fry, T. C., Probability and its engineering uses.

Kapteyn and Van Uven, Skew-frequency curves in biology and statistics (two papers), Groningen, Hoitsema Bros., 1916.

Ralph R. Randell (Am. Soc. Civil Eng. Proc., January 1928, p. 205) gives several criticisms of the theoretical methods:

(a) The theoretical equation may not express with sufficient accuracy the true relationship during the period and within the range of the observations, as determined by the data of record.

(b) The relationship for other periods or ranges may not follow the same equation or laws. Complications may be caused by planetary or climatic cycles; by influence of storage, affecting one part of the duration curve and not another; or by the likelihood of occurrence of humidity and temperature conditions favoring rain, which affects the whole curve.

(c) Curves drawn by eye should give more reliable results, as they can be made to fit the data near the limits of the region covered.

(d) Mathematical methods convey false impressions of truth and accuracy but are practically valueless for estimates involving very long periods.

John Paul Dean (letter to N. C. Grover, May 4, 1927) considers that the best use for frequency curves is in evaluating the expectancy of frequent phenomena, as in design of cofferdams, roads, and structures.

He questions whether the extension of any type of frequency curve made up solely of records at a single station will give predictions of great precision.

J. J. Slade, Jr. (An asymmetric probability function: Am. Soc. Civil Eng. Proc., vol. 60, pp. 1007-1023, 1934) shows that the normal probability curve has much theoretical and experimental justification under certain conditions and has been found very useful for scientific work. In most engineering problems, however, the normal curve does not apply. As the relation between positive and negative variations is not known, various mathematical expressions must be tried out to find those which best fit the data. The Pearson curves are based on a general formula which merely says that the frequency has a maximum value and that it approaches the axis asymptotically as the frequency vanishes. This results in a variety of types and requires the computation of the fourth moment of the variations to permit determination of the proper type. When the data are meager, a fourth moment is meaningless. (In Foster's application of certain types of the Pearson curves, only three moments are used.) "The various skew functions, though no doubt including the general theory of frequency functions within their scope, are too general in character, Pearson's functions remaining, in spite of all that may be said against them, still the most useful."

Slade does not favor the use of graphic methods. "The methods convey to the eye a simplicity which does not really exist. A straight line which seems to fit the data closely may not be a good fit at all when one remembers that small deviations in certain regions of the paper may represent quite large errors."

Apparently a prerequisite to practical use of the Slade method, as in those of Horton and Goodrich, is the conception and the determination of an ultimate finite limiting magnitude of flood flow, or the limiting flood potentialities of the drainage basin. This item is necessarily derived from a consideration of physical features of the area or of comparable areas elsewhere. One method recently used for this purpose with satisfactory results is the unit or distribution graph, described beyond. After this value has been determined, the Slade method is capable of allocating what seem to be reasonably acceptable frequency positions to flood events of a lesser order.

R. D. Goodrich (Am. Soc. Civil Eng. Trans., vol. 91, p. 93, 1927) quotes several criticisms of the mathematical basis of Pearson's curves. This question is also discussed by Foster (Am. Soc. Civil Eng. Trans., vol. 91, p. 44, 1927).

The use of theoretical frequency curves in hydrologic studies will probably never be as satisfactory as in statistical work, owing in considerable part to the generally scanty data available. The choice of method must depend not so much on its mathematical development as on convenience in use and the closeness with which the theoretical curve fits the recorded data.

There is some difference of opinion as to whether there is an ultimate limit to floods. With the Pearson curves, type 1 includes an upper limit, but type 3 has no upper limit. Hazen's table involves no upper limit. Goodrich's method generally requires only a lower limit. Horton considers that there is a definite upper limiting flood on any given stream, as the amount of rainfall that can be produced at a given place in a given time interval has a natural limit. On the other hand, as pointed out by Hazen, a frequency study based on flood records covering a short period of years may give no indication of the ultimate possible flood, so that there is always some possibility that any assumed rate of flow may be exceeded. Hence, greater safety in design is insured by not considering any upper limit in plotting the duration curve.

The California Department of Public Works (Flow in California streams: Bull. 5, ch. 5, 1923) concluded, after a study of flood flows in 140 streams, that the maximum flood had not occurred in any stream of the State since the coming of the white man and that the greatest flood yet observed in any of the streams may be exceeded at any time, but only at intervals that are increasingly long as the magnitude of the flood is greater.

2. The duration-curve method

"By the duration curve is meant a curve that shows on the percentage scale the proportion of time in which given limits of flow are exceeded. The curve is frequently drawn to cover the entire range of flows from the lowest to the highest. Duration curves serve a variety of uses in hydraulic calculations and are very commonly made aside from the study of flood flows." - Hazen. (For a discussion of these curves in general, see Foster, H. A., Duration curves: Am. Soc. Civil Eng. Proc., October 1933, p. 1223.)

The group of flood-study methods covered by this classification all attempt to obtain a duration curve of flood flows directly from the recorded data, without the use of any theoretical frequency or probability formula. The duration curve is sometimes expressed as an equation, which is entirely empirical and represents only the upper end of the duration series.

Methods of selecting data.- Three methods of selecting data for flood studies have been in common use:

(a) Annual flood method (recommended by Hazen): The one highest flood flow in each year (either 24-hour average or peak flow) is recorded, and these figures are arranged in order of magnitude and plotted as a duration curve. This method is also suitable for analysis by theoretical probability curves.

(b) Basic stage methods: A certain rate of discharge is adopted as the minimum flood, or "basic stage," for the given stream. The floods in excess of this rate are tabulated to obtain the duration curve. Two methods of selecting the floods from the record have been used - (1) the complete duration series, in which all daily flows equal to or exceeding the basic stage are included; (2) the partial duration series (individual floods), in which the greatest daily flow (or peak flow) occurring in each flood is listed, only one flood being used for each more or less arbitrarily selected storm period.

(c) The complete duration series (recommended by Hazen, Flood flows, p. 107) is really a detailed analysis of the upper end of a complete daily-flow duration curve for the entire period of record. The "tail end" of the duration or frequency curve, above a basic stage, is plotted in such a way as to magnify the probability (or percent of time) scale, so that the separate flood items can be shown. All the 1-day flows above the basic stage are plotted in order of magnitude, the percent of time being computed with reference to the whole number of days in the record period. After the few highest terms are plotted, the others may be treated as averages of groups of convenient size. The lowest of the four curves in figure 3, page 75, illustrates the use of a daily flow duration series above a given basic stage. Figure 7, page 87, illustrates the use of a complete daily flow duration series of flood data.

If n = number of years in record period, $365n$ = number of days in record period, and m = relative position of any given day's flow in the duration series, then $100 \times \frac{(2m-1)}{2 \times 365n}$ = percent of time at which the given flood is plotted in the complete daily-flow duration curve.

The "10-year flood" or "10 percent chance flood" will be found at the decimal position corresponding to the reciprocal of the number of days in 10 years, or at $100 \times \frac{1}{10 \times 365} = 0.0274$ percent. The "100-year flood" or "1 percent chance flood" will be at 0.00274 percent, etc.

The data may be plotted on logarithmic, semilogarithmic, logarithmic-probability, or arithmetic-probability paper. Plotting will best be made by showing the flood quantity in c.f.s. "All these methods of plotting should check closely for the 10 percent chance flood and with records of 20 years and over will give results that do not differ widely for the 1 percent chance flood. For less frequent floods the estimates will diverge according to the method followed." Logarithmic paper will usually give higher results, and semilogarithmic paper lower results, than the logarithmic-probability paper.

The series of floods selected by this method should not be treated as a full duration series, as it is only one end of such a series. Therefore the theoretical probability methods cannot be used in the analysis. The duration curve must be obtained by graphic means, or as an empirical curve to fit the actual data.

John Paul Dean (Captain, Corps of Engineers, U. S. Army) has proposed a formula to represent this basic-stage duration curve (letter to N. C. Grover, May 4, 1927):

$$Q = A\,(1 - R \log (2n-1) + R \log 2T)$$

where Q = magnitude of flood, in units of flow.

A = the "average annual flood" or the flood which is exceeded once a year on the average in a long record; or it is that value of Q which corresponds to the abscissa $(2n-1 = 2T)$.

T = number of years in the observed record.

n = total number of floods above the basic stage.

$R = \frac{C}{A}$. (C = the increase in Q in one logarithmic cycle of the abscissa, as between the 1-year and the 10-year floods.)

Dean's formula plots as a straight line on semilogarithmic paper, the uniform scale being used for Q and the logarithmic scale for $f = \frac{2n-1}{2T}$, the number of floods per year that exceed Q.

The partial duration series (plotting individual floods) has been rather commonly used for presenting flood records. It was used by the research committee of the American Society of Civil Engineers on flood-protection data. Other examples of this method are:

Flow in California streams: California Dept. Public Works Bull. 5, ch. 5, 1923; The control of floods by reservoirs: Bull. 14, 1928.

F. G. Switzer (Probability of flood flows: Am. Soc. Civil Eng. Proc., April 1927, p. 563): "A list was made containing the maximum 24-hour flood for every storm that caused a peak flow in excess of an arbitrary value. These data were arranged to obtain a frequency curve, from which a probability curve was obtained. For plotting the probability curves, the coefficients as given by Mr. Foster were used."

W. P. Creager (Hydroelectric handbook, ch. 5, 1927): "A single flood, for use in frequency studies, may be defined as an increase in flow above an assumed basic stage, irrespective of the number of days above that stage or the number of peaks and valleys in the flow before the discharge again receded below the basic stage. The choice of basic stage influences the number of floods to be considered. In general, a basic stage equal to or slightly lower than the lowest maximum yearly flood is recommended." Creager treats this flood series like a complete duration series, from zero to 100 percent of time, and applies the theoretical probability methods to his basic-stage tabulation.

The partial duration series is not a true probability or frequency series. The items do not furnish a proper "sample" of the higher flows, as they occur at irregular intervals of time. They have no real average frequency of occurrence. In contrast, the yearly floods, or the monthly floods (one in each month of record), furnish a true frequency series, as they are selected at uniform intervals of time.

The complete duration series is part of a true frequency series and can be plotted to show one end of a true duration curve. The partial duration series, though resembling the complete series in form, can only give an approximation to a true duration curve.

It is theoretically incorrect to subject either the partial or the complete duration series to the mathematical processes involved in the theoretical probability methods. Hazen (Flood flows, p. 108) says: "These (probability) methods should not be applied to such data, because the numbers selected do not form a proper series. When floods are selected with reference to their size and without regard to the time of their recurrence, the numbers representing them do not form a series to which probability methods can be expected to apply. Such data should be subjected to graphic methods and graphic methods only." (See also discussion of this point by Sigurd Eliassen, Am. Soc. Civil Eng. Proc., August 1927, p. 1305.)

Switzer (Floods: Cornell Univ., Eng. Exper. Sta., Bull. 13, p. 3, 1929) claims that "the results from the use of all daily flows are substantially the same as those obtained from the use of peak flows only, so long as the exclusion of smaller floods does not reduce the number of data too much to permit of curve definition." Switzer treated each of his flood tabulations as a complete duration series, distributed from 0 to 100 percent of time.

The partial duration series may be considered a listing of all individual flood events, without reference to limitations of time, as, for example, by selecting the highest flood in the month or year. This method is actractive in that it requires less work in tabulating the data and has already been considerably used by the engineering profession and for those reasons was adopted in compiling the records of floods published in this report.

Selection of basic stage: If the complete duration series is used, the choice of a basic stage is entirely arbitrary. Enough items should be included to enable plotting of the end of the duration curve with sufficient accuracy. If too low a basic stage is used, the work will be increased unnecessarily, with no corresponding increase of accuracy in defining the curve. One or two hundred terms should ordinarily be reasonably sufficient for this purpose. If all flows in excess of the minimum annual flood are included, the same tabulation may be used to list the "annual floods." But for a long record, the minimum annual flood may be too small to use as basic stage. The basic stage for each gaging station as adopted for chronological listings of flood data in table 3 was determined with reference to the foregoing considerations.

Theoretical vs. empirical duration curves.- There is some difference of opinion as to whether better results are obtained by use of theoretical probability curves and factors or by the empirical duration curve - that is, as to which of the two general statistical methods is to be preferred. According to Hazen, "There is no reason why results obtained by it (the empirical duration curve) should not be as accurate as those obtained by the procedure previously described (probability method). Divergences will commence as the lines are carried by extrapolation away from the actual data and therefore become less certain."

Creager (Hydroelectric handbook, p. 43) states: "In the yearly-flood method, many floods that should be considered in a true probability study are excluded. The method involves considerably less work than the true or basic-stage method but should only be used for approximate calculations."

The objection to the annual-flood method as not giving enough items to define a satisfactory curve may be partly overcome by using monthly floods instead.

Some engineers prefer strictly graphic methods, as permitting an opportunity to adjust the curve more readily to the recorded data. Others consider that the theoretical probability methods or formulas can be used as guides in constructing the duration curve, thereby eliminating errors due to personal judgment.

Curves of average intervals between floods.- This method of showing the probability of occurrence of floods has had considerable use. It may be called the "California method," as it was used by the California State Department of Public Works (Flow in California streams: Bull. 5, ch. 5, 1923). It is closely related to the duration-curve methods, except that instead of plotting the floods against the percent of time or probability of their occurrence, they are plotted against their probable frequency of occurrence in 100 years. Sometimes the average interval (in years) between floods of a given value is used. These two methods are equivalent, as the flood that may be expected once every 20 years is the flood that occurs with an average frequency of five times in 100 years.

However, there is an important difference between the duration curve as usually plotted and the frequency curve as used in the "California method.

Let m = relative position of any flood item, when the floods are listed in decreasing order of magnitude.

n = total number of items in the record.

y = number of years in the record.

g = number of flood items in any group, when the floods are grouped for convenience in plotting.

Then, in the usual duration-curve method, the percent of time at which any flood, or group of floods, is plotted, is found by the formula

$$100 \times \frac{(m - 0.5\,g)}{n}$$

This is equivalent to plotting each flood (or group of floods) at the midpoint of the division of the percent of time axis that represents that group. If there are 200 items in the series, each item represents $\frac{100}{200}$ or 0.5 percent of time; and the first item is plotted at the midpoint of 0.5 percent of time, or at 0.25 percent of time. The curve shows the floods that are "equaled or exceeded," with a given probability of occurrence in a long-term record.

The theoretical basis for this method of plotting is the assumption that a given record covering a few years is a true sample of a much longer record. In a 10-year record, the largest item will represent 10 percent of time. If the record covered 100 years, it would be expected that of the 10 highest items some would be greater and some smaller than the original 10-year maximum, which would come approximately in the middle of the group of 10 items. In other words, the maximum item of the 10-year record should be plotted at 5 percent instead of 10 percent of time, in order to obtain a smooth duration curve typical of a long-term record. (See Foster, H. A., Duration curves: Am. Soc. Civil Eng. Proc., October 1933, p. 1223.)

In the "California method" as generally used the frequency of occurrence (in 100 years) of any flood in the record is taken as 100 x $\frac{m}{y}$. The maximum flood thus occurs $\frac{100}{y}$ times in 100 years; the second item occurs 100 x $\frac{2}{y}$ times in 100 years, etc. If there are 30 floods in 10 years, the maximum flood will be plotted at a frequency of 10 times in 100 years, and the smallest flood at 300 times in 100 years. These are the floods which, under this method, are assumed to be "equaled or exceeded," as shown by the given record.

If, now, this 10-year curve is extended to cover 100 years, it is assumed to represent 300 instead of 30 items. The first 9 items (as scaled from the extended curve) all have a frequency of occurrence (per 100 years) of less than 10, and they are all shown as being greater in value than the tenth item, which is the maximum of the original 10-year record. In other words, this method of plotting assumes that in a 100-year record the 9 largest items are all greater than the maximum in a single 10-year record. Obviously, this is not in accord with the basic assumptions of the duration-curve method.

The distinction may be expressed in another way. The duration-curve method shows the flood that is expected to be "equaled or exceeded" with any given probability over a long term of years. The "California method" as originally published shows a flood of such magnitude that there is an even chance that in any given period of years the maximum flood will be greater or less than the flood shown - that is, it shows the most probable flood magnitude.

To place the "California method" on a basis equivalent to the duration curve method, the data should first be plotted at mid-interval, as above indicated for the latter method, and the percent of time used for plotting any given item should be multiplied by $\frac{n}{y}$. That is, instead of plotting percent of time with a base of 100 percent = n items, the floods are plotted as occurrences per 100 years, with a base of y years. Hence, the position for plotting any given item will be 100 x $\frac{m - 0.5 g}{y}$, as frequency of occurrence per 100 years.

The 5-year flood will have a frequency of 20 per 100 years.
10-year flood will have a frequency of 10 per 100 years.
100-year flood will have a frequency of 1 per 100 years.
1000-year flood will have a frequency of 0.1 per 100 years.

This "modified California method" should give practically the same results as the duration-curve method. It may be applied to either the annual floods, partial flood series, or complete flood series.

The discrepancy between the original "California method" and the duration-curve method has frequently been a source of confusion to engineers who have attempted to apply both methods to analysis of flood records. It seems quite likely that a similar discrepancy may exist respecting some of the flood-frequency formulas. Fuller's formula was definitely based on the plotting of average maximum floods, instead of floods "equaled or exceeded," which would tend to increase the flood rates, in addition to the discrepancy noted above. Fuller's formula, therefore, should give appreciably higher values than the duration-curve method. If the other flood-frequency formulas were obtained by a method of plotting similar to that used in the "California method," they should be considered as giving the "most probable flood" rather than the flood "equaled or exceeded."

D. Methods dependent on relation of rainfall to run-off

An important group of methods for estimating flood flows is presented by the so-called "rational" or synthetic methods of computing stream flow from rainfall records. A detailed comparison of these methods is outside the scope of the present study. In brief, their purpose is to take a given or assumed rainfall record and from it construct a hydrograph of river flow.

The relation of these methods to the study of flood frequency depends on a determination of the frequency of occurrence of storms of various magnitudes and durations. The most instructive study of this nature was that of the Miami Conservancy District (Storm rainfall of eastern United States: Tech. Repts., pt. 5, 1917). The "rational" method, so called, is based on the assumption that the maximum rate of flow from a certain average rainfall intensity on the drainage basin is produced by that rainfall which is maintained for a time equal to the period of concentration of flow at the measuring station. This, as usually accepted, is the time required for the surface run-off from the most remote part of the drainage area to reach the point of observation. Considerations of frequency of occurrence enter into the selection of the rainfall intensity to be applied. This depends on the further assumption that the greater intensities, which may prevail for shorter periods, and likewise lower intensities, corresponding to longer periods, would be incapable of producing a flood crest as great as the one for the critical period as above defined. For the shorter periods of more intense rainfall only a portion of the drainage basin would be contributing to the flood crest, and for the longer periods of less intense rainfall earlier components would have passed the point of observation.

The formula used in connection with this method is one of the most convenient yet devised for showing the relation of rainfall to maximum expected run-off from areas within the range of its proper use, as follows:

$$Q = C\,i\,A$$

where
- Q = maximum run-off, in c.f.s.
- C = the percentage of average rainfall appearing as run-off at the end of the prescribed period at the point of observation.
- i = average rainfall intensity prevailing during the period, in inches per hour.
- A = drainage area in acres.

This formula is simplified by the coincidence that 1 acre-inch is very closely equivalent to 1 c.f.s. for 1 hour.

Miami Conservancy District study

All United States rainfall records prior to January 1, 1915, were scanned for storms in which the average precipitation equaled or exceeded 1 inch per 24 hours. The United States east of the 103d meridian was divided into 2° quadrangles. The number of stations per quadrangle varied from 75 to 5, with an average of 25.

The frequency of excessive precipitation is the average length of period, in years, during which the phenomenon has happened only once; or, as dealt with in the Miami Conservancy District reports, the length of time within which the rainfall of a given intensity is reached or exceeded once, on the average. Each quadrangle was treated as a unit; the records at all stations within the quadrangle were averaged, each station being weighted according to the number of years of its record. "Thus the records at all the stations are combined and treated in some respects as equivalent to a record at a single station extending over a period as long as the aggregate of all the years of record at the separate stations."

The "pluvial index" for any quadrangle equals the depth of rainfall that will probably be equaled or exceeded at any point in the quadrangle once in a given number of years. Pluvial indexes for each quadrangle for rains lasting 1 to 6 days were computed for periods of 100, 50, 25, and 15 years. These are shown on maps, with isopluvial lines for successive 1-inch depths of rainfall. (The map for 100-year 1-day rainfall has been extended by F. G. Switzer to cover the entire United States. See Cornell Univ., Eng. Exper. Sta., Bull. 13, p. 10, 1929.)

The study of great storms included all storms with 3-day precipitation records equaling or exceeding 6 inches at not less than five stations and included 160 storms, between 1892 and 1916. They were arranged in order of size, on the basis of the fifth highest 3-day precipitation record. The storms were also plotted by months, to show the season of occurrence of each storm. The geographic distribution was shown by plotting 6-inch isohyetals for the maximum 3-day period of each storm, grouped on maps by quarters of the year. The maps show a marked variation in storm types with reference to location and season.

Curves showing the time-area-depth relations of 33 storms were computed by the following process:

(1) Rainfall data were assembled.
(2) Dates of greatest 1-day, 2-day, etc., rainfall were determined.
(3) Rainfall figures were plotted on large-scale map.
(4) Isohyetals were drawn.
(5) Areas within isohyetals were measured.
(6) Average depth within each isohyetal was computed.
(7) Time-area-depth curves were drawn on coordinate paper (area in square miles vs. average depth of rainfall).

These curves show that almost invariably more than half of the total storm rainfall occurs on the day of maximum fall. Tables are included giving average depth of precipitation for areas of 1, 500, 1,000, 2,000, 4,000, and 6,000 square miles for each of the storms during the maximum consecutive periods of 1 to 5 days.

For each month and year, 1888 to 1916, the average rainfall over the eastern United States was plotted. A similar study was made for Illinois, Indiana, Ohio, Kentucky, and West Virginia. Very little evidence of any cyclic nature of rainfall was noted. Variations in total annual rainfall depend chiefly upon the occurrence of great storms.

From records of floods in the Danube at Vienna (900 years), in the Seine at Paris (300 years), and in the Tiber at Rome (1,500 years), it appears that the greatest flood of 1,000 years is not much in excess of the greatest in 100 years.

Comments on the Miami Conservancy District studies: The "pluvial index" gives the rate of rainfall that may be expected to be "equaled or exceeded" at a given station once in the given number of years. The method of combining the records in a given quadrangle to obtain an equivalent long-term record has been criticized by certain writers as not giving a true indication of the influence of length of record.

The "pluvial index" is based on rainfall records of single stations. As average rates of rainfall tend to decrease as the area affected increases, some writers have claimed that these indexes should be adjusted when used to indicate rainfall rates over extensive drainage areas. Examples of such corrections may be found in the following papers:

Hazen, Allen, The frequency of high rates of rainfall: Eng. News-Record, vol. 87, p. 858, 1921.

Creager, W. P., Hydroelectric handbook, p. 14, 1927.

Switzer, F. G., and Miller, H. G., Floods: Cornell Univ., Eng. Exper. Sta., Bull. 13, 1929.

Rainfall probability

The theoretical or graphic probability methods have been used to some extent for analysis of rainfall, particularly annual rainfall records. Outside of the work of the Miami Conservancy District, the application of probability methods to storm records has been relatively slight.

Factors to be used in the general equation for average rainfall intensity, $i = \frac{K F^x}{t^n}$, for the eastern United States have been developed by Merrill M. Bernard (Am. Soc. Civil Eng. Trans., vol. 96, p. 592, 1932) and are presented in the form of isohyetal charts having application to rainfall duration periods ranging from 2 hours to 4 days. This work combines the researches of the Miami Conservancy District with those of Adolph F. Meyer.

Unit-hydrograph method

The unit-hydrograph method is a procedure for determining the rates of surface run-off from a particular basin, by analogy, from observed rainfalls and the corresponding observed hydrographs of surface run-off from the same basin. The hypothesis upon which the method is based is that in a given drainage basin surface run-off from rainfall occurring in a unit of time will produce hydrographs of approximately equal bases and with ordinates varying with the quantity of rainfall minus infiltration and other subtractions. The method is comparatively new, having been originated by L. K. Sherman in 1932 and amplified by Merrill M. Bernard in 1934. In its present state of development it is found to be particularly valuable in the study of floods, especially those produced by storms of unusual magnitude.

It is hoped that ultimately procedure will be developed that will make it possible to estimate more accurately the run-off coefficient, or deduction for infiltration, etc., necessary to the utilization of the method, the objective being to produce the hydrograph of surface run-off from a knowledge of rainfall and antecedent surface soil conditions. This method and its developments appear to be among the most valuable recent contributions to the science and practical application of hydrology.

Among the drainage basins on which this method of analysis has been applied, particularly with reference to run-off from severe storms, are those of the French Broad River at Dandridge, Tenn.; the Muskingum River at Dresden, Ohio; the Red River near Denison, Tex.; the Wabash River at Logansport, Ind.; the Skunk River at Augusta, Iowa; the Kansas River at Kansas City, Mo.; the Delaware River at Port Jervis, N. Y.; and the Susquehanna River at Towanda, Pa.

The investigation of the unit hydrograph has been conducted as part of the study of relations between rainfall and run-off, and the detailed description of such investigation is presented in the report of that study*. A digest of the method and its application to estimates of flood flow, as prepared by Mr. Bernard, appears on pages 451 to 461 of this report.

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* (U. S. Geol. Survey Water-Supply Paper 772).

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E. Method for estimating peak flow from 24-hour average flow

Although engineers are in general particularly interested in determining what the maximum rate of flood run-off will be at a given location, the records of floods as usually published do not give the instantaneous peak flow (except for isolated days), but rather each daily average flow throughout the flood event. In recent years the installation of automatic recording gages at numerous stations has made it possible to determine the crest rate of any flood flow covered by the record. The scarcity of published records of momentary flood peaks has hitherto made it necessary in any general study of floods to base the investigation on daily average flows. It is therefore important to establish, if possible, some relation between daily average flood rates and instantaneous flood peaks. This would obviously assist in the reverse process of estimating the daily average flows from momentary flood peaks, if occasion should arise.

On any stream the maximum average daily flow will not necessarily occur on the same day as the maximum instantaneous peak flow. As a flood study will be concerned largely with maximum discharge rates, as well as with average daily flows, it will not always suffice to determine the relation between the peak and the average of the same day, but rather it may be necessary to consider the relation between the maximum discharge rate and the maximum daily average for any flood event, or year, or period of years, regardless of the day on which the peak occurs. Rarely, if ever, is the momentary peak flow farther removed from the maximum average daily flow than 1 or 2 days, on streams thus far investigated.

The most important study of this question hitherto published was made by Weston E. Fuller (Am. Soc. Civil Eng. Trans., vol. 77, pp. 564-694, 1914). He was able to find only 26 flow records from which the comparison could be made, on the basis of which he derived the formula

$$Q_{max} = Q\ (1 + 2\ A^{-0.3})$$

giving the relation between crest flow and daily average flow (Q) in terms of the drainage area (A).

Fuller's formula has been rather widely used but is at best admittedly approximate, and furthermore is based on meager data. Further study of this question is greatly needed, to utilize the extensive data which later became available. As a step in this direction, a special study was initiated under this project, as described elsewhere in this report and particularly under the heading of "Momentary flood peaks and other flow characteristics of flood rises," pages 90 to 113.

EXAMPLES OF PROCEDURE FOR ANALYZING FLOOD FLOWS

The special study of floods reported in this volume has included a review not only of the available data on flood flow but also of several methods ordinarily employed in their analysis and interpretation. Among the first undertakings of this project were lists of references to related literature and a brief description of methods for estimating floods. Both of these compilations were distributed to members of advisory committees, to notable technical writers in this field, and to several other engineers and consultants. In this manner fairly representative cross sections of technical literature and of current trends and practices were obtained, which brought prominently into view the divergences of concepts and procedures relating to flood-flow statistics and their analysis.

In an effort to evaluate the various methods of approach, many test stations were selected, representing both a wide geographic distribution and a wide diversity of run-off and flood-flow characteristics.

Various significant elements of the available records were treated by different empirical flood formulas, and the results were plotted on cross-section charts of various types for comparison. Some of the arrays of flood data were subjected to statistical and mathematical treatment, and also to graphic methods, in order to develop and compare the probable trends of the data for extension to magnitudes and frequencies beyond the limits shown by the record period.

In the review of technical literature and methods relating to estimation and analysis of flood flows it became apparent that usages and viewpoints are not as nearly uniform as would seem to be attainable and desirable. A special effort was therefore made to select such methods and procedures as conform to approved practice among some of the investigators who are well equipped and experienced in this particular field. Moreover, it was made a primary requirement that the assumptions and procedures adopted should be consistent with one another and capable of justification either upon logical grounds or upon the basis of broad observation and experience.

Of necessity the various steps in the procedures and methods described herein coincide for the most part with well-established practice; the slight innovations or departures in minor details, the order of arrangement as adopted in the following pages, and the elementary treatment of the different subjects are the only new contributions. This chapter is mainly a brief discussion of various methods and their use in the analysis of floods, particularly as related to their periodicities and corresponding magnitudes, the selection and weighting of representative data, and the interpretation of results. Furthermore, it is intended as an exposition of processes and methods that have become more or less widely used, rather than an indicator of relative merit among such methods.

Symbols

The following symbols are used in statistical investigations. Definitions of the terms are given on pages 461 to 466.

m = Serial number, or summation of all items from the beginning of a series, arranged in decreasing order of magnitude.

n = Total number of items included for consideration; the maximum limiting value of m.

y = Number of years included for analysis of records.

g = Number of items (such as floods) in a group, where data are grouped for convenience in plotting.

v = Variation (or deviation).

SV = Standard variation (or deviation).

CV = Coefficient of variation (or deviation).

CS = Coefficient of skew.

CS_{comp} = Computed coefficient of skew.

CS_{adj} = Adjusted coefficient of skew, to compensate for the varying number of terms.

p.e. = Probable error.

Fundamental methods for analyzing flood data*

Statistical arrays

1. Annual flood. The maximum daily flows for every year during the period of record are arranged in descending order of magnitude and plotted as a cumulative frequency curve (discussed on p. 73) - that is, the flood flows are plotted against the cumulative percentages of time. The percentage of time for each item is 100 times the ratio of one year to the total number of years in the record. However, the plotting occurs at mid-intervals, as more fully explained below, under "Plotting procedures." The percentage for plotting is $100 \frac{(m - 0.5g)}{n}$, where n = y = number of items (years) in the record. If the data are not grouped, g = 1 and the expression reduces to $100 \frac{(m - 0.5)}{n}$. By multiplying both numerator and denominator by 2, the expression becomes $100 \frac{(2m-1)}{2n}$ which is the form used by Hazen and Foster.

2. Monthly flood. The maximum daily flows for each month during the record period are arranged in descending order of magnitude and plotted as a cumulative frequency curve. The percentage of time for each item is the ratio of one month to the total number of months in the period of record. The percentage for plotting = $100 \frac{(m - 0.5g)}{n}$, where n = 12 y. If the inclusion of all monthly maxima encumbers the array with many flows of little or no significance respecting flood occurrence, the list may be limited to flows above some basic stage or magnitude. Such a partial list would not, of course, represent a complete time series.

3. Daily flow. The daily flows above some stated magnitude (all daily flows might be used if desired) are arranged in descending order of magnitude and plotted as a cumulative frequency curve. The percentage of time for each item is the ratio of one day to the total number of days in the record (not the number of days in the series used, which represent only flows above the stated magnitude). The resulting graph is only the upper end of a complete daily duration curve. The percentage for plotting is $100 \frac{(m - 0.5g)}{n}$, where n = 365 y plus the number of leap years in the record.

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* For definitions of terms see pp. 462-467.

4. Flood event or partial series. The maximum daily flows occurring in all flood events during the period of record are arranged in descending order of magnitude and plotted as a cumulative frequency curve. The percentage for each item is 100 times the ratio of one to the total number of items. The percentage for plotting (percentage of flood peaks, representing flood events, not percentage of time) is $100 \frac{(m - 0.5g)}{n}$, where n = number of flood events in the array. Ordinarily some limit of stage or flow can be fixed below which flood peaks have very little significance. The more significant items of the partial series can be considered by omitting flood peaks below a selected base and treating the remaining series by the procedure outlined in the next paragraph.

5. Average number of flood events per century (modified California method). An array identical with that of the method based on flood events or partial series is formed, except that only flood peaks above some selected base need be considered. The number of flood events per century as obtained by the formula $100 \frac{(m - 0.5g)}{y}$ is plotted against the discharge corresponding to the flood peak having serial number m. This is similar to the formula given by Hazen* for plotting arrays of this type, but his formula is based on the number of flood events per year, instead of per century.

Graphic methods for analysis of flood flow data

Among the graphic devices that have been widely used in the study of stream-flow data is the hydrograph of discharge, which depicts the average flows by days, weeks, months, years, or other time intervals as ordinates, plotted chronologically against such time units. An example of such a hydrograph based on daily average flow is shown on figure 6, with distinctive marks for the various classes of flood data, such as annual floods, monthly floods, and flood events.

One of the ways of utilizing the data portrayed by the hydrograph, particularly as related to flood events, is by the frequency curve, which shows the number of flood occurrences (g) in the successive groups within prescribed limits of magnitude of discharge. Figure 1 includes some of the types of graphic representation relating to frequency curves.

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* Hazen, Allen, Flood flows, p. 107, New York, 1930.

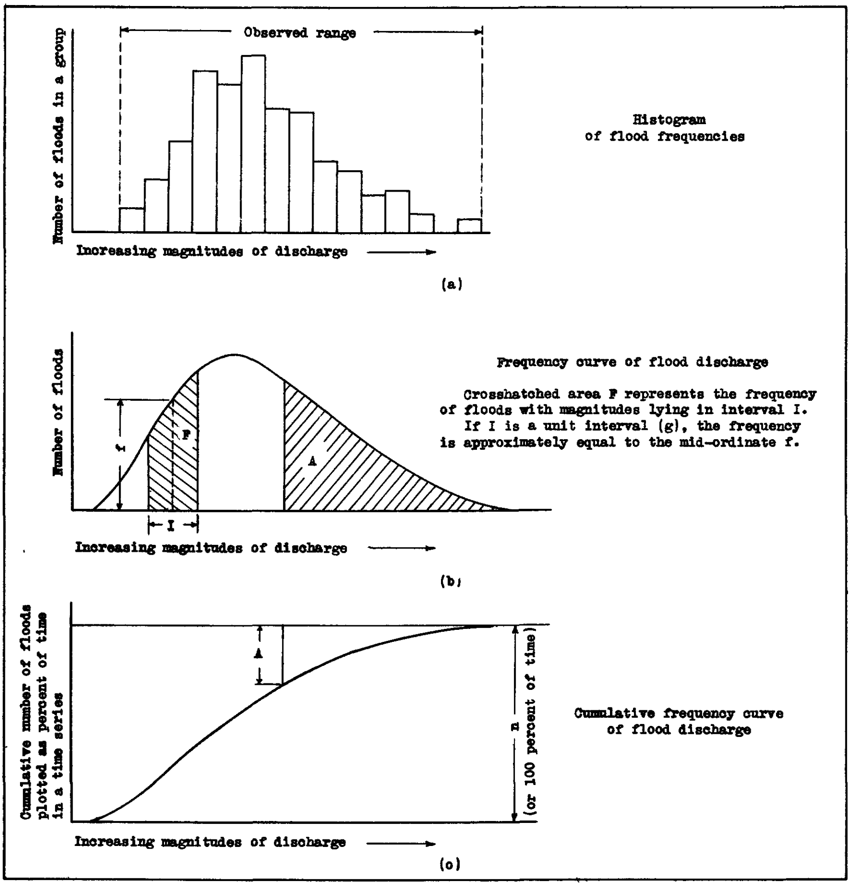


Figure 1.

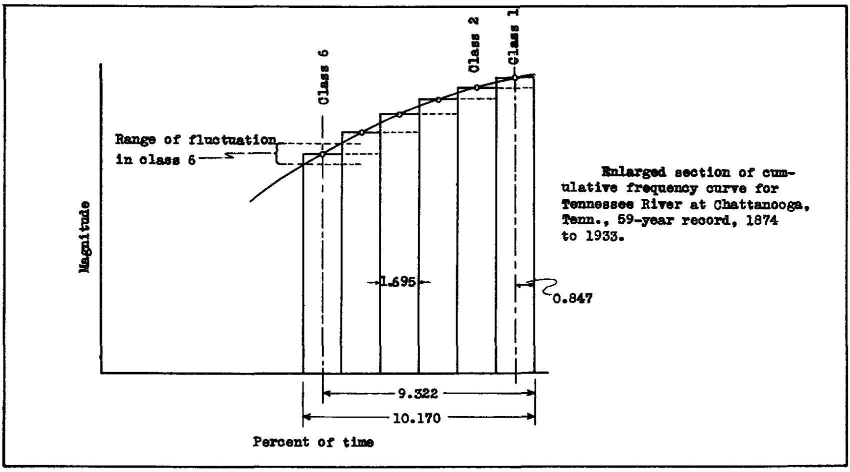


Figure 2.

The subdivisions of the abscissa scale are so determined as to give a convenient number of classes into which the observed data may be grouped, in order to reduce the labor of plotting individual items. Figure 1, a, is a frequency distribution histogram or block diagram on which the ordinates show the number of observed events for each designated interval on the scale of discharge magnitude.

From the frequency distribution histogram above described, a smooth frequency curve (fig. 1, b) may be derived by any one of various statistical and mathematical methods, such as those of Pearson, Hazen, Foster, Goodrich, and Slade, or by sketching in a curve by eye and then smoothing or adjusting it to suit the personal judgment respecting satisfactory fit. One of the properties of the frequency curve is that the area between the curve and the axis of abscissas within any magnitude interval is proportional to the number of occurrences within that range of magnitude. It therefore follows that the mid-ordinate of each magnitude interval is proportional to the frequency or number of observed occurrences within those limits except for the effect of curvature, usually of small amount and readily taken into account if desired. If the data are numerous or the magnitude interval is sufficiently large, the ordinates of the frequency curve ordinarily increase continuously from the initial point on the abscissa axis to a maximum called the "mode," representing the magnitude where occurrence is most frequent. Beyond the mode the slope is downward to the intersection with the axis at some point indicating the limit of magnitude and generally impracticable to determine with close accuracy.

If the successive values of frequency curve ordinates corresponding to the successive intervals on the magnitude scale are added progressively and plotted, a cumulative frequency curve is obtained, as in figure 1, c. This curve shows the total number of items which are smaller (or larger) than any given amount. A cumulative frequency curve that indicates the length of time or the percentage of time during which an event of a given magnitude (a daily flow, for example) has been equaled or exceeded is known as a "duration curve." Figures 3 to 5 illustrate the use of a curve closely related to and derivable from the cumulative frequency curve, showing the number of flood occurrences per century with daily average discharges equal to or greater than each successive flood magnitude.

Figure 3 shows for the Susquehanna River at Harrisburg, Pa., the plotted points and the resulting curves from flood data of four different types, described in the foregoing pages and referred to later as annual, monthly, and partial series, or flood events, and complete daily flow duration series. These curves occupy so nearly the same positions for the higher magnitudes as to make it impracticable to show them all on a single cross-section chart. The divergences of the curves are more or less pronounced among the lower magnitudes, in the left half of the figure, the curves based on the more numerous data being in the higher positions.

Figure 4 shows the relation between flood frequency and magnitude as observed at selected stations of the Susquehanna River system, (a) expressed in second-feet and (b) expressed as second-feet per square mile.

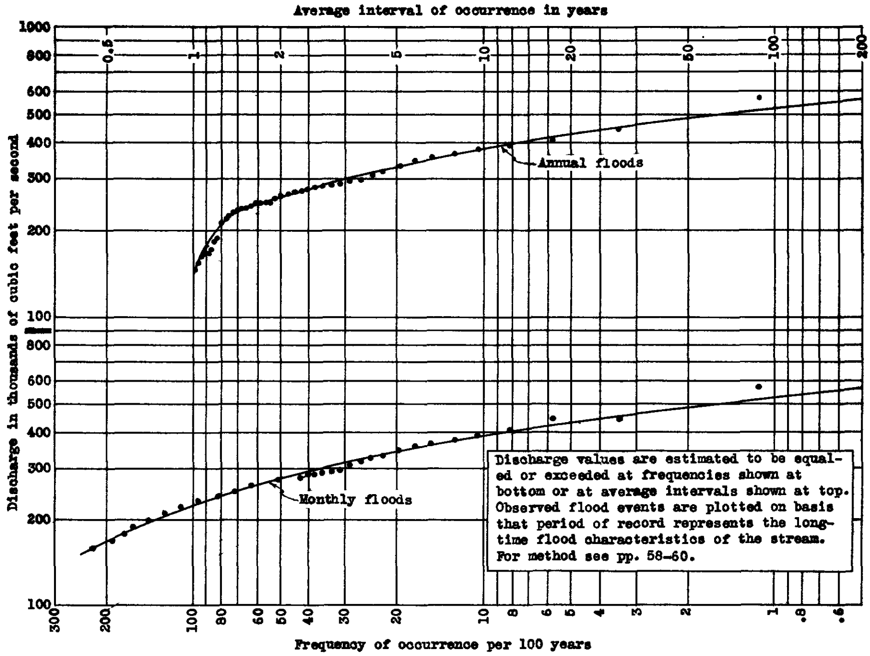
Figure 5 shows the relation between flood frequency and magnitude for selected stations on the Sacramento River system, (a) expressed in second-feet and (b) expressed in second-feet per square mile. On both figures 4, b, and 5, b, the curves shown in figures 4, a, and 5, a, are merely displaced to other positions on the scale of ordinates, for the purpose of transforming from second-feet to second-feet per square mile.

The ease with which these transformations of units may be accomplished on a logarithmic scale of ordinates suggests the possibility of drawing parallel curves at suitable distances either above or below those shown on figure 5, to express the quantities in any desired units, as acre-feet per day, million gallons per day, cubic meters per square mile or per square kilometer, depth on the drainage area in either inches or centimeters per day, or million cubic feet per day.

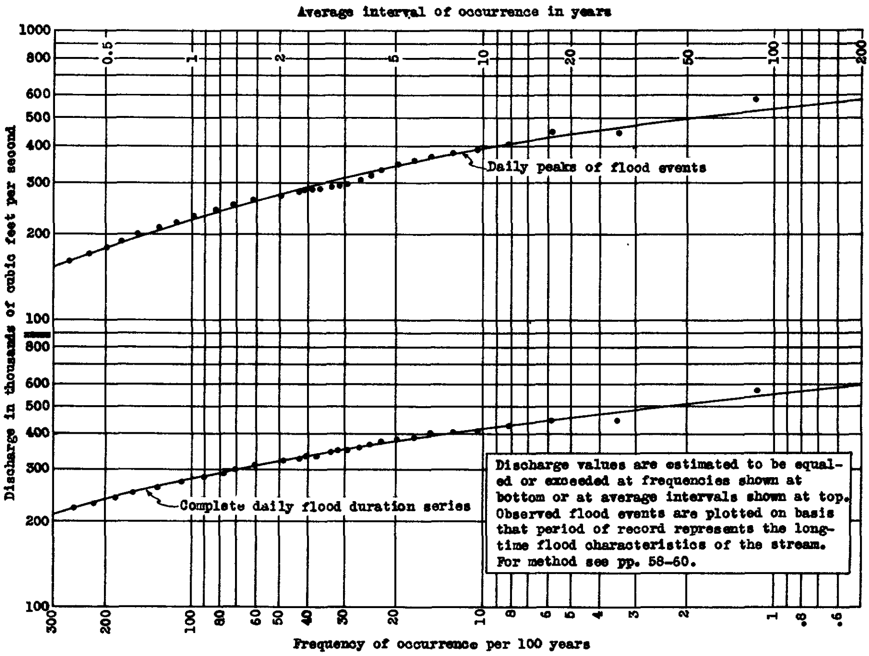
Plate 2 is a graphic presentation of all notable flood rises within the period of record for the Delaware River at or near Riegelsville, N. J., from 1897 to 1933, except for the time from January 1904, to June 1906. Four flood rises (with roughly estimated daily flood peaks ranging from 78,000 to 130,000 second-feet) were thereby omitted from this drawing, because of uncertainties relating to the record during the period of their occurrence.

To avoid superposition of many flood hydrographs within the months of most frequent flood occurrence, the record period was divided into four segments of 8 to 10 years each, thus providing a comparison among such periods of years as well as among the separate months with respect to flood frequency and magnitude.

COMPARISON OF PLOTTED ARRAYS OF FLOOD FLOW DATA
FOR SUSQUEHANNA RIVER AT HARRISBURG, PA.



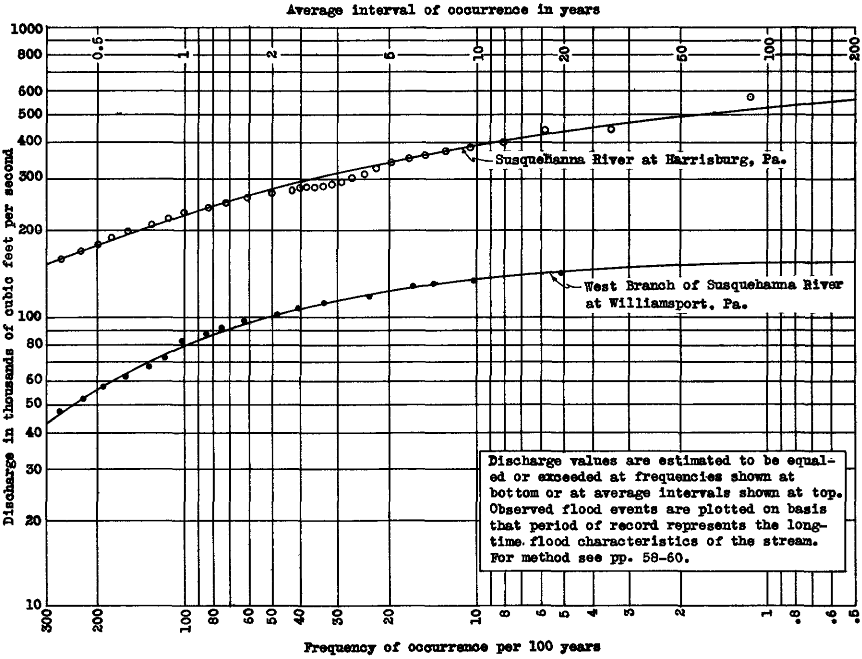
(a)



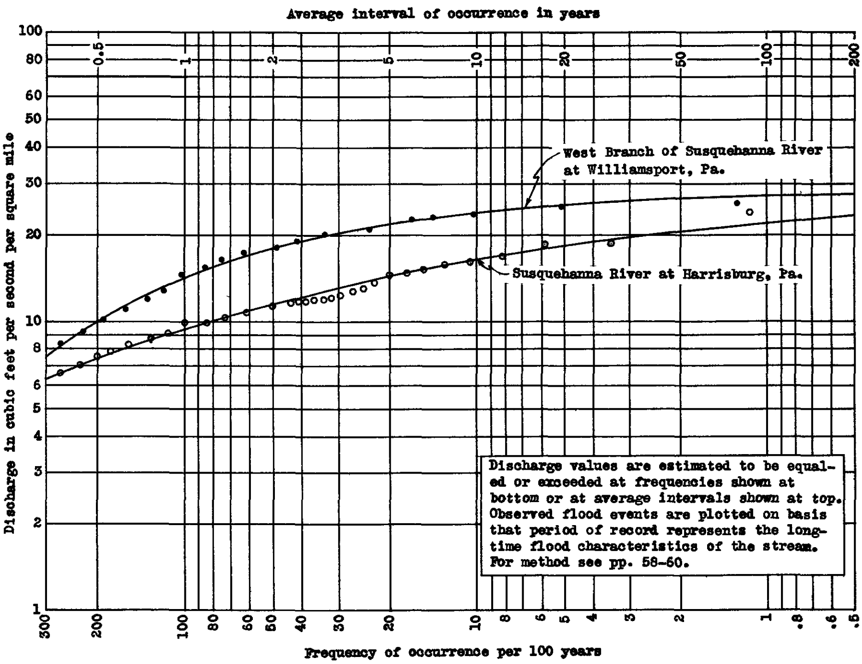
(b)

Figure 3.

COMPARISON OF FLOOD-FREQUENCY TRENDS AT SELECTED RIVER STATIONS ON THE BASIS OF CUBIC FEET PER SECOND AND CUBIC FEET PER SECOND PER SQUARE MILE



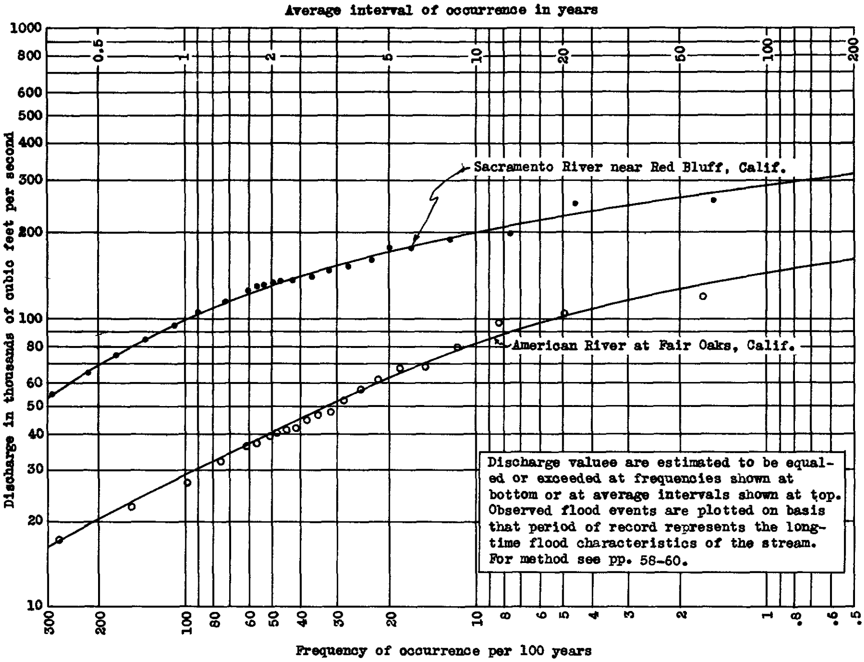
(a)



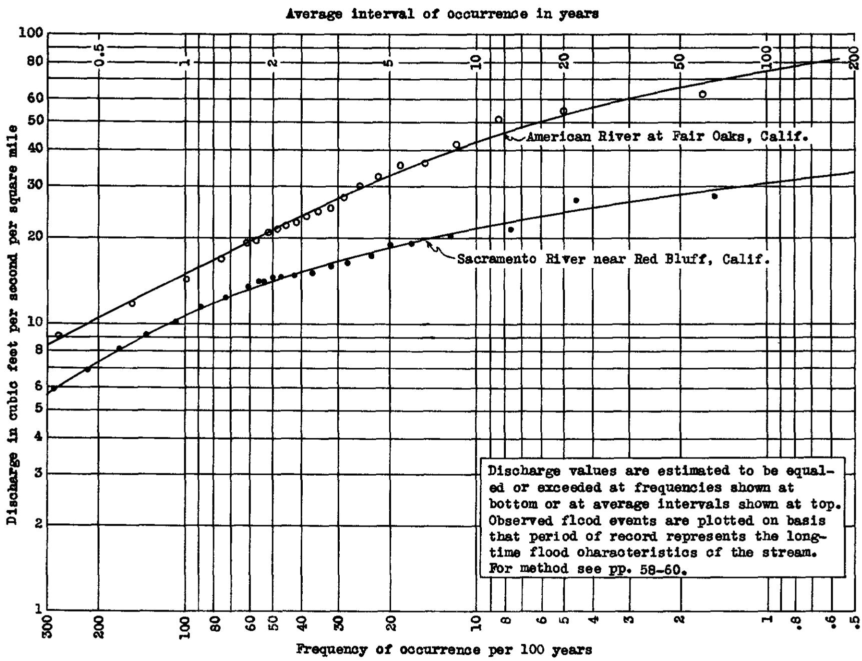
(b)

Figure 4.

COMPARISON OF FLOOD-FREQUENCY TRENDS AT SELECTED RIVER STATIONS ON THE BASIS OF CUBIC FEET PER SECOND AND CUBIC FEET PER SECOND PER SQUARE MILE



(a)



(b)

Figure 5.

Plotting procedures

Annual floods

The formula for determining percentage of time or percentage of the total number of floods for plotting flood-flow data, as given in the foregoing paragraphs, is

$$100 \frac{(m - 0.5g)}{n}$$

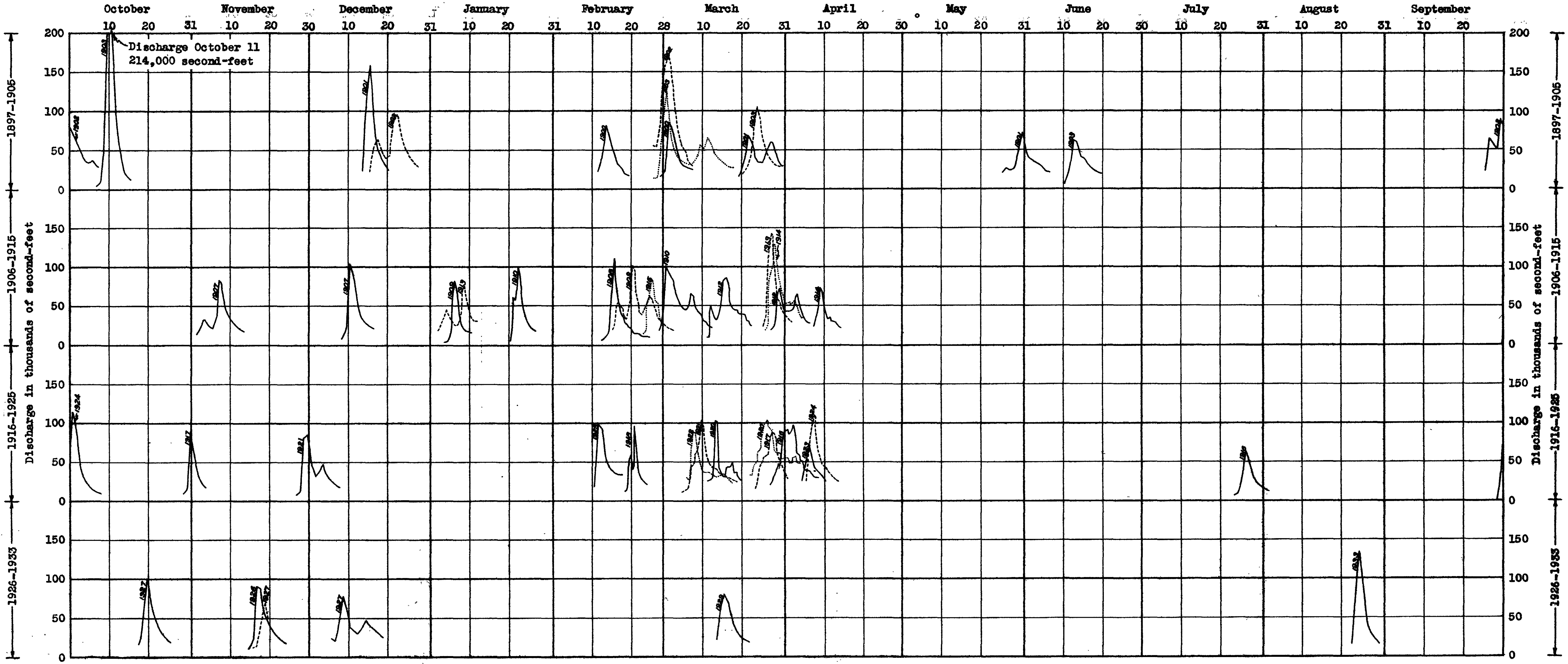
This formula requires that the points be plotted at mid-group intervals. The following explanations are offered in justification of this practice.

In a 10-year record of annual floods, for example, the maximum represents the highest discharge of a period covering 10 percent of the years of that record. In a longer record - say 100 years, or, in other words, ten consecutive 10-year periods - the ten highest items represent the first 10 percent of time on the cumulative frequency curve. These will include some of the highest figures from the several 10-year records but probably not all of them. It is reasonable to assume that some items are likely to be higher and some lower than the highest of the first 10-year record. Although this 10-year maximum may ultimately prove to be of any magnitude from somewhat below the minimum to the maximum of the ten highest items in the longer record, it is much more likely to be intermediate. As in general it is as likely to be in the upper as in the lower half of the group of ten maxima it may logically be assumed to represent the median. Thus, if it represents the median of a class of flows ranging in frequency from 0 to 10 percent of the time, it should be plotted at the mid-interval of the class, or 5 percent of the time.

This is not likely to be the magnitude of the 10-year flood (the flood equaled or exceeded, on the average, once in 10 years). The 10-year flood is not the median of the class extending from 0 to 10 percent of the time, but the minimum within this range - that is, the discharge quantity on the frequency curve corresponding to the ordinate for 10 percent of the time.

In applying a more detailed method of reasoning with respect to an actual record, the annual floods of the Tennessee River at Chattanooga, Tenn., for a 59-year period were arranged in descending order of magnitude in table 1, column 1. Columns 2 and 3 show respectively the date of occurrence and corresponding gage height; column 4 shows the magnitude of the flood. The total of this column divided by the number of annual

Plate 2, to face page 78, is to be reduced 20 percent, to bring the 10-inch width to 8 inches to fit the printed page of the Water-Supply Paper. Only black lines and reading matter. The plate will then fold in one direction.



Typical hydrographs of flood discharges of the Delaware River at Riegelsville, N. J.

Records prior to July 1906 are for the station at Lambertville, representing a drainage area 6.6 percent greater than at Riegelsville.

Discharge records have not been evaluated for the period October 1903 to June 1906 except for estimates of the October 1903 flood which are presented in House Document No. 179, 73d Congress, 2d Session. Determinations of discharge at Lambertville above 100,000 second-feet are subject to considerable error.

Plotted points on the graphs represent discharges for once daily or twice daily gage readings prior to 1924 and mean daily discharges from water-stage recorder records thereafter. No floods have been shown below 70,000 second-feet at the crest except as required in order to include at least one flood per month.

Table 1

ANNUAL FLOODS ON TENNESSEE RIVER AT CHATTANOOGA, TENN., 1875 to 1933

(1) Serial no. of flood	(2) Date of flood	(3) Gage height (feet)	(4) Daily average discharge (c.f.s.)	(5) Ratio to average annual flood	(6) Percent of time in years for plotting
1	Mar. 1, 1875	54.0	361,000	1.741	0.847
2	Apr. 3, 1886	52.2	349,000	1.684	2.542
3	Mar. 8, 1917	47.4	310,000	1.495	4.237
4	Mar. 10, 1884	42.8	285,000	1.375	5.932
5	Mar. 2, 1890	42.5	283,000	1.365	7.627
6	Apr. 5, 1920	43.5	275,000	1.326	9.322
7	Jan. 2, 1902	40.8	271,000	1.307	11.017
8	Apr. 5, 1896	40.5	269,000	1.297	12.712
9	Jan. 19, 1882	40.2	267,000	1.287	14.407
10	Mar. 22, 1899	40.0	266,000	1.283	16.102
11	Feb. 2, 1918	42.5	266,000	1.283	17.797
12	Jan. 1, 1933		261,000	1.259	19.492
13	Mar. 11, 1891	38.9	259,000	1.249	21.186
14	Mar. 18, 1880	38.3	254,000	1.225	22.881
15	Jan. 23, 1883	38.2	254,000	1.225	24.576
16	Jan. 15, 1879	38.0	252,000	1.215	26.271
17	Jan. 17, 1892	37.9	252,000	1.215	27.966
18	Mar. 14-15, 1897	37.9	252,000	1.215	29.661
19	Dec. 29, 1926	38.35	248,000	1.196	31.356
20	Mar. 26, 1929	38.22	246,000	1.186	33.051
21	Jan. 23, 1922	34.3	229,000	1.104	34.746
22	Dec. 31, 1875	34.2	227,000	1.095	36.441
23	Feb. 20, 1893	33.4	221,000	1.066	38.136
24	Nov. 22, 1906	33.3	220,000	1.061	39.831
25	Aug. 17, 1901	32.8	217,000	1.046	41.525
26	Jan. 12, 1895	32.1	212,000	1.022	43.220
27	Apr. 11, 1903	31.8	210,000	1.013	45.915
28	Feb. 12, 1921	34.1	210,000	1.013	46.610
29	Mar. 30, 1913	33.1	202,000	.974	48.305
30	Feb. 18, 1889	29.6	195,000	.940	50.000
31	Apr. 9, 1911	29.9	195,000	.940	51.695
32	Mar. 31, 1912	31.3	190,000	.916	53.390
33	Apr. 11, 1877	28.7	189,000	.911	55.085
34	Jan. 5, 1919	32.0	189,000	.911	56.780
35	Feb. 7, 1923	32.1	188,000	.906	58.475
36	Feb. 2, 1932		188,000	.906	60.169
37	Dec. 28, 1914	33.1	183,000	.882	61.864
38	Dec. 20, 1915	32.8	183,000	.882	63.559
39	July 2, 1928	30.36	181,000	.873	65.254
40	Feb. 28, Mar. 1, 1887	27.3	180,000	.868	66.949
41	Mar. 31, 1888	27.0	178,000	.858	68.644
42	Dec. 3, 1880	26.5	174,000	.839	70.339
43	Jan. 18, 1885	26.5	174,000	.839	72.034
44	Feb. 6, 1894	25.5	167,000	.803	73.729
45	Nov. 19, 1929	28.67	167,000	.803	75.424
46	Sept. 5, 1898	24.6	164,000	.791	77.119
47	June 6, 1909	25.3	163,000	.786	78.814
48	Feb. 17, 1908	24.7	162,000	.781	80.508
49	Feb. 15, 1900	24.3	157,000	.757	82.203
50	Feb. 11, 1905	22.4	146,000	.704	83.898
51	Jan. 5, 1924	26.9	143,000	.690	85.593
52	Mar. 25, 1904	21.8	142,000	.685	87.288
53	Jan. 26, 1906	21.4	140,000	.675	88.983
54	Dec. 10, 1924	22.1	138,000	.665	90.678
55	Feb. 25, 1878	19.2	125,000	.603	92.373
56	Apr. 8, 1931		123,000	.593	94.068
57	Apr. 3, 1914	21.4	102,000	.492	95.763
58	Apr. 16, 1926	20.65	92,900	.448	97.458
59	Feb. 20, 1910	13.9	85,900	.414	99.153

$$\frac{\text{Total of Column 4 .... } 12{,}232{,}800}{\text{Number of annual floods .. } 59} = 207{,}366 \text{ c.f.s., the average annual flood}$$

floods (59) gives the average annual flood, which is 207,336 cubic feet per second. As the data are accurate only to three significant figures, 207,000 represents the average in round numbers. Column 5 gives the ratio of each flood to the average annual flood; column 6, plotting position.

As each flood represents 1 item out of 59, it is equivalent to $100 \frac{(1)}{59}$ or 1.695 percent of the total number of annual floods in the record. If 59 years is regarded as 100 percent of the record period, each flood represents an event occurring 1.695 percent of the time in years. The largest flood was equaled 1.695 percent of the time. The second largest flood was equaled or exceeded twice in 59 years, or 2 x 1.695 = 3.390 percent of the time; the third, 3 x 1.695 = 4.985 percent of the time; etc. However, these figures do not represent the points on the percentage scale at which the respective magnitudes of the floods (or ratios to the average flood) are plotted, for the reasons presented above and further discussed below in relation to this specific example.

The method of investigating flood flows by the statistical processes described herein is based on the "theory of sampling." This theory assumes, in the example just used, that the available 59-year record constitutes a representative sample of what would be obtained if a record at the same point for a very long period (say 1,000 years) were available and a considerable number of samples, each containing 59 consecutive annual floods, were picked at random from it. In some of these samples the largest floods would probably be greater than the maximum (361,000 second-feet) in the 59-year record here used for an example, and in others the largest floods would be smaller. If this particular record were approximately representative of all the 59-year samples, then its maximum (361,000 second-feet) would of course be about the average of the maxima in all the samples.

To illustrate, select at random ten samples of 59 years each. Call the largest floods in each sample the floods of class 1, the second largest the floods of class 2, etc. Each flood in any particular sample represents the frequency of occurrence of the class in which it falls - that is, $100 \frac{(1)}{59} = 1.695$ percent of the time. In figure 2 are shown the classes thus formed, arranged in order of magnitude in the form of a cumulative frequency distribution. On the assumption that any flood in a particular sample represents either the average or the median of the floods in that class, nearly 50 percent of these floods will be larger than this one, and nearly 50 percent will be smaller. Therefore, this flood magnitude is plotted at the middle of the block representing 1.695 percent of the time for its class, or at 0.847 percent. For instance, if the flood of sixth rank in a particular sample has been equaled or exceeded $100 \frac{(6)}{59} = 10.170$ percent of the time, this is taken as the frequency with which the floods of class 6, as a whole, are equaled or exceeded. As the flood of class 6 in this particular sample is assumed to be exceeded on the average by nearly 50 percent of all the floods of class 6 in the several samples, a flood frequency corresponding to 10.170 - (0.5 x 1.695) = 9.322 percent of the time is plotted for class 6 (actually its mid-point). By formula, the percentage for plotting $= 100 \frac{(6 - 0.5\ (1)\ )}{59} = 9.322$. The positions for successive plotting points can be more easily determined by merely taking one-half of 1.695 = 0.847 percent for the class representing the highest flood magnitude and adding 1.695 for each successive class, if the data are not treated in groups.

Interpretation of frequency curves

1. Annual flood. The discharge ordinate at any point on the frequency curve shows the magnitude of the annual flood flow which, on the average, is estimated to be equaled or exceeded in the percentage of time in years represented by the corresponding frequency coordinate. For example:

The 5-year annual flood = flood equaled or exceeded 20 times in 100 years. This is the ordinate at $\frac{100}{5} = 20$ percent of time on scale.

The 10-year annual flood = flood equaled or exceeded 10 times in 100 years. This is the ordinate at $\frac{100}{10} = 10$ percent of time on scale.

The 100-year annual flood = flood equaled or exceeded 1 time in 100 years. This is the ordinate at $\frac{100}{100} = 1$ percent of time on scale.

The 1,000-year annual flood = flood equaled or exceeded 0.1 time in 100 years. This is the ordinate at $\frac{100}{1,000} = 0.1$ percent of time on scale.

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The 5-year, 10-year, 100-year, 1,000-year annual flood is that record-day average rate of flow which in a long period of years satisfies two conditions - it will be a maximum for a record year, and it will be equaled or exceeded, on the average, once in every 5, 10, 100, 1,000 years, respectively. As these two conditions must both be satisfied, the 5-year, 10-year, 100-year, etc., annual flood is not simply the record-day average rate of flow likely to be equaled or exceeded on the average once in 5, 10, 100 years, etc. This can be readily seen from the hydrograph in figure 6, where items A, A are annual floods. One of these annual floods was exceeded by one or more daily flows (C), which would not appear in the tabulation and plotting of annual floods, because they were not the largest daily flows during the record years in which they occurred.

If the annual floods for 100 years (100 items) are arranged in descending order of magnitude, the 5-year annual flood for the period of record will lie on the frequency curve between the 20th and 21st items on the frequency scale, as plotted at mid-intervals as described above under "Plotting procedures." Similarly, the 10-year annual flood will lie on the frequency curve between the 10th and 11th items, and the 100-year annual flood will lie between the 1st and 2d items.

2. Monthly flood. The discharge ordinate at any point on the frequency curve shows the magnitude of the monthly flood flow which, on the average, is estimated to be equaled or exceeded in the percentage of time in months represented by the corresponding frequency coordinate. As there are 12 months in a year, the 5-year and other floods as defined above will be found as follows:

$$\text{5-year flood} = \frac{100}{12 \times 5} = 1.667 \text{ percent of time on scale.}$$

$$\text{10-year flood} = \frac{100}{12 \times 10} = 0.833 \text{ percent of time on scale.}$$

$$\text{100-year flood} = \frac{100}{12 \times 100} = 0.0833 \text{ percent of time on scale.}$$

$$\text{1,000-year flood} = \frac{100}{12 \times 1{,}000} = 0.00833 \text{ percent of time on scale.}$$

The 5-year, 10-year, 100-year, 1,000-year monthly flood is that record-day average rate of flow which in a long period of years satisfies two conditions - it will be a maximum for a calendar month, and it will be equaled or exceeded, on the average, once in every 5, 10, 100, 1,000 years, respectively.

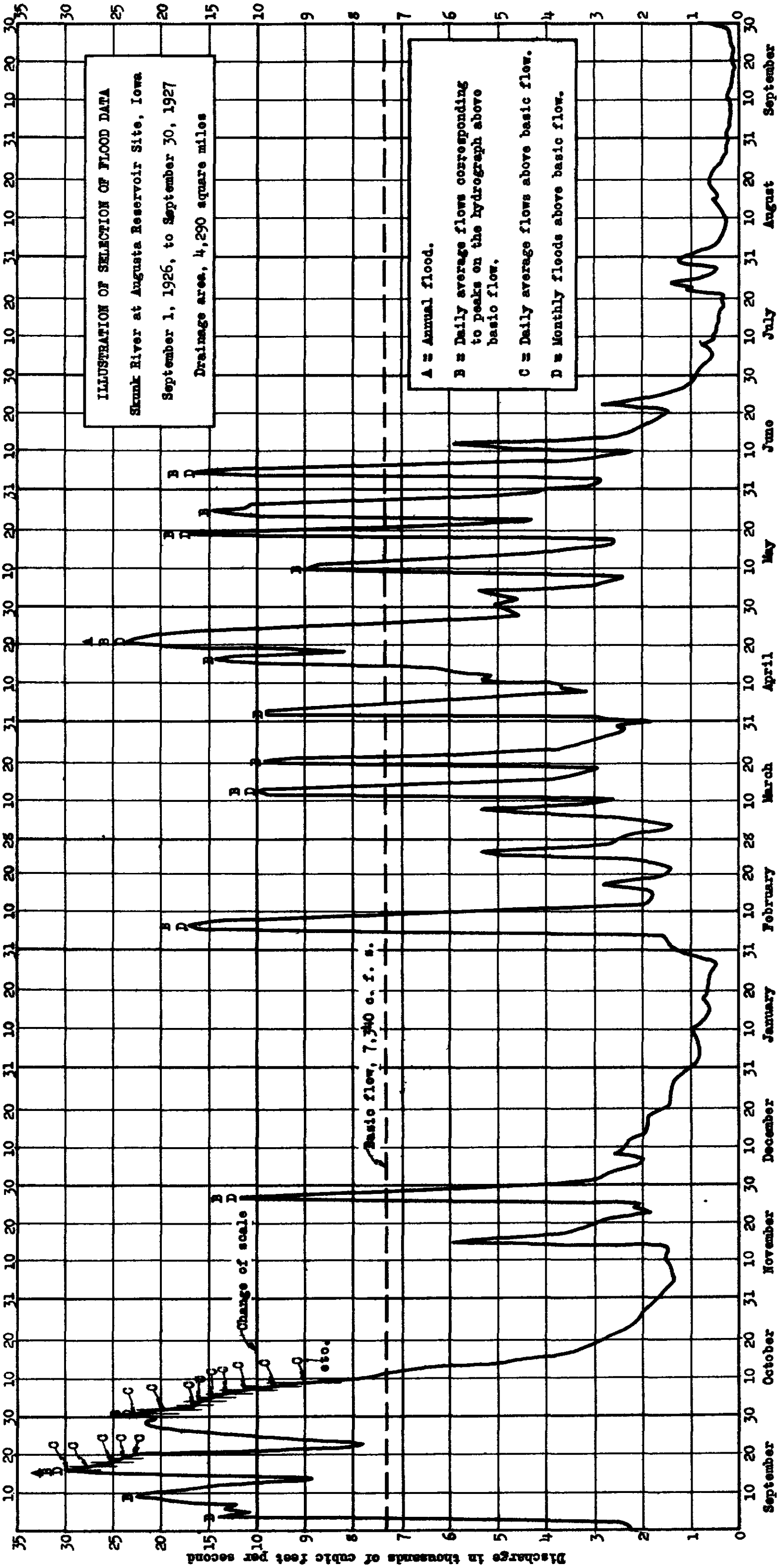


ILLUSTRATION OF SELECTION OF FLOOD DATA
Skunk River at Augusta Reservoir Site, Iowa
September 1, 1926, to September 30, 1927
Drainage area, 4,290 square miles
A = Annual flood.
B = Daily average flows corresponding to peaks on the hydrograph above basic flow.
C = Daily average flows above basic flow.
D = Monthly floods above basic flow.
Basic flow, 7,340 c. f. s.
Change of scale
etc.
Discharge in thousands of cubic feet per second
September
October
November
December
January
February
March
April
May
June
July
August
September

Figure 6.

If the monthly floods for 100 years or 1,200 months are arranged in descending order of magnitude, the 5-year monthly flood for the period of record will lie on the frequency curve between the 20th and 21st items on the frequency scale, as plotted at mid-intervals. Similarly, the 10-year monthly flood will lie between the 10th and 11th items, and the 100-year monthly flood will lie between the 1st and 2d items. By the same reasoning as developed previously, the 5-year, 10-year, 100-year, etc., monthly flood is not simply the record-day average rate of flow likely to be equaled or exceeded on the average once in 5, 10, 100, etc., years, respectively. It can be determined only by data on the daily flow.

3. Daily flow. The discharge ordinate at any point on the frequency curve shows the magnitude of record-day flows which, on the average, is estimated to be equaled or exceeded in the percentage of time in days represented by the corresponding frequency coordinate. As there are 365 days in a year, the floods as defined will be found as follows:

$$\text{5-year flood} = \frac{100}{5 \times 365} = 0.0548 \text{ percent of time on scale.}$$

$$\text{10-year flood} = \frac{100}{10 \times 365} = 0.0274 \text{ percent of time on scale.}$$

$$\text{100-year flood} = \frac{100}{100 \times 365} = 0.00274 \text{ percent of time on scale.}$$

$$\text{1,000-year flood} = \frac{100}{1{,}000 \times 365} = 0.000274 \text{ percent of time on scale.}$$

The 5-year, 10-year, 100-year, 1,000-year daily flood is that record-day average rate of flow which in a long period of years will be equaled or exceeded, on the average, once in 5, 10, 100, 1,000 years respectively.

The daily, monthly, and annual flood flows equaled or exceeded in like periods, such as 5, 10, or 100 years, may closely approach one another, even though the significance of each is distinctly different. This is explained by the fact that many of the items in the upper range of magnitude in the selected data appear in each array, and the maximum daily flow in the record will be the first term in each array. However, owing to their inherent differences in character, they should over a very long period of time give at least slightly differing, rather than actually concordant trends and results.

4. Flood event or partial series (closely related to and convertible into the modified California method). Any point on the frequency curve shows the magnitude of the flood event which is estimated to be equaled or exceeded, on the average, in the percentage of daily flood peaks (not percent of time) shown by the corresponding point on the frequency scale. That is, the discharge corresponding to 1 percent on the frequency scale is the daily flood peak estimated to be equaled or exceeded an average of once out of 100 occurrences.

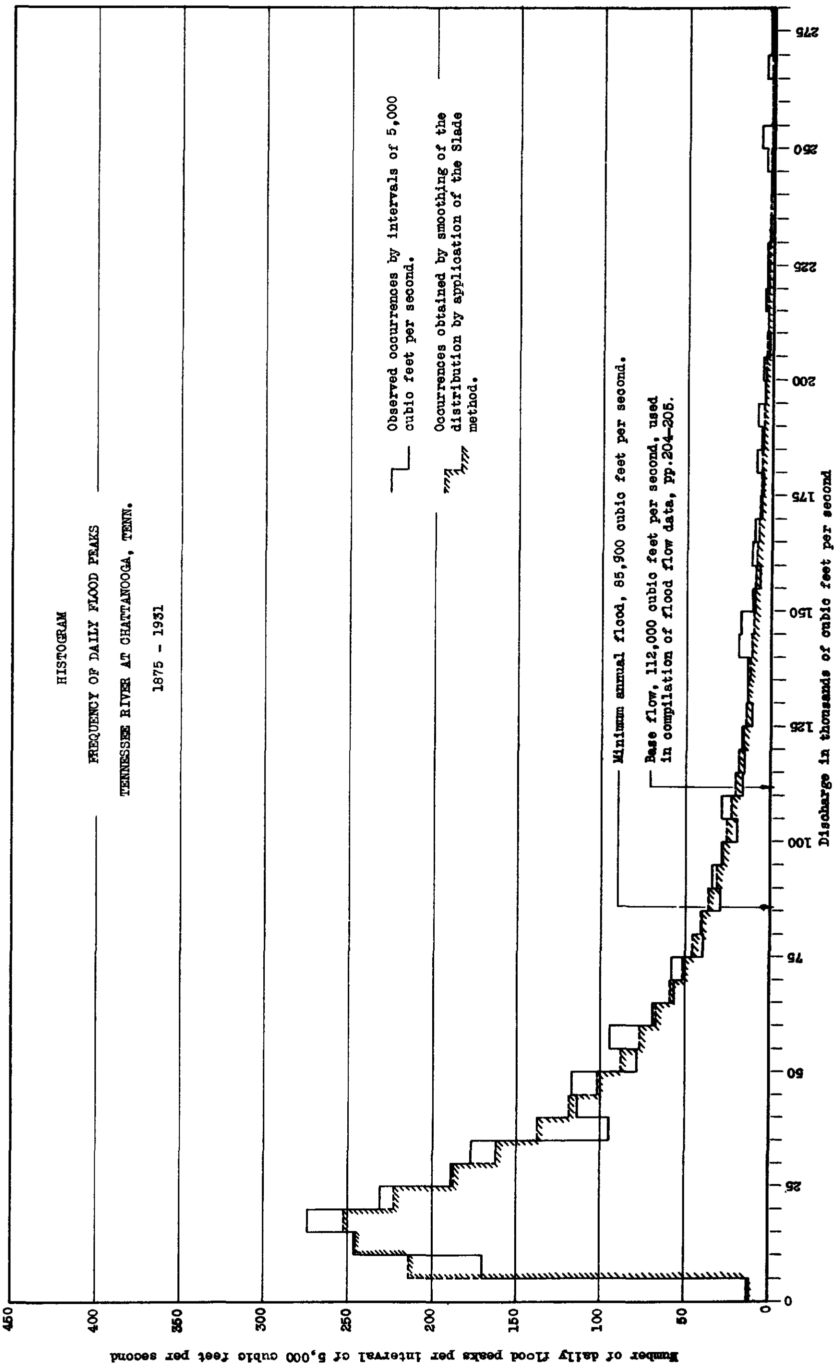
5. Average number of flood events per 100 years (modified California method). Any point on the frequency curve shows the magnitude of the daily flood peak which is estimated to be equaled or exceeded, on the average, such number of times per 100 years as is indicated by the corresponding point on the frequency scale. A flood event equaled or exceeded on the average five times in 100 years may also be interpreted as being equaled or exceeded on the average once in 20 years, or, by definition, as a 20-year flood. Similarly, a flood peak equaled or exceeded on the average 10 times in 100 years may be interpreted as being equaled or exceeded on the average once in 10 years, or as a 10-year flood. Thus in this method two frequency scales may be used - the average number of flood events per 100 years and the average interval of occurrence in years.

General comments

Five different methods for analyzing flood frequencies have been outlined in the foregoing pages. Each of the first four is based on a different array; the fifth is essentially identical with the fourth. Each of the five methods give a different type of result or interpretation. The first three methods are or may be based on complete series made up of equal time intervals (years, months, and days) covering the period of record but differing in the number of terms. The fundamentally correct procedure to determine the daily flow likely to be equaled or exceeded once on the average in a given period of time, as distinguished from a flood event, is method 3, based on daily-flow data. The first three methods are all susceptible of mathematical analysis by fitting frequency curves to the plotted points by the methods developed by Hazen, Foster, Slade, and others.

The fourth and fifth methods, using a partial series array, though not representing complete time series, give results in a form that may be more nearly what is desired in certain practical problems than those derived by methods 1 to 3. The frequency of flood events is a quite different matter from the frequency of daily floods above a given magnitude. No theoretical frequency curve of the Foster-Hazen type can be passed through the points representing flood events above a basic stage or flow which exceeds the lower magnitudes. Where the data representing daily peaks of flood events are found to plot so that a smooth curve fits the points representing the higher flows, the result may be what is actually desired for purposes of design more often than a knowledge of the frequency of daily flows as derived from the complete daily duration series.

Figure 7 presents an example of the application of the Slade method of mathematical and statistical treatment to flood peaks as representatives of flood events for all such items throughout the record period under consideration. On this figure the daily average discharges representing peaks of flood rises that would appear on hydrographs of daily flow of the Tennessee River at Chattanooga were found to number 2,440, or an average of 43 per year for the 57-year record, 1875 to 1931 inclusive. These were classified in steps of 5,000 second-feet, beginning with zero, so that the mid-point of the first class falls somewhat below the minimum observed daily discharge of 3,360 c.f.s., and extending to 365,000 c.f.s. in order to include the maximum observed discharge of 361,000 c.f.s. For mathematical treatment the total number of occurrences within any class is regarded as if it applies to the mid-point of the group or class; thus ranging from 2,500, 7,500, 12,500, etc., to 362,500 second-feet, but each class is here plotted as a bar ordinate covering the corresponding magnitude interval. The resulting histogram provides an example of an array of hydrographic data showing pronounced skewness as regards frequency of occurrence. It also illustrates how a theoretical curve may smooth out the somewhat irregular ordinates representing observed frequencies within successive steps or ranges of discharge. The extensive area under the curve up to the discharge magnitude of 112,000 second-feet, as compared with that which lies beyond this limit, is a measure of the number of items (2,206, or 90 percent of the total 2,440) added below the base flow


HISTOGRAM
FREQUENCY OF DAILY FLOOD PEAKS
TENNESSEE RIVER AT CHATTANOOGA, TENN.
1875 - 1931
Observed occurrences by intervals of 5,000 cubic feet per second.
Occurrences obtained by smoothing of the distribution by application of the Slade method.
Minimum annual flood, 85,900 cubic feet per second.
Base flow, 112,000 cubic feet per second, used in compilation of flood flow data, pp.204-205.
Discharge in thousands of cubic feet per second
0
25
50
75
100
125
150
175
200
225
250
275
Number of daily flood peaks per interval of 5,000 cubic feet per second
0
50
100
150
200
250
300
350
400
450

as adopted for the chronologic listing of flood data on page 204. For most purposes in connection with flood analysis, these 2,206 items of lower discharge peaks have apparently only slight significance and may therefore be omitted.

Any attempt to analyze flood data for a specific problem involving flood economics should take into account the purpose to be served or the nature of the damage to be guarded against, as well as the kind of data on which the analysis is to be based. The inherent limitations of various methods of analysis, types of data, and practical means of interpreting and applying the results have been referred to in various parts of this report, and particularly on pages 29 and 33, as well as in the progress report of the Committee on Flood Protection Data* appointed by the American Society of Civil Engineers. Thus, the determining feature may be the river stage, as affecting levees or bridges, the frequency of moderate rises as affecting cofferdam design and construction, seasonal occurrence and duration of overflow as affecting agriculture and other industries, or possibly any one of several other aspects of flood occurrence significant in relation to a special problem.

Illustrative examples

Examples of flood statistics as listed, arranged, and plotted by various methods during this investigation are shown in figures 3 to 5 and 9 to 15. Consideration of the results obtained for many stations by these and similar processes has led to the following generalizations.

Annual floods: The given flow will be equaled or exceeded as an annual flood maximum on the average once in a certain number of years (as X). Theoretically, however, it will have been reached as a daily flow or as a peak of an individual flood with a frequency somewhat greater than once in X years.

Daily duration series: The given flow will be equaled or exceeded as a daily flow on the average once in a certain number of years (as Y). The frequency of occurrence of such flow, either as an annual flood or as a flood peak, is likely to be less than once in Y years.

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* Am. Soc. Civil Eng. Proc., vol. 61, no. 3, pp. 336-338, March 1935.

Flood events or peaks: The given flow will be equaled or exceeded as a peak flow on the average once in a certain number of years (as Z). It will, however, probably have been reached as a daily flow with greater frequency than once in Z years and as an annual peak with less frequency than once in Z years.

It follows that for a given frequency, such as once in N years, the daily duration curve will probably show the largest result, the peak flows the next largest, and the annual floods the smallest. This means that theoretically the magnitude of results for any frequency from 5 years to 1,000 years, or outside these limits, should vary in this order.

If the three series of data above mentioned are plotted by the modified California method, as illustrated in figures 3 to 5 theoretically the curves could not cross but would approach coincidence at the maximum possible daily flow, the point toward which all the graphs are directed, each in its own way. These characteristics should be given appropriate weight in the extrapolation of frequency curves beyond the limits of observed data.

MOMENTARY FLOOD PEAKS AND OTHER FLOW CHARACTERISTICS OF FLOOD RISES

Rates of flow during periods of flood rises, as during other periods covered by stream-flow records, are commonly published and treated in the computations of monthly and annual flow as mean rates of flow for calendar days. The average flow for the calendar day is the basic rate of flow adopted in the listings of flood data in this report, and the recorded flow is that for the day on which this average reached a maximum during a given flood - here called the "recorded day." The average flow for that day is here called the "daily peak."

Such records, though marking significant flood events in the recorded history of a stream, may fall short of giving the detailed information that is required for an adequate knowledge of flood characteristics or that may be desired in investigations of some special types. In the design of engineering works for flood protection and control, the need for details of rates and volumes of flow throughout the flood rise may be very great. On a stream where the peak stage or flow varies materially from the average flow for the day and especially where life and property may be jeopardized by even a short peak that exceeds a given stage and corresponding flow, consideration of such a peak may be a critical factor in some problems. Indeed, users of flood data should be particularly cautioned to remember that the maximum daily average does not show the maximum flow or stage attained in a flood rise. The procedure followed in estimating so-called "momentary" peak flows is discussed in the chapter "Methods for estimating floods."

Under some circumstances the volumes of flow to be expected in short intervals of time, beyond the degree of detail afforded by the usual records of flow for calendar days, may be of critical importance. For example, need for such information may arise in the study of pondage and spillway provisions where storage capacity is limited.

It is not practicable in this report to do more than present certain basic observations and suggestions for the information of the investigator in reaching sound conclusions. Upon those who determine the design of works for flood control and protection must, of course, rest the responsibility for exercising due caution and wise judgment.

In the listings of flood data in this report it has fortunately been practicable to include many of the momentary peaks attained in flood rises along with the corresponding daily peaks, thus furnishing essential information for guiding the judgment of the investigator in such matters. The increasing use of continuous water-stage recorders has not only facilitated the determination of the momentary peak of a flood rise but has also provided a continuous hydrograph of stage and flow throughout such a rise, for use where information of that kind is needed.

In the early days of stream gaging the rates of flow as published by the Geological Survey were determined very largely or exclusively from readings of staff or chain gages, often with only one or two observations a day. Where a single gage reading is taken in early morning or late evening, or at any other time far removed from midday, it is not entirely clear that the calendar day is logically the basic unit of time reckoning, even though it is so used. The individual descriptions of stations accompanying the compilations of flood data elsewhere in this report show the basis of flow determinations with respect to the type of gage and the number of observations per day. The use of such observations to the extent that they are available affords the best means for a detailed study of the hydrograph of the flood rise. Moreover, a fair approximation of the hydrograph of flow throughout a flood rise, and also of the momentary peaks, may be obtained by plotting the mean daily flows for each day through the flood rise as bar ordinates of a width equal to the day interval on the graph, connecting the mid-points of the upward and downward limbs of the rise, and extending them to such intersection on the day of peak flow as will give results for that day consistent with the known average daily flow. Available time and space do not permit the inclusion in this report of the detailed information to suit such special needs, and therefore such information must generally be obtained by reference to the published or original records of stage and flow.

The limitations upon flood investigations presented by the publication of the flow for a calendar day are sufficiently noted in the preceding paragraphs. It was believed that significant and valuable information would be developed by investigating the magnitude of the maximum 24-hour flows, regardless of coincidence with a calendar day, and the momentary flood peaks associated with the peak flows as recorded for calendar days, and that the collection of such data for representative gaging stations throughout the country that are equipped with continuous recorders would aid in the understanding of flood characteristics and in the wiser use of available flood records.

The cooperation of all district engineers of the water-resources branch of the Geological Survey was enlisted in this project. Each district organization was requested to select several gaging stations equipped with automatic recording gages on streams from representative drainage areas, including those of small, medium, and large size. The momentary peak discharges were determined from the records of automatic stage recorders and compared with the corresponding average flows for both maximum calendar days and maximum 24-hour periods. Thus, from more than 30 districts, comparisons were afforded among these items for some 124 gaging stations. As each of these stations usually affords several items, the total represented comparisons of data relating to 690 flood events. The selections were made more or less at random, with an effort to cover various conditions and without consideration of possibly more significant aspects, such as might be developed by further study of the subject. Some of the discharge quantities represent the latest revisions of hitherto published figures. No distinction has been made between floods resulting entirely from rainfall and those affected by melting ice or snow. For stations in the areas of colder climate flood rises during the winter and early spring would be expected to reflect some influence of melting snow and ice.

The accompanying tabulation of this information shows the date of the record day for each selected flood event, the corresponding average discharge for that day, the maximum 24-hour flow, and the momentary peak stage with corresponding discharge. The two final columns show the percentages by which the record-day average flows are exceeded by the maximum 24-hour averages and the corresponding momentary peak flows.

The maximum 24-hour average flow always includes a considerable portion of the record day and usually extends over into a preceding or following day. The peak flow usually occurs on the record day but occasionally occurs on an adjacent day. The minus and asterisk signs preceding dates in the first column of the table indicate, respectively, preceding or following days for the momentary peaks.

The results varied widely, particularly on streams having flashy habits of discharge. Such flashiness may result from a variety of causes, such as steepness of drainage slopes, imperviousness of surface, and shape of drainage basin, especially wherever it approaches a segment of a circle, or where length and width are nearly equal. Furthermore, the flashy habits may be related to peculiarities of rainfall distribution, the short intense rainfalls of the cloudburst type being capable of causing unusually high and destructive run-offs from relatively small drainage areas. Whatever may be the factors accounting for the flashiness of flow in a given stream, the normal accompanying and related behavior will probably include corresponding periods of low discharge. The outstanding extremes of irregular flow may thus be expected in regions subject to great variations in rainfall habits - as, for instance, in semiarid country, in steep, rugged, either rock-surfaced or frozen areas of humid regions, and in general wherever opportunities for infiltration, absorption, detention, and regulation are notably lacking.

In contrast with the foregoing, there may be relatively small differences between the momentary and daily average flood peaks wherever regulation is sufficiently effective. This close agreement may result from soil infiltration and absorption, or from storage or retention in natural or artificial basins or in the channels of the larger river systems, such effect usually being associated either with gentle surface slopes or with extensive drainage basins. Occasionally there is no measurable difference between the momentary flood peak and the record-day average or the maximum 24-hour average. The record-day average depends on a maximum crest extending continuously throughout the record day; the maximum 24-hour average depends on the slightly different requirement, that the maximum crest continues for at least 24 hours, whether or not confined to one calendar day.

The difference between the maximum 24-hour discharge and that of the record day may be too small to measure, or in extreme cases it may amount to as much as one-half of the maximum 24-hour discharge - in other words, the record-day flow cannot be less than one-half the maximum 24-hour flow, for otherwise that day could not be the record day. The average flow during a record day will therefore be equaled or exceeded (the possible difference being not more than 100 percent) by the maximum 24-hour average flow; and this in turn will be either equaled or else exceeded in widely varying amounts by the momentary peak discharge.

Although the data and comparisons afforded by the 690 flood events above mentioned and by other tabulated records of some 200 stations, published herewith, seem to represent a great mass of useful information, it has not yet responded to efforts at generalized analysis. Not only the seasonal influences but also the wide variety in soil moisture, directions of storm movement, duration and distribution of rainfall on a given river system, influence of thaws, and shape of drainage basin may be reflected in the relative values of the three run-off rates included in the comparisons above described.

On some rivers the momentary peaks may be visualized as due to some peculiarly fortuitous occurrence of intense rainfall, such as a cloudburst, at a critically effective position in the drainage basin. On other rivers the momentary peaks may be visualized as due to intense precipitation or melting snow embracing the entire drainage area and continuing over the period of concentration for that basin. Where the drainage basin has a dumb-bell form, or two compact areas connected by a narrow strip, there is ample opportunity for a split peak, or double crest. There is opportunity for infinite variety in the combination of these causative factors. Where sufficient data are available and the application can be appropriately made, momentary peaks are well suited, of course, to analysis by statistical methods.

It has been suggested that an extended application of the principle of the unit hydrograph and distribution graph, described elsewhere in this report, migh affort a means for estimating peak flows that may be expected. The use of continuous recording rain gages as well as water-stage recorders on a given drainage area would supply the data on distribution by hours or any other short periods, which would be essential for such application, at least to the smaller basins.

Figure 8 illustrates the derivation of the approximate peak from a record of mean daily flows, in accordance with the method referred to on page 91. These daily flows were plotted as bar ordinates, and approximately the mid-points of their summits, except for the daily peaks and valleys, were connected by lines to represent the continuous hydrograph

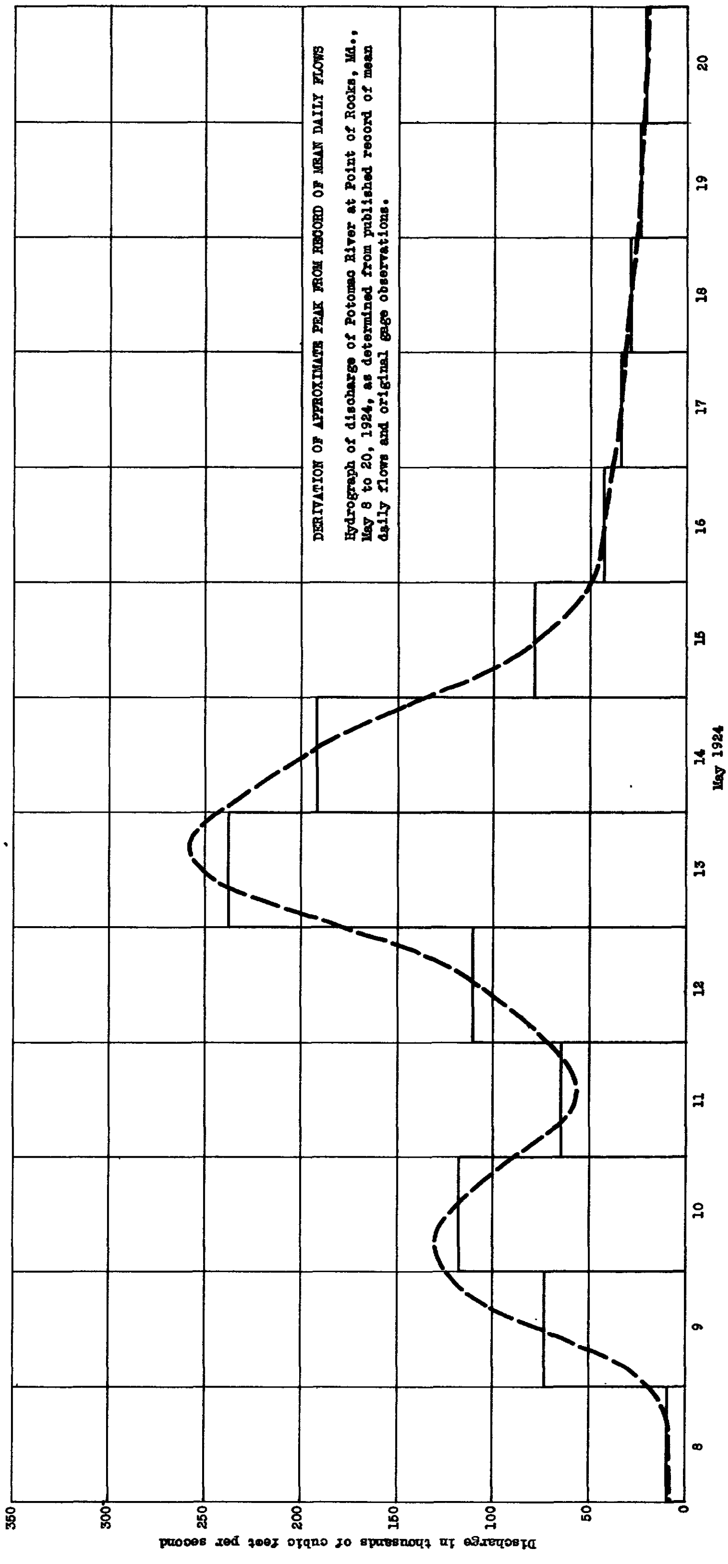
DERIVATION OF APPROXIMATE PEAK FROM RECORD OF MEAN DAILY FLOWS
Hydrograph of discharge of Potomac River at Point of Rocks, Md., May 8 to 20, 1924, as determined from published record of mean daily flows and original gage observations.
Discharge in thousands of cubic feet per second
0
50
100
150
200
250
300
350
8
9
10
11
12
13
14
15
16
17
18
19
20
May 1924

Figure 8.

of discharge, with due regard to the requirement that the nearly triangular areas above and below each bar ordinate must be equal, in order to conform to the value of the mean flow. For the days of maximum (or minimum) discharge, the intersection of the ascending and descending lines of trend, modified to make a suitably rounded summit (or valley), determines the approximate maximum (or minimum).

Where all available sources of information are appropriately utilized in plotting the data and drawing the lines, the resulting curve should approximate the hydrograph of discharge, including the momentary peak. In this example the original observations were utilized in the determination of the hydrograph.

The increasing number of gaging stations equipped with continuous water-stage recorders makes it possible to derive the desired details more readily from official records and not only to reduce the number of estimates necessary but to furnish better bases for such estimates whenever they are required.

Precautions are necessary in the use and interpretation of the tabulated data and their comparisons. For instance, the peak characteristics of small, flashy streams are not generally applicable to larger or better-watered drainage basins. Moreover, the ratios derived from medium floods would often be quite unrepresentative for high stages. Run-off from general storms of long duration, for example, although perhaps producing greater total discharge on a certain stream, may not normally afford the wide excess over the record-day discharge produced by floods on that stream resulting from cloudbursts.

From the following tabulation undoubtedly many interesting and valuable facts could be deduced, for which time is insufficient within the limits of the present project. It is hoped that the basic data here given may afford material on which further studies may be made as special needs and opportunities may occur, and that the range of differences illustrated in the comparisons of peak and daily average flows may receive due consideration.

Table 2

COMPARISON OF FLOOD FLOWS

Maximum calendar-day average (daily flood peak), maximum 24-hour average, and momentary flood peak

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Discharge (c.f.s.)	Discharge (c.f.s.)	Gage height (ft.)	Discharge (c.f.s.)	Max. 24-hr. av.	Flood peak
Penobscot River at West Enfield, Maine (Drainage area 6,600 square miles)							
May 1,1923	24.95	152,000	152,000	25.15	153,000	0	0.7
May 5,1926	15.00	66,400	67,100	15.15	67,500	1.1	1.7
Nov. 6,1927	13.88	58,700	59,400	14.20	60,800	1.2	3.6
May 28,1928	13.01	52,400	52,400	13.10	53,100	0	1.3
May 4,1929	14.84	65,000	66,400	15.28	68,700	2.2	5.7
Apr. 13,1932	14.90	65,700	67,900	15.40	69,500	3.3	5.8
Sept. 18,1932	14.54	62,900	63,600	15.20	67,900	1.1	8.0
Apr. 19,1933	13.45	55,200	55,900	13.56	56,600	1.3	2.5
Mattawamkeag River at Mattawamkeag, Maine (Drainage area 1,500 square miles)							
Apr. 21,1929	8.85	13,400	13,400	8.88	13,600	0	1.5
May 5,1929	9.75	16,100	16,100	9.75	16,100	0	0
Apr. 15,1930	8.92	13,600	13,600	8.94	13,600	0	0
Apr. 14,1931	8.99	13,900	13,900	9.00	13,900	0	0
May 5,1932	7.74	10,500	.10,700	7.77	10,700	1.9	1.9
Oct. 31,1932	6.96	8,680	8,680	7.00	8,680	0	0
Apr. 13,1933	9.17	14,400	14,400	9.20	14,400	0	0
Carrabassett River near North Anson, Maine (Drainage area 351 square miles)							
-May 4,1926	10.00	7,680	7,870	10.57	8,590	2.5	11.9
-Nov. 20,1926	S	5,640	7,330	10.99	9,280	30.0	64.6
-Nov. 5,1927	S	9,590	13,800	17.83	18,600	43.9	93.9
May 3,1929	S	8,480	10,500	13.88	12,900	23.8	52.1
-Apr. 8,1930	10.72	8,290	10,000	13.11	11,800	20.6	42.3
Apr. 11,1931	7.73	4,030	4,580	8.47	5,140	13.6	27.5
Sept. 17,1932	S	13,000	13,900	18.91	20,100	6.9	54.6
-Apr. 19,1933	S	6,860	7,610	10.83	8,440	10.9	23.0
Saco River at Cornish, Maine (Drainage area 1,300 square miles)							
Apr. 14,1922	12.07	17,800	17,800	12.20	18,000	0	1.1
May 2,1923	14.60	22,800	22,800	14.72	23,000	0	.9
May 4,1924	9.58	12,800	12,800	9.63	12,900	0	.8
Apr. 1,1925	11.10	15,800	15,800	11.16	15,900	0	.6
Apr. 11,1928	9.96	13,600	13,600	10.00	13,600	0	0
Apr. 15,1932	10.17	13,800	13,800	10.22	13,800	0	0
Apr. 21,1933	12.83	19,300	19,300	12.90	19,500	0	1.0
Pemigewasset River at Plymouth, N. H. (Drainage area 622 square miles)							
*Apr. 8,1929	9.55	12,700	12,950	9.9	13,400	2.0	5.5
May 3,1929	S	16,100	18,690	14.14	23,200	16.1	44.1
Apr. 8,1930	S	14,500	18,200	13.14	20,700	25.5	42.8
Apr. 13,1932	S	13,100	15,600	12.10	18,200	19.1	38.9
Nov. 20,1932	S	12,600	13,100	11.20	16,200	4.0	28.6
Apr. 18,1933	S	18,200	19,300	12.77	19,900	6.0	9.3
Willimantic River near South Coventry, Conn. (Drainage area 122 square miles)							
-Nov. 11,1932	5.94	868	1,060	6.83	1,180	22.1	35.9
-Mar. 22,1933	6.14	939	967	6.4	1,030	3.0	9.7
-Apr. 5,1933	6.25	977	1,020	6.62	1,170	4.4	19.8
Apr. 19,1933	5.69	787	787	5.85	838	0	6.5
Sept. 17,1933	6.19	956	956	6.51	1,070	0	11.9
Hop River near Columbia, Conn. (Drainage area 76.5 square miles)							
Nov. 10,1932	8.18	1,070	1,350	10.7	1,900	26.2	77.6
Feb. 21,1933	6.05	531	544	6.55	648	2.4	22.0
Mar. 22,1933	7.28	830	868	8.03	1,030	4.6	24.1
Apr. 5,1933	6.49	632	716	7.20	810	13.3	28.2
Apr. 14,1933	6.29	582	603	6.58	653	3.6	12.2

(a) - Momentary flood peak occurred on preceding day.
 * Momentary flood peak occurred on following day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Connecticut River at North Stratford, N. H. (Drainage area 797 square miles)							
Apr. 12,1931	S	11,300	11,800	9.62	12,300	4.4	8.8
-Apr. 11,1932	8.65	9,670	9,930	8.84	10,200	2.7	5.5
-Sept. 17,1932	S	7,350	7,850	8.15	8,410	6.8	14.4
-Apr. 19,1933	11.80	19,200	20,300	12.39	21,500	5.7	12.0
May 4,1933	10.67	15,400	15,400	10.80	15,800	0	2.6
Connecticut River at Montague City, Mass. (Drainage area 7,950 square miles)							
Apr. 9,1930	21.26	47,400	47,800	21.80	49,500	0.8	4.4
Apr. 12,1931	25.98	68,600	68,600	26.74	72,100	0	5.1
Apr. 13,1932	29.93	89,600	90,600	30.32	91,900	1.1	2.6
Nov. 20,1932	S	64,400	68,500	26.52	71,100	6.4	10.4
Apr. 19,1933	37.01	133,000	135,500	37.56	137,000	1.9	3.0
Passumpsic River at Passumpsic, Vt. (Drainage area 423 square miles)							
*May 3,1929	9.80	5,570	5,900	10.80	6,370	5.9	14.4
Apr. 8,1930	8.57	4,610	4,850	9.38	5,250	5.2	13.9
Apr. 11,1931	S	3,600	4,020	8.28	4,370	11.7	21.4
Apr. 13,1932	S	4,700	5,240	10.13	5,810	11.5	23.6
Apr. 18,1933	14.01	9,180	9,360	14.36	9,540	2.0	3.9
Swift River at West Ware, Mass. (Drainage area 186 square miles)							
Apr. 7,1923	9.05	2,380	2,380	9.08	2,390	0	0.4
*Nov. 5,1927	8.43	2,140	2,180	8.60	2,230	1.9	4.2
Apr. 2,1932	7.91	1,880	1,930	8.13	1,980	2.7	5.3
Apr. 20,1933	8.87	2,130	2,130	8.95	2,160	0	1.4
Sept. 18,1933	8.96	2,160	2,160	9.07	2,200	0	1.8
Housatonic River at Falls Village, Conn. (Drainage area 644 square miles)							
Nov. 20,1932	9.69	5,370	5,450	10.2	5,830	1.5	8.6
Apr. 5,1933	9.65	5,340	5,360	9.75	5,420	.4	1.5
Apr. 9,1933	9.6	5,290	5,290	9.73	5,390	0	1.9
Apr. 19,1933	9.8	5,470	5,470	9.86	5,520	0	.9
Sept. 18,1933	12.4	7,950	7,950	12.65	8,160	0	2.6
Tenmile River near Gaylordsville, Conn. (Drainage area 204 square miles)							
Nov. 20,1932	6.71	2,770	2,900	7.1	3,090	4.7	11.6
Mar. 22,1933	4.51	1,260	1,260	4.56	1,290	0	2.4
Apr. 2,1933	4.19	1,080	1,100	4.29	1,140	1.8	5.6
Apr. 18,1933	4.98	1,540	1,540	5.1	1,610	0	4.5
Sept. 17,1933	4.75	1,400	1,430	4.87	1,470	2.1	5.0
Pomperaug River at Southbury, Conn. (Drainage area 75.8 square miles)							
Nov. 10,1932	6.95	1,620	1,720	8.3	3,010	6.2	85.8
Mar. 8,1933	5.36	600	657	6.0	935	9.5	55.8
Mar. 21,1933	5.77	802	1,050	7.04	1,700	30.9	112
Apr. 18,1933	5.46	658	660	5.80	820	.3	24.6
Sept. 16,1933	5.15	508	508	5.72	776	0	52.8
Sacandaga River at Hadley, N. Y. (Drainage area 1,057 square miles)							
Mar. 28,1913	S	34,150	34,300	12.36	35,500	0.4	4.0
Apr. 21,1914	S	19,500	20,380	10.22	20,800	4.5	6.7
Apr. 13,1922	S	22,430	22,480	10.68	23,000	.2	2.5
Apr. 26,1926	S	21,970	22,080	10.60	22,500	.5	2.4
Apr. 9,1928	S	20,220	20,220	10.20	20,400	0	.9

(a) - Momentary flood peak occurred on preceding day.
* Momentary flood peak occurred on following day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Discharge (c.f.s.)	Discharge (c.f.s.)	Gage height (ft.)	Discharge (c.f.s.)	Max. 24-hr. av.	Flood peak
Batten Kill at Battenville, N. Y. (Drainage area 394 square miles)							
Apr. 7,1923	S	4,727	5,504	8.13	5,630	16.4	19.1
Dec. 1,1923	S	5,773	5,873	8.60	6,240	1.7	8.1
Nov. 4,1927	S	17,940	18,210	17.70	21,300	1.5	18.7
July 22,1931	S	7,414	8,811	11.07	9,710	18.8	31.0
Apr. 19,1933	S	5,330	5,345	8.28	5,560	.3	4.3
Susquehanna River at Conklin, N. Y. (Drainage area 2,240 square miles)							
Nov. 29,1921	S	39,260	39,280	16.03	39,900	0.1	1.6
Sept. 30,1924	S	25,070	42,610	16.86	44,200	70.0	76.3
Feb. 12,1925	S	42,360	42,360	17.04	44,900	0	6.0
Oct. 19,1927	S	36,240	39,170	16.88	43,500	8.1	20.0
Mar. 17,1929	S	44,160	46,030	17.60	47,000	4.2	6.4
Susquehanna River at Wilkes-Barre, Pa. (Drainage area 9,960 square miles)							
Mar. 9,1930	16.22	63,800	65,400	16.7	67,600	2.5	6.0
Mar. 30,1931	17.38	72,100	72,100	17.64	74,700	0	3.6
Apr. 2,1932	20.16	104,000	104,000	20.54	107,000	0	2.9
Apr. 12,1932	15.13	63,300	64,000	15.26	64,700	1.1	2.2
Aug. 25,1933	18.62	90,400	93,800	19.72	99,800	3.8	10.4
Susquehanna River at Harrisburg, Pa. (Drainage area 24,100 square miles)							
Mar. 17,1929	12.47	233,000	233,000	12.55	235,000	0	0.9
Apr. 18,1929	10.96	196,000	196,000	11.19	201,000	0	2.6
Apr. 23,1929	S	222,000	225,000	12.29	228,000	1.4	2.7
May 4,1929	S	172,000	172,000	10.26	179,000	0	4.1
Apr. 2,1932	12.80	240,000	242,000	13.02	245,000	.8	2.1
Mar. 22,1933	9.82	167,000	167,000	9.88	170,000	0	1.8
Aug. 25,1933	S	249,000	249,000	14.04	269,000	0	8.0
West Branch of Susquehanna River at Williamsport, Pa. (Drainage area 5,682 square miles)							
-Mar. 16,1929	15.75	86,400	91,500	16.62	94,500	5.9	9.4
Feb. 27,1930	11.90	51,700	52,400	12.29	54,700	1.4	5.8
May 24,1931	12.47	56,200	57,000	12.76	58,600	1.4	4.3
Apr. 1,1932	S	66,800	72,800	14.68	75,600	9.0	13.2
May 12,1932	S	62,100	64,600	13.94	68,200	4.0	9.8
Mar. 16,1933	S	67,800	68,200	14.30	71,800	.6	5.9
Loyalsock Creek at Loyalsock, Pa. (Drainage area 443 square miles)							
Nov. 16,1926	8.16	12,000	22,000	12.3	34,000	83.3	183
Mar. 14,1927	7.26	8,400	8,400	7.43	8,790	0	4.6
Dec. 8,1927	7.38	8,790	9,590	8.51	13,200	9.1	50.2
June 6,1928	7.49	9,190	9,590	8.74	14,500	4.4	57.8
June 30,1928	7.80	10,400	10,400	9.00	15,800	0	51.9
May 3,1929	8.36	12,800	13,500	10.50	23,600	5.5	84.4
Apr. 1,1932	S	8,290	8,770	8.06	12,000	5.8	44.8
Aug. 24,1933	S	22,100	22,700	12.20	33,900	2.7	53.4
Juniata River at Newport, Pa. (Drainage area 3,354 square miles)							
Oct. 23,1929	S	43,200	51,800	17.26	57,500	19.9	33.1
May 24,1931	S	33,200	33,800	12.94	35,800	1.8	7.8
Apr. 1,1932	13.44	38,000	39,300	13.99	40,600	3.4	6.8
Mar. 16,1933	S	34,900	36,200	13.35	38,000	3.7	8.9
Mar. 21,1933	12.43	33,600	33,600	12.64	34,400	0	2.4
May 11,1933	S	31,500	31,700	12.28	33,100	.6	5.1

(a) - Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

	Maximum calendar-day average		Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
North Branch of Patapsco River near Marriotsville, Md. (Drainage area 165 square miles)							
Oct. 6,1932	S	906	923	6.96	1,850	1.9	104
Nov. 1,1932	S	1,200	1,310	8.23	2,650	9.2	121
Jan. 26,1933	S	949	949	6.65	1,600	0	68.6
Mar. 21,1933	S	883	883	5.62	1,050	0	18.9
Apr. 17,1933	S	1,430	1,450	7.56	2,160	1.4	51.0
-Apr. 20,1933	S	1,240	1,410	6.98	1,820	13.7	46.8
July 3,1933	S	946	1,050	6.31	1,440	11.0	52.2
Aug. 24,1933	S	6,850	10,300	20.8	19,500	50.4	185
North Branch of Potomac River near Cumberland, Md. (Drainage area 875 square miles)							
Nov. 20,1932	7.60	4,710	4,850	8.25	5,590	3.0	18.7
Mar. 14,1933	S	17,300	17,300	17.8	23,400	0	35.2
Mar. 20,1933	11.48	11,000	11,400	12.09	12,100	3.6	10.0
Apr. 20,1933	14.0	15,700	15,700	14.92	17,400	0	10.8
May 10,1933	S	9,160	9,180	11.00	10,100	.2	10.3
Aug. 24,1933	S	3,920	5,020	9.68	7,930	28.1	102
Potomac River at Shepherdstown, W. Va. (Drainage area 5,940 square miles)							
Mar. 1,1929	13.10	42,800	43,700	13.46	44,600	2.1	4.2
Apr. 17,1929	S	108,000	119,000	25.53	124,000	10.2	14.8
Oct. 23,1929	S	68,400	69,800	19.83	82,400	2.0	20.5
May 24,1931	10.54	30,400	31,300	10.90	32,200	3.0	5.9
Feb. 6,1932	S	52,700	55,000	16.48	61,400	4.4	16.5
May 14,1932	S	96,600	112,000	24.75	119,000	15.9	23.2
-Nov. 11,1932	10.88	32,200	34,100	11.69	36,000	5.9	11.8
Jan. 27,1933	S	36,500	36,600	12.80	41,300	.3	13.2
Mar. 15,1933	12.74	40,800	40,800	13.27	43,800	0	7.4
Mar. 21,1933	14.11	47,900	47,900	14.34	49,000	0	2.3
Apr. 21,1933	S	69,600	73,900	19.1	77,800	6.2	11.8
May 11,1933	11.52	35,000	35,500	11.84	36,400	1.4	4.0
Aug. 25,1933	S	37,200	39,400	13.47	44,800	5.9	20.4
Potomac River near Washington, D. C. (Drainage area 11,560 square miles)							
-Oct. 20,1932	6.60	39,500	45,100	7.50	49,600	14.2	25.6
Nov. 11,1932	9.20	72,300	72,300	9.39	75,100	0	3.9
Jan. 28,1933	8.59	63,900	69,500	9.37	75,100	8.8	17.5
Mar. 22,1933	9.10	70,900	75,100	9.42	75,100	5.9	5.9
Apr. 19,1933	9.62	77,900	80,700	10.11	85,200	3.6	9.4
Apr. 22,1933	12.35	121,000	123,000	12.78	127,000	1.7	5.0
May 11,1933	7.43	48,400	48,400	7.54	49,600	0	2.5
Aug. 25,1933	10.24	86,700	86,700	10.57	92,700	0	6.9
Wills Creek near Cumberland, Md. (Drainage area 247 square miles)							
Nov. 10,1932	5.15	1,320	1,320	5.40	1,540	0	16.7
Jan. 26,1933	4.88	1,120	1,120	5.08	1,280	0	14.3
Mar. 14,1933	7.60	5,800	6,390	8.8	9,680	10.2	66.9
Mar. 20,1933	6.48	3,040	3,240	6.70	3,450	6.6	13.5
Apr. 20,1933	7.21	4,690	4,960	7.55	5,660	5.8	20.7
May 10,1933	7.11	4,430	4,560	7.53	5,660	2.9	27.8
Monocacy River at Jug Bridge near Frederick, Md. (Drainage area 817 square miles)							
-Oct. 19,1932	S	9,820	12,700	12.85	13,500	29.3	37.5
Nov. 10,1932	S	10,300	11,600	12.6	13,100	12.6	27.2
Mar. 21,1933	10.40	9,280	9,280	10.9	10,100	0	8.8
Apr. 17,1933	S	10,000	11,900	12.9	13,700	19.0	37.0
Aug. 11,1933	S	15,600	15,900	16.1	20,300	1.9	30.1
Aug. 24,1933	S	42,100	44,000	28.1	51,000	4.5	21.1
Sept. 17,1933	S	12,600	15,800	16.7	21,600	25.4	71.4

(a) - Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Rappahannock River near Fredericksburg, Va. (Drainage area 1,590 square miles)							
June 5,1922	7.11	17,700	19,900	9.30	27,200	12.4	53.7
May 9,1924	7.78	19,600	20,500	8.36	22,600	4.6	15.3
Apr. 22,1927	6.76	14,400	16,600	7.85	18,800	15.3	30.6
Apr. 28,1928	8.48	22,400	22,900	8.98	24,800	2.2	10.7
Oct. 23,1929	11.29	37,100	41,900	12.67	44,800	12.9	20.8
Nov. 10,1932	10.46	32,600	35,400	11.84	39,900	8.6	22.4
Apr. 18,1933	8.70	23,500	26,200	9.52	27,400	11.5	16.6
*Sept. 17,1934	10.15	30,800	33,600	11.08	36,000	9.1	16.9
James River at Buchanan, Va. (Drainage area 2,080 square miles)							
Sept. 20,1928	11.09	21,300	22,600	12.63	26,100	6.1	22.5
Apr. 17,1929	10.79	20,200	20,400	11.77	23,500	1.0	16.3
Nov. 19,1929	13.24	28,200	33,800	16.50	39,000	19.9	38.3
Mar. 8,1930	8.18	12,200	12,900	9.03	14,600	5.7	19.7
Feb. 5,1932	12.79	26,800	27,100	15.30	35,000	1.1	30.6
Dec. 29,1932	11.16	21,600	22,200	12.00	24,300	2.8	12.5
Feb. 21,1933	9.65	16,800	17,000	10.37	19,200	1.2	14.3
Mar. 28,1934	11.80	23,700	27,400	14.36	32,000	15.6	35.0
James River at Cartersville, Va. (Drainage area 6,240 square miles)							
Apr. 28,1928	14.21	41,500	45,400	15.97	48,900	9.4	17.8
Apr. 17,1929	17.41	55,200	55,200	17.58	56,100	0	1.6
-Mar. 9,1930	13.53	38,500	42,300	15.44	46,200	9.9	20.0
Oct. 18,1932	19.85	67,600	72,900	21.54	75,400	7.8	11.5
Dec. 29,1932	15.97	49,400	50,400	16.70	52,800	2.0	6.9
Apr. 18,1933	19.83	67,500	68,300	20.48	70,600	1.2	4.6
-Mar. 6,1934	15.13	45,300	47,600	15.93	49,000	5.1	8.2
Mar. 30,1934	12.90	35,600	40,400	14.63	43,000	13.5	20.8
North River near Lexington, Va. (Drainage area 487 square miles)							
Jan. 19,1926	8.20	4,760	5,740	9.75	6,870	20.6	44.3
-Mar. 6,1929	8.20	4,780	6,170	9.97	7,150	29.1	49.6
Apr. 16,1929	8.44	5,590	7,950	11.95	10,000	42.2	78.9
Mar. 8,1930	8.15	4,830	5,520	9.99	7,250	14.3	50.1
Feb. 5,1932	8.33	5,020	6,110	11.05	8,650	21.7	72.3
Oct. 18,1932	8.99	5,960	8,210	12.63	11,100	37.8	86.2
Mar. 20,1933	7.90	4,430	5,060	9.25	6,080	14.2	37.2
Mar. 28,1934	7.93	4,420	4,420	8.61	5,290	0	19.7
Roanoke River at Roanoke Rapids, N. C. (Drainage area 8,410 square miles)							
-Jan. 11,1932	14.65	52,200	53,300	14.88	53,900	2.1	3.3
Mar. 9,1932	18.06	73,300	73,900	18.43	75,200	.8	2.6
Oct. 21,1932	S	86,300	86,800	20.84	90,400	.6	4.8
Dec. 31,1932	15.50	57,500	57,500	15.78	59,300	0	3.1
Apr. 11,1934	S	58,600	65,400	17.52	69,600	11.6	18.8
Dan River at Leaksville, N. C. (Drainage area 1,150 square miles)							
Oct. 2,1929	S	17,300	18,200	21.3	18,500	5.2	6.9
Jan. 9,1932	12.80	12,000	12,000	13.37	12,500	0	4.2
Mar. 7,1932	S	12,700	14,400	16.75	15,000	13.4	18.1
Oct. 18,1932	S	21,000	21,200	25.0	22,800	1.0	8.6
Mar. 4,1934	S	14,000	14,000	15.7	14,300	0	2.1
Sept. 17,1934	S	10,700	13,300	15.3	14,000	24.3	30.7
Pee Dee River near Rockingham, N. C. (Drainage area 6,910 square miles)							
Apr. 28,1928	S	74,600	79,600	13.70	90,700	6.7	21.6
-Sept. 20,1928	21.90	182,000	196,000	24.38	212,000	7.7	16.5
Mar. 1,1929	S	144,000	148,000	19.70	155,000	2.8	7.6
Oct. 3,1929	S	159,000	162,000	20.53	165,000	1.9	3.8
Jan. 10,1932	S	76,000	80,200	13.90	82,800	5.5	8.9

(a) * Momentary flood peak occurred on following day.
\- Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Santee River at Ferguson, S. C. (Drainage area 14,800 square miles)							
Jan. 23 and - 24,1925	17.05	143,000	146,000	17.13	146,000	2.1	2.1
Aug. 22,1928	20.48	248,000	248,000	20.60	251,000	0	1.2
Mar. 5,1929	16.78	137,000	140,000	16.91	140,000	2.2	2.2
Mar. 10,1929	17.45	155,000	158,000	17.55	160,000	1.9	3.2
Oct. 7,1929	20.94	260,000	263,000	21.04	263,000	1.2	1.2
Pacolet River near Fingerville, S. C. (Drainage area 212 square miles)							
Dec. 15,1931	S	2,710	3,260	6.45	3,810	20.3	40.6
Oct. 17,1932	S	8,260	8,270	13.31	11,000	.1	33.2
Nov. 1,1932	S	3,830	3,890	7.52	4,910	1.6	28.2
Mar. 4,1934	S	3,280	3,290	6.40	3,810	.3	16.2
Mar. 28,1934	S	2,580	2,610	6.01	3,450	1.2	33.7
Saluda River at Chappells, S. C. (Drainage area 1,290 square miles)							
Aug. 17,1928	29.64	54,200	54,700	29.97	56,200	0.9	3.7
Mar. 1,1929	23.40	26,600	27,300	23.77	28,100	2.6	5.6
Mar. 6,1929	24.30	30,200	30,600	24.54	31,000	1.3	2.6
Sept. 28,1929	30.00	56,200	58,700	30.9	60,700	4.4	8.0
-Oct. 3,1929	30.10	56,700	61,200	31.5	63,700	7.9	12.3
Oconee River at Dublin, Ga. (Drainage area 4,350 square miles)							
Jan. 4,1933	14.40	19,400	19,400	14.45	19,500	0	0.5
Feb. 24,1933	14.92	20,500	20,700	15.07	21,000	1.0	2.4
Mar. 9,1934	16.07	23,500	23,500	16.15	23,700	0	.9
June 12,1934	13.26	17,300	17,300	13.35	17,500	0	1.2
Peace Creek at Arcadia, Fla. (Drainage 1,330 square miles)							
Apr. 20,1931	9.66	5,930	5,930	9.70	5,930	0	0
Sept. 16,1932	9.97	6,230	6,230	9.99	6,230	0	0
Sept. 9,1933	17.65	34,700	36,200	17.69	36,200	4.3	4.3
June 23,1934	12.70	10,300	10,300	12.80	10,400	0	1.0
Withlacoochee River near Holder, Fla. (Drainage area 1,660 square miles)							
Oct. 16,1929	11.26	5,830	5,830	11.26	5,830	0	0
-Aug. 21,1933	6.18	1,800	1,800	6.19	1,800	0	0
Sept. 25 and 26,1933	11.16	5,860	5,860	11.16	5,860	0	0
July 9 and 10,1934	11.62	6,740	6,740	11.63	6,740	0	0
Suwannee River at Ellaville, Fla. (Drainage area 6,580 square miles)							
Oct. 5,1928	31.37	43,500	43,500	31.40	43,500	0	0
Oct. 12,1929	26.90	34,000	34,000	26.92	34,000	0	0
Aug. 30,1932	12.29	11,200	11,300	12.33	11,300	.9	.9
Sept. 27,1932	15.65	15,300	15,500	15.67	15,500	1.3	1.3
Feb. 26,1933	24.01	26,400	26,400	24.03	26,400	0	0
Apr. 19,1933	18.39	18,300	18,300	18.41	18,300	0	0
Chattahoochee River at West Point, Ga. (Drainage area 3,550 square miles)							
Mar. 5,1929	22.00	63,900	66,300	22.75	68,700	3.8	7.5
Mar. 15,1929	23.85	75,500	84,400	25.45	87,600	11.8	16.0
Nov. 17,1930	13.99	29,500	29,500	14.35	30,900	0	4.7
Feb. 22,1932	13.32	26,400	28,200	14.24	29,200	6.8	10.6
Dec. 30,1932	21.58	58,000	58,000	21.74	58,600	0	1.0
Mar. 5,1934	16.05	32,900	34,000	16.52	34,700	3.3	5.5

(a) - Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Apalachicola River near River Junction, Fla. (Drainage area 17,100 square miles)							
Mar. 20,1929	34.60	291,000	291,000	34.70	293,000	0	0.7
Oct. 5,1929	20.92	86,800	86,800	21.00	87,700	0	1.0
Mar. 11,1930	16.06	53,200	53,200	16.16	53,700	0	.9
Nov. 21,1930	18.96	70,700	70,700	19.10	71,500	0	1.1
Feb. 25,1932	14.13	44,900	44,900	14.24	45,300	0	.9
Jan. 3,1933	18.51	67,200	67,200	18.56	67,900	0	1.0
Mar. 24,1933	19.33	73,100	73,900	19.43	73,900	1.1	1.1
Mar. 8,1934	17.48	62,800	62,800	17.57	63,400	0	1.0
Little River near Jamestown, Ala. (Drainage area 121 square miles)							
Mar. 14,1929	S	6,180	6,230	10.40	9,430	0.8	52.6
Nov. 14,1929	7.20	5,400	6,000	9.38	8,130	11.1	50.6
Mar. 7,1930	6.00	4,010	4,120	7.20	5,400	2.7	34.7
Dec. 14,1931	5.64	3,570	3,570	6.60	4,680	C	31.1
Jan. 30,1932	6.60	4,680	5,400	8.65	7,090	15.4	51.5
Allegheny River at Red House, N. Y. (Drainage area 1,640 square miles)							
Oct. 30,1917	S	23,890	24,450	10.84	25,300	2.3	5.9
Mar. 15,1918	S	28,120	28,790	11.70	30,000	2.4	6.7
Mar. 15,1920	S	30,680	30,750	11.95	31,500	.2	2.7
Nov. 18,1927	S	26,100	26,120	10.95	26,800	.1	2.7
Dec. 1,1927	S	34,720	35,550	12.6	36,600	2.4	5.4
Ohio River at Paducah, Ky. (Drainage area 202,700 square miles)							
Mar. 15,1934	39.24	771,000	771,000	39.27	771,000	0	0
Apr. 3,1934	35.29	642,000	642,000	35.34	642,000	0	0
Muskingum River at Dresden, Ohio (Drainage area 5,980 square miles)							
Jan. 23,1927	24.5	50,600	52,900	25.4	53,500	4.5	5.7
Mar. 23,1927	25.7	54,500	54,800	26.0	55,500	.6	1.8
Dec. 17,1927	24.0	49,000	49,600	24.3	51,200	1.2	4.5
Feb. 28,1929	S	52,200	52,200	25.3	53,200	0	1.9
Jan. 15,1930	24.0	49,000	49,600	24.3	50,000	1.2	2.0
Mar. 18,1933	23.8	54,100	54,500	24.0	54,900	.7	1.5
May 15,1933	21.8	46,000	46,800	22.2	47,600	1.7	3.5
Walhonding River at Pomerene, Ohio (Drainage area 1,490 square miles)							
Feb. 26,1926	S	15,600	16,000	11.4	17,100	2.6	9.6
Jan. 20,1927	11.8	18,000	18,700	13.0	20,900	3.9	16.1
Dec. 1,1927	13.2	21,400	21,600	14.0	23,400	.9	9.3
Jan. 19,1929	S	17,500	19,500	13.2	21,400	11.4	22.3
Feb. 26,1929	S	20,500	25,000	15.5	27,400	21.9	33.7
Jan. 18,1932	S	14,800	14,800	11.4	17,100	0	15.5
Mar. 15,1933	12.0	19,000	19,300	12.2	19,500	1.6	2.6
May 14,1933	12.8	21,000	21,000	13.2	22,000	0	4.8
New River at Eggleston, Va. (Drainage area 2,920 square miles)							
Apr. 22,1927	10.26	22,100	26,200	11.95	28,900	18.6	30.8
Aug. 17,1928	16.54	47,600	47,600	18.04	53,800	0	13.0
Sept. 7,1928	11.40	26,500	31,300	13.98	37,100	18.1	40.0
Oct. 2,1929	14.95	42,100	59,100	22.44	72,300	40.4	71.7
Oct. 23,1929	11.83	28,300	35,200	15.32	42,500	24.4	50.2
Aug. 23,1931	8.74	15,800	16,100	9.15	17,600	1.9	11.4
Dec. 29,1932	9.90	20,300	20,600	10.28	22,000	1.5	8.4
Mar. 28,1934	11.57	26,200	27,800	12.71	30,700	6.1	17.2

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COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Kanawha River at Kanawha Falls, W. Va. (Drainage area 8,367 square miles)							
Oct. 3,1929	18.80	139,000	141,000	21.35	168,000	1.4	20.9
Nov. 19,1929	16.0	110,000	126,000	18.20	133,000	14.6	20.9
Feb. 5,1932	15.15	101,000	102,000	16.08	111,000	1.0	9.9
July 5,1932	S	64,700	65,900	16.30	113,000	1.9	74.7
Mar. 5,1934	20.07	153,000	153,000	21.43	168,000	0	9.8
Greenbrier River at Alderson, W. Va. (Drainage area 1,340 square miles)							
Nov. 18,1929	S	26,600	31,600	14.20	36,300	18.8	36.5
Feb. 5,1932	14.42	37,100	38,100	16.96	46,400	2.7	25.1
-Mar. 29,1932	S	19,300	26,200	13.02	32,000	35.7	65.8
Mar. 5,1934	12.79	31,300	31,600	13.23	32,700	1.0	4.5
Mar. 28,1934	10.87	24,500	24,800	12.15	29,100	1.2	18.8
Gauley River above Belva, W. Va. (Drainage area 1,340 square miles)							
Dec. 1,1928	S	29,700	32,500	16.25	41,400	9.4	39.4
-Oct. 3,1929	S	36,900	45,300	20.32	59,900	22.8	62.3
Nov. 18,1929	S	29,500	32,700	16.22	41,400	10.8	40.3
Feb. 5,1932	S	28,000	33,100	16.9	44,600	18.2	59.3
July 5,1932	S	60,900	67,200	28.6	105,000	10.3	72.4
Mar. 5,1934	S	37,500	37,500	17.3	46,400	0	23.7
Williams River at Dyer, W. Va. (Drainage area 128 square miles)							
Feb. 4,1932	S	4,250	4,450	10.53	8,500	4.7	100
Mar. 17,1932	S	3,110	3,660	8.60	5,740	17.1	84.5
Mar. 28,1932	S	3,960	3,960	10.30	8,200	0	107
Mar. 4,1934	S	4,340	5,080	9.90	7,600	17.1	75.0
Aug. 16,1934	S	1,460	1,580	8.45	5,470	8.2	275
Olentangy River near Delaware, Ohio (Drainage area 387 square miles)							
Jan. 22,1927	10.8	5,980	5,980	11.6	6,860	0	14.7
Mar. 21,1927	15.7	12,200	12,400	16.9	14,100	1.6	15.6
-July 20,1927	11.6	6,860	9,280	15.4	11,800	35.2	72.0
Dec. 1,1927	14.4	10,400	10,600	15.5	12,000	1.9	15.4
Jan. 19,1929	11.4	6,640	6,750	11.7	6,970	1.7	5.0
Feb. 26,1929	S	10,200	11,800	16.3	13,200	15.7	29.4
-Jan. 9,1930	13.2	8,760	9,150	13.9	9,670	4.4	10.4
Dec. 31,1932	S	8,280	8,500	13.4	9,020	2.7	8.9
Mar. 14,1933	S	6,560	6,970	12.1	7,420	6.2	13.1
May 13,1933	S	6,240	10,400	15.8	12,400	66.7	98.8
Licking River at Catawba, Ky. (Drainage area 3,300 square miles)							
Feb. 27,1929	S	41,500	42,100	29.90	43,200	1.4	4.1
Apr. 4,1931	S	31,000	31,500	26.20	35,400	1.6	14.2
Jan. 30,1932	27.22	37,500	39,800	28.56	40,500	6.1	8.0
*Feb. 5,1932	27.29	37,700	39,400	28.48	40,200	4.5	6.6
Jan. 22,1933	34.20	52,400	54,000	35.22	54,600	3.1	4.2
West Fork of Whitewater River near Alpine, Ind. (Drainage area 528 square miles)							
Feb. 26,1929	14.11	18,800	19,100	14.80	20,900	1.6	11.2
July 1,1929	S	14,600	16,000	14.77	20,900	9.6	43.1
Jan. 13,1930	S	13,200	13,500	12.89	15,200	2.3	15.2
Dec. 31,1932	12.78	13,600	13,900	13.31	15,000	2.2	10.3
May 14,1933	S	13,400	16,400	14.76	19,200	22.4	43.3

(a) - Momentary flood peak occurred on preceding day.
* Momentary flood peak occurred on following day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Discharge (c.f.s.)	Discharge (c.f.s.)	Gage height (ft.)	Discharge (c.f.s.)	Max. 24-hr. av.	Flood peak
Wabash River at Terre Haute, Ind. (Drainage area 12,200 square miles)							
May 20,1929	21.53	58,000	58,800	21.63	58,800	1.4	1.4
Jan. 16,1930	25.61	104,000	104,000	25.63	104,000	0	0
Jan. 23,1932	19.98	46,500	46,500	20.08	47,200	0	1.5
Mar. 25,1933	22.26	64,000	64,000	22.30	64,000	0	0
May 15,1933	26.32	103,000	106,000	26.53	106,000	2.9	2.9
Wabash River at Mt. Carmel, Ill. (Drainage area 28,600 square miles)							
Jan. 30,1929	22.9	148,000	148,000	22.9	148,000	0	0
Apr. 17,1929	21.06	112,000	112,000	21.09	112,000	0	0
*May 23,1929	23.61	155,000	155,000	23.68	155,000	0	0
Dec. 26,1929	19.33	106,000	106,000	19.39	106,000	0	0
Jan. 17,1930	27.03	277,000	278,000	27.06	279,000	.4	.7
Jan. 26,1932	23.77	156,000	156,000	23.79	156,000	0	0
Jan. 8,1933	21.49	116,000	116,000	21.52	116,000	0	0
Mar. 29,1933	23.67	152,000	152,000	23.70	152,000	0	0
Apr. 25,1933	20.69	102,000	102,000	20.71	102,000	0	0
May 21,1933	26.06	232,000	232,000	26.08	232,000	0	0
Cumberland River at Celina, Tenn. (Drainage area 7,320 square miles)							
Feb. 5,1932	47.26	108,000	109,000	47.34	109,000	0.9	0.9
-Jan. 2,1933	32.22	65,100	65,400	32.36	65,500	.5	.6
Jan. 24,1933	33.63	68,900	68,900	33.81	69,400	0	.7
Mar. 21,1933	34.15	70,300	70,500	34.28	70,700	.3	.6
May 13,1933	36.08	75,700	76,700	36.58	77,100	1.3	1.8
French Broad River at Asheville, N. C. (Drainage area 949 square miles)							
Aug. 16,1928	S	34,600	36,900	13.27	42,700	6.6	23.4
Oct. 16,1932	6.85	14,000	14,800	7.33	15,800	5.7	12.9
Dec. 28,1932	5.76	10,900	11,500	6.18	12,100	5.5	11.0
Mar. 4,1934	S	10,300	10,600	5.92	11,200	2.9	8.7
Mar. 28,1934	S	6,660	6,780	4.34	7,010	1.8	5.3
Tennessee River at Guntersville, Ala. (Drainage area 24,200 square miles)							
Apr. 9,1931	22.43	136,000	137,000	22.54	137,000	0.7	0.7
Feb. 4,1932	30.71	216,000	216,000	30.82	217,000	0	.5
Jan. 3,1933	34.38	254,000	254,000	34.43	255,000	0	.4
Feb. 20,1933	30.98	219,000	219,000	31.06	220,000	0	.5
Mar. 23,1933	23.88	149,000	150,000	23.97	150,000	.7	.7
Little Pigeon River at Sevierville, Tenn. (Drainage area 346 square miles)							
Mar. 23,1929	S	11,500	12,600	13.45	26,300	9.6	129
Apr. 4,1931	S	7,950	8,350	9.50	13,500	5.0	69.8
Jan. 30,1932	S	11,000	11,000	11.00	18,200	0	65.4
Dec. 28,1932	S	12,100	12,200	10.86	17,900	.8	47.9
Feb. 15,1933	S	15,100	15,200	12.54	23,200	.7	53.6
Tuckasegee River at Bryson, N. C. (Drainage area 673 square miles)							
Mar. 5,1929	S	9,290	9,380	6.55	11,300	1.0	21.6
Mar. 14,1929	S	9,050	9,180	6.85	12,000	1.4	32.6
Jan. 30,1932	S	7,010	7,090	5.90	9,760	1.1	39.2
Dec. 28,1932	S	15,600	15,700	9.25	18,300	.6	17.3
-Mar. 4,1934	S	10,300	11,900	8.15	15,300	15.5	48.5
Hiwassee River at Murphy, N. C. (Drainage area 410 square miles)							
Mar. 30,1928	S	10,400	10,800	11.72	17,400	3.8	67.3
Sept. 26,1929	S	12,300	12,500	10.31	14,300	1.6	16.3
Dec. 14,1931	S	7,200	7,220	8.26	10,100	.3	40.3
Dec. 28,1932	S	16,500	16,500	12.20	18,700	0	13.3
Mar. 3,1934	S	9,020	10,900	10.67	15,200	20.8	68.5

(a) * Momentary flood peak occurred on following day.
- Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Wolf River at Keshena Falls, Wis. (Drainage area 812 square miles)							
May 6,1928	7.45	2,120	2,120	7.48	2,170	0	2.4
Aug. 22,1928	6.88	1,530	1,530	6.90	1,530	0	0
-Sept. 16,1928	7.95	2,660	2,780	8.10	2,830	4.5	6.4
Oct. 19,1928	7.41	2,070	2,070	7.42	2,070	0	0
Nov. 25,1931	6.67	1,320	1,320	6.67	1,320	0	0
May 2,1933	7.00	1,660	1,710	7.04	1,710	3.0	3.0
Genesee River at St. Helena, N. Y. (Drainage area 1,017 square miles)							
May 17,1916	S	31,270	32,590	11.84	44,400	4.2	42.0
May 22,1919	S	23,810	25,940	11.40	31,600	8.9	32.7
Mar. 13,1920	S	28,750	32,800	12.29	39,600	14.1	37.8
Dec. 1,1927	S	32,420	32,790	12.80	42,700	1.1	31.7
Apr. 21,1929	S	22,200	22,200	10.70	25,900	0	16.7
Winooski River at Essex Junction, Vt. (Drainage area 1,070 square miles)							
Mar. 17,1929	10.67	17,400	18,200	11.64	19,200	4.6	10.3
Jan. 9,1930	S	17,800	19,400	12.60	21,300	9.0	19.7
Apr. 11,1931	S	17,400	20,100	13.22	22,700	15.5	30.5
Apr. 13,1932	S	18,500	20,700	13.68	23,600	11.9	27.6
Apr. 19,1933	S	28,300	32,400	18.60	34,600	14.5	22.3
Pine Creek near Pine Creek, Minn. (Drainage area 76 square miles)							
May 13,1930	8.75	433	449	8.83	460	3.7	6.2
May 25,1933	8.94	476	500	9.03	515	5.0	8.2
Mississippi River at St. Paul, Minn. (Drainage area 36,800 square miles)							
*Mar. 29,1928	11.3	33,000	33,000	11.4	33,600	0	1.8
# Mar. 22 to 24,1929	12.9	45,000	45,400	13.0	45,800	.9	1.8
May 19,1930	8.78	22,000	22,000	8.80	22,000	0	0
Minnesota River at Mankato, Minn. (Drainage area 14,600 square miles)							
*Mar. 14,1927	14.30	11,400	11,500	14.50	11,700	0.9	2.6
Mar. 18,1929	18.85	21,100	21,100	19.0	21,400	0	1.4
-Apr. 4,1933	14.80	13,100	13,300	15.05	13,500	1.5	3.1
Chippewa River at Chippewa Falls, Wis. (Drainage area 5,600 square miles)							
Apr. 23,1916	13.40	52,100	52,200	13.45	52,400	0.2	0.6
Mar. 27,1920	15.41	66,200	74,800	17.0	78,000	13.0	17.8
Sept. 20,1926	11.40	39,000	39,300	12.55	46,400	.8	19.0
Mar. 16,1927	12.42	45,400	46,400	13.40	52,100	2.2	14.8
-Apr. 8,1929	10.92	36,200	38,400	12.50	44,000	6.1	21.5
June 15,1930	10.80	35,600	35,600	11.6	40,200	0	12.9
Apr. 7,1934	12.34	26,500	26,800	13.44	30,500	1.1	15.1
Red Cedar River near Colfax, Wis. (Drainage area 1,100 square miles)							
Mar. 14,1927	5.75	5,750	5,750	6.00	6,100	0	6.1
May 23,1927	3.65	2,580	2,700	4.04	3,080	4.6	19.4
*Mar. 23,1928	5.06	4,260	4,260	5.34	4,550	0	6.8
June 14,1930	3.43	2,040	2,150	3.67	2,370	5.4	16.2
Apr. 3,1934	9.87	17,600	21,500	12.00	24,200	22.2	37.5

(a) - Momentary flood peak occurred on preceding day.
    * Momentary flood peak occurred on following day.
    # Momentary flood peak occurred on same day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis- charge (c.f.s.)	Dis- charge (c.f.s.)	Gage height (ft.)	Dis- charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Zumbro River at Zumbro Falls, Minn. (Drainage area 1,120 square miles)							
Apr. 4,1934	S	18,300	19,300	26.26	22,000	5.5	20.2
--Sept. 26,1934	S	4,110	4,310	17.48	9,620	4.9	134
Maquoketa River near Maquoketa, Iowa (Drainage area 1,550 square miles)							
-Aug. 21,1924	18.63	17,000	18,200	19.8	19,300	7.1	13.5
June 17,1925	19.1	18,000	18,400	19.7	19,100	2.2	6.1
May 24,1927	S	10,400	11,900	15.9	12,900	14.4	24.0
Mar. 13,1928	S	11,100	11,700	15.40	12,100	5.4	9.0
Mar. 14,1929	20.2	21,000	21,300	20.62	21,800	1.4	3.8
Mar. 26,1932	S	7,040	9,760	15.0	11,400	38.6	61.9
*May 20,1933	S	7,580	8,450	13.5	9,130	11.5	20.4
Iowa River at Iowa City, Iowa (Drainage area 3,230 square miles)							
July 1,1924	15.00	19,100	19,400	15.34	19,900	1.6	4.2
Sept. 23,1926	14.94	17,400	17,600	15.05	17,800	1.1	2.3
May 24,1927	S	9,310	9,650	11.80	10,900	3.7	17.1
Mar. 16,1929	16.47	21,900	21,900	16.53	22,000	0	.5
June 15,1930	S	11,300	11,300	13.3	13,600	0	20.4
Cedar River at Cedar Rapids, Iowa (Drainage area 6,640 square miles)							
Feb. 26 and -27,1922	10.9	28,300	31,600	12.15	33,300	11.7	17.7
Aug. 22,1924	10.1	24,500	24,500	10.54	26,300	0	7.3
Aug. 29,1928	10.88	28,500	28,500	11.05	29,200	0	2.5
Mar. 19,1929	19.1	67,200	70,100	20.1	72,000	4.3	7.1
Apr. 30,1929	9.00	20,300	20,700	9.30	21,500	2.0	5.9
Apr. 4,1933	18.26	63,300	63,300	18.6	64,800	0	2.4
Missouri River at Boonville, Mo. (Drainage area 505,710 square miles)							
Nov. 28,1931	21.5	221,000	221,000	21.5	221,000	0	0
June 7,1932	17.3	151,000	153,000	17.4	153,000	1.3	1.3
June 24,1932	18.2	174,000	177,000	18.4	177,000	1.7	1.7
July 8,1932	17.9	154,000	154,000	18.0	156,000	0	1.3
May 28,1933	13.9	93,000	95,000	14.3	97,000	2.2	4.3
June 2,1933	14.6	102,000	103,000	14.9	105,000	1.0	2.9
Marias River near Shelby, Mont. (Drainage area 2,610 square miles)							
May 24,1928	7.00	6,240	6,240	7.10	6,450	0	3.4
June 10,1933	6.12	5,070	5,280	6.30	5,500	4.1	8.5
June 8,1934	10.15	14,000	15,500	11.05	16,200	10.7	15.7
Kansas River at Topeka, Kans. (Drainage area 56,400 square miles)							
May 10,1921	14.60	33,000	35,050	16.47	44,300	6.2	34.2
June 18,1921	14.15	31,150	31,850	14.85	34,300	2.2	10.1
July 3,1921	13.20	26,500	27,050	14.10	30,500	2.1	15.1
June 10,1923	20.90	69,800	70,060	21.50	73,700	.4	5.6
July 5,1923	14.20	30,700	30,700	15.10	35,100	0	14.3
-June 5,1925	11.40	18,500	22,900	13.59	26,800	23.8	44.9
Osage River near Ottawa, Kans. (Drainage area 1,250 square miles)							
Apr. 2,1927	22.60	9,540	9,620	23.20	9,880	0.8	3.6
Apr. 9,1927	17.54	6,740	7,180	19.55	7,840	6.5	16.3
Apr. 21,1927	30.85	17,300	18,300	31.38	18,800	5.8	8.7
Oct. 2,1927	24.37	10,560	10,620	24.92	10,880	.6	3.0
-Nov. 18,1928	36.96	46,300	53,830	38.65	58,400	16.3	26.1

(a) -- Momentary flood peak occurred two days earlier.
- Momentary flood peak occurred on preceding day.
* Momentary flood peak occurred on following day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Discharge (c.f.s.)	Discharge (c.f.s.)	Gage height (ft.)	Discharge (c.f.s.)	Max. 24-hr. av.	Flood peak
Osage River at Osceola, Mo. (Drainage area 8,220 square miles)							
May 21,1931	16.83	26,300	26,600	17.35	27,700	1.1	5.3
Aug. 9,1931	13.90	19,400	20,100	14.50	20,800	3.6	7.2
June 30,1932	15.3	22,400	24,200	16.40	25,300	8.0	12.9
Dec. 26,1932	19.60	33,200	34,700	20.65	35,800	4.5	7.8
May 16,1933	21.08	36,900	37,000	21.16	37,600	.3	1.9
May 30,1933	14.75	21,300	21,600	15.20	22,400	1.4	5.2
Niangua River near Decaturville, Mo. (Drainage area 627 square miles)							
Aug. 7,1931	S	6,450	7,580	12.60	8,070	17.5	25.1
June 29,1932	S	9,110	15,000	17.00	22,000	64.6	142
July 9,1932	S	4,720	4,720	10.90	6,770	0	43.4
Dec. 25,1932	S	12,700	13,200	15.62	17,100	3.9	34.7
Apr. 17,1933	S	9,000	9,160	13.70	11,800	1.8	31.1
May 15,1933	S	12,800	16,500	16.30	19,400	28.9	51.6
Mississippi River near Vicksburg, Miss. (Drainage area 1,140,000 square miles)							
Feb. 26,1932	50.07	1,410,000	1,410,000	50.3	1,410,000	0	0
Jan. 19,1933	37.56	947,000	947,000	37.58	947,000	0	0
June 10,1933	47.47	1,360,000	1,360,000	47.50	1,360,000	0	0
Jan. 21,1934	21.80	540,000	540,000	21.85	540,000	0	0
Mar. 24,1934	31.56	843,000	843,000	31.58	843,000	0	0
Apr. 13,1934	34.51	876,000	876,000	34.55	877,000	0	.1
Neosho River near Iola, Kans. (Drainage area 3,800 square miles)							
Sept. 13,1926	32.75	43,800	43,800	33.20	46,000	0	5.0
Apr. 19,1927	S	31,740	32,890	29.8	34,040	3.6	7.2
June 18,1928	21.42	20,700	20,860	21.80	21,220	.8	2.5
Nov. 20,1928	30.00	34,400	34,840	30.42	35,200	1.3	2.3
July 18,1929	20.45	19,300	19,350	20.60	19,540	.3	1.2
Canadian River near Bell Ranch, N. Mex. (Drainage area 6,400 square miles)							
Oct. 5,1930	S	2,570	4,340	8.30	19,600	68.9	662
June 24,1932	S	853	917	4.50	3,080	7.5	261
Aug. 4,1933	S	6,740	6,750	7.90	17,200	.1	155
Canadian River at Logan, N. Mex. (Drainage area 11,200 square miles)							
June 11,1930	S	2,840	2,840	8.10	10,000	0	252
Oct. 1,1930	S	8,420	13,200	12.02	39,000	56.8	363
June 23,1932	S	936	1,040	6.20	3,160	11.1	238
June 25,1932	S	11,100	11,400	10.02	23,100	2.7	108
Sept. 26,1932	S	1,530	1,530	6.55	4,040	0	164
Vermejo River near Dawson, N. Mex. (Drainage area 250 square miles)							
Aug. 23,1931	S	71	81	4.63	641	14.1	803
June 30,1934	S	62	78	5.60	1,090	25.8	1,660
July 27,1934	S	71	74	5.39	782	4.2	1,000
Mora River near Shoemaker, N. Mex. (Drainage area 1,160 square miles)							
June 12,1933	S	290	349	5.49	2,830	20.3	876
June 19,1933	S	228	228	3.06	620	0	172
May 27,1934	S	200	270	4.30	1,570	35.0	685
Sept. 1,1934	S	238	248	3.48	906	4.2	281

(a) - Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Discharge (c.f.s.)	Discharge (c.f.s.)	Gage height (ft.)	Discharge (c.f.s.)	Max. 24-hr. av.	Flood peak
Sabine River near Ruliff, Tex. (Drainage area 9,450 square miles)							
Nov. 12,1925	13.84	47,700	50,000	13.90	50,000	4.8	4.8
Jan. 4,1927	14.03	52,200	52,200	14.14	54,400	0	4.2
June 1,1929	14.33	59,000	59,000	14.40	61,200	0	3.7
Mar. 3,1932	15.10	62,800	62,800	15.10	62,800	0	0
Aug. 5,1933	15.53	67,000	67,000	15.55	68,600	0	2.4
Colorado River near Tow, Tex. (Drainage area 31,100 square miles)							
Oct. 8,1930	19.60	47,200	47,900	19.97	50,000	1.5	5.9
Oct. 17,1930	22.07	66,300	67,200	22.50	69,900	1.4	5.4
May 12,1932	17.70	35,400	36,800	18.20	38,400	4.0	8.5
May 26,1933	S	21,900	24,200	15.83	25,300	10.5	15.5
Apr. 7,1934	S	37,700	38,600	18.75	42,000	2.4	11.4
Colorado River at Austin, Tex. (Drainage area 38,200 square miles)							
Apr. 28,1922	20.94	103,000	104,000	21.67	110,000	1.0	6.8
- -May 3,1922	S	100,000	108,000	22.60	120,000	8.0	20.0
May 29,1929	S	96,400	113,000	27.35	132,000	17.2	36.9
Oct. 7,1930	S	79,500	88,100	22.50	97,600	10.8	22.8
Sept. 3,1932	S	61,800	67,700	19.00	77,500	9.5	25.4
Guadalupe River near Spring Branch, Tex. (Drainage area 1,430 square miles)							
Apr. 21,1926	S	11,000	11,300	20.72	19,800	2.7	80.0
May 29,1929	S	17,600	17,700	19.82	18,600	.6	5.7
-June 13,1930	S	3,340	5,230	15.80	13,300	56.6	298
Oct. 7,1930	S	15,000	15,300	24.57	24,000	2.0	60.0
July 3,1932	S	62,800	78,000	42.10	121,000	24.2	92.7
Sandies Creek near Westhoff, Tex. (Drainage area 493 square miles)							
Jan. 6,1932	S	4,700	4,740	21.29	5,040	0.9	7.2
Apr. 30,1932	S	4,900	5,290	21.79	5,780	8.0	18.0
Aug. 1,1933	S	4,680	4,780	21.50	5,320	2.1	13.7
Mar. 3,1934	S	3,520	3,540	20.13	3,640	.6	3.4
July 28,1934	S	1,880	1,880	17.58	2,030	0	8.0
Frio River at Concan, Tex. (Drainage area 485 square miles)							
Oct. 6,1930	S	7,330	7,460	22.30	47,000	1.8	541
July 19,1931	S	5,570	5,770	14.60	18,200	3.6	227
July 1,1932	S	41,200	42,000	34.44	162,000	1.9	293
Sept. 1,1932	S	6,420	6,580	20.30	26,600	2.5	314
Colorado River near Grand Canyon, Ariz. (Drainage area 138,700 square miles)							
Sept. 19,1923	26.45	98,500	101,900	28.5	112,000	3.5	13.7
July 2,1927	28.15	117,200	122,900	29.25	126,600	4.9	8.0
Sept. 15,1927	27.72	113,600	113,700	28.95	124,000	.1	9.2
June 3,1928	27.75	113,900	114,000	27.85	114,700	.1	.7
May 29,1929	27.18	108,200	108,800	27.5	110,900	.6	2.5
May 26,1932	25.91	101,000	101,100	26.1	102,400	.1	1.4
Green River at Green River, Utah (Drainage area 40,600 square miles)							
June 27,1917	14.3	66,700	67,200	14.53	68,100	0.7	2.1
June 17,1921	14.07	64,100	64,200	14.12	65,500	.2	2.2
June 12,1922	10.75	45,800	45,800	10.80	46,200	0	.9
June 29,1927	11.23	30,500	33,400	13.20	46,300	9.5	51.8
Sept. 14,1927	10.85	27,500	27,500	11.75	34,700	0	26.2
May 31,1928	13.05	44,300	44,500	13.1	44,700	.5	.9
*May 29,1929	12.90	41,900	42,000	13.0	42,300	.2	1.0
*May 26,1932	12.15	36,600	36,600	12.40	38,200	0	4.4

(a) - - Momentary flood peak occurred two days earlier.
- Momentary flood peak occurred on preceding day.
* Momentary flood peak occurred on following day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Ashley Creek near Vernal, Utah (Drainage area 101 square miles)							
-May 29,1920	6.54	1,100	1,120	7.05	1,360	1.8	23.6
-May 30,1921	7.80	1,750	1,810	8.23	2,050	3.4	17.1
-June 9,1922	8.27	1,480	1,480	8.67	1,700	0	14.9
-May 26,1923	8.07	1,010	1,030	8.47	1,250	2.0	23.8
May 21,1932	8.10	990	1,040	8.55	1,340	5.1	35.4
June 1,1933	7.99	913	913	8.45	1,260	0	38.0
San Juan River near Bluff, Utah (Drainage area 24,000 square miles)							
Sept. 10,1927	19.8	32,900	34,200	32.0	70,000	4.0	113
Sept. 14,1927	21.1	36,400	36,700	23.6	43,400	.8	19.2
Aug. 6,1929	15.9	18,800	19,800	19.4	27,600	5.3	46.8
Aug. 12,1929	23.2	38,300	40,300	27.8	56,000	5.2	46.2
Aug. 9,1930	13.1	13,900	15,600	18.8	28,500	12.2	105
Aug. 11,1930	13.8	15,800	16,600	15.9	21,100	5.1	33.5
Aug. 29,1932	14.8	16,500	16,900	17.2	21,300	2.4	29.1
Little Colorado River at Grand Falls, Ariz. (Drainage area 22,140 square miles)							
Sept. 27,1926	17.88	17,200	18,200	22.5	27,800	5.8	61.6
-June 29,1927	15.98	12,700	15,500	22.9	28,800	22.1	127
Apr. 5,1929	20.76	27,100	34,900	30.0	50,500	28.8	86.3
July 29,1929	15.43	13,200	17,400	21.0	23,900	31.8	81.1
-Feb. 11,1932	19.42	19,800	23,900	23.8	31,300	20.7	58.1
San Francisco River at Clifton, Ariz. (Drainage area 2,787 square miles)							
Aug. 8,1929	6.22	1,730	2,190	9.2	5,400	26.6	212
Sept. 23,1929	6.16	1,910	2,250	10.1	7,060	17.8	270
Feb. 15,1931	7.70	2,630	2,690	8.5	3,240	2.3	23.2
Sept. 19,1931	7.13	2,230	2,380	8.1	2,920	6.7	31.0
Feb. 10,1932	10.24	5,630	6,900	12.0	8,090	22.6	43.7
Mar. 1,1932	8.02	2,860	2,960	8.45	3,200	3.5	11.9
Feb. 26,1933	7.08	2,170	2,350	8.1	2,920	8.3	34.6
Sabino Creek near Tucson, Ariz. (Drainage area 35.0 square miles)							
-July 16,1932	2.62	108	183	5.40	700	69.5	548
July 26,1932	1.85	63	92	5.00	582	46.0	824
July 30,1932	3.08	176	186	4.83	535	5.7	204
Sept. 10,1933	2.33	99	129	4.73	508	30.3	413
Sept. 22,1934	1.76	63	107	4.65	487	69.8	673
South Fork of Ogden River near Huntsville, Utah (Drainage area 148 square miles)							
-May 17,1921	4.32	1,210	1,250	4.57	1,300	3.3	7.4
May 6,1922	4.43	1,220	1,220	4.82	1,380	0	13.1
May 10,1923	4.95	1,270	1,290	5.40	1,450	1.6	14.2
-May 1,1927	4.45	1,080	1,100	4.80	1,220	1.9	13.0
-Apr. 29,1928	4.30	1,020	1,060	4.70	1,180	3.9	15.7
May 14,1932	5.10	1,360	1,370	5.35	1,480	.7	8.8
San Gabriel River near Azusa, Calif. (Drainage area 214 square miles)							
Jan. 18,1916	S	22,300	25,400	12.0	40,000	13.9	79.4
Mar. 7,1918	S	4,120	4,820	9.45	8,680	17.0	111
Dec. 19,1921	S	16,900	19,700	15.0	22,300	16.6	32.0
Feb. 16,1927	S	11,400	11,600	10.2	18,200	1.8	59.7
Feb. 9,1932	6.87	5,830	6,440	7.25	7,500	10.5	28.7
Jan. 19,1933	S	1,630	2,020	6.90	5,820	23.9	257

(a) - Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Discharge (c.f.s.)	Discharge (c.f.s.)	Gage height (ft.)	Discharge (c.f.s.)	Max. 24-hr. av.	Flood peak
Kings River at Piedra, Calif. (Drainage area 1,700 square miles)							
May 20,1920	12.40	14,900	14,900	12.95	17,000	0	14.1
June 12,1921	11.8	12,400	12,400	12.7	15,600	0	25.8
June 5,1922	13.30	17,100	17,100	14.02	19,900	0	16.4
Dec. 28,1931	S	11,300	11,300	12.12	20,100	0	77.8
-Feb. 7,1932	S	10,300	12,100	11.46	18,000	17.5	74.8
Merced River at Happy Isles Bridge near Yosemite, Calif. (Drainage area 181 square miles)							
-May 29,1919	6.36	3,020	3,240	7.1	3,800	7.3	25.8
*June 4 and 5,1922	6.22	2,820	2,920	6.55	3,240	3.5	14.9
May 16,1927	5.84	2,470	2,570	6.20	2,820	4.0	14.2
Mar. 25,1928	S	1,310	1,310	4.69	1,460	0	11.4
June 22,1932	5.64	2,280	2,330	5.96	2,570	2.2	12.7
Sacramento River near Red Bluff, Calif. (Drainage area 9,300 square miles)							
Jan. 30,1921	18.75	96,000	97,600	22.36	127,000	1.7	32.3
-Feb. 12,1925	21.02	115,000	138,000	25.18	156,000	20.0	35.6
Feb. 5,1926	S	82,900	94,400	20.52	110,000	13.9	32.7
Feb. 21,1927	S	137,000	142,000	26.00	164,000	3.6	19.7
Mar. 27,1928	S	140,000	140,000	26.1	166,000	0	18.6
Quinault River at Quinault Lake, Wash. (Drainage area 264 square miles)							
Dec. 18,1917	S	27,800	29,100	14.8	32,300	4.7	16.2
Dec. 29,1917	S	27,800	28,200	14.2	30,300	1.4	9.0
Dec. 14,1918	S	21,400	22,000	12.1	23,800	2.8	11.2
Oct. 29,1921	S	32,300	33,200	15.4	34,200	2.8	5.9
Dec. 12,1921	S	31,500	33,200	16.3	37,000	5.4	17.5
Feb. 27,1932	13.2	27,200	27,500	13.5	28,100	1.1	3.3
Puyallup River at Puyallup, Wash. (Drainage area 914 square miles)							
Dec. 18,1917	S	35,600	36,400	34.15	40,500	2.2	13.8
Jan. 23,1919	S	32,600	33,400	32.03	36,500	2.5	12.0
*Dec. 12,1921	15.78	32,400	33,700	17.05	35,600	4.0	9.9
-Feb. 27,1932	S	24,500	27,800	16.0	33,000	13.5	34.7
Nov. 13,1932	13.6	28,000	31,000	17.1	37,800	10.7	35.0
Dec. 10,1933	20.2	53,300	54,800	21.5	57,000	2.8	6.9
Dec. 22,1933	17.35	44,400	44,800	17.9	46,000	.9	3.6
Skagit River at Newhalem, Wash. (Drainage area 1,160 square miles)							
Feb. 12,1924	10.0	26,700	26,700	10.85	31,400	0	17.6
-May 22,1928	489.35	24,800	25,400	489.75	27,200	2.4	9.7
Feb. 27,1932	492.56	43,300	43,300	493.14	47,400	0	9.5
Columbia River at Grand Coulee, Wash. (Drainage area 74,100 square miles)							
June 14,1931	962.60	242,000	242,000	962.7	243,000	0	0.4
June 19 and 20,1932	973.03	360,000	361,000	973.2	363,000	.3	.8
June 23,1933	979.80	467,000	467,000	979.88	469,000	0	.4
June 3,1934	973.38	378,000	378,000	973.44	378,000	0	0
Kootenai River at Leonia, Idaho (Drainage area 11,470 square miles)							
May 23,1932	14.84	68,300	68,800	14.96	69,100	0.7	1.2
June 5,1932	14.95	69,000	69,100	15.04	69,600	.1	.9
June 16,1932	14.91	70,400	70,400	15.01	71,100	0	1.0
*June 6,1933	15.35	72,000	72,600	15.50	73,200	.8	1.7
June 18,1933	18.07	95,300	95,300	18.11	95,600	0	.3

(a) - Momentary flood peak occurred on preceding day.
* Momentary flood peak occurred on following day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Discharge (c.f.s.)	Discharge (c.f.s.)	Gage height (ft.)	Discharge (c.f.s.)	Max. 24-hr. av.	Flood peak
Boundary Creek near Port Hill, Idaho (Drainage area 97 square miles)							
May 31,1929	3.04	689	778	3.50	955	12.9	38.6
May 14,1931	3.75	1,120	1,120	4.03	1,310	0	17.0
May 20,1932	4.23	1,490	1,540	4.44	1,670	3.4	12.1
May 26,1933	4.36	1,620	1,620	4.44	1,690	0	4.3
June 15,1933	4.86	2,070	2,080	5.22	2,400	.5	15.9
Clark Fork near Plains, Mont. (Drainage area 19,900 square miles)							
June 5,1913	17.9	115,000	115,000	17.94	115,000	0	0
June 9,1922	17.1	113,000	114,000	17.25	114,000	.9	.9
June 14,1927	17.6	117,000	117,000	17.6	117,000	0	0
May 28,1928	18.35	126,000	126,000	18.41	126,000	0	0
Clark Fork at Priest River, Idaho (Drainage area 24,200 square miles)							
-June 16 to 19,1929	15.3	72,400	72,400	15.36	73,200	0	1.1
#May 26 and 27,1932	18.7	97,200	97,200	18.77	98,000	0	.8
#June 19 to 21,1933	24.1	135,000	136,000	24.18	136,000	.7	.7
#May 12 to 14,1934	18.2	91,200	91,200	18.24	91,200	0	0
Henrys Fork at Warm River, Idaho (Drainage area 666 square miles)							
*Apr. 11,1930	5.59	1,860	1,870	5.77	2,000	0.5	7.5
Apr. 19,1931	4.77	1,200	1,200	4.83	1,280	0	6.7
May 12,1932	6.48	2,560	2,560	6.59	2,660	0	3.9
Apr. 29,1933	5.49	1,790	1,800	5.57	1,860	.6	3.9
Apr. 9,1934	4.56	1,010	1,020	4.67	1,080	1.0	6.9
Boise River near Twin Springs, Idaho (Drainage area 830 square miles)							
May 29,1919	7.08	7,950	8,030	7.50	8,790	1.0	10.6
May 17,1921	7.38	8,560	8,600	7.50	8,800	.5	2.8
June 12,1921	7.37	8,540	8,620	7.67	9,150	.9	7.1
May 20,1925	6.59	6,840	6,840	6.69	7,040	0	2.9
-May 11,1928	7.68	8,940	9,020	7.93	9,460	.9	5.8
May 14,1932	6.70	7,060	7,060	6.87	7,400	0	4.8
Salmon River at Salmon, Idaho (Drainage area 3,600 square miles)							
June 12,1930	4.77	5,820	5,850	4.86	6,060	0.5	4.1
May 22,1932	5.35	7,330	7,360	5.43	7,540	.4	2.9
June 17,1932	6.17	9,560	9,580	6.22	9,700	.2	1.5
June 4,1933	5.91	8,220	8,220	5.97	8,380	0	1.9
-June 15,1933	6.35	9,980	9,990	6.42	10,100	.1	1.2
Bear Valley Creek near Cape Horn, Idaho (Drainage area 180 square miles)							
May 26,1923	4.20	2,000	2,030	4.48	2,280	1.5	14.0
June 16,1925	3.19	1,060	1,070	3.33	1,170	.9	10.4
May 26,1928	5.09	2,880	2,890	5.30	3,120	.3	8.3
*May 24,1929	3.61	1,410	1,420	3.73	1,520	.7	7.8
June 16,1932	4.36	2,120	2,120	4.56	2,340	0	10.4
Bull Run River near Bull Run, Oreg. (Drainage area 102 square miles)							
-Jan. 26,1920	S	9,890	12,500	10.72	16,000	26.4	61.9
Jan. 2,1921	8.90	11,400	11,400	10.70	15,000	0	31.6
Nov. 20,1921	S	14,500	15,700	13.06	20,200	8.3	39.3
Nov. 25,1927	S	10,600	13,100	10.58	15,000	23.6	41.5
Dec. 22,1933	9.94	11,600	11,600	11.30	14,800	0	27.6

(a) - Momentary flood peak occurred on preceding day.
 # Momentary flood peak occurred on same day.
 * Momentary flood peak occurred on following day.
(b) S Discharge obtained by subdivision of the hydrograph.

COMPARISON OF FLOOD FLOWS--Continued

Maximum calendar-day average			Maximum 24-hr.av.	Momentary flood peak		Percentage in excess of max. calendar-day av.	
Date(a)	Gage height(b) (ft.)	Dis-charge (c.f.s.)	Dis-charge (c.f.s.)	Gage height (ft.)	Dis-charge (c.f.s.)	Max. 24-hr. av.	Flood peak
Willamette River at Springfield, Oreg. (Drainage area 2,030 square miles)							
Dec. 19,1929	14.5	45,200	45,200	16.5	55,400	0	22.6
Apr. 1,1931	14.23	43,700	46,200	15.75	51,800	5.7	18.5
Mar. 19,1932	17.46	60,700	61,200	18.1	64,000	.8	5.4
-Jan. 3,1933	S	37,700	47,700	16.4	55,600	26.5	47.5
-Jan. 24,1934	11.26	31,400	35,000	12.9	38,600	11.5	22.9
Clackamas River near Cazadero, Oreg. (Drainage area 665 square miles)							
-Nov. 21,1921	S	31,700	41,400	46.0	52,100	30.6	64.4
Jan. 6,1923	S	49,700	52,300	56.2	60,000	5.2	20.7
Nov. 25,1927	S	24,700	24,700	47.85	29,900	0	21.1
Mar. 31,1931	50.20	37,900	50,500	56.5	60,800	33.2	60.4
Dec. 22,1933	49.39	35,200	35,200	50.65	39,400	0	11.9
North Umpqua River above Rock Creek near Glide, Oreg. (Drainage area 886 square miles)							
Dec. 30,1924	S	27,400	30,900	15.45	38,100	12.8	39.1
Feb. 4,1925	12.36	24,700	25,200	13.69	30,200	2.0	22.3
Feb. 20,1927	S	42,400	48,600	19.95	60,000	14.6	41.5
Nov. 28,1927	11.77	22,200	23,400	13.45	29,200	5.4	31.5
-Mar. 19,1932	S	32,200	37,200	16.04	40,600	15.5	26.1
Rogue River above Prospect, Oreg. (Drainage area 332 square miles)							
Dec. 30,1924	5.31	5,060	5,300	6.20	7,220	4.7	42.7
-Feb. 21,1927	5.42	5,390	6,980	6.97	8,960	29.5	66.2
Nov. 28,1927	5.30	5,180	5,700	5.96	6,610	10.0	27.6
Mar. 19,1932	6.20	6,470	6,830	6.68	7,490	5.6	15.8
June 9,1933	6.04	6,080	6,080	6.30	6,680	0	9.9

(a) - Momentary flood peak occurred on preceding day.
(b) S Discharge obtained by subdivision of the hydrograph.

RECORDS OF FLOODS ON SELECTED RIVERS

It is important to emphasize strongly that the soundest basis for the study of floods as a guide for protective works and measures is the available authentic information regarding floods that have occurred. This information may pertain either directly to the stream under investigation or to other streams having comparable physical characteristics. Though flood formulas have a definite and valuable place in the recording of experience and in the analysis and interpretation of flood flows, they have such limitations of use that the individual investigator is safest if he bases his analysis to the fullest degree possible on original flood data and related hydrologic information.

The opinion stated above has been especially emphasized by both the former Special Committee on Flood Protection Data and the present Committee, similarly designated, of the American Society of Civil Engineers. In its progress report of December 26, 1934 (Am. Soc. Civil Eng. Proc., March 1935, p. 335) the present committee has stated:

> "The greatest good to the user of flood data will result from placing before him just as complete an array of flood events as historical and engineering records can be made to yield. This relieves him of the necessity of undertaking research work . . . at a time when his energies usually are fully occupied."

In appreciation of these conditions the chief objective of the activities described in this report has been the compilation of reliable records of flood stages and flows as complete and generally representative as it has been possible to make them by the use of the available resources.

In the early stages of the flood study, investigation was made to assure selection of data which with due consideration of practical limitations would best satisfy the needs of users. It was impracticable, of course, to meet all possible future needs, inasmuch as they may involve details regarding the characteristics of flood rises which if supplied in this report would have materially reduced the number of streams that could be included in the compilation. It is fully realized that in any detailed study of floods there may be need to go back of the records in this report to the published records of daily flow in the water-supply papers of the Geological Survey or other publications or even to the original sources (graphs, cards, or notebook records) of such published data.

As a result of a comprehensive review of the applications of different methods of analyzing and interpreting flood records, described elsewhere in this report, it was decided that the daily (average) flood peaks above some selected base afforded the most practicable and useful basis of recording flood data. It was also decided to show all annual (maximum) floods for the period of record based on both the calendar year and the record year (October to September), even though a few might be below the adopted base, in order to permit study of annual floods where desired. Momentary flood peaks are also shown so far as they are available. As readily identified by the descriptive notes, the nearest available approximation to the flood peak may correspond to the highest of several daily gage readings or to the higher of two daily readings.

In the selection of records to be compiled the chief criteria have been (a) the length of time covered by the records, (b) representative geographic distribution of the records, and (c), so far as practicable, comparative freedom of the records from major effects of storage and release and of diversion within the drainage basin or to and from adjacent basins.

In general, floods have been listed only for measurement stations with records of 20 years or longer which were reasonably continuous - that is, which did not contain numerous segments of short records considerably scattered as to time. The paucity of flood records in certain regions has led to the listing of some records shorter than 20 years. In regions where available records were more plentiful the records that were believed to furnish the most useful information were selected. The location of the gaging stations covered by the published records is shown on plate 3. On plate 1, facing page 26, are shown the locations of nearly 3,000 active stream-gaging stations listed by the United States Geological Survey as of September 1933.

As explained on page 21, flood occurrences resulting primarily from either ice or log jams, failures of storage dams, or the action of tidal waves and gales along the coast are not included.

It is becoming rare to find a stream whose flow has not been more or less affected by regulation by storage or retarding basins, or by diversions. Numerous records have been eliminated from inclusion in the present report because the effect of such factors has so greatly modified the stream flow that any consideration of flood characteristics would involve an appraisal of many other data relative to diversion and storage. An effort has been made in the descriptions accompanying the listings for the gaging stations to show sufficient information regarding the influence of these factors during the period of the record to guard the investigator against uses to which the data are unsuited. The main source of flood records has been the water-supply papers of the Geological Survey, but valuable records have been obtained from numerous other sources, particularly in the records of historic floods generally antedating systematic stream gaging. The sources of data are cited for each station.

The descriptive matter also contains much other essential information concerning the records shown in the tables, such as location of stations, drainage areas, records available, and methods of observation. In general, the listed data include the daily flood peaks, with both stages and discharges, and, where available, the momentary flood peaks.

The base discharge or the lower limit of selection of discharges was ordinarily the minimum annual flood. Many exceptions have been made to this general rule, however, because on some streams the minimum annual flood is so low as to have little significance, and its use as a base would burden the record with a mass of data that would be comparatively useless. However, all the annual floods have been recorded, even though some of them were below the chosen base discharge.

The primary objective in the selection of daily flood peaks was to obtain an adequate number of such data to show the flood characteristics of the given stream. Generally, it was required that for a daily flood maximum to qualify as a flood peak, it should be at least 10 percent higher than the preceding and following lower discharges - in other words, a peak at least 10 percent higher than the adjacent troughs. Where only gage-height records were available, the criterion for a flood peak was a difference between peak and troughs of a certain amount on the gage - for example, 1.0 foot, determined for each station with a view to approaching as nearly as practicable the discharge criterion just stated.

Relatively smaller humps on the hydrographs of either daily discharge or daily gage heights were disregarded. It is obvious that other methods of selecting flood data for the tabulations in this paper would have given somewhat different arrays and results from analysis; but it does not seem probable that they would be more applicable or significant for general use. It was found that on some streams, through peculiarity of flow characteristics, strict compliance with these rules introduced so many flood events as to be considerably out of proportion with the normal data of other streams and as probably to include data of relatively little significance. The length of the record was also a factor to be considered in determining the number of items that should be included in the tabulation. The recourse has been to eliminate the lesser flows by adopting a higher base flow. Generally the list for each gaging station includes an average of three to five items a year (not including momentary peaks) for the period or periods where daily records were available. It is quite evident, however, that fragmentary and early historical data relating to maximum periodic or notably destructive floods cannot be listed in this way, as there is ordinarily only one outstanding flood occurrence noted in such records for each group of years, often a decade or longer period. Usually 100 to 200 items have been included for each station.

For most records both gage readings and the corresponding discharges are listed, but for some entire records as above indicated and parts of other records gage readings are missing. There are various reasons for these omissions. For example, gage readings do not appear where there have been several locations of the gage with no related datums, where gages were destroyed by floods and discharges were estimated from run-off on adjacent areas, where discharges were determined by graphic or mechanical integration of the gage height graph with no mean gage height designated for the record day, where there was no stage-discharge relation, as at powerhouses or diversion canals, or where discharges were the sum of the flows over dams, through turbine wheels and venturi meters, or as determined by other devices.

At some important gaging stations, as on the Mississippi, Missouri, and Ohio Rivers, where records of stages of flood rises have been made but reliable long-time determinations of flow are not available, appropriate notes have been inserted as to the impermanence of the stage-discharge relation due to river-channel regulation or stabilization, the irregularity of water-surface slope, and other pertinent conditions. Under such conditions the criterion by which a separate flood was defined was made to correspond as nearly as practicable to the criterion indicated above for stations where the discharges were known.

The information here given has been compiled from reliable sources, and in connection with the data originating in the Geological Survey station descriptions and tables have been checked in the district offices of the Survey to assure the best possible accuracy. Some former determinations of rates of flood flow have been revised to conform to latest information. Appropriate note is made where the rate of flow given here differs from the record previously published.

Those familiar with methods of determining stream flow understand that these methods depend fundamentally upon the rating of the stage-discharge relation by actual measurements of flow. The practical difficulties involved in making an adequate number of measurements for close definition of the rating in the highest ranges of stage result often in materially less accuracy in estimates of flood flows than in the estimates of ordinary flows. Although the accuracy of the determinations is the best that can be practicably attained and very satisfactory for many purposes, the user of the data should have their limitations in mind, so that the records may not be applied ill-advisedly nor carried into refinements of calculation beyond the significance of the basic information.

The flood data compiled in this paper necessarily present a compromise between satisfaction of needs for complete information and limitations of time and space. It is hoped that the data may suffice for many needs and may serve as helpful guides or clues to deeper research by the investigator in the more complete sources of the data and elsewhere. For instance, the data listed herein may serve to identify the outstanding storm and flood occurrences for a given region and thus directly point the way to more detailed information in original records dealing with that region.

The records are presented in accordance with the regular arrangement adopted by the Geological Survey in its water-supply papers. The main drainage-basin subdivisions are as listed below. Plate 3 shows these areal subdivisions and also the locations of the 207 gaging stations where the following flood data were observed.

Part 1. North Atlantic slope basins (St. John River to York River).

2. South Atlantic slope and eastern Gulf of Mexico basins (James River to Mississippi River).

3. Ohio River Basin.

4. St. Lawrence River Basin.

5. Hudson Bay and upper Mississippi River Basins.

6. Missouri River Basin.

7. Lower Mississippi River Basin.

8. Western Gulf of Mexico basins.

9. Colorado River Basin.

10. The Great Basin.

11. Pacific slope basins in California.

12. North Pacific slope basins, in three parts:

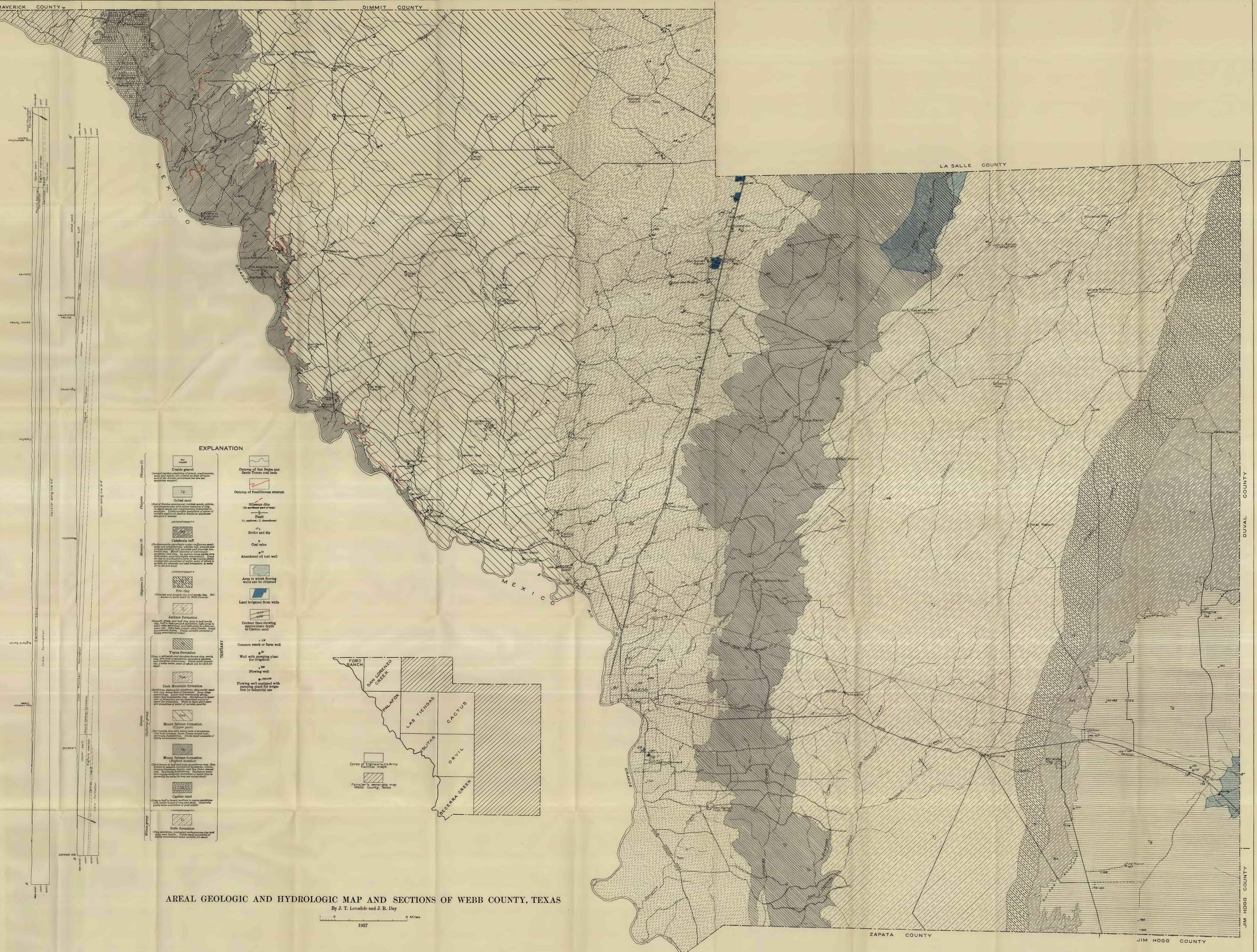
A, Pacific slope basins in Washington and upper Columbia River Basin.

B, Snake River Basin.

C, Pacific slope basins in Oregon and lower Columbia River Basin.

Under these subdivisions, stations on the main stem of a stream are treated first in downstream order and then stations on tributaries in similar order, beginning with the uppermost. The table of contents presents the stations in the order in which they appear herein; the index shows the stations alphabetically according to stream names and place names.

Studies of floods more often than not may involve streams not listed herein and require a general analysis of all available records of the particular streams considered or of neighboring streams. However, as discussed on page 18 of this report, it should not be inferred that neighboring drainage areas necessarily have similar flood characteristics. Communication with the district office of the Geological Survey having charge of stream gaging in the drainage basins under study will elicit latest information as to all available and pertinent records. The Geological Survey has compiled and has made available for distribution, for the several drainage subdivisions, indexes of river-measurement stations up to September 30, 1933, for which records had been published or were in course of publication at that time. Locations of these stations are shown on plate 1, facing page 26.



AREAL GEOLOGIC AND HYDROLOGIC MAP AND SECTIONS OF WEBB COUNTY, TEXAS

By J. T. Lonsdale and J. R. Day

1937

Table 3.- Flood Records

Part 1. North Atlantic slope basins

Penobscot River at West Enfield, Maine

Location.- At highway bridge 1,000 feet below mouth of Piscataquis River and 1 mile southwest of West Enfield, Penobscot County.
Drainage area.- 6,600 square miles.
Records available.- November 1901 to September 1933.
Sources of data.- Gage-height record and results of many discharge measurements furnished by Thomas W. Clark, hydraulic engineer, Old Town, subsequent to 1912; all other records from U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths twice daily except during ice periods, when it was read three times a week prior to Dec. 11, 1912; recording gage thereafter.
Stage-discharge relation.- Affected by ice and occasionally by logging operations. Control practically permanent.
Storage and regulation.- Flow regulated for log driving, power and recently for flood control at lakes having a combined storage capacity of about 1,800,000 acre-feet and combined drainage area of 1,900 square miles.

Flood stages and discharges
(Base discharge 34,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1901	Dec.	17	14.5		69,700
1902	Mar.	31	15.00		73,400
	Apr.	14	10.70		40,200
	May	2	10.65		39,900
	June	10	12.20		51,400
1903	Mar.	12	17.55		93,400
		25	13.50		61,600
	Apr.	10	12.05		50,200
1904	Apr.	12	11.20		43,800
	May	1	12.30		52,200
		13	11.80		48,200
		21	12.00		49,800
1905	Apr.	12	9.8		34,100
1906	Apr.	18	12.15		50,900
	May	4	12.5		53,600
		11	13.4		60,800
1907	May	2	17.1		91,400
	Nov.	8	11.2		43,800
	Dec.	12	10.6		39,600
1908	May	2	14.4		68,900
		13	12.2		51,300
	June	2	10.95		42,000
1909	Apr.	17	15.2		62,000
	May	12	12.4		48,600
		17	12.35		48,300
	Sept.	30	16.6		76,300
1910	Apr.	8	10.6		37,400
		28	10.3		38,600
1911	May	2	10.9		39,200
1912	Apr.	11	10.25		35,400
		24	14.05		59,200
	June	2	13.55		56,000
	Oct.	27	12.55		49,500
	Nov.	9	14.65		63,200
1913	Mar.	26	13.30		52,400
	Apr.	20	11.25		41,400
		30	12.05		46,400
1914	Apr.	22	13.00		54,500
	May	10	14.80		67,300
1915	Apr.	13	10.2		35,400
	May	2	12.75		52,700
1916	Apr.	19	10.30		36,100
		19	10.40	P	36,700
	Dec.	2	10.10		34,700
1917	Apr.	9	13.15	*	41,400
		24	13.15		55,600
	May	16	10.15		35,100
	June	13	13.10		55,200
		19	17.50		86,400
		19	17.7	P	87,900
	Nov.	1	10.10		34,100
1918	Apr.	25	10.60		37,100
	May	2	10.85		38,600
		2	11.2	P	40,700
	Nov.	21	11.15		40,400
1919	Mar.	25	10.75	*	37,700
		30	11.45		42,200
	Apr.	14	11.25		41,000
		26	11.91	P	45,000
		27	11.65		43,400
	May	4	11.70		43,700
		24	10.25		35,000
		28	10.95		39,200
1920	Apr.	9	15.45		48,600
		15	15.60		71,100
		15	15.75	P	72,300
		30	13.65		57,000
	May	10	13.50		55,900
	Oct.	2	11.35		41,600
1921	Mar.	29	12.65		50,000
		29	12.85	P	51,400
	Apr.	2	11.9		44.900
		26	10.65		37,400
1922	Apr.	13	12.35		47,800
	June	23	13.95		59,000
		23	14.15	P	60,400
		30	11.35		41,600
1923	May	1	24.95		152,000
		1	25.15	P	153,000
1924	May	3	12.8		51,000
		3	13.20	P	53,800
1925	Apr.	4-5	10.0	†	33,500
	Nov.	17	12.1		46,100
1926	May	5	15.0		66,400
		5	15.15	P	67,500
	Nov.	20	10.6		37,100
		20	11.38	P	41,800
1927	Apr.	25	10.9		38,900
	Oct.	21	11.37		41,900
	Nov.	6	13.88		58,700
		6	14.2	P	60,800
	Dec.	10	10.23		34,700
1928	Apr.	10	12.32		47,500
	May	8	11.00		39,500
		28	13.01		52,400
1929	Apr.	19	12.03		45,500
		30	13.06		53,100
	May	4	14.84		65,000
		4	15.28	P	68,700
1930	Mar.	14	12.14	*	34,900
	Apr.	9	12.43		48,200
		9	12.68	P	50,300
1931	Apr.	4	10.35		35,900
		12	10.73		37,700
	June	10	11.40		41,900
		10	11.78	P	44,300
1932	Apr.	13	14.90		65,700
		13	15.40	P	69,500
	Sept.	18	14.54		62,900
1933	Apr.	9-11	11.25		40,700
		19	13.45		55,200
		19	13.56	P	56,600
		27	11.15		40,700
	May	4	10.48		36,500

* Estimated
† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

East Branch of Penobscot River at Grindstone, Maine

Location.- Prior to June 30, 1929, at Bangor & Aroostook Railroad bridge half a mile south of Grindstone, Penobscot County, and 9½ miles above confluence with West Branch of Penobscot River; thereafter 500 feet downstream.
Drainage area.- 1,070 square miles; includes about 240 square miles of Chamberlain Lake drainage area through Telos Canal.
Records available.- October 1902 to September 1933.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read as follows: Prior to Oct. 1, 1917, to tenths twice daily, three readings a week in ice periods; Oct. 1, 1917, to Feb. 3, 1919, to half-tenths once daily, three readings a week in ice periods; Feb. 4, 1919, to Sept. 30, 1920, to hundredths once daily, three readings a week in ice periods; Oct. 1, 1920, to June 30, 1929, to hundredths twice daily, one reading daily during ice periods; thereafter recording gage. All gages set to same datum.
Stage-discharge relation.- Affected by ice and occasionally by log jams. Control practically permanent.
Regulation.- Flow regulated for log driving at lakes having a combined storage capacity of 211,000 acre-feet. Gates generally left open after log driving season.

Flood stages and discharges
(Base discharge 6,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1903	Mar.	25-26	10.00		10,800
	Apr.	10-11	8.40		6,110
	May	18	8.4		6,110
1904	May	2	10.8		13,200
		13	9.5		9,280
		17	8.7		6,910
		21	9.0		7,780
		29	8.9		7,480
1905	Apr.	7	8.95		7,630
1906	Apr.	21-23	8.7		6,910
	May	8	10.4		12,000
		22	9.3		8,680
		25	8.9		7,480
	June	8	8.7		6,910
1907	May	2	12.15		17,400
	July	1	9.00		7,780
	Nov.	9	9.45		9,130
	Dec.	12	9.4		8,980
1908	Apr.	29	10.05		10,900
	May	2	11.05		14,000
		10	9.35		8,830
		28	8.45		6,240
	June	1	9.75		10,000
1909	Apr.	16	10.5		12,300
		22	10.4		12,000
	May	11	11.4		15,100
		24	8.4		6,110
	June	19	9.1		8,080
	Sept.	29	13.4		21,400
1910	Apr.	7	9.25		8,170
		24-26	8.80		7,120
	June	4	9.30		8,290
1911	May	3	9.82		9,550
1912	Apr.	24	10.75		11,900
	May 31-June 1		10.05		10,100
	Oct.	26	11.45		13,800
	Nov.	9	10.55		11,400
1913	Apr.	3	10.40		11,000
		25	9.38		8,530
	June	1	9.30		8,290
	Oct.	21	9.10		7,810
1914	Apr.	20	9.15		6,890
		30	9.70		9,250
	May	10	11.85		14,900
1915	Apr.	14	8.65		6,780
	May	5	9.95		9,880
		5	10.0	P	10,000
1916	Apr.	19	8.55		6,540
	July	5	8.6		6,660
		5	8.7	P	6,890
1917	Apr.	8	9.7		7,350
		24	10.0		10,000
	May	15-16	8.6		6,660
	June	13	9.2		8,050
		19	12.5	*	16,700
		19	12.6	P*	17,000
	Oct.	31	9.2		8,400
1918	Apr.	24	8.8		7,210
	May	2	9.1		8,100
	July	9	10.6		12,600
		9	10.7	P	12,900
		13	9.4		9,000
		16	9.5		9,300
1919	Mar.	31	8.9		7,500
	Apr.	14	9.5		9,300
		26	9.9		10,500
	May	3	9.4		9,000
		14			6,300
		19	8.9		7,500
		27	9.1		8,100
1920	Mar.	28			6,930
	Apr.	8	8.6		6,650
		15	10.5		12,300
	Apr. 30-May 1		9.4		9,000
	May	10	10.9		13,500
		10	11.08	P	14,000
	Oct.	2	9.7		9,900
1921	Mar.	29	10.6		12,600
	Apr.	1	9.2		8,400
		10	8.4		6,110
		17	8.7		6,930
		26	9.0		7,800
1922	Apr.	12-13	8.5		6,380
	June	19	9.1		8,100
		23	11.1		14,100
		23	11.2	P	14,400
		30	8.6		6,650
1923	Apr.	30	16.2		33,700
		30	16.5	P	35,100
	May	10	9.2		7,990
1924	May	2	11.2		13,900
		14	9.2		7,990
		16	9.4		8,520
1925	Apr.	3	8.4		6,020
		3	8.45	P	6,140
	Nov.	17	10.4		11,400
1926	May	4-5	11.0		13,200
		4	11.16	P	13,700
	Nov.	20	8.7		6,730
1927	Apr.	24	9.9		9,910
		24	10.0	P	10,200
	May	29-30	8.6		6,490
	June	6	8.4		6,020
	Nov.	5	12.47		18,300
		5	13.29	P	21,300
		19	8.69		6,730
	Dec.	9	9.06		7,730
1928	Apr.	10	10.24		10,800
		16	9.42		8,520
	May	7	9.56		9,060
		27	9.57		9,060
1929	Apr.	18-19	8.81		6,970
		30	10.13		10,500
	May	4	11.29		14,200
		4	11.40	P	14,500
1930	Apr.	9	8.67		7,840
		14-15	8.61		7,650
		21	8.31		6,730

* Estimated

Flood stages and discharges of
East Branch of Penobscot River at Grindstone, Maine-Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1930	May	4	9.20		9,360		Apr.	23	9.31		9,670
		4	9.33	P	9,670		May	3	8.50		7,270
		28	8.58		7,550		Sept.	17	11.37	P	16,600
1931	Apr.	12	8.58		7,550			18			12,300
	June	10	8.59		7,550	1933	Apr.	18	11.44	P	16,600
		10	8.77	P	8,130			19	10.31		12,900
1932	Apr.	13	10.62		13,900		May	4	9.35		9,980

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Mattawamkeag River at Mattawamkeag, Maine

Location.- Prior to Feb. 21, 1929, at Maine Central Railroad bridge at Mattawamkeag, Penobscot County, half a mile above mouth of river; thereafter at Gordon Falls, 3 miles upstream from Mattawamkeag and first location.
Drainage area.- 1,500 square miles.
Records available.- August 1902 to September 1933.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths twice daily prior to Oct. 1, 1919; to quarter tenths twice daily Oct. 1, 1919, to Feb. 21, 1929; recording gage thereafter. Prior to Feb. 21, 1929, gage read once daily when river was frozen over.
Stage-discharge relation.- Affected by ice and occasionally by backwater from log jams and from a fish weir during years 1925-28. Ice has been the only disturbing factor subsequent to change of location in 1929. Control practically permanent.
Regulation.- Flow is regulated for logging purposes at three lakes with combined storage capacity of 89,000 acre-feet. After log running is completed, sluices are usually left open for remainder of season.
Remarks.- Flood of May 1, 1923, which is among the highest known, was due to a heavy 2-day rain falling on snow, the melting of which is supposed to have supplied half the run-off.

Flood stages and discharges
(Base discharge 10,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1903	Mar.	13	12.9		21,300		June	20	13.3		23,300
		25-26	11.25		16,300	1918	Apr.	26	9.9		12,400
	Apr.	11	10.1		12,800		May	3	9.2		10,500
1904	Apr.	14	10.05		12,700		Nov.	22-23	9.6		11,600
	May	3	11.1		15,900	1919	Apr.	1-2	10.1		13,000
		15	11.7		17,700			15-18	9.9		12,400
1905	Apr.	2	11.4		16,800			26	9.6		11,600
		9-10	10.0		12,500		May	3-4	9.4		11,000
1906	Jan.	25	11.6		17,400			28	9.3		10,800
	Apr.	25	10.8		14,900	1920	Apr.	18	13.9		25,300
	May	6-8	11.1		15,900			18	14.0	P	25,600
1907	May	2	13.9		24,400		May	12	10.5		14,200
1908	Apr.	9	9.2		10,300	1921	Apr.	2	10.8		15,100
	May	2	11.55		17,200			2	10.85	P	15,300
1909	Apr.	20-21	12.80		21,100	1922	Apr.	14-15	10.2		13,300
	May	7	9.60		11,400		June	24	11.4		17,000
		13-16	10.20		13,100			24	11.5	P	17,400
	Sept.	30	10.15		13,000	1923	Apr.	18	9.8		10,000
1910	Apr.	10	9.2		10,300		May	1	19.2		42,800
		25	9.35		10,700			1	19.55	P	43,900
1911	Apr.	20	9.15		10,100	1924	May	2-3	10.5		14,200
	May	2	9.55		11,200	1925	Apr.	4-5	9.2		10,500
1912	Apr.	22	9.8		12,200			5	9.25	P	10,600
	June	3-4	12.15		19,500		Nov.	19	9.3		10,800
	Nov.	10	10.75		15,000	1926	May	5-6	13.1		23,900
1913	Mar.	28	12.1		19,300			6	13.15	P	24,100
	Apr.	29	12.6		21,000	1927	Apr.	25	10.4		14,100
	Oct.	29	9.4		11,000		Nov.	6	11.20		16,900
1914	May	10-11	12.55		20,800	1928	Apr.	15	10.50		14,400
1915	Apr.	17	9.15		10,400		May	3	9.62		11,600
	May	6-7	11.2		16,400	1929	Apr.	21-22	8.85		13,400
1916	Apr.	6	9.05		10,100		May	5	9.75		16,100
		6	9.1	P	10,200	1930	Apr.	11	8.86		13,600
1917	Apr.	9	10.0		12,700	1931	Apr.	7	8.54		12,600
		25	11.6		17,700			14	8.99		13,900
	May	13	9.1		10,200	1932	Apr.	15		*	21,600

* Estimated

Flood stages and discharges of Mattawamkeag River at Mattawamkeag, Maine--Continued

Date		Gage height (feet)	Discharge (second-feet)
1932 Apr.	15	11.7	P 21,700
May	5	7.74	10,500
1933 Apr.	13	9.17	14,400
Apr.	20		* 17,500
	20	10.3	P 17,600

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Piscataquis River near Foxcroft, Maine

Location.- At Lows Bridge, three quarters of a mile above mouth of Black Stream and 4½ miles above Foxcroft, Piscataquis County.
Drainage area.- 286 square miles.
Records available.- August 1902 to September 1933.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read twice daily prior to July 1, 1920; to half tenths July 1, 1920, to Sept. 30, 1923; to quarter tenths Oct. 1, 1923, to Sept. 30, 1926; to hundredths Oct. 1, 1926, to July 20, 1930; recording gage thereafter.
Stage-discharge relation.- Affected by ice and occasionally by backwater owing to log jams. Control practically permanent.
Regulation.- Low water flow regulated by power plants upstream.
Historical data.- Floods of 1909, 1917, and 1923 are regarded as having been as high as any known.

Flood stages and discharges
(Base discharge 4,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1902 Oct.	29	6.25	4,340
1903 Mar.	12	10.9	13,800
	18	6.1	4,150
	21	6.75	5,460
	24	7.25	6,230
June	14	6.95	5,840
1904 Apr.	11	10.2	12,400
May	1	7.0	5,840
	12	8.2	8,210
	17	6.6	5,080
1905 Apr.	1	8.3	8,410
	7	8.2	8,210
1906 Apr.	17	10.0	12,000
May	2	6.2	4,340
	10	8.1	8,010
1907 Apr.	25	8.4	8,610
May	1	9.4	10,700
Oct.	30	6.2	4,340
Nov.	7	9.3	10,500
Dec.	11	9.1	10,100
1908 Apr.	29	8.6	9,040
May	1	8.6	9,040
1909 Apr.	9	6.05	4,060
	15	9.65	11,200
	20	7.15	6,130
May	13	6.4	4,700
Sept.	29	12.75	18,100
	29	14.3	P 21,700
1910 Apr.	2	6.25	4,430
1911 Apr.	16	7.6	7,010
	29	6.45	4,800
1912 Apr.	19	6.6	5,080
	23	9.1	10,100
May	31	6.8	5,460
Oct.	26	8.05	7,910
Nov.	8	7.6	7,010
1913 Mar.	22	8.2	8,220
	26	8.15	8,120
Apr.	1	8.7	9,240
Oct.	21	8.25	8,320
	21	8.7	P 9,240
Nov.	10	6.15	4,240
1914 Apr.	21	8.45	8,730
	21	8.7	P 9,240
	29	6.8	5,460
May	6	7.05	5,940
May	10	8.35	8,530
	10	8.7	P 9,240
1915 Feb.	26	8.0	7,810
	26	8.8	P 9,500
Apr.	13	7.65	7,110
May	1	7.85	7,510
1916 Apr.	2	7.10	6,040
	19	6.70	5,270
	24	6.05	4,060
May	18	7.90	7,610
	18	8.0	P 7,810
Dec.	1	7.5	6,820
1917 Mar.	29	8.5	* 7,210
Apr.	7	9.6	* 9,040
	23	7.4	6,620
June	12	7.6	7,010
	18	12.5	17,500
	18	13.5	P 19,800
July	31	8.0	7,810
Oct.	31	7.4	4,830
	31	7.8	P 5,310
1918 May	2	6.8	4,110
1919 Mar.	29	6.9	4,230
	29	7.0	P 4,350
1920 Apr.	7	9.8	* 5,600
	14	9.4	7,430
	14	9.7	P 7,600
	29	6.9	4,230
May	9	7.6	5,070
Oct.	1	7.3	4,710
Dec.	15	7.4	4,830
	15	9.0	P 6,750
1921 Mar.	26	7.1	4,470
1922 Apr.	12	8.0	5,550
June	19	6.8	4,110
	22	6.9	4,230
	30	8.3	5,910
	30	9.5	P 7,350
1923 Apr.	22	7.4	4,830
	29	17.5	P 21,200
	30	16.1	18,600
1924 May	2	8.9	6,870
	2	10.0	P 8,300
1925 Apr.	1	6.4	† 3,720
Nov.	14	6.8	4,200
	16	7.6	5,200

* Estimated
† Below base

Flood stages and discharges of Piscataquis River near Foxcroft, Maine--Continued

Date			Gage height (feet)		Discharge (second-feet)
1925	Nov.	16	9.30	P	7,390
1926	May	4	8.2		5,960
	Nov.	20	8.2		5,960
		20	9.0	P	7,000
1927	May	28	6.8		4,200
	Oct.	20	10.50		8,950
		20	11.20	P	9,860
	Nov.	5	7.7		5,320
	Dec.	9	6.80		4,200
1928	Apr.	8	8.81		6,740
	May	25	9.35		7,520
1929	Apr.	18	7.35		4,950
		29-30	7.58		5,200
	May	3	10.7	P	9,210
		4	9.2		7,260
1930	Apr.	8	8.85		6,740
		8	9.40	P	7,520
1931	June	9-10	7.98		5,570
		10	8.93	P	6,870
1932	Apr.	13	9.16		7,260
	Sept.	17			8,850
		17	13.50	P	12,900
	Nov.	20			5,160
1933	Apr.	19	7.56		5,200
		19	8.15	P	5,960

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kennebec River at The Forks, Maine

Location.- Prior to Oct. 18, 1919, at highway bridge at The Forks, Somerset County, half a mile above mouth of Dead River; thereafter half a mile upstream.
Drainage area.- 1,570 square miles.
Records available.- September 1901 to September 1933.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths generally twice daily prior to June 21, 1912; recording gage for use in open water season thereafter. Prior to June 21, 1912, nonrecording gage read once a week when river was frozen over; thereafter read daily throughout ice periods. Recording gage on left bank and nonrecording gage at center of bridge span at first location set to read same at low water but at high water recording gage read lower owing to influence of bend in river.
Stage-discharge relation.- Affected by ice and by backwater from Dead River and by logging operations at Indian Pond. Control practically permanent.
Storage and regulation.- Flow regulated throughout record by storage in Moosehead Lake (capacity, 542,000 acre-feet) and subsequent to 1927 in Brassua Lake (capacity, 206,000 acre-feet). Controlled area of Moosehead Lake, 1,240 square miles. Large diurnal fluctuation usually during May, June, and July due to log sluicing operations at Indian Pond. Regulation recently for flood control.
Remarks.- Discharge record for 1905-10 revised in 1920 but not published previous to this report.

Flood stages and discharges
(Base discharge 8,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1901	Dec.	15	9.0		19,900
1902	Apr.	1	8.6		18,300
		22	6.25		10,100
	May	3-4	8.2		16,800
		9	6.7		11,500
		14	7.1		12,900
		26-27	6.5		10,900
	June	6	7.8		15,300
		15	7.3		13,600
		19-20	5.9		9,020
		25	6.1		9,630
	July	2	6.15		9,780
		13	5.8		8,720
	Aug.	3	5.65		8,280
1903	Apr.	6	7.05		12,700
		18	7.05		12,700
1904	May	19	5.65		8,220
		25	5.6		8,100
	June	3	6.25		8,330
		7	6.4		8,930
		14	6.9		8,240
		20	7.5		8,860
1905	June	26			8,330
1906	May	18	6.9		9,980
		22	6.7		9,520
		24	6.75		9,640
	June	7	6.2		8,410
1907	May	2	6.05		8,080
		14	7.0		10,200
		19	7.1		10,400
	May	21	7.3		10,900
		30	6.2		8,410
	Nov.	9	8.5		13,900
1908	May	2	6.2		8,410
		6	8.3		13,400
		8	8.25		13,100
		10	8.25		13,100
		18	6.65		9,300
		21	6.7		9,520
	June	4	7.2		10,700
1909	May	11	8.65		14,100
		18	8.1		12,900
		23	7.0		10,200
		27	6.45		8,850
1910	Apr.	28	6.5		9,070
	May	2			8,040
		11			9,810
1911	June	3		†	6,830
1912	May	2	8.70		14,400
		13	6.40		8,850
		26	6.80		9,750
	May 31-June 1		8.30		13,400
1913	Apr.	17			8,960
		22			9,150
		27-28			12,400
1914	May	12	9.75		17,000
1915	May	12		†	5,080
1916	May	20			8,080
		20	7.2	P	10,700
1917	June	12			14,700

† Below base

Flood stages and discharges of Kennebec River at The Forks, Maine--Continued

Date			Gage height (feet)		Discharge (second-feet)
1917	June	18	10.1	P	23,700
		19			18,000
		30			9,400
	July	31			11,000
	Aug.	11			9,800
1918	May	22		†	5,000
	Nov.	21			15,000
		22	8.0	P	15,400
1919	Apr.	26			14,600
	May	4-5			11,500
		9			9,300
		19			11,400
		19	8.0	P	15,400
		27			8,600
1920	May	12	8.50	P	16,000
		13	8.4		15,800
		20	6.2		8,980
1921	Apr.	18			8,600
		18	6.36	P	9,440
1922	June	22	7.4		12,600
		22	7.75	P	13,700
		26	6.9		11,000
		30	7.0		11,300
1923	Apr.	30	9.7		19,900
		30	10.05	P	21,100
	May	12	6.80		10,700
1924	May	14	5.5	†	7,010
1925	July	1			9,200
		1	7.09	P	11,600
	Nov.	17	8.2		15,100
		17	8.30	P	15,500
	Dec.	7	6.4		9,560
1926	June	16			8,900
1927	May	29	7.10	P	11,600
		30	6.9		11,000
	Nov.	19	6.03		8,400
	Dec.	9	6.46		9,850
1928	May	6	6.36		9,560
		10	6.24		8,980
		28	8.57		16,400
	June	5-6	6.44		9,560
		9	6.77		10,700
1929	May	6	9.06		18,200
		6	9.44	P	19,100
	June	2			8,210
1930	May	30	6.1	P	8,690
		31	6.06		8,690
	Dec.	13	6.08		8,690
		13	6.19	P	8,980
1931	Jan.	14	4.63		4,250
1932	May	5	5.03	†	5,810
1933	May	14	6.59		10,100
		14	6.60	P	10,100
		29	6.37		9,560

† Below Base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kennebec River at Waterville, Maine

Location.- At dam and mill of Hollingsworth & Whitney Co., at Waterville, Kennebec County, 2 miles above Sebasticook River and 3½ miles above Messalonskee Stream.

Drainage area.- 4,270 square miles.

Records available.- March 1892 to September 1933.

Source of data.- Records furnished by Hollingsworth & Whitney Co.

Gages.- Nonrecording gage in pond above dam and in tailrace of mill, both read once daily prior to about 1918; recording gage used in pond thereafter.

Stage-discharge relation.- Discharge computed from flow over dam and through logway, waste gates, and wheels of mill.

Storage and regulation.- Regulation at numerous power-plant dams and storage in lakes above station, Moosehead and Brassua Lakes alone having a combined capacity of 748,000 acre-feet. Flow regulated in interest of power users and recently for flood control.

Historical data.- Flood of Dec. 16, 1901, was greatest in period of at least 100 years and was caused by a warm rain falling on a heavy snow cover. Gates at Moosehead Lake dams were closed throughout time of this flood. Flood of May 22, 1832, had an estimated discharge of 140,000 second-feet (71st Cong., 3 sess., H. Doc. 658, p. 15). Heights of important floods at a landmark known as "freshet oak", in Winslow, Maine, referred to Hollingsworth & Whitney Co. datum, are as follows: May 22, 1832, 104.8 feet; October 1854, 102.8 feet; October 1869, 102.7 feet; Apr. 30, 1887, 102.2 feet; Dec. 16, 1901, 105.14 feet.

Flood discharges
(Base discharge 27,500 second-feet)

Date				Discharge (second-feet)
1892	Apr.	7		28,200
	June	29		30,000
	July	4		30,000
1893	May	3		27,600
		5		60,500
		14		54,500
		18		83,500
1894	Apr.	23		35,300
1895	Apr.	10		54,200
		15		86,200
1896	Mar.	2		111,000
	Apr.	17		64,700
		21		74,500
		24		46,700
	May	6		30,900
	Nov.	6		29,900
1897	Apr.	17		34,800
	Apr.	20		32,800
		28		66,900
	May	5		40,700
		12		41,200
		14		41,300
	July	15		55,600
1898	Apr.	15		50,400
		25		52,100
	May	2		39,400
		14		34,300
1899	Apr.	16		38,800
		20		41,600
		24		45,700
1900	Apr.	21		62,300
	May	4		52,300
		10		28,600
		20		48,500
1901	Apr.	6		58,000
		9		76,600
		24		66,000
	Dec.	16		151,000
		16	P	157,000
1902	Mar.	4		54,300
		18		46,600
		23		46,700
		30		58,000
	May	1		34,400
		29		29,200
	June	27		33,900
1903	Mar.	12		31,300
		20		35,700
	June	14		30,000
1904	Apr.	11		33,500
		30		36,100

Flood discharges of Kennebec River at Waterville, Maine--Continued

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1904 May 12	37,800	Apr. 27	31,900	Dec. 7	28,700
17	37,600	1914 Apr. 10	39,100	16	34,200
1905 Apr. 1	32,100	13	28,200	1921 Mar. 27	37,900
14	30,000	21	57,000	30	29,600
1906 Apr. 16	39,400	May 6	33,200	1922 Apr. 13	60,600
23	32,900	10	54,300	20	39,100
May 11	34,400	1915 Feb. 27	31,600	June 20	30,000
1907 Apr. 25	41,400	Apr. 12	41,700	24	30,000
27	29,600	May 2	44,200	July 2	34,300
May 2	44,000	July 10	39,700	1923 Apr. 24	39,500
June 2	47,300	1916 Apr. 3	29,000	May 1	134,000
Nov. 4	27,900	19	32,800	1924 May 2	36,200
8	71,200	24	35,400	14	28,500
Dec. 12	41,200	May 19	44,500	1925 Mar. 29	32,500
1908 Apr. 29	29,200	1917 Apr. 7	40,900	Nov. 17	42,000
June 1	27,900	24	30,000	1926 Apr. 26	27,500
1909 Apr. 16	44,200	June 13	76,500	May 5	36,200
19	29,900	18	88,500	Nov. 20	41,200
May 9	27,800	Aug. 1	34,000	1927 Oct. 22	70,000
11	38,500	1918 Apr. 3	52,900	Nov. 5	76,800
18	30,000	May 2	33,900	Dec. 9	31,900
June 3	30,200	Nov. 22	39,800	1928 Apr. 9	87,200
Sept. 29	34,300	1919 Mar. 22	28,500	16	28,200
1910 Mar. 27	30,600	24	39,800	May 7	38,800
Apr. 3	34,700	29	36,000	25	79,200
7	36,000	Apr. 14	31,000	1929 Apr. 18	33,500
9	33,500	26	27,300	30	38,300
28	28,700	May 3	30,800	May 4	66,400
1911 Apr. 16	27,900	19	28,700	1930 Apr. 8	36,700
1912 Apr. 19	40,500	24	30,700	1931 June 10	29,400
24	45,500	1920 Apr. 7	27,500	1932 Apr. 13	59,600
May 3	28,900	15	54,300	23	33,200
June 1	36,300	24	36,800	Sept. 17	47,600
1913 Mar. 25	43,400	29	36,800	Nov. 20	35,800
Apr. 2	33,100	May 10	37,100	1933 Apr. 19	38,900
18	28,200	Oct. 2	29,600	May 4	33,000

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Dead River at The Forks, Maine

Location.- One-eighth of a mile above farmhouse of Jeremiah Durgin and 1½ miles west of The Forks, Somerset County; moved 300 feet upstream on Sept. 29, 1923.
Drainage area.- 878 square miles.
Records available.- September 1901 to August 1907, March 1910 to September 1933, except winters 1901-7.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths twice daily prior to Oct. 1, 1920, and to hundredths twice daily Oct. 1, 1920, to Sept. 29, 1923; recording gage thereafter. Gage read three times a week during winters 1911-20 and once daily during winters 1921-23. Recording gage set to same datum but in different pool from nonrecording gage.
Stage-discharge relation.- Affected by ice. Control practically permanent. Banks not subject to overflow.
Regulation.- Dams on lakes at headwaters regulate flow for power and for log driving during April, May, and June.

Flood stages and discharges
(Base discharge 6,500 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1902 June 26	4.55	8,240	May 27	5.4	11,500
29	4.15	6,900	29	4.85	9,330
29	4.3	P 7,390	June 3	4.15	6,900
....	....	.....	6	4.65	8,600
1903 June 13	4.8	9,140	9	4.75	8,960
....	....	.....	....	....	.....
1904 Apr. 5	4.95	9,700	1905 Mar. 28	4.85	9,330
....	....	.....	Apr. 23	4.95	9,700
Apr. 29	6.05	14,300	May 2	4.15	6,900
May 5	6.85	18,000	4	5.85	13,400
5	8.0	P 23,100	4	7.4	P 20,100
11	5.15	10,500	8	4.25	7,230
15	5.6	12,400	11	4.55	8,240
19	6.15	14,800	16	5.7	12,800

Flood stages and discharges of Dead River at The Forks, Maine--Continued

Date			Gage height (feet)	Discharge (second-feet)
1905	May	20	5.2	10,700
		26	5.15	10,500
....			....	......
1906	Apr.	23	4.65	8,600
	May	2	4.4	7,730
		6-7	4.35	7,560
		12	4.75	8,960
		12	7.6	P 21,100
		18	4.35	7,560
....			....	......
1907	May	2	6.9	18,300
		2	7.1	P 18,700
		11	4.55	8,240
		17	4.6	8,420
		21-22	4.45	7,900
....			....	....
1910	Apr.	2	4.7	8,780
		6	5.35	11,300
		7	6.2	P 14,600
		8	5.7	12,800
		23	4.6	8,420
		25	4.6	8,420
		30	4.45	9,270
	May	26	3.9	7,830
		31	4.55	8,250
....			....	......
1911	May	2	5.4	11,300
		9	4.5	7,840
		10	6.6	P 16,400
1912	Apr.	19	4.95	9,510
		24	5.30	10,900
		26	5.00	9,700
	May	1	4.25	6,960
		14	7.75	21,900
		14	8.0	P 23,100
1913	Mar.	28	4.90	9,320
	Apr.	29	4.90	9,320
	May	5	5.60	12,100
		5	7.0	P 18,200
		8	4.25	6,960
1914	Apr.	23	4.55	8,020
	May	5	5.45	11,500
		10	6.55	16,200
		10	6.8	P 17,400
		18	4.65	8,380
1915	Apr.	13	4.3	7,130
	May	2	4.3	7,130
1916	Apr.	26	4.20	6,790
	May	18	5.1	P 10,100
		19	4.45	7,660
1917	Apr.	24	5.2	10,500
	May	14	4.3	7,130
	June	13	5.2	10,500
		18		13,800
		21		17,800
		21	7.9	P 22,600
	July	31		14,600
	Oct.	31	4.2	6,790
	Nov.	3	4.2	6,790
1918	Apr.	2	4.3	7,130
		26	4.2	6,790
		30	4.2	6,790
1919	Apr.	13	4.2	6,790
		15-16	4.4	7,480
		19	4.2	6,790
	May	1	4.4	7,480
		4	4.4	7,480
		20	4.4	7,480
		30	4.6	8,200
		30	5.0	P 9,700
1920	Apr.	24-25	4.8	8,940
		24	4.9	P 9,320
	May	9	4.2	6,790
		12	4.4	7,480
	June	8	4.5	7,840
1921	Mar.	27	4.7	8,570
1922	Apr.	14	5.8	12,900
		19	5.4	11,300
1923	Apr.	23-24	5.0	9,700
		30	8.1	23,600
		30	8.15	P 23,800
	May	8	4.4	7,480
1924	May	2-3	6.4	9,690
		10		7,370
		11	8.25	P 15,500
		14		9,450
	Nov.	25		* 7,900
1925	Apr.	1	5.4	6,720
		28		6,560
	Nov.	17	5.7	7,580
1926	May	4	7.1	11,800
		4	7.40	P 12,800
1927	Apr.	21		7,200
	Oct.	21	6.42	9,690
	Nov.	5	7.76	14,100
1928	Apr.	9	7.08	11,800
	May	7		7,820
		25	6.67	10,600
1929	Apr.	10-11	5.92	8,180
		30		9,490
	May	3	8.93	P 17,600
		4		15,800
1930	Apr.	15	5.33	6,580
	May	3		11,400
		28		6,550
1931	Apr.	12	5.04	† 5,780
1932	Apr.	13	6.26	9,380
		23	5.87	8,180
	May	4		6,940
1933	Apr.	22	6.57	11,300
		28	5.38	7,190
	May	4	8.10	17,000
		4	8.38	P 18,200

* Estimated
† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Dec. 9, 1901, to June 24, 1902; Dec. 27, 1902, to June 3, 1903; Jan. 1 to Apr. 4, 1904 and Apr. 6-10, 1904; Dec. 11, 1904, to Mar.27, 1905; Dec. 17, 1905, to Apr. 9, 1906; Dec. 14, 1906, to Mar. 16, 1907; Feb. 12, to Apr. 16, 1911.

Androscoggin River at Rumford, Maine

Location.- Above each of two dams and in tailrace of power station of Rumford Falls Power Co. at Rumford, Oxford County.
Drainage area.- 2,090 square miles.
Records available.- May 1892 to September 1933.
Source of data.- Records furnished by Rumford Falls Power Co.
Gage.- Nonrecording.
Stage-discharge relation.- Discharge computed from flow over dams and through wheels.
Regulation.- Storage aggregating about 680,000 acre-feet in Rangeley system of lakes, controlled in the interest of water-power users above and below station.
Historical data.- Flood of April 1895 is greatest on record at Rumford Falls.

Flood discharges of Androscoggin River at Rumford, Maine
(Base discharge 14,000 second-feet)

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1892 June 29	19,900	May 20	16,800	June 10	15,900
July 5	17,500	Dec. 15	27,800	1917 June 12	21,700
Nov. 17	24,500	1902 Mar. 3	17,200	18	30,300
19	16,300	30	18,500	Oct. 31	15,200
1893 May 5	25,500	May 1	14,600	1918 Apr. 3	† 12,400
15	28,500	28	17,500	1919 May 23	14,600
18	38,100	1903 Mar. 21	19,000	1920 Apr. 14	19,300
1894 Apr. 21	22,200	25	19,800	1921 Mar. 22	16,800
28	16,900	June 13	26,800	1922 Apr. 12	21,900
May 3	14,200	1904 May 10	14,400	19	18,100
30	19,200	17	14,900	June 19	16,000
1895 Apr. 9	15,000	1905 July 31	17,500	23	17,200
15	55,200	1906 May 28	15,400	30	16,000
22	16,500	1907 May 1	23,800	1923 Apr. 22-23	18,500
May 13	17,100	Oct. 29	14,000	30	33,800
Nov. 27	15,600	Nov. 3	23,000	1924 May 1	19,900
1896 Jan. 1	21,500	7	22,800	13	17,200
Mar. 2	39,000	Dec. 11	14,900	Sept. 11	26,200
Apr. 17	27,400	1908 Apr. 29	15,900	Nov. 24	23,400
21	25,300	May 1	18,700	1925 Feb. 13	14,200
1897 Apr. 26	19,000	1909 Apr. 15	23,600	Mar. 29	21,400
May 1	16,400	20	20,000	1926 May 4	20,400
4	19,300	May 11	14,600	1927 Apr. 23	† 11,600
14	19,200	17	16,100	Nov. 5	39,100
June 11	14,800	1910 Jan. 23	14,200	1928 Apr. 8	21,600
July 15	22,900	Apr. 27	14,300	May 25	19,000
1898 Apr. 25	16,700	1911 May 2	15,000	1929 Apr. 9	14,300
May 13	15,600	1912 Apr. 17	17,000	29	14,700
1899 Apr. 27	23,300	1913 Mar. 22	15,900	May 4	22,000
May 2	24,100	26	19,100	1930 Apr. 8	20,600
1900 Apr. 20	22,000	28	16,900	May 27	14,600
May 1	16,200	Apr. 1	14,700	1931 May 24	14,100
4	17,100	Nov. 10	22,000	June 10	20,200
20	24,500	1914 Apr. 21	23,900	1932 Apr. 13	18,700
1901 Apr. 9	17,100	May 10	16,100	Sept. 17	24,000
15	14,300	1915 July 9	17,100	Nov. 20	14,100
22	32,700	1916 Apr. 24	14,900	1933 Apr. 19	24,500
May 1	16,100	May 18	19,500	26	16,300
12	16,500			May 4	22,200

† Below base

Note.- All discharge quantities are average daily flows.

Pemigewasset River at Plymouth, N. H.

Location.- Prior to Sept. 30, 1926, at highway bridge in Plymouth, Grafton County, three-quarters of a mile below mouth of Bakers River; thereafter 500 feet downstream.

Drainage area.- 622 square miles.

Records available.- January 1886 to September 1933. Gage-height records only in winter 1886-1907.

Sources of data.- U. S. Geological Survey records, except gage-height records prior to Sept. 4, 1903, and July 1, 1907, to Mar. 21, 1919, which were furnished by Proprietors of Locks and Canals, Lowell, Mass.

Gage.- Nonrecording gage read twice daily prior to July 1, 1907; read to half inches once daily July 1, 1907, to Dec. 31, 1914; to half inches twice daily Jan. 1, 1915, to June 11, 1925; to half inches three times daily June 12, 1925, to Sept. 30, 1926; recording gage thereafter. Gage used 1903-10 set to datum 1.11 feet lower than gages used before and since, but relation between simultaneous gage readings at different stages varied between 0.99 and 1.11 feet. In this report all gage-height records prior to 1910 have been corrected by minus 1.10 feet in order to make them approximately comparable with readings on present gage.

Stage-discharge relation.- Affected by ice. High-water control probably permanent.

Regulation.- From mill upstream at extreme low water.

Remarks.- When only one or two daily readings were taken, average daily gage-height and discharge records were subject to considerable error because rapid changes in stage usually occur during high water. Discharge records prior to 1932 have been revised from previously published figures.

Flood stages and discharges of Pemigewasset River at Plymouth, N. H.
(Base discharge 10,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1886	Jan.	6	** 14.17	
	Feb.	14	** 15.25	
	Apr.	2	** 16.00	
		16	8.17	10,300
		19	9.50	12,600
1887	Apr.	24-25	9.00	11,700
		30	10.67	15,100
	May	5	11.00	15,800
		9	8.75	11,300
	June	24	12.92	20,200
1888	Apr.	30	14.00	22,800
	May	10	10.58	14,900
		13	12.75	19,900
1889	June	2	8.50	10,800
1890	May	7	11.50	16,900
		21	11.00	15,800
	Aug.	28	8.25	10,300
	Sept.	14	10.50	14,700
		17	9.58	12,800
1891	Apr.	20	10.50	14,700
		24	9.58	12,800
1892	June	28	8.00	† 9,920
1893	May	5	11.33	16,500
		13	9.58	12,800
		17	9.87	13,400
		17	12.50	P 19,200
1894	Apr.	22	12.00	18,000
	May	29	10.17	14,000
1895	Apr.	15	** 24.00	
		16	9.71	13,000
1896	Mar.	1	** 20.00	
	Apr.	17	12.00	18,000
	Oct.	22	8.50	10,800
	Nov.	6	12.50	19,200
1897	Apr.	16	8.50	10,800
		26	9.75	13,200
	May	14	13.75	22,300
	June	10	9.54	12,600
		10	11.33	P 16,500
	July	15	17.75	32,800
1898	Apr.	25	8.58	11,000
	May	13	10.00	13,600
1899	Apr.	24	9.50	12,600
		27	10.25	14,000
	May	2	10.83	15,400
1900	Feb.	14	** 18.00	
	Apr.	20	12.50	19,200
	May	20	9.33	12,200
1901	Apr.	23	9.25	12,000
	May	20	9.00	11,700
	Dec.	16	** 14.50	
1902	Mar.	3	** 17.00	
	May	1	9.00	11,700
		28	9.00	11,700
	Oct.	29	12.00	18,000
1903	June	13	8.33	10,400
1904	Apr.	10	8.30	10,400
		30	8.58	11,000
	May	17	8.80	11,300
		20	8.40	10,600
1905	Mar.	28	** 12.00	
		31	8.15	10,300
1906	Apr.	16	11.25	16,200
	May	28	10.35	14,500
1907	Mar.	30	8.30	10,400
	May	1	10.05	13,600
	Oct.	29	11.15	16,200
	Nov.	3	11.75	17,600
		7	9.15	12,000
	Dec.	11	12.5	19,200
1908	Feb.	16	12.35	19,000
		16	12.65	P 19,400
	Apr.	17	8.35	10,400
		28-29	9.9	13,400
		28	11.0	P 15,800
	May	16	9.4	12,400
1909	Apr.	8	9.35	12,400
		15	13.85	22,300
		20	11.5	16,900
1910	Jan.	22	8.5	10,800
1911	Apr.	15	9.1	11,900
		29	8.5	10,800
	May	2	8.9	11,500
1912	Apr.	8	10.6	14,900
		17	9.12	11,900
		23	9.08	11,900
	Oct.	25	8.62	11,000
	Nov.	8	8.58	11,000
1913	Mar.	16	14.5	* 12,100
		22	13.75	* 16,500
		26	12.33	18,700
		28	15.42	26,400
	Apr.	1	9.25	12,000
	Nov.	10	9.75	13,200
1914	Mar.	3	10.67	15,100
	Apr.	21	15.17	25,900
1915	Feb.	26	16.54	* 16,200
	Mar.	2	8.54	10,800
	Apr.	12	9.50	12,600
	July	9	11.06	16,000
1916	Apr.	1	9.60	12,800
	May	18	9.80	13,200
1917	Mar.	29	8.81	11,300
	Apr.	23	8.58	11,000
	June	12	10.1	13,800
		18	11.5	16,900
	Oct.	31	9.8	13,200
1918	Apr.	3	8.54	10,800
	Sept.	27	8.92	11,500
1919	Mar.	29	10.82	15,400
	May	23	11.71	17,300
		23	12	P 18,000
1920	Mar.	28	11.08	16,000
	Apr.	14	12.54	19,200
		14	13.5	P 21,600
		22	9.50	12,600
	Oct.	1	10.90	15,600
		1	11.5	P 16,900
	Dec.	6	9.17	12,000
		15	10.46	14,700
1921	Mar.	10	10.18	* 10,400
		22	9.88	13,400
		26	8.62	11,000
	Apr.	1	9.71	13,000
1922	Apr.	12	13.50	21,600
		12	14.0	P 22,800
	June	4	8.34	10,400
		30	8.92	11,500
1923	Apr.	9	11.42	16,700
		23	11.50	16,900
		29	16.08	28,300
		29	18.17	P 33,800
	Nov.	25	8.33	10,400
	Dec.	1	9.92	13,400
1924	May	1	9.54	12,600
	Sept.	10	9.17	12,000
		10	11.7	P 17,300
	Oct.	1	9.92	13,400
	Nov.	23	8.25	10,300
1925	Feb.	12	12.25	18,500
		12	15.8	P 27,500
	Mar.	29	13.12	20,600
1926	Apr.	25	9.54	12,600
	May	4	10.77	15,400
		4	11.50	P 16,900
	Nov.	17	7.90	† 9,750
1927	Nov.	4		40,100
		4	27.4	P 60,000
1928	Mar.	28	8.2	10,300
	Apr.	8	11.98	18,000
1929	Apr.	8	9.55	12,700
	May	3		16,100

* Estimated
** Ice gorge
† Below base

Flood stages and discharges of Pemigewasset River at Plymouth, N. H.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1929 May	3	P 14.14	23,200	Apr.	13	12.10	P 18,200
1930 Apr.	8		14,500	Oct.	7		12,200
	8	13.14	P 20,700	Nov.	20		12,600
1931 June	10	7.31	† 8,730	1933 Apr.	18		18,200
1932 Apr.	13		13,100		18	12.77	P 19,900

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Merrimack River at Franklin Junction, N. H.

Location.- Prior to Sept. 12, 1923, at railroad bridge at Franklin Junction, Merrimack County, 1 mile below confluence of Pemigewasset and Winnepesaukee Rivers; thereafter 350 feet upstream.

Drainage area.- 1,507 square miles.

Records available.- July 1903 to September 1933.

Sources of data.- U. S. Geological Survey records, except gage-height records July 1907 to September 1923, which were furnished by Proprietors of Locks and Canals, Lowell, Mass.

Gage.- Nonrecording gage read to half tenths twice daily prior to Sept. 12, 1923; recording gage thereafter. Both gages set to same datum. Zero of gages is 250.4 feet above mean sea level.

Stage-discharge relation.- Affected by ice during periods of extremely cold weather. Control permanent. Rating curve defined to about 30,000 second-feet.

Storage and regulation.- Storage in Winnepesaukee, Squam, and Newfound Lakes. Low-water regulation from mills upstream.

Remarks.- Rating curves indicate that nonrecording gage read 3 or 4 tenths of a foot lower than recording gage for same discharge. Discharge for flood of Nov. 5, 1927, has been revised from previously published figures.

Flood stages and discharges
(Base discharge 11,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1904 Apr.	10	11.50	16,100	1913 Mar.	22	16.2	25,000
	30	13.45	21,000		26	15.4	23,300
May	17	11.40	15,800		28	17.6	28,100
	20	12.50	18,600	Apr.	1	11.1	13,900
....		.....	......	1914 Mar.	3	13.6	19,300
1905 Mar.	30	13.0	19,800	Apr.	21	19.0	31,200
Sept.	4	11.05	15,000		21	19.5	P 32,300
	19	11.85	17,000		30	10.7	13,100
1906 Apr.	16	16.2	24,700	1915 Feb.	26	17.8	28,600
May	28	14.7	21,600	Apr.	12	12.0	15,800
....		.....	......	July	9	13.6	19,300
1907 Mar.	31	12.15	16,200	1916 Apr.	3	9.9	11,400
Apr.	25	10.35	12,400		24	10.8	13,300
	27	9.9	11,500	May	18	14.4	20,100
May	1	11.9	15,700		18	14.4	P 20,800
Oct.	29	12.6	17,200	1917 Apr.	23	12.0	15,700
Nov.	4	12.55	17,100	June	13	14.2	20,500
	7	11.3	14,400		18	13.6	19,200
	10	10.15	12,000		18	15.1	P 22,600
Dec.	11	13.05	18,100	Oct.	31	13.0	17,900
1908 Feb.	16	9.90	11,500		31	13.0	P 18,000
Apr.	29	12.25	16,400	1918 Apr.	3	11.9	15,500
May	4	10.25	12,200	Sept.	27	11.2	14,000
1909 Apr.	8	12.85	17,900	1919 Apr.	12		14,000
	15	17.60	27,900	May	23	15.2	22,700
	20	13.45	19,200		23	16.2	P 24,900
1910 Jan.	23	11.10	14,200	Nov.	14	10.6	12,700
Mar.	26	10.00	11,900	1920 Mar.	28	13.6	19,200
	30	9.58	11,000	Apr.	6	10.8	13,100
Apr.	27	10.50	13,000		14	16.8	26,400
1911 Apr.	15	10.25	12,400		14	17.5	P 27,800
May	2	11.05	14,100		23-24	13.0	17,900
....		.....	......		29	13.8	19,700
1912 Apr.	8	12.6	17,400	May	10	10.0	11,400
	17	12.4	17,000		23	10.0	11,400
Oct.	25		* 16,000	Oct.	1	11.2	14,000

* Estimated

Flood stages and discharges of Merrimack River at Franklin Junction, N. H.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1920	Dec.	6	13.0		17,900
		15	14.3		20,800
		15	15.0	P	22,300
1921	Mar.	10	10.8		13,100
		22	14.4		21,000
		26	13.2		18,300
		29	10.0		11,500
	Apr.	1	11.4		14,400
1922	Mar.	9	10.3		12,100
		30	11.8		15,300
	Apr.	12	17.5		27,800
		12	18.4	P	29,000
		19	12.3		17,400
	May	6	12.7		17,200
	June	4	9.8		11,000
		19	11.6		14,800
		24	13.2		18,300
		30	13.8		19,700
....			....		......
1923	Apr.	9	11.4		14,400
		23	13.6		19,200
		30	22.4		38,600
		30	23.5	P	41,000
	Nov.	25			11,200
1924	Apr.	20			14,200
	May	2			15,800
		5			11,100
	Sept.	11			15,900
		11	14.50	P	19,300
	Nov.	24			14,100
1925	Feb.	13			28,000
	Feb.	13	* 22.8	P	37,400
	Mar.	30			28,300
1926	Apr.	26	14.50		19,400
		26	15.12	P	20,600
	May	4	13,70		17,700
1927	Mar.	19	10.48		11,200
	Nov.	5			42,100
		5	30.85	P	55,600
		19	11.17		12,500
	Dec.	9			17,400
1928	Apr.	8			22,400
1929	Apr.	9	13.22		16,700
		27			12,800
		30			13,200
	May	4	15.33		21,400
		4	17.67	P	27,300
1930	Apr.	8	14.10		18,700
		8	16.14	P	23,300
1931	June	10			16,000
		10	14.24	P	18,900
1932	Apr.	9	10.67		11,500
		13	16.76		25,100
		13	17.73	P	27,300
	Oct.	7			12,800
	Nov.	20			15,900
1933	Apr.	8	11.39		12,900
		19			28,700
		19	19.99	P	30,700
		26	11.04		12,100
	May	4	11.78		13,600

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Jan. 4 to Mar. 14, 1904; Oct. 23-31, 1904; Dec. 18-31, 1904; Jan. 30 to Mar. 9, 1905; Feb. 11-28, 1907; Feb. 1 to Mar. 12, 1912; Jan. 6 to Mar. 28, 1923.

Merrimack River at Lawrence, Mass.

Location.- At dam of Essex Co., Lawrence, Essex County, about 10 miles below mouth of Concord River.

Drainage area.- Total, 4,674 square miles; net, excluding diverted areas, 4,463 square miles.

Records available.- October 1879 to September 1933.

Source of data.- Essex Co., Lawrence; records computed from flow over dam and through wheels and gates.

Storage, regulation, and diversions.- Some storage in Winnepesaukee, Squam, and Newfound Lakes. Low-water regulation for power at Lowell, about 10 miles upstream. Practically entire flow from 211 square miles of South Branch of Nashua River, Sudbury River, and Lake Cochituate diverted for use by Metropolitan Water Supply District of Boston. Waste water from these areas directed back into Merrimack River. Diverted drainage areas have been as follows: 97 square miles prior to Jan. 1, 1881; 94 square miles Jan. 1, 1881, to Mar. 6, 1898; 212 square miles Mar. 7, 1898, to June 30, 1909; 211 square miles thereafter.

Remarks.- Flood flows above base flow can be considered as coming from net area, as wasted water is usually a small percent of flood flow. Water surface estimated to be 3.5 percent of entire drainage area.

Flood discharges
(Base discharge 24,700 second-feet)

Date				Discharge (second-feet)
1880	Jan.	30		25,000
	Apr.	6		27,700
1881	Mar.	12		29,400
	May	18		28,300
	Dec.	31		29,300
1882	Mar.	4		35,000
1883	Apr.	15		30,500
1884	Mar.	29		46,600
	Apr.	19		41,100
1885	Apr.	6		24,700
	Nov.	11		24,700
1886	Jan.	7		38,400
	Feb.	15		46,100
	Apr.	3		40,700
		8		31,100
		17		25,500
1887	Jan.	31		33,600
	Apr.	13		40,700
		26		28,800
	May	1		33,900
	June	25		25,600
1888	Mar.	24		25,600
	Apr.	3		28,200
		8		33,200
	May	1		38,800
		14		37,400
	Nov.	29		29,800
	Dec.	19		35,000
1889	Nov.	30	†	23,800
1890	Mar.	24		25,200
	Oct.	21		31,400
1891	Jan.	25		32,200
	Feb.	28		29,800

† Below base

Flood discharges of Merrimack River at Lawrence, Mass.--Continued

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1891 Mar. 15	32,500	1903 Mar. 2	30,000	1919 Mar. 30	38,200
25	41,200	13	45,500	May 24	33,100
Apr. 14	31,700	25	39,000	1920 Mar. 19	27,100
21	27,500	Apr. 2	25,700	29	51,600
1892 May 24	24,800	June 23	35,600	Apr. 7	34,100
1893 Mar. 16	25,800	1904 Mar. 28	36,200	15	38,100
May 6	44,800	Apr. 11	37,000	25	34,300
19	32,600	May 1	46,300	30	38,300
1894 Mar. 9	27,900	21	27,300	Dec. 7	29,900
1895 Apr. 11	39,200	1905 Mar. 30	45,900	16	40,400
16	65,300	Apr. 7	25,500	1921 Mar. 11	28,400
1896 Feb. 9	27,000	1906 Apr. 17	35,400	1922 Mar. 10	25,200
Mar. 3	82,200	May 30	36,900	30	33,800
22	27,000	1907 Apr. 1	27,300	Apr. 13	42,900
Apr. 18	30,100	Nov. 8	32,300	May 7	34,800
1897 June 11	40,900	1908 Feb. 17	† 22,900	June 23	32,900
July 16	41,500	1909 Apr. 17	34,900	1923 Apr. 8	42,400
Dec. 17	36,800	1910 Mar. 3	28,400	24	26,200
1898 Mar. 15	36,000	1911 Mar. 31	† 20,900	May 1	55,100
22	30,200	1912 Mar. 18	26,100	Nov. 26	26,400
Apr. 26	30,400	31	26,500	1924 Apr. 9	47,700
1899 Apr. 11	29,400	Apr. 9	30,700	21	31,500
17	38,200	1913 Mar. 17	27,300	1925 Feb. 14	29,300
25	31,700	23	27,500	Mar. 31	49,700
1900 Feb. 15	53,000	29	37,000	1926 Apr. 27	33,700
26	27,600	1914 Mar. 4	32,600	1927 Mar. 17	30,200
Mar. 3	37,700	30	27,700	Nov. 6	66,600
Apr. 21	34,900	Apr. 3	31,100	Dec. 10	27,400
1901 Mar. 28	26,400	11	24,900	1928 Apr. 9	28,600
Apr. 9	62,500	22	37,100	1929 Mar. 17	25,400
26	31,800	29	27,300	24	29,700
May 21	28,200	1915 Feb. 27	39,200	Apr. 23	26,000
Dec. 17	41,500	July 10	29,900	May 5	32,500
1902 Jan. 1	26,500	1916 Apr. 3	32,800	1930 Apr. 9	25,100
Mar. 4	61,200	25	26,500	1931 Apr. 13	26,100
15	34,200	May 19	32,900	June 11	31,000
18	35,000	1917 Mar. 29	31,100	1932 Apr. 3	28,700
31	31,800	June 14	25,200	14	43,200
Apr. 11	39,200	19	31,500	1933 Apr. 9	41,100
May 2	25,500	1918 Apr. 4	26,900	20	66,500

† Below base

Note.- All discharge quantities are average daily flows.

Connecticut River at Orford, N. H., and South Newbury, Vt.

Location.- Aug. 6, 1900, to July 21, 1918, at highway bridge between Orford, Grafton County, N. H., and Fairlee, Orange County, Vt., about 8 miles below mouth of Waits River; July 22, 1918, to Sept. 16, 1930, at highway bridge between South Newbury, Orange County, Vt., and Haverhill, Grafton County, N. H., about 4 miles above mouth of Waits River; thereafter about 200 feet downstream from second location.

Drainage area.- Aug. 6, 1900, to July 21, 1918, 3,100 square miles; thereafter 2,825 square miles.

Records available.- August 1900 to December 1921, August 1922 to September 1933.

Source of data.- U. S. Geological Survey.

Gage.- Nonrecording gage read to tenths once daily prior to 1915; to tenths twice daily 1915 to July 21, 1918; to half tenths twice daily July 22, 1918, to Sept. 30, 1923; to hundredths four times daily Oct 1, 1923, to Sept. 30, 1925, and Oct. 1, 1928, to Sept. 16, 1930; to hundredths twice daily Oct. 1, 1925, to Sept. 30, 1928; recording gage thereafter. Datum of gage at South Newbury 8.8 feet higher than that at Orford.

Stage-discharge relation.- Affected by ice. Control probably permanent.

Storage and regulation.- Storage in Connecticut Lakes (capacity, 88,200 acre-feet); storage and regulation at Fifteenmile Falls Dam (capacity, 33,100 acre-feet) subsequent to August 1930.

Remarks.- Discharge records July 22, 1918, to Sept. 30, 1931, have been revised from previously published figures.

Historical data.- Flood of Nov. 5, 1927, was probably largest and that of Mar. 28, 1913, second largest since October 1869.

Flood stages and discharges of
Connecticut River at Orford, N. H., and South Newbury, Vt.
(Base discharge 19,100 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1901	Mar.	28	17.4	21,300
	Apr.	9	22.4	31,900
		25	22.7	32,600
	Dec.	16	21.7	30,400
1902	Mar.	3	27.5	43,400
	Apr.	1	18.3	23,200
	May	29	22.4	31,900
	Oct.	29	16.6	19,700
1903	Mar.	12	23.1	33,400
		24	26.1	40,100
	Apr.	5	18.2	22,900
1904	Mar.	29	17.6	21,700
	Apr.	11	17.6	21,700
	May	2	18.2	22,900
		19	18.5	23,600
1905	Mar.	29-30	24.8	37,200
1906	Jan.	25	20.2	27,100
	Apr.	17	21.6	30,200
	May	18	16.6	19,700
		29	20.4	27,600
1907	Mar.	31	19.95	27,000
	May	3	26.1	40,600
	Dec.	12	19.7	26,500
1908	Mar.	30	21.9	30,600
	Apr.	30	24.7	36,700
1909	Apr.	9	21.6	29,900
		16	30.3	49,700
	May	12	18.4	23,200
		19	16.8	19,900
1910	Mar.	3	17.5	21,500
		27	16.85	20,200
	Apr.	2	18.95	24,500
		9	18.35	23,300
1911	Apr.	8	17.7	21,900
		16	19.6	25,900
	May	3	23.6	34,500
1912	Apr.	8	24.6	36,700
		19	24.4	36,300
		25	19.8	26,300
	June	2	21.8	30,600
1913	Mar.	16-17	20.4	27,600
		22	21.8	30,600
		28	32.9	56,000
		28	33.4	P 57,300
	Apr.	6	17.2	20,900
1914	Apr.	3	17.8	20,100
		22	27.9	44,300
		22	28.2	P 45,000
	Apr.30-May	1	18.8	24,200
	May	7	17.1	20,700
1915	Feb.	26	23.2	33,700
	Apr.	13	18.6	23,800
	July	10	17.7	21,900
1916	Apr.	3	23.2	31,700
		20	16.8	20,100
		25	17.8	22,100
	May	19	16.4	19,300
1917	Mar.	29	19.9	26,500
	Apr.	3	26.7	26,700
		7	16.8	20,100
		24	21.3	29,500
	June	13	23.4	23,400
		19	20.2	27,100
	Nov.	1	19.2	24,300
1918	Apr.	3	21.3	28,900
	May	2-3	17.0	20,500
	Oct.	7	20.6	26,100
	Nov.	1	21.1	27,000
1919	Mar.	29	20.0	25,100
	Apr.	14	21.1	27,000
1920	Mar.	29	23.8	32,000
	Apr.	6	17.6	21,100
		14	20.8	26,400
		24	22.5	29,500
		29	19.9	24,900
1921	Mar.	11	19.0	* 23,400
		22-23	20.2	25,400
		29	18.8	23,100
......	......	......	.....	......
1923	Apr.	7	21.4	27,500
		24	23.6	31,600
	May	1	30.6	51,100
1924	Apr.	20	17.2	20,500
	May	2	21.5	27,700
	Sept.	12-13	23.5	31,400
	Nov.	24	18.3	22,300
1925	Feb.	13	21.4	* 22,500
	Mar.	30	23.9	32,200
	Nov.	17	18.05	21,800
1926	Apr.	26	25.62	35,700
	May	5	26.67	38,400
1927	Mar.	19	19.28	23,900
		19	19.48	P 24,200
	Nov.	5	33.93	64,300
		5	35.4	P 70,300
	Dec.	9	18.82	23,100
1928	Apr.	9	30.74	51,500
	May	26	16.83	19,900
1929	Apr.	11	22.81	30,000
		30	20.20	25,400
	May	5-6	22.10	28,800
1930	Apr.	8	19.68	P 24,600
		9	18.98	23,400
		15	16.76	19,900
1931	Apr.	13	16.34	19,100
		14	16.73	P 19,700
1932	Apr.	9	17.96	21,800
		13	24.10	32,600
		13	24.40	33,200
	Nov.	20		20,600
1933	Apr.	8	18.72	22,900
		20	30.07	49,100
		20	30.30	P 49,900
	May	5	23.43	31,200

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Connecticut River at White River Junction, Vt.

Location.- At railroad bridge at White River Junction, Windsor County, just below mouth of White River and about 1 mile above Mascoma River.

Drainage area.- 4,068 square miles.

Records available.- November 1902 to September 1933. Records for 1902-11 only for flood season November to April.

Sources of data.- Gage-height records by U. S. Weather Bureau November 1902 to April 1911, and by Weather Bureau in cooperation with New England Power Co. November 1911 to November 1930. Discharge records by U. S. Geological Survey.

Gage.- Nonrecording gage read to tenths once daily Nov. 1, 1902, to Nov. 27, 1919; to tenths twice daily Nov. 28, 1919, to Nov. 3, 1930; recording gage thereafter. Zero of gage is 321.59 feet above mean sea level.

Stage-discharge relation.- Affected by ice. Control practically permanent; flood in 1927 caused only known shift. Banks not subject to overflow.

Storage and regulation.- Storage in Connecticut Lakes (capacity, 88,200 acre-feet); storage and regulation at Fifteenmile Falls Reservoir (capacity, 33,100 acre-feet) subsequent to August 1930.

Remarks.- Discharge records have been revised from previously published figures; those for 1901-11 are estimates.

Historical data.- Flood of Nov. 4, 1927, was largest and that of Mar. 27-28, 1913, was second largest since Oct. 3-4, 1869.

Flood stages and discharges
(Base discharge 30,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1902	Dec.	23	15.5		35,300
1903	Mar.	1	14.6		31,600
		12	19.3		52,100
		24	21.8		64,000
1904	Apr.	11	14.3		30,400
		30	14.8		32,400
1905	Mar.	26	14.5		31,200
		31	20.2		56,400
1906	Jan.	24	14.5		31,200
	Apr.	16	17.3		43,100
1907	Apr.	1	15.2		34,000
		27	19.2		51,300
	Nov.	7	14.5		31,200
	Dec.	12	14.5		31,200
1908	Feb.	16	14.8		32,400
	Mar.	29	15.0		33,200
	Apr.	30	17.0		41,800
1909	Apr.	8	19.8		54,600
		16	22.6		67,900
1910	Mar.	26	14.4		30,800
	Apr.	1-2	14.6		31,600
1911	Apr.	16	16.4		39,200
		30	16.0		37,400
1912	Apr.	8	23.0		69,800
		19	18.5		48,400
	June	1	16.4		39,200
1913	Mar.	23	16.2		38,300
		27	30.0	P	104,000
		28	26.0		84,500
1914	Apr.	21	22.5		67,400
		30	16.3		38,700
1915	Feb.	26	17.2		42,700
	Apr.	12	14.9		32,800
1916	Apr.	2	16.7		40,500
		24	14.6		31,600
1917	Apr.	4	14.7		32,000
		23	16.4		39,200
	June	13	14.3		30,400
		19	14.6		31,600
	Nov.	1	14.7		32,000
1918	Apr.	3	17.9		45,800
	Oct.	8	14.5		31,200
	Nov.	1	14.6		31,600
1919	Mar.	29	16.8		40,900
	Apr.	14	15.5		35,300
1920	Mar.	28	16.4		39,200
	Apr.	14	17.4		43,600
	Apr.	24	18.2		47,100
		24	18.4	P	48,000
		30	15.8		36,600
	Dec.	15	14.3		30,400
1921	Mar.	17	14.7		32,000
		22	16.3		38,700
		22	16.5		39,600
		29	15.5		35,300
1922	Mar.	29	17.5		44,000
	Apr.	12	26.1		85,000
		12	26.8	P	88,500
	June	30	14.8		32,400
1923	Apr.	9	17.4		43,600
		12	14.4		30,800
		24	17.0		41,800
	May	1	21.8		64,000
		1	22.0	P	65,000
1924	Apr.	20	15.5		35,300
	May	2	16.6		40,000
		2	16.8	P	40,900
	Sept.	13	15.9		37,000
1925	Feb.	12	16.7	*	36,100
	Mar.	29	21.4		62,100
		29	22.5	P	67,400
1926	Apr.	25	20.4		57,300
	May	5-6	18.8		49,700
1927	Mar.	20	15.2		34,000
		20	15.3	P	34,500
	Nov.	4	32.3		116,000
		4	35.0	P	131,000
	Dec.	9	16.0		32,500
1928	Apr.	10	21.8		57,200
1929	Apr.	10	16.35		34,100
		29-30	15.8		31,800
	May	6	16.6		34,900
		29	16.7	P	35,300
1930	Apr.	8	15.60		31,100
1931	Apr.	12	14.20	†	26,000
1932	Apr.	9	16.63		34,900
		12	20.60	P	51,900
		13	19.53		47,100
	Nov.	20	15.45		30,300
1933	Apr.	8	16.47		34,500
		19	23.87		67,200
		19	24.20	P	68,700
	May	5	16.75		35,700

* Estimated

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Hudson River at Mechanicville, N. Y.

Location.- At dam of West Virginia Pulp & Paper Co. in Mechanicville, Saratoga County.
Drainage area.- 4,500 square miles.
Records available.- October 1887 to September 1933.
Source of data.- West Virginia Pulp & Paper Co. (formerly the Duncan Co.).
Gages.- Nonrecording gage read twice daily prior to 1910; recording gage thereafter.
Stage-discharge relation.- Discharge computed from flow over spillway and through wheels. Control not permanent, owing to damage and removal of flashboards on dam. Crest of dam raised about 3 feet in 1904.
Storage, regulation, and diversions.- Storage of 109,000 acre-feet in Indian Lake Reservoir since 1898, 689,000 acre-feet in Sacandaga Reservoir since 1929, and undetermined storage in several other small reservoirs. Considerable regulation of flood flows since 1929. Diversions out of drainage area for navigation in Champlain Canal, about 100 second-feet from May to November inclusive prior to December 1915 and about 25 second-feet thereafter. Since Oct. 1, 1916, discharge records include diversions at dam but not diversions into Glen Falls feeder of canal.
Historical data.- A flood estimated at 70,000 second-feet occurred in April 1869.

Flood discharges
(Base discharge 25,000 second-feet)

Date			Discharge (second-feet)
1888	Apr.	2	27,100
		7	31,100
	May	2	45,600
		12	29,400
		15	30,700
	Dec.	18	27,300
1889	May	1	† 22,400
1890	May	7	25,100
	Sept.	18	26,000
1891	Feb.	26	31,100
	Mar.	26	27,700
	Apr.	20	33,200
1892	Jan.	4	29,000
		15	33,500
		19	26,500
	Apr.	7	43,900
	May	25	30,100
1893	Apr.	15	25,500
	May	6	54,100
	Aug.	30	26,400
1894	Mar.	24	26,600
1895	Apr.	10	49,600
		15	49,300
	Nov.	28	30,900
1896	Mar.	2	32,900
	Apr.	19	59,400
	Nov.	7	25,700
1897	Apr.	27	25,200
	June	11	27,200
	July	15	31,100
	Dec.	16	35,700
1898	Mar.	14	39,200
		21	35,900
1899	Apr.	17	31,100
		26	41,500
1900	Feb.	14	41,300
	Apr.	23	43,500
1901	Apr.	8	37,500
		19	26,500
		24	54,900
	Dec.	16	31,900
1902	Mar.	1	37,100
		3	41,400
		18	42,900
		31	29,500
	Apr.	11	26,900
1903	Mar.	1	28,900
		9	29,700
		13	45,400
		25	56,300
	Oct.	11	27,300
1904	Apr.	11	36,300
		30	29,100
1905	Apr.	1	48,900
		7	33,600
		12	25,200
1906	Apr	16	40,300
	May	29	27,800
1907	Apr.	1	36,700
		27	25,900
	Nov.	8	31,800
1908	Feb.	16	28,300
	Mar.	30	32,800
	Apr.	9-10	26,700
		28	34,300
	May	3	32,000
		9	25,600
1909	Feb.	20	27,600
		25	29,700
	Apr.	9	34,900
		16	46,300
	May	13	28,200
1910	Jan.	22	31,200
	Feb.	28	37,700
	Mar.	8	29,100
	Apr.	3	37,800
1911	May	3	26,200
1912	Mar.	16	28,900
	Apr.	8	47,300
		19	37,400
		24	31,300
	Oct.	24	27,600
		26	32,200
1913	Mar.	23	27,300
		28	114,000
		28	P 120,000
	Apr.	6	25,800
1914	Mar.	28	27,700
	Apr.	2	37,600
		9	42,300
		22	64,800
		30	35,800
	May	2	35,700
1915	Feb.	25	33,200
	Apr.	13	31,400
	July	9	25,400
1916	Jan.	28	25,700
	Apr.	2	35,800
		25-26	25,600
	May	19	27,000
1917	Mar.	28	31,800
	Apr.	4	35,500
		23	30,300
	June	13	36,300
1918	Apr.	3	35,500
		10	25,200
1919	Mar.	28	26,000
	Apr.	13	31,600
1920	Apr.	6	36,100
		14	29,900
		24	29,400
	Dec.	16	28,900
1921	Mar.	10	27,800
		17	29,200
		22	33,000
	Apr.	1	29,500
1922	Mar.	30	35,600
	Apr.	12	72,900
	June	24	26,700
1923	Apr.	9	43,700
		24	30,400
		30	32,700
	Dec.	1	28,200
1924	Apr.	8	33,300
		19	39,800
	May	2	33,400
		5	34,800
1925	Feb.	12	26,600
	Mar.	30	44,300
	Nov.	16	29,200
1926	Apr.	15	25,500
		26	51,800
	May	4	31,000
1927	Mar.	21	35,600
	Nov.	4	70,000
	Dec.	3	25,900
		8	34,700
1928	Apr.	9	46,600
1929	Mar.	17	35,700
		25	40,200
	Apr.	9	30,800
		21	28,000
		26	31,600
	May	4	26,700
1930	Apr.	8	† 23,600
1931	July	22	† 24,300
1932	Apr.	12	27,700
	Nov.	20	35,000
1933	Apr.	19	46,700

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Passaic River at Paterson, N. J.

Location.- At hydroelectric power plant of The Society for Establishing Useful Manufactures in Paterson, Passaic County.
Drainage area.- 785 square miles.
Records available.- August 1897 to September 1933.
Source of data.- Base data furnished by John H. Cook, Governor, The Society for Establishing Useful Manufactures.
Gages.- To determine flow over spillway only, nonrecording gage read three times daily prior to Jan. 7, 1933; recording gage thereafter.
Stage-discharge relation.- Discharge represents total actual flow just above Great Falls; determined from flow over spillway and through turbines.
Storage, regulation, and diversions.- Storage in Wanaque, Newark, and Jersey City Reservoirs and Greenwood Lake. Diversions for municipal uses above station.

Flood discharges
(Base discharge 3,370 second-feet)

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1897 Aug. 25	3,380	Apr. 16	5,180	1917 Mar. 12	3,370
Dec. 16	5,600	1907 Jan. 1	3,700	17	3,460
1898 Jan. 24	5,640	Mar. 19	8,100	28	4,530
Feb. 22	9,500	Sept. 24	3,430	Apr. 7	3,420
May 10	5,610	Oct. 30	7,960	1918 Feb. 22	5,640
18	5,010	Nov. 4	6,230	28	6,490
27	3,600	8	9,190	1919 Mar. 2	3,910
Nov. 20	3,700	26	3,800	10	4,290
Dec. 6	5,300	Dec. 11	5,140	29	4,010
24	3,400	25	6,320	July 24	8,630
1899 Jan. 27	3,590	1908 Jan. 8	3,950	1920 Mar. 9	5,110
Feb. 28	6,440	14	7,160	18	11,600
Mar. 6	7,830	Feb. 17	7,460	Apr. 6	4,660
24	7,060	27	6,120	Oct. 2	4,570
30	5,940	Mar. 15	3,780	Dec. 6	3,730
Apr. 9	4,600	20	5,120	15	4,510
1900 Jan. 21	3,560	May 1	3,430	1921 Jan. 15	3,960
Feb. 14	9,430	9	7,020	Mar. 4	6,240
23	6,070	23	4,330	10	4,760
Mar. 3	8,420	31	4,020	1922 Mar. 9	6,560
May 20	3,890	1909 Feb. 21	4,960	21	3,660
1901 Mar. 12	5,150	25	6,490	Apr. 2	3,490
22	6,400	Mar. 26	5,110	May 20	4,800
Apr. 8	5,780	Apr. 16	6,150	1923 Jan. 2	4,060
23	9,270	22	4,550	Mar. 18	7,680
May 11	4,060	May 2	5,230	Dec. 7	3,540
Aug. 26	8,530	1910 Jan. 24	5,720	1924 Jan. 18	4,400
Dec. 16	5,260	Feb. 22	4,490	Apr. 8	10,800
31	10,500	Mar. 2	8,300	19	4,180
1902 Jan. 23	7,840	Apr. 19	4,450	May 14	6,590
Mar. 2	21,400	27	8,980	1925 Feb. 16	6,040
11	7,540	1911 Apr. 6	3,370	Mar. 2	5,620
14	7,240	Oct. 23	4,030	Nov. 14	3,410
Apr. 10	5,890	1912 Feb. 27	3,740	Dec. 5	3,950
Oct. 2	6,000	Mar. 16-17	10,400	1926 Feb. 26	5,520
6	6,040	25	4,640	Mar. 8	4,450
13	6,050	30	6,010	Nov. 17	3,710
29	5,020	May 9	3,370	1927 Feb. 27	3,640
Dec. 18	8,300	1913 Jan. 4	5,620	Aug. 15	3,440
23	11,000	Mar. 17	5,250	30	4,060
1903 Jan. 4	3,890	21	5,010	Sept. 3	8,710
22	3,490	29	7,450	Oct. 21	5,960
Feb. 5	3,960	Apr. 17	5,840	Nov. 5	5,740
13	3,740	Oct. 26	4,460	18	4,800
Mar. 2	7,660	Nov. 10	3,530	20	4,700
11	4,190	1914 Feb. 1	4,130	Dec. 9	5,130
25	7,260	Mar. 18	3,430	1928 Feb. 16	4,100
31	3,420	29	7,980	24	4,210
Apr. 17	8,760	Apr. 9	3,410	Apr. 30	4,400
June 24	3,440	27	3,560	Aug. 28	4,370
30	3,620	1915 Jan. 14	7,800	1929 Mar. 7	5,120
Oct. 10	28,000	19	6,910	Apr. 17	4,310
Dec. 22	4,880	Feb. 2	5,300	29	4,440
1904 Feb. 24-25	3,960	7	5,650	1930 Mar. 9	3,610
Mar. 9	9,090	16	3,710	1931 June 18	3,950
Apr. 2	4,010	26	5,470	1932 Mar. 29	3,810
Sept. 15	5,160	Apr. 13	3,520	Apr. 2	4,650
Oct. 22	4,040	Aug. 5	4,920	Nov. 12	4,990
1905 Jan. 9	8,000	9	4,570	21	8,200
Mar. 22	8,760	Dec. 28	4,280	21	P 8,480
1906 Mar. 5	6,110	1916 Feb. 27	5,700	1933 Mar. 23	5,050
31	4,180	Apr. 1	6,130	Apr. 7	3,480
Apr. 11	5,810	15	4,220	19	7,170
				Aug. 25	6,620
				Sept. 18	7,950

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Delaware River at Port Jervis, N. Y.

Location.- At or near highway bridge at Port Jervis, Orange County, 1½ miles above mouth of Neversink River.
Drainage area.- 3,076 square miles.
Records available.- October 1904 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read once or twice daily prior to Aug. 14, 1928; recording gage thereafter. Zero of present gage is 415.605 feet above mean sea level.
Stage-discharge relation.- Control shifts occasionally. Bank-full stage, about 18 feet.
Storage and regulation.- Storage of 216,000 acre-feet in Wallenpaupack Reservoir since 1925, 26,000 acre-feet in Toronto Reservoir since 1926, 37,000 acre-feet in Swinging Bridge Reservoir since 1930, and an undetermined amount in several other small reservoirs. Some regulation of flood flows.
Historical data.- Greatest known flood Oct. 10, 1903, stage 23.1 feet (discharge, about 155,000 second-feet). A stage of 25.5 feet occurred on Mar. 8, 1904, due to an ice gorge.

Flood stages and discharges
(Base discharge 26,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1904	Oct.	22	10.7		44,200
1905	Jan.	8	9.5		35,600
	Mar.	20	10.7		44,200
		26	11.6		50,900
	Dec.	4	10.3		41,300
1906	Mar.	5	9.3		34,200
	Apr.	11	9.0		32,100
		16	11.4		49,400
1907	Jan.	1	9.0		32,100
	Mar.	24	8.9		31,400
	Nov.	8	10.7		44,200
	Dec.	11	13.1		62,500
		25	8.4		28,100
1908	Feb.	16	13.5		65,700
	Mar.	15	9.5		35,600
		25	8.6		29,400
		29	10.8		44,900
	May	8	8.1		26,200
1909	Jan.	7	10.0		42,800
	Feb.	17	8.4		30,500
		21	11.7		56,600
		25	9.3		37,300
	Apr.	16	8.4		30,500
	May	2	8.5		31,200
1910	Jan.	23	10.9		50,100
	Mar.	1	13.0		67,300
		8	9.0		35,000
	Apr.	27	9.3		37,300
1911	Jan.	4	8.0		27,500
	Mar.	28	10.7		48,400
	Apr.	8	8.5		31,200
	June	14	8.4		30,500
1912	Mar.	16	10.2		44,400
		30	10.6		47,600
	Apr.	3	10.2		44,400
		17	7.8		26,000
		19	8.2		29,000
1913	Jan.	4	8.0		27,500
		9	11.0		50,900
	Mar.	15	8.0		27,500
		28	15.0		84,000
		28	15.5	P	88,400
	Nov.	10	9.7		40,400
1914	Mar.	28	16.0		92,700
	Apr.	3	9.3		37,300
		9	11.0		50,900
		21	9.1		35,800
1915	Jan.	8	8.6		32,000
		8	9.1	P	35,800
		20	9.4		38,100
		20	9.88	P	41,800
	Feb.	16	9.1		35,800
		16	9.20	P	36,500
		25	9.8		41,200
		25	10.3	P	45,200
	Apr.	12	7.9		26,800
		12	8.00		27,500
	July	9	8.8		33,500
		9	9.40		38,100
1916	Jan.	23	8.00		27,500
		28	8.10		28,200
		28	8.10	P	28,200
	Feb.	26	11.0	P	50,900
		27	8.10		28,200
	Apr.	1	12.0	P	59,100
		2	11.6		55,800
		15	8.70		32,700
		15	8.70	P	32,700
1917	Jan.	15	9.2		36,500
	Mar.	15	8.3		29,700
		25	10.3		45,200
		28	11.3		53,400
	Apr.	2	8.0		27,500
	June	12	8.7		32,700
	Oct.	31	12.3		61,600
1918	Feb.	21	9.0		35,000
		27	9.0		35,000
	Mar.	2	8.1		28,200
1919	Mar.	10	7.0	†	20,500
1920	Mar.	13	11.0		50,900
		13	14.0	P	75,500
		18	8.6		32,000
		13	8.8	P	33,500
		27	10.4		46,000
		27	10.5	P	46,800
	July	25	8.3		29,700
		25	8.4	P	30,500
	Oct.	2	8.6		32,000
		2	8.9	P	34,200
	Nov.	24	8.4		30,500
		24	8.5	P	31,200
	Dec.	2	9.0		35,000
		2	9.0	P	35,000
		15	8.7		32,700
		15	8.9	P	34,200
1921	Mar.	4	9.4		38,100
		4	9.5	P	38,900
		10	11.9		58,300
		10	12.3	P	61,600
	Nov.	29	13.0		67,300
		29	13.1	P	68,100
1922	Feb.	24	9.7		40,400
		24	12.0	P	59,100
	Mar.	8	11.2		52,500
		8	12.0	P	59,100
		29	8.2		29,000
		29	8.3	P	29,700
	June	4	8.6		32,000
		4	8.8	P	33,500
1923	Mar.	18	9.83	*	32,000
		24	11.0		51,500
		24	11.8	P	57,900
	Apr.	6	10.6		48,300
		6	10.8	P	49,900

* Estimated
† Below base

Flood stages and discharges of Delaware River at Port Jervis, N. Y.--Continued

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1924 Jan. 12	10.7	49,100	Nov. 18	11.7	P 57,100
12	10.8	P 49,900	Dec. 9		44,500
Apr. 7	12.1	59,900	14	8.3	30,400
7	12.42	P 62,500	14	8.3	P 30,400
Oct. 1	13.8	73,900	1928 Apr. 24	8.7	33,200
1	14.7	P 81,400	24	8.7	P 33,200
1925 Feb. 12	14.7	80,000	30	8.3	30,400
12	14.9	P 83,100	30	8.3	P 30,400
Nov. 17		29,700	June 7		32,900
17	8.8	P 33,900	7	9.4	P 38,700
1926 Apr. 10		38,000	30		43,800
10	9.4	P 38,700	30	11.8	P 57,900
Nov. 17		58,200	1929 Mar. 15	11.5	56,500
17	13.8	P 73,900	15	11.9	P 59,700
1927 Mar. 15		46,800	Apr. 13		31,300
15	10.85	P 50,300	22	10.0	44,500
17		34,100	27		26,000
17	9.15	P 36,700	1930 Mar. 9		26,600
22		33,200	9	8.05	29,400
22	9.00	P 35,500	1931 Mar. 30		32,100
May 25	8.5	P 31,800	30	8.82	P 35,100
26	8.3	30,400	1932 Apr. 1	9.97	P 44,300
Sept. 2	8.65	P 32,800	2		35,000
3	7.7	26,200	Oct. 7		52,200
Oct. 20		56,900	Nov. 20	8.4	31,900
20	13.1	68,300	1933 Apr. 18		29,700
Nov. 5		36,800	Aug. 25		70,100
5	9.5	P 39,500	25	15.03	85,600
18		43,800	Sept. 17		26,900

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Perkiomen Creek at Frederick, Pa.

Location.- At Frederick (Spring Mount), Montgomery County, 12 miles above mouth.
Drainage area.- 152 square miles.
Records available.- August 1884 to December 1913.
Source of data.- Discharge records furnished by Philadelphia Bureau of Water.
Gage.- Recording.
Stage-discharge relation.- Rating curve well defined.

Flood discharges
(Base discharge 2,000 second-feet)

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1884 Dec. 7	3,420	Nov. 9	5,390	Mar. 29	2,520
15	2,410	19	2,270	Oct. 13	2,710
1885 Jan. 6	2,600	28	2,800	Nov. 5	2,440
Feb. 10	2,110	1890 Feb. 9	7,050	1897 Feb. 7	4,080
Apr. 4	3,190	Mar. 22	4,050	May 2	2,580
Dec. 14	2,550	May 27	2,510	13	4,750
1886 Jan. 5	3,040	1891 Jan. 12	3,430	Nov. 2	3,090
Feb. 11	4,390	22	3,940	Dec. 15	2,560
13	4,400	Mar. 21	4,800	1898 Jan. 23	2,760
Apr. 6	4,020	Sept. 5	2,370	Feb. 20	5,550
May 8	3,090	1892 Jan. 14	3,770	May 8	3,490
1887 Jan. 24	4,100	Mar. 1	2,070	Nov. 19	3,810
Feb. 18	2,370	Nov. 16	2,840	Dec. 5	3,410
1888 Jan. 1	4,300	1893 Feb. 10	3,250	1899 Jan. 25	2,690
Feb. 21	3,280	Mar. 10	3,550	Feb. 27	4,040
25	2,460	12	3,400	Mar. 5	3,520
Mar. 21	3,540	May 4	5,140	19	2,420
Apr. 6	2,750	1894 May 21	8,770	Sept. 26	3,360
Aug. 22	3,340	24	3,540	1900 Jan. 12	2,070
Sept. 18	5,300	28	2,440	20	2,340
21	2,800	Sept. 19	2,490	Feb. 5	3,610
Dec. 17	4,790	Oct. 10	2,340	13	3,110
1889 Mar. 4	4,240	Dec. 12	4,130	22	2,500
June 1	2,190	1895 Jan. 11	2,370	1901 Mar. 11	4,720
July 15	4,020	26	2,210	21	2,000
31	5,570	Apr. 9	4,200	Apr. 25	2,240
Sept. 17	3,130	1896 Feb. 6	6,790	Dec. 15	2,750
Oct. 27	3,360	Mar. 20	[illegible],150	29	6,020

Flood discharges of Perkiomen Creek at Frederick, Pa.--Continued

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1902 Jan. 22	5,260	Mar. 19	2,490	Feb. 24	3,370
Feb. 26	6,040	21	3,020	Dec. 14	3,180
28	6,840	Aug. 16	3,240	1910 Jan. 22	4,590
Mar. 10	2,840	Nov. 29	3,160	Feb. 22	3,450
Oct. 12	2,350	1906 Feb. 22	2,160	Mar. 1	2,500
Dec. 16	4,200	Mar. 4	4,050	1911 Aug. 31	2,090
22	5,010	28	2,000	Oct. 18	2,050
1903 Jan. 3	3,840	Apr. 10	3,030	Nov. 18	2,130
21	2,020	15	2,530	1912 Feb. 22	3,660
Feb. 4	2,520	June 19	2,200	27	2,820
28	6,180	Dec. 31	3,360	Mar. 13	4,670
Mar. 23	2,780	1907 Mar. 14	3,450	15	5,200
Apr. 15	2,130	Sept. 23	4,020	24	2,120
July 18	2,060	29	4,850	Sept. 25	3,780
Oct. 9	4,240	Nov. 7	3,110	Dec. 30	3,070
Dec. 20	2,810	Dec. 10	2,650	1913 Jan. 3	2,630
1904 Jan. 23	4,460	23	2,820	Mar. 14	2,720
Feb. 22	3,820	1908 Jan. 12	2,250	27	4,950
Mar. 7	3,580	Feb. 15	5,570	Apr. 12	2,980
June 7	2,580	26	3,790	16	2,850
Sept. 15	5,460	Mar. 19	2,260	28	2,900
Oct. 21	3,820	1909 Jan. 6	2,030	Dec. 26	2,430
1905 Jan. 7	5,710				

Note.- All discharge quantities are average daily flows.

Susquehanna River at Towanda, Pa.

Location.- At highway bridge at Towanda, Bradford County.
Drainage area.- 7,797 square miles.
Records available.- December 1892 to September 1933.
Sources of data.- Gage-height records from U. S. Weather Bureau prior to Jan. 28, 1914. Discharge records for same period and all gage-height and discharge records thereafter from the Pennsylvania Department of Forests and Waters; collaboration by U. S. Geological Survey 1918-20, 1931-33.
Gage.- Nonrecording gage read to tenths once daily prior to Jan. 28, 1914, to half tenths twice daily thereafter (read oftener during high stages). Zero of gage is 693.85 feet above mean sea level.
Stage-discharge relation.- Practically permanent except as affected by ice. Bank-full stage, about 26 feet.
Historical data.- Maximum known stage, about 25.0 feet Mar. 17, 1865 (discharge not determined).

Flood stages and discharges
(Base discharge 53,500 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1893 Mar. 10	11.6	66,000	1902 Mar. 2	23.0	* 220,000
Apr. 9	10.7	58,900	2	24.5	P* 240,000
May 5	15.0	97,300	14	12.0	69,200
1894 Mar. 8	11.7	66,800	18	12.3	71,700
Apr. 24	10.2	55,000	July 7	10.3	55,800
....	....	......	22	10.9	60,400
1895 Apr. 10	14.5	92,100	Dec. 23	11.5	65,200
1896 Jan. 1	10.0	53,500	1903 Jan. 31	10.8	59,600
Mar. 2	11.0	61,200	Feb. 5	13.5	82,200
Mar. 31-Apr.1	15.0	97,300	Mar. 1	14.4	91,000
....	....	......	12	12.6	74,200
1897 Mar. 25	11.3	63,600	24	14.8	95,200
1898 Mar. 14	10.6	58,100	24	15.5	P 103,000
Apr. 25-26	12.0	69,200	Aug. 30	14.5	92,100
....	....	......	30	15.2	P 99,500
1899 Mar. 6	10.5	57,300	Oct. 11	15.2	99,500
....	....	......	1904 Feb. 8	11.8	67,600
1900 Feb. 23	11.0	61,200	Mar. 8	12.5	73,400
....	....	......	27	17.0	122,000
1901 Mar. 28	14.5	92,100	1905 Mar. 20	11.8	67,600
Apr. 8	11.5	65,200	26	15.0	97,300
22	13.3	80,300	Dec. 4	10.5	57,300
....	....	......	1906 Mar. 31	10.2	55,000
			1907 Apr. 27	9.4	† 49,000

* Estimated
† Below base

Flood stages and discharges of Susquehanna River at Towanda, Pa.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1907	Dec.	11	11.2	62,800
		11	11.8	P 67,600
		25	11.2	62,800
1908	Feb.	16	14.5	92,100
	Mar.	16	13.8	85,000
		30	12.8	75,900
1909	Feb.	21	11.8	67,600
		21	12.0	P 69,200
		25	11.6	66,000
	Apr.	15	10.8	59,600
	May	2	13.4	81,200
1910	Jan.	23	10.8	59,600
		23	13.0	P 77,600
	Mar.	3	18.4	P 142,000
		3	18.2	139,000
		8	13.0	77,600
	Apr.	25	14.0	87,000
1911	Mar.	28-29	12.5	73,400
	Apr.	8	11.3	63,600
1912	Feb.	27	12.0	69,200
	Mar.	18	11.7	66,800
		30	15.7	105,000
		30	16.0	P 109,000
	Apr.	3	15.0	97,300
		8	11.5	65,200
1913	Jan.	4	10.5	57,300
		9	14.0	87,000
	Mar.	28	20.0	167,000
	Apr.	29	10.0	53,500
		29	10.2	P 55,000
1914	Feb.	1	10.00	53,500
	Mar.	29	20.20	P 170,000
		29	19.90	165,000
	Apr.	9	14.00	87,000
		21	10.77	59,600
	May	13	13.90	86,000
		13	14.80	P 95,200
1915	Jan.	8	13.35	81,200
		8	13.80	P 85,000
		20	10.58	58,100
	Feb.	16	12.66	75,100
		25	16.90	120,000
		25	17.44	P 127,000
	July	9	17.12	123,000
		9	17.45	P 127,000
1916	Apr.	2	18.0	136,000
		15	12.3	71,700
		23	10.6	58,100
	June	18	11.5	65,200
		18	12.4	P 72,600
1917	Mar.	28	12.0	69,200
		28	12.3	P 71,700
	Oct.	31	11.9	68,400
1918	Feb.	21	11.3	63,600
		27	10.4	56,500
	Mar.	1	13.2	79,400
		15	15.8	106,000
		15	16.9	P 120,000
	Apr.	16	11.5	65,200
1919	May	11	10.81	59,600
	May	23	12.13	70,000
		23	12.39	P 72,600
1920	Mar.	13	16.25	111,000
		13	17.2	P 124,000
		17	11.95	69,200
		27-28	12.30	71,700
	Dec.	3	10.06	54,300
1921	Mar.	10	11.86	68,400
		10	12.3	P 71,700
	Nov.	29	14.91	96,200
		29	15.6	P 104,000
1922	Feb.	24	11.71	66,800
	Mar.	8	12.47	73,400
1923	Mar.	4	13.4	P 81,200
		5	11.55	66,000
		17	9.98	53,500
		24	11.22	62,800
	Apr.	6	11.55	66,000
1924	Jan.	12	10.88	60,400
	Apr.	7	16.55	116,000
		7	17.8	P 133,000
		19	10.15	55,000
	May	13	10.70	58,900
	Oct.	1	16.12	110,000
1925	Feb.	12	17.68	131,000
		12	18.70	P 146,000
		24	10.48	57,300
1926	Mar.	26	12.90	76,800
	Apr.	9	12.83	75,900
		9	13.6	P 83,100
	Nov.	17	15.70	105,000
		17	16.6	P 116,000
1927	Mar.	9	10.00	53,500
		15	14.40	91,000
		22	12.25	70,900
	May	25	13.85	85,000
	Oct.	20	17.02	122,000
		20	17.30	P 126,000
	Nov.	18	11.95	69,200
		29	11.25	62,800
	Dec.	2	10.58	58,100
		9	10.32	55,800
1928	Mar.	27	11.30	63,600
	May	1	12.90	76,800
1929	Mar.	16	16.40	114,000
	Apr.	17	10.25	55,000
		22	19.18	154,000
		22	19.90	P 165,000
	May	4	10.02	53,500
1930	Feb.	26	10.56	54,400
	Mar.	8	12.1	P 65,100
		9	10.87	55,800
1931	Mar.	29	11.80	62,700
		29	12.4	P 67,500
1932	Apr.	1	14.76	P 88,000
		3	13.60	77,400
		12	10.84	55,100
1933	Mar.	22	10.68	54,400
	Aug.	25	12.9	P 71,500
		25	12.08	65,100

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: May 16, 1894, to Feb. 28, 1895; May 1 to Dec. 31, 1896; May 1 to Dec. 31, 1898; May 1, 1899, to Jan. 31, 1900; May 1, 1900, to Jan. 31, 1901; May 1, 1901, to Jan. 31, 1902.

Susquehanna River at Harrisburg, Pa.

<u>Location</u>.- Prior to July 18, 1904, at city waterworks pumping station, Harrisburg, Dauphin County; July 18, 1904, to Sept. 30, 1928, at Walnut Street Bridge about 2,100 feet downstream; thereafter at Nagle Street Bridge, about 4,200 feet downstream from Walnut Street Bridge.

<u>Drainage area</u>.- 24,100 square miles.

<u>Records available</u>.- October 1890 to September 1933.

<u>Sources of data</u>.- Fragmentary data 1786-1890 from Water Resources Inventory Report, Part VIII (1916), Water Supply Commission of Pennsylvania. Discharge records 1890-1929 from report of Stone & Webster Engineering Corporation; U. S. Geological Survey records thereafter. Gage-height records prior to July 18, 1904, by the Harrisburg Water Board; July 18, 1904, to July 15, 1906, by toll collector at Walnut Street Bridge; July 16, 1906, to Sept. 30, 1928, by U. S. Weather Bureau and Pennsylvania Department of Forests and Waters; thereafter by U. S. Geological Survey.

<u>Gages</u>.- Nonrecording gage read to nearest inch once daily prior to July 18, 1904. Walnut Street gage read to half-tenths once daily through November 1909; read to hundredths once daily through 1910 and twice or more daily thereafter. Recording gages used in conjunction with nonrecording gage October 1914 to June 1928. Recording gage at Nagle Street Bridge established June 15, 1928, and records used after Sept. 30, 1928. Gage at Walnut Street station still being read. Zero of gages is 289.40 feet above mean sea level.

<u>Stage-discharge relation</u>.- Practically permanent. Banks are high and not subject to overflow. Relation affected by ice during winter. Backwater from construction of low dam April 1914 to August 1916, which formed new control for all but extremely high flows.

<u>Regulation</u>.- Small diversion through Pennsylvania Canal prior to fall of 1901.

Flood stages and discharges
(Base discharge 154,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1786	Oct.	5	22	P	494,000
1833	May	15	18	P	357,000
1846	Mar.	15	22	P	494,000
		26	16	P	297,000
1847	Oct.	9	18	P	357,000
1853	Feb.	7	18	P	357,000
1865	Mar.	18	24.6	P	602,000
1868	Mar.	19	20.0	P	422,000
1874	Jan.	9	11.1	P	170,000
	Apr.	22	11.3	P	175,000
1875	Mar.	2	14.1	P	
		18	15.6	P	
	Apr.	4	18.0	P	
1876	Apr.	16	11.9	P	189,000
	June	19	12.3	P	199,000
1877	Mar.	11	13.1	P	219,000
		29	13.6	P	232,000
1878	Feb.	25	13.6	P	232,000
	Mar.	14-15	11.1	P	170,000
	Dec.	12	19.9	P	419,000
1879	Mar.	13	14.1	P	245,000
1880	Feb.	15	10.9	P	166,000
1881	Feb.	13	19.4	P	
	Mar.	21	12.6	P	206,000
	June	11	13.6	P	232,000
	Dec.	29	12.6	P	206,000
1882	Feb.	23	13.3	P	224,000
	Mar.	3	13.6	P	232,000
1883	June	28	12.6	P	206,000
1884	Feb.	8	15.6	P	286,000
		15	17.2	P	332,000
	Mar.	14	11.6	P	182,000
1885	Apr.	5	13.9	P	
1886	Jan.	6	19.0	P	389,000
	Feb.	13	20.8	P	
	Apr.	2	16.1	P	300,000
		8	16.1	P	300,000
	Nov.	20	11.6	P	182,000
1887	Jan.	26	11.1	P	170,000
	Feb.	13	12.6	P	206,000
1888	Feb.	24	11.3	P	175,000
	Mar.	23	11.5	P	179,000
		31	11.6	P	182,000
	Apr.	7	12.3	P	199,000
	Dec.	19	13.1	P	219,000
1889	June	2	26.8	P	707,000
	Nov.	21	15.1	P	272,000
1890	Mar.	24	11.3	P	175,000
	Apr.	10	11.3	P	175,000
	May	22	12.1	P	194,000
	Oct.	26	13.60		233,000
1891	Feb.	2-3	11.51		181,000
		19	19.01		387,000
		28	12.73		211,000
	Mar.	15	10.61		161,000
		26	10.71		163,000
1892	Jan.	16	12.70		210,000
	Mar.	29	12.83		213,000
	Apr.	5	14.47		256,000
	June	5	12.35		201,000
1893	Feb.	12	10.65		161,000
	Mar.	13	14.85		267,000
	Apr.	23	10.88		167,000
	May	5	16.32		308,000
1894	Mar.	9	11.86		189,000
	May	22	24.66		575,000
1895	Apr.	11	13.45		229,000
1896	Feb.	8	12.02		193,000
	Apr.	1	14.61		260,000
1897	Mar.	26	11.45		180,000
1898	Jan.	25	10.34		155,000
	Mar.	24	15.44		283,000
1899	Mar.	7	13.12		221,000
1900	Jan.	23	11.54		182,000
	Feb.	24	10.97		169,000
	Mar.	2	12.91		215,000
1901	Mar.	12	11.83		189,000
		29	12.57		207,000
	Apr.	9	12.53		206,000
		23	13.32		226,000
	May	31	13.71		236,000
	Dec.	16	20.89		445,000
1902	Mar.	3	22.94		449,000
		14	13.67		235,000
		18	14.72		263,000
	Apr.	10	14.51		257,000
	Dec.	23	12.62		173,000
1903	Feb.	6	14.19		210,000
	Mar.	2	16.33		266,000
		11	12.13		163,000
		25	15.09		233,000
	Apr.	16	12.81		177,000
1904	Jan.	24	14.73		263,000
	Mar.	8	20.84		298,000
		28	13.62		195,000
	Apr.	3	13.26		187,000
1905	Mar.	21	15.83		292,000
		26	14.00		241,000
	Dec.	5	11.84		186,000
1906	Apr.	1	10.83		163,000

Flood stages and discharges of Susquehanna River at Harrisburg, Pa.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1906	Apr.	16	10.90	164,000
1907	Mar.	16	12.79	210,000
		21	11.23	172,000
	Dec.	26	10.45	155,000
1908	Feb.	17	13.92	239,000
	Mar.	17	14.30	249,000
		20	15.67	288,000
		30	11.30	173,000
	May	9	10.95	166,000
1909	Feb.	26	12.44	201,000
	Apr.	16	10.96	166,000
	May	2	15.64	287,000
1910	Jan.	23	12.20	195,000
	Mar.	3	17.13	330,000
	Apr.	26	14.37	266,000
1911	Jan.	16	10.79	162,000
1912	Mar.	17	11.57	180,000
		31	13.66	232,000
	Apr.	4	13.86	238,000
1913	Jan.	10	12.76	209,000
	Mar.	28	18.72	378,000
1914	Feb.	2	12.29	197,000
	Mar.	30	17.69	347,000
	Apr.	10	10.99	166,000
	May	15	12.23	196,000
1915	Jan.	9	12.13	188,000
		21	11.33	168,000
	Feb.	17	12.71	202,000
		26	15.46	278,000
1916	Mar.	30	18.06	356,000
	Apr.	16	13.10	212,000
1917	Mar.	29	10.68	† 152,000
	Oct.	31	12.58	197,000
1918	Feb.	22	13.60	224,000
		27	12.86	204,000
	Mar.	3	11.35	167,000
		16	15.27	272,000
	Apr.	17	12.87	204,000
1919	May	23	15.12	268,000
1920	Mar.	14	19.58	404,000
		18	13.01	208,000
		28	11.16	163,000
1921	Mar.	11	11.44	169,000
	Nov.	30	15.18	269,000
1922	Mar.	9	12.20	187,000
1923	Mar.	6	14.29	244,000
1924	Jan.	18	10.80	155,000
	Mar.	31	11.28	165,000
	Apr.	8	16.68	314,000
	May	14	13.94	234,000
	Oct.	1	13.36	218,000
1925	Feb.	13	18.30	363,000
1926	Mar.	27	11.17	164,000
	Nov.	17	15.63	282,000
1927	Jan.	24	11.80	161,000
	Mar.	10	11.31	166,000
		16	12.20	188,000
		23	12.66	200,000
	May	27	11.80	178,000
	Oct.	21	14.40	247,000
	Dec.	18	10.80	154,000
1928	May	2	14.38	247,000
	June	8	11.11	161,000
	July	1	10.93	158,000
1929	Mar.	17	12.47	233,000
	Apr.	18	10.96	196,000
		23		222,000
	May	4		172,000
1930	Feb.	28		166,000
1931	Mar.	31		† 145,000
1932	Apr.	2	12.80	240,000
1933	Mar.	17		161,000
		22	9.82	167,000
	Apr.	20	9.35	158,000
	Aug.	25		249,000

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Chemung River at Chemung, N. Y.

Location.- At or near highway bridge three-quarters of a mile southwest of Chemung, Chemung County, and about half a mile above New York-Pennsylvania State line.

Drainage area.- 2,530 square miles.

Records available.- September 1903 to September 1933.

Source of data.- U. S. Geological Survey.

Gages.- Nonrecording gage read to hundredths twice daily prior to Jan. 10, 1930; recording gage thereafter.

Stage-discharge relation.- Low water affected by ice and by aquatic growth. Control fairly permanent.

Historical data.- Maximum known flood occurred June 1, 1889, estimated discharge, 138,000 second-feet at Elmira.

Flood stages and discharges
(Base discharge 20,000 second-feet)

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1904	Jan.	23	10.95	23,800	12.3	30,200
	Feb.	8	16.30	53,800	17.6	63,200
	Mar.	8	15.97	51,500	16.07	52,200
		24	11.40	25,800	12.70	32,200
		26	13.20	34,800	13.40	35,900
1905	Mar.	20	14.1	39,800	14.7	43,400
		25	13.20	34,800	13.3	35,400
	June	22	10.55	22,000	12.0	28,700
1906	Mar.	28	11.94	28,400	12.72	32,300
		31	11.09	24,400	11.46	26,100

Flood stages and discharges of Chemung River at Chemung, N. Y.--Continued

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1907	Apr.	27	10.14	20,300	10.71	22,700
	Dec.	24	12.12	29,300	12.35	30,400
1908	Feb.	16	14.75	42,900	14.98	45,100
	Mar.	14	13.38	35,300	13.48	36,300
		16	12.69	32,000	13.05	34,000
		29	10.31	21,000	10.44	21,500
1909	Feb.	25	11.01	24,000	11.85	28,000
	Apr.	15	10.73	22,800	12.11	29,200
	May	1	15.39	46,200	15.72	49,900
1910	Jan.	22	11.62	26,900	11.62	26,900
	Mar.	1	14.62	42,400	15.15	46,200
		7	11.92	28,300	12.37	30,500
	Apr.	25	16.56	52,100	16.76	57,000
1911	Jan.	15	8.7	† 14,200		
1912	Mar.	16	12.7	31,500	13.35	34,800
		18	10.2	20,000	10.68	21,900
		30	14.9	42,500	15.98	47,900
	Apr.	2	11.6	26,000	12.34	29,700
		6	10.2	20,000	10.59	21,600
1913	Jan.	4	11.1	23,800	11.73	26,600
		9	10.2	20,000	11.70	26,500
	Mar.	27	16.2	49,000	16.7	51,500
	Apr.	29	13.9	37,500	14.47	40,400
	Nov.	10	10.6	21,600	10.98	23,300
1914	Jan.	30	11.8	27,000	12.5	30,500
	Mar.	28	16.0	48,000	17.0	53,000
	Apr.	2	10.2	20,600	11.04	24,000
		9	11.6	26,200	13.15	32,400
	May	6	11.4	25,400	13.02	31,900
		13	15.1	41,000	16.30	46,400
1915	Jan.	8	12.7	30,600	15.0	40,600
	Feb.	16	12.6	30,200	13.5	33,800
		25	15.8	44,200	16.42	47,000
	July	9	12.7	30,600	13.97	36,000
1916	Jan.	3	10.5	21,800	11.35	25,200
		6	11.1	24,200	11.55	26,000
	Mar.	29	15.3	51.400	16.23	54,400
		31	15.5	49,400	15.68	50,600
	Apr.	15	12.2	30,000	15.3	48,100
		23	12.3	30,500	13.5	37,000
	June	18	14.5	42,900	18.2	68,900
1917	Mar.	12	10.8	23,400	11.7	27,600
	Oct.	25	11.0	24,300	11.36	26,000
1918	Mar.	1	11.3	25,700	12.90	33,700
		15	16.3	54,900	17.96	67,000
	Apr.	16	12.8	33,100	13.32	36,000
1919	May	11	11.8	28,000	12.7	32,600
		23	16.1	53,500	17.0	59,900
1920	Mar.	13	17.0	59,900	17.18	61,200
		17	11.8	28,000	11.9	28,500
1921	Feb.	17	11.6	26,600	11.6	26,600
	Nov.	28	11.0	23,800	11.97	28,300
1922	Mar.	8	11.1	24,800	12.36	30,800
1923	Mar.	5	13.1	34,800	13.65	37,900
	Apr.	6	10.2	20,800	10.76	23,200
1924	Apr.	7	14.8	44,800	15.55	49,700
		19	11.4	26,100	12.45	31,200
	May	13	12.2	30,000	13.66	37,900
	Oct.	1		26,300	14.5	42,900
1925	Feb.	12		43,300	15.6	50,100
1926	Mar.	26	11.1	24,800	12.1	29,500
	Apr.	9		24,300	11.95	28,800
	Nov.	17		33,200	14.1	40,500
1927	Mar.	14	10.0	20,000	10.25	21,000
		22		23,800	12.2	30,000
	May	25		23,600	12.2	30,000
	Oct.	20		25,100	11.8	28,400
	Nov.	4		22,900	11.9	29,000
		18		41,000	15.7	47,800
		28		21,700	11.0	24,600
	Dec.	2		33,800	15.6	49,600
		17		21,300	11.4	26,500
1928	May	1		32,900	13.8	39,400
	June	6		21,200	10.8	23,700
1929	Mar.	15	12.8	33,900	12.9	34,400
	Apr.	21		49,700	17.2	58,000
1930	Feb.	26		23,300	11.7	26,300
1931	Mar.	29		† 18,600		
1932	Feb.	12		20,300	11.50	25,300
	Apr.	1		* 35,500	14.13	* 39,400

* Estimated
† Below base

Flood stages and discharges of Chemung River at Chemung, N. Y.--Continued

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1932	Apr.	3		21,700	11.08	23,400
	May	9		20,900	11.13	23,600
		12		24,700	12.45	30,200
1933	Aug.	24		23,500	13.03	33,400

West Branch of Susquehanna River at Williamsport, Pa.

Location.- At Market Street Bridge, Williamsport, Lycoming County.
Drainage area.- 5,682 square miles.
Records available.- March 1895 to September 1933.
Sources of data.- Gage-height records by U. S. Weather Bureau and discharge records by U. S. Geological Survey prior to August 1913. Records by Pennsylvania Department of Forests and Waters August 1913 to September 1933; collaboration by U. S. Geological Survey 1918-21 and 1931-33.
Gage.- Nonrecording gage read once daily prior to Aug. 24, 1913; twice daily Aug. 24, 1913, to Oct. 1, 1928 (read oftener during high water); recording gage thereafter. Zero of gages is 494.55 feet above mean sea level.
Stage-discharge relation.- Probably permanent except as affected by ice. Rating curve well defined to 120,000 second-feet. Bank-full stage, about 24 feet.
Historical data.- Fragmentary data 1846-94 taken from Water Resources Inventory Report, Part VIII (1916), Water Supply Commission of Pennsylvania, except flood discharges for Mar. 17, 1865, June 1, 1889, and May 21, 1894, which are revisions made by Corps of Engineers, U. S. Army.

Flood stages and discharges
(Base discharge 45,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1846	Mar.	13	24	P	178,000
1847	Oct.	9	20	P	130,000
1851	July	16	22	P	152,000
1861	Sept.	28	24	P	178,000
1865	Mar.	17	26	P	212,000
1886	Jan.	16	23	P	164,000
1889	June	1	32.4	P	318,000
1891	Feb.	18	22.0	P	152,000
1894	May	21	30.0	P	276,000
1895	Apr.	10	12.0		52,300
1896	Mar.	31	13.9		68,000
1897	Mar.	25	11.3		47,200
1898	Mar.	24	21.0		142,000
1899	Mar.	6	13.1		61,000
1900	Jan.	21-22	13.0		60,200
	Nov.	27	17.0		98,000
1901	Mar.	28	11.2		46,600
	Apr.	8	11.5		48,600
		22	15.2		80,000
	May	30	14.0		68,900
	Dec.	15	20.17		133,000
1902	Mar.	2	21.10		144,000
		14	12.2		53,900
		17	13.8		67,100
	Apr.	10	16.6		93,900
1903	Jan.	31	11.0		45,200
	Feb.	4	16.0	P	87,900
		5	15.5		82,900
	Mar.	1	17.07		98,700
		9	13.2	P	61,900
		9-10	12.7		57,800
		24	13.3		62,700
	Apr.	16	11.7		50,100
	Nov.	18	12.0		52,300
1904	Jan.	24	13.3		62,700
	Mar.	4	19.0		119,000
		8	17.4		102,000
		24	9.9		68,900
		24	18.00	P	108,000
		27	12.6		57,000
	Apr.	2	16.8		96,000
1905	Mar.	20	18.4		113,000
		26	11.7		50,100
	Dec.	4	16.8		96,000
1906	Jan.	24	11.4		47,900
1907	Jan.	21	11.0		45,200
	Mar.	15	16.7		94,900
		21	12.3		54,600
		24	11.1		45,900
1908	Feb.	16	17.0		98,000
	Mar.	16	15.8		85,900
		20	17.4		102,000
		30	12.4		55,400
1909	Feb.	17	12.0		52,300
		25	14.5		73,400
	Apr.	15	12.3		54,600
		15	12.8	P	58,600
	May	1	21.0		142,000
1910	Jan.	22	12.14		53,400
		22	12.5	P	56,200
	Mar.	1	16.2		89,900
		1	16.4	P	91,900
		8	13.7		66,200
	Apr.	26	17.1		99,000
		26	17.3	P	101,000
1911	Jan.	16	15.5		82,900
	Sept.	10	11.13		46,100
	Oct.	3	15.92		87,100
1912	Mar.	16	13.95		68,600
		16	18.40	P	113,000
		31	16.00		88,400
	Apr.	3	17.40		103,000
	May	18	10.95		45,100
1913	Jan.	9	17.20		101,000
		9	17.37	P	102,000
	Mar.	27	20.40	P	135,000
		28	18.90		119,000
	Apr.	29	11.40		48,000
	May	29	12.40		55,400
1914	Feb.	1	11.89		51,600
		1	13.25	P	62,400
	Mar.	29	18.28		112,000

Flood stages and discharges of
West Branch of Susquehanna River at Williamsport, Pa.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1914	Mar.	29	18.90	P	119,000
	May	14	13.33		63,100
1915	Jan.	8	14.29		71,700
		8	16.34	P	91,900
		20	11.66		49,900
	Feb.	16	12.45		55,800
		25	16.80		96,600
1916	Mar.	28	20.3		133,000
	Apr.	15	14.4		72,700
	June	4	16.0		88,400
		17	21.0	P	141,000
		18	18.5		114,000
1917	Mar.	13	11.1		46,000
		13	11.6	P	49,400
1918	Feb.	21	17.7		106,000
		21	21.4	P*	145,000
		27	13.3		62,800
	Mar.	2	11.0		45,400
		15	18.6		115,000
	Apr.	16	11.0		45,400
1919	May	11	15.46		83,400
		23	20.06		130,000
		23	20.9	P	140,000
	Nov.	28	10.95		45,400
1920	Mar.	13	19.79		128,000
		13	20.4	P	135,000
		18	12.66		57,800
1921	Mar.	9	11.52		48,800
		9	11.8	P	50,900
	Nov.	29	15.29		81,400
		29	15.8	P	86,400
1922	Feb.	24	10.76	**	44,100
1923	Mar.	5	18.02		109,000
		5	21.6	P	147,000
	May	14	12.62		57,000
1924	Mar.	31	12.35		55,400
	Apr.	7	18.16		111,000
		7	18.96	P	120,000
	May	13	15.57		84,400
1925	Feb.	12	18.68		116,000
		12	19.52	P	125,000
1926	Mar.	25	11.10		46,000
	Sept.	6	13.5	P	64,600
		7	12.05		52,400
	Nov.	17	13.23		62,000
1927	Jan.	22	18.7	P	117,000
		23	14.20		70,900
	Mar.	9	13.15		62,000
		15	12.70		57,800
		22	15.27		81,400
	May	26	12.19		53,900
	Nov.	30	11.40		48,000
	Dec.	15	12.85		58,600
		17	13.38		63,700
1928	Mar.	31	11.83		50,900
	Apr.	9	11.60		49,400
	May	1	13.20		62,000
	June	6	17.86	P	108,000
		7	15.56		84,400
	July	6	13.36		63,700
1929	Mar.	15-16	15.75		86,400
		15	16.62	P	94,500
1930	Feb.	27	11.90		51,700
		27	12.29	P	54,700
1931	Apr.	5	11.13		46,100
	May	15	10.95		45,400
		24	12.47		56,200
		24	12.76	P	58,600
1932	Apr.	1	13.74		66,800
		1	14.68	P	75,600
	May	12	13.21		62,100
1933	Mar.	16	13.85		67,800
		16	14.30	P	71,800
		22	11.03		45,400

* Estimated ** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Juniata River at Newport, Pa.

Location.- At highway bridge at Newport, Perry County, 1,000 feet above Little Buffalo Creek.
Drainage area.- 3,354 square miles.
Records available.- March 1899 to July 1906, January 1907 to September 1933.
Sources of data.- U. S. Geological Survey records March 1899 to March 1907; Pennsylvania Department of Forests and Waters April 1907 to September 1933; collaboration by the U. S. Geological Survey 1907-13, 1918-21, 1931-33.
Gage.- Nonrecording gage read to tenths once daily prior to 1907; to tenths twice daily 1907 to Oct. 4, 1921; to half-tenths twice daily Oct. 5, 1921, to Sept. 30, 1925; and to quarter-tenths twice daily Oct. 1, 1925, to July 16, 1929 (sometimes read oftener during high water); recording gage thereafter. Zero of gage is 363.16 feet above mean sea level.
Stage-discharge relation.- Permanent except as affected by ice and aquatic growth. Rating curve well defined up to about 70,000 second-feet.
Historical data.- Estimated flood records for 1810-99 taken from Water Resources Inventory Report, Part VIII (1916), Water Supply Commission of Pennsylvania; those for 1896-99 were derived from the Weather Bureau gage at Mifflin.

Flood stages and discharges
(Base discharge 30,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1810	Nov.	20	28	P	131,000
.....	.....	.....	....		....
1846	Mar.	13	20	P	79,200
.....	.....	.....	....		....
1847	Oct.	9	28.5	P	134,000
.....	.....	.....	....		....
1889	June	1	35.9	P	182,000
.....	.....	.....	....		....
1894	May	21	31.0	P	151,000
.....	.....	.....	....		....
1896	Oct.	1	15.5		51,000
1897	Feb.	23	13		37,400

Flood stages and discharges of Juniata River at Newport, Pa.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1897	May	3	12.		32,600
1898	Mar.	23	13.		37,400
	Oct.	24	13.		37,400
	....		....		......
1900	Feb.	22	11.7		31,300
	Mar.	2	12.9		36,900
	Nov.	27	11.6		30,800
1901	Mar.	11	15.9		53,300
	Apr.	22	13.8		41,400
	May	23	13.0		37,400
		30	13.3		38,800
	Dec.	15-16	18.0		66,100
		18	13.65		40,600
		21	12.05		32,900
1902	Mar.	1	25.3		114,000
		14	14.1		43,000
		17	15.3		49,800
	Apr.	9-10	18.5		69,400
1903	Feb.	5	14.5		45,200
	Mar.	1	15.5		51,000
		24	12.7		36,000
	Apr.	16	15.6		51,600
1904	Feb.	7	11.5		30,400
	Mar.	2	12.0		32,600
		4	13.5		39,800
		8	14.0		42,400
	Apr.	2	13.4		39,300
1905	Mar.	11	12.2		33,600
		22	11.7		31,300
1906	Mar.	31	11.0	**	28,100
	....		....		......
1907	Mar.	15	22.10		92,800
		21	15.15		48,900
1908	Jan.	14	11.45		30,100
	Feb.	16	13.90		41,900
	Mar.	9	12.75		36,200
		14	12.50		35,000
		19	20.75	P	84,100
		20	19.60		76,700
	May	8	12.85		36,700
		20	15.60		51,600
1909	Feb.	25	11.95		32,400
		25	12.2	P	33,600
1910	Jan.	22	13.57		40,200
		22	17.4	P	62,400
	Mar.	2	13.45		39,600
	Apr.	26	13.05		37,600
1911	Jan.	15	10.40	**	25,500
1912	Feb.	27	11.60		31,300
	Mar.	16	13.60		41,100
		16	13.81	P	42,300
		30	12.10		33,600
1913	Mar.	28	12.51		35,600
		28	12.86	P	37,300
	May	29	15.22		50,000
1914	Feb.	1	13.50		40,600
		1	13.80	P	42,200
	Mar.	18	12.50		35,500
	Mar.	29	11.77		32,000
1915	Feb.	3	12.86		37,300
		16	13.92		42,800
		25	13.78		42,100
		25	14.50	P	46,000
	June	4	15.30		50,500
		4	16.16	P	55,400
1916	Mar.	29	19.70		70,600
	June	17	18.6		64,300
		17	20.0	P	72,300
1917	Mar.	13	13.4		38,000
		13	13.7	P	39,400
1918	Feb.	21	13.5		38,400
		27	16.0		50,500
		27	16.7	P	54,100
	Apr.	16	14.0		40,700
1919	May	23	17.16		56,700
		23	17.36	P	57,800
1920	Mar.	13	17.81		59,900
		13	19.1	P	67,200
1921	May	6	14.9		45,000
		6	16.0	P	50,500
	Nov.	30	13.25		37,100
		30	14.4	P	42,600
1922	Feb.	24		**	24,200
1923	Mar.	3	15.1	P	46,000
		4	11.83		31,000
1924	Jan.	18	12.50		34,000
	Mar.	31	14.50		43,100
	Apr.	7	15.30		47,000
	May	10	13.07		36,700
		13	18.27		62,700
		13	18.97	P	66,600
	June	30	13.55		38,900
1925	Feb.	13	14.40		42,600
		13	16.00	P	50,500
1926	Feb.	26	12.21		32,700
		26	13.20	P	37,100
	Nov.	16	14.2	P	41,700
		17	13.50		38,000
1927	Mar.	9	12.22		32,700
	Oct.	20	15.46		48,000
1928	May	1	16.92		55,200
		1	17.60	P	58,800
1929	Apr.	17	14.15		41,700
		17	15.40	P	47,500
	Oct.	23	14.52		43,200
		23	17.26	P	57,500
1930	Feb.	26-27	11.2	**	28,400
1931	May	24	12.32		33,200
		24	12.94	P	35,800
1932	Apr.	1	13.44		38,000
		1	13.99	P	40,600
1933	Mar.	16	12.70		34,900
		16	13.35	P	38,000
		21	12.43		33,600
	May	11	11.92		31,500

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Potomac River at Point of Rocks, Md.

Location.- At highway bridge at Point of Rocks, Frederick County, a third of a mile below Catoctin Creek and 6 miles above mouth of Monocacy River.
Drainage area.- 9,650 square miles.
Records available.- February 1895 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths or hundredths once daily prior to Oct. 30, 1929, (sometimes oftener during high water); recording gage thereafter. Gage datum lowered 0.45 foot Apr. 1, 1902. Zero of present gage 200.54 feet above mean sea level. All gage-height records in this report corrected to present datum.
Stage-discharge relation.- Slightly affected by ice. Control permanent. Bank-full stage, about 22 feet.
Regulation and diversions.- Slight regulation. Water diverted into Chesapeake & Ohio Canal not included in records.
Remarks.- Records prior to 1902 may be seriously in error owing to uncertain gage-height corrections. Discharge records prior to November 1929 revised from previously published records.
Historical data.- Flood of June 2, 1889, reached a stage of 40.2 feet (estimated discharge, 320,000 second-feet).

Flood stages and discharges
(Base discharge 50,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1895	Mar.	3	11.05		56,900
	Apr.	10	11.25		58,400
1896	July	26	9.15	†	44,100
	Oct.	1	22.30		149,000
1897	Feb.	8	10.95		56,900
		24	25.05		173,000
	May	4	14.45		83,100
		15	13.05		72,100
1898	Mar.	26	10.95		56,900
	May	9	11.50		60,700
	Aug.	12	16.50		100,000
	Oct.	23	13.55		76,800
1899	Feb.	23	15.25		89,500
		28	14.35		83,100
	Mar.	6	17.00		104,000
1900	Mar.	22	9.15	†	44,100
1901	Mar.	12	12.85		70,600
	Apr.	16	15.45		91,200
		22	21.25		140,000
	May	24	14.65		84,700
		30	10.15		51,100
	Dec.	16	17.65		109,000
		31	18.85		119,000
1902	Feb.	27	27.35		194,000
	Mar.	2	29.45		212,000
		13	14.45		83,100
		18	11.05		56,900
	Apr.	9	16.85		103,000
1903	Jan.	4	11.65		61,400
	Mar.	2	15.3		90,300
		25	12.1		65,200
	Apr.	16	15.1		88,700
	June	30	12.15		66,000
1904	June	2	7.8	†	34,700
1905	Mar.	11	11.0		57,000
1906	Mar.	29	12.9		71,300
		29	13.1	P	72,900
	Oct.	21	16.1		96,800
		21	16.2	P	97,600
1907	Jan.	15	10.7		54,700
		21	12.0		64,400
	Mar.	15	17.0		104,000
		21	12.4		67,500
	June	3	14.6		84,700
		3	15.2	P	89,500
	Dec.	25	11.7		62,200
1908	Jan.	13	19.7		127,000
		13	21.0	P	138,000
	Feb.	16	18.8		119,000
		16	20.2	P	131,000
	Mar.	10	12.0		64,400
		10	12.3	P	66,700
	May	8	15.0		87,900
		8	16.4	P	99,300
		23	18.1		113,000
	May	23	18.3	P	115,000
1909	Apr.	16	12.3		66,700
		16	13.3	P	74,400
1910	Jan.	22	13.5		76,000
		22	14.0	P	80,000
	June	18	22.0		146,000
		18	23.5	P	159,000
1911	Feb.	1	10.5		53,300
	Sept.	1	14.6		84,700
		1	16.0	P	96,000
1912	Feb.	28	13.0		72,100
		28	14.8	P	86,300
	Mar.	17	13.0		72,100
		17	13.2	P	73,700
		22	10.4		52,600
		22	10.6	P	54,000
	May	14	11.6		61,400
		18	11.1		57,700
1913	Mar.	28	17.5		108,000
		28	20.0	P	129,000
	Apr.	17	10.8		55,500
		17	11.0	P	56,900
	May	29	11.3		59,200
1914	Mar.	19	11.4		59,900
1915	Jan.	8	13.0		72,100
		8	17.0	P	104,000
		13	10.2		51,100
		13	11.0	P	56,900
		20	13.5		76,000
	Feb.	3	17.9		112,000
		3	18.0	P	113,000
	June	4	18.6		118,000
		4	19.2	P	123,000
1916	Mar.	23	11.14		57,700
		29	17.9		112,000
		29	18.3	P	115,000
1917	Mar.	10	14.2		81,500
		13	17.5		108,000
		13	17.9	P	112,000
1918	Feb.	13	16.0		96,000
		21	11.1		57,700
	Apr.	11	10.64		54,000
		16	16.7		102,000
		16	16.85	P	103,000
		22	16.65		101,000
		22	17.10	P	105,000
1919	May	12	11.1		57,700
1920	Mar.	6	15.7		93,600
		13	10.1		50,400
		21	10.1		50,400
1921	Mar.	6	13.60		76,800
1922	Mar.	17	10.82		55,500
1923	Apr.	16	8.10	†	36,700
1924	Jan.	18	12.48		68,200
	Mar.	31	22.40		150,000

† Below base

Flood stages and discharges of Potomac River at Point of Rocks, Md.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1924	Mar.	31	23.6	P	160,000
	Apr.	7	10.20		51,100
	May	10	18.75		119,000
		10	19.7	P	127,000
		13			238,000
		13	32.2	P	258,000
	Oct.	1	10.58		54,000
1925	Feb.	13	13.50		76,000
1926	Feb.	26	10.80		55,500
	Nov.	18	12.98		72,100
		18	13.88	P	79,200
	Dec.	27	11.16		58,400
1927	Feb.	25	11.50		60,700
	Oct.	20	12.90		71,300
		20	13.2	P	73,700
1928	May	2	21.20		140,000
1929	Mar.	1	11.80		62,900
		7	14.10		80,700
	Apr.	18	22.35		150,000
		18	24.94	P	172,000
	Oct.	23	17.00		104,000
	Nov.	20			54,600
	Nov.	20	11.60	P	61,300
1930	Mar.	9	6.52	†	26,600
1931	May	24		†	35,100
1932	Feb.	6			67,700
		6	13.28	P	74,400
	Mar.	30			55,000
		30	11.30	P	59,200
	May	14			145,000
		14	23.34	P	158,000
	Nov.	11	11.30		59,200
		11	11.75	P	62,900
1933	Jan.	27			59,800
		27	12.76	P	70,600
	Mar.	22	12.04		64,400
		22	12.28	P	66,700
	Apr.	18			65,200
		18	13.95	P	80,000
		21	19.30	P	123,000
		22			104,000
	Aug.	25			56,700
		25	11.78	P	62,900

† Below base

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Monocacy River near Frederick, Md.

Location.- At highway bridge, 3 miles northeast of Frederick, Frederick County, and about 3,000 feet below Tuscarora Creek.
Drainage area.- 665 square miles.
Records available.- August 1896 to September 1930.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths once daily prior to 1916; to half-tenths once daily 1916 to 1921, 1925 to July 14, 1927, and Oct. 1, 1927, to Mar. 2, 1929; to hundredths once daily 1921 to 1925 and July 15 to Sept. 30, 1927; to hundredths twice daily Mar. 3, 1929, to Sept. 30, 1930.
Stage-discharge relation.- Often affected by ice. Control shifts.

Flood stages and discharges
(Base discharge 9,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1897	Feb.	7	15.0		9,750
		23	14.6		9,330
	May	13-14	15.6		10,400
	Aug.	24	16.2		11,000
	Nov.	2	14.85		9,590
	Dec.	15	14.6		9,330
1898	Feb.	21	14.8		9,540
	Dec.	5	17.95		12,800
1899	Jan.	7	14.85		9,590
	Feb.	23	15.65		10,400
		27	17.8		12,700
	Mar.	5	17.2		12,100
1900	Feb.	13	15.1		9,860
		22	20.8		15,800
1901	Mar.	11	20.5		15,500
	Apr.	3	18.0		12,900
		21	14.6		9,330
	Dec.	15	19.75		14,700
		30	18.5		13,400
1902	Jan.	22	18.05		13,000
	Feb.	22	14.4		9,120
		26	24.0		19,200
	Mar.	1	25.2		20,500
		11	15.5		10,300
		17	14.6		9,330
	Apr.	9	17.9		12,800
	Dec.	3	16.0		10,800
		16	15.3		10,100
		22	17.1		12,000
1903	Jan.	2	15.8		10,600
	Feb.	4	16.35		11,200
	Mar.	1	21.4		16,500
		24	18.2		13,100
	Apr.	15	21.6		16,700
	May	30	14.8		9,540
	June	29	21.2		16,300
	July	13	18.8		13,700
1904	Jan.	23	19.9		14,800
	Mar.	8	17.2		12,000
1905	Jan.	7	17.4		12,200
	Mar.	10	14.6		9,230
		21	14.8		9,440
	Aug.	26	18.8		13,600
	Dec.	21	18.65		13,500
1906	Jan.	4	18.35		13,200
	Mar.	4	16.65		11,400
		28	17.45		12,200
	Apr.	10	16.8		11,500
		15	21.8		16,800
	Aug.	3	16.1		10,800
1907	Jan.	20	15.0		9,650
	Mar.	14	17.6		12,400
	July	12	15.9		10,600
	Dec.	10	16.5		11,200
1908	Jan.	12	14.9		9,540
		12	18.2	P	13,000
	Feb.	16	24.1		19,200
		27	23.5		18,600

Flood stages and discharges of Monocacy River near Frederick, Md.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1908	May	8	19.0		13,800
		20	22.3		17,300
		23	19.6		14,500
1909	Feb.	24	15.85		10,500
	Dec.	14	14.5		9,120
1910	Jan.	22	17.8		12,600
	Feb.	18	15.55		10,200
	Apr.	25	15.3		9,960
1911	Aug.	31	22.35		17,400
	Sept.	1	27.7	P*	23,000
1912	Feb.	22	18.5		13,000
		27	15.4		9,780
	Mar.	16	19.4		14,000
		29	18.0		12,500
	Sept.	25	22.70		17,400
	Dec.	31	15.0		9,360
1913	Mar.	14	16.0		10,400
		28	18.7		13,200
1914	Feb.	1	14.2	†	8,520
1915	Jan.	7	18.6		13,000
		13	26.4		20,900
		13	27.2	P	21,700
	Feb.	2	23.2		17,100
		25	16.2		9,780
	June	3	21.0		14,800
	Aug.	4	15.9		9,460
		6	19.3		13,000
	Sept.	7	17.2		10,800
1916	Mar.	28	17.4		9,940
	June	16	21.0		13,300
		16	22.7	P	14,900
1917	Mar.	12	17.2		9,750
		13	20.4	P	12,700
	Oct.	30	20.1		12,400
1918	Feb.	14	16.75		9,390
		16	16.9		9,480
	Feb.	20	21.4		13,700
		20	22.1	P	14,300
		26	19.45		11,800
	Dec.	23	17.15		9,750
1919	Mar.	9	14.85	†	7,550
1920	Mar.	13	18.10		10,600
		13	19.80	P	12,200
1921	May	5	18.60		11,000
		13	20.28		12,600
1922	Mar.	8	15.41	†	8,100
1923	July	31	20.67		13,000
1924	Jan.	17	22.40		14,600
	Mar.	8	19.00		11,400
		30	19.20		11,600
	Apr.	7	19.02		11,400
	May	12	19.92		12,300
	June	29	18.48		11,000
1925	Feb.	12	19.60		12,000
	Nov.	13	16.70		9,290
1926	Feb.	26	21.15		13,500
	Aug.	13	16.35		9,020
	Nov.	16	23.50		15,600
		16	28.	P*	20,000
1927	Oct.	19	21.65		13,800
1928	Feb.	15	19.50		11,900
	Apr.	28	20.60		12,900
	June	19	19.60		12,000
		21	18.40		10,900
	July	13	19.80		12,200
1929	Mar.	6	17.98		10,500
	Apr.	17	18.43		10,900
	May	3	22.86		15,000
		3	23.98	P	16,100
	Oct.	3	16.68		9,290
		3	22.38	P	14,600
1930	Mar.	8	15.66	†	8,370

* Estimated
† Below base
Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Part 2. South Atlantic slope and eastern Gulf of Mexico basins

James River at Buchanan, Va.

Location.- At highway bridge near Chesapeake & Ohio Railway station, Buchanan, Botetourt County.

Drainage area.- 2,084 square miles.

Records available.- August 1895 to September 1934.

Sources of data.- Gage-height records by U. S. Weather Bureau prior to July 1, 1927; subsequent gage-height records and all discharge records by U. S. Geological Survey.

Gages.- Nonrecording gage read to tenths once daily prior to July 1, 1927; recording gage thereafter. Prior to Feb. 12, 1898, datum of gage uncertain; thereafter zero of gage has been 802.63 feet above mean sea level.

Stage-discharge relation.- Affected by ice. Control shifts at high stages. Bank-full stage, about 17 feet.

Remarks.- Records prior to Feb. 12, 1898, not used in this report because of uncertainties in gage datum.

Historical data.- Flood of Nov. 27, 1877, reached stage of 24.6 feet (data of U. S. Weather Bureau).

Flood stages and discharges
(Base discharge 14,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1898 Mar.	30	8.5	14,600
May	7	11.0	22,500
Aug.	11	11.55	24,400
Oct.	22	14.1	32,500
1899 Jan.	7	10.25	20,000
Feb.	7	8.4	14,300
	22	10.2	20,000
	28	9.65	18,000
Mar.	5	19.05	48,700
1900 Jan.	20	9.3	17,100
Feb.	14	9.2	16,800
Mar.	2	9.25	16,800
	21	10.3	20,300
Oct.	24	10.45	20,600
Nov.	26	17.5	43,800
Dec.	5	9.3	17,100
1901 Jan.	12	9.85	18,700
Mar.	11	9.0	16,200
Apr.	4	10.25	20,000
	15	8.5	14,600
	21	12.2	26,400
May	23	13.6	30,900
	28	9.6	18,000
June	16	11.6	24,400
Aug.	7	9.75	18,700
	15	9.3	17,100
Dec.	15	14.9	35,200
	30	19.25	49,700
1902 Jan.	28	8.4	14,300
Feb.	26	14.40	33,500
Mar.	1	19.05	48,700
	17	8.65	14,900
1903 Jan.	3	10.75	21,900
Feb.	5	8.6	14,900
	17	14.8	34,800
Mar.	1	11.25	23,200
	24	15.1	35,800
Apr.	27	9.1	16,500
1904 Mar.	7	8.39	14,300
May	19	10.2	20,000
June	3	8.84	15,500
1905 Mar.	10	11.22	23,200
May	13	9.25	16,800
	16	8.28	14,000
July	13	14.82	34,800
1906 Jan.	23	9.41	17,400
Oct.	5	9.1	16,500
	20	15.6	37,500
1907 Apr.	7	8.7	15,200
	9	8.8	15,500
June	14	16.4	40,100
Sept.	24	8.4	14,300
Dec.	11	9.3	17,100
	24	11.9	25,400
1908 Jan.	13	16.7	41,100
Feb.	16	18.3	46,400
Mar.	7	8.6	14,900
Apr.	1	9.5	17,700
May	8	10.3	20,300
1909 Jan.	6	8.6	14,900
Feb.	11	9.1	16,500
Apr.	15	13.0	28,900
May	22	10.0	19,300
1910 Jan.	22	8.7	15,200
June	14	15.6	37,500
	17	14.4	33,500
July	19	8.4	14,300
1911 Jan.	4	11.0	22,500
	31	10.6	21,200
Apr.	6	9.6	18,000
1912 Mar.	16	14.4	33,500
	30	16.2	39,500
May	13	10.6	21,200
	17	10.8	21,900
1913 Mar.	15	12.0	25,700
	27	11.3	23,500
	27	31	P
....	....	....	....
1914 Feb.	20	8.9	14,300
Dec.	6	9.0	14,600
1915 Jan.	8	15.4	35,300
	19	10.4	19,000
Feb.	3	17.3	41,300
	25	9.6	16,500
Oct.	1	12.0	24,100
Dec.	30	12.0	24,100
1916 Jan.	12	7.6	** 10,600
1917 Mar.	5	17.6	42,600
1918 Feb.	14	9.6	16,500
Mar.	14	17.0	40,600
Apr.	22	11.5	22,500
Oct.	27	8.8	14,000
	31	8.8	14,000
Dec.	16	11.4	22,200
	23	14.7	33,000
1919 Jan.	3	18.0	43,900
June	27	12.8	26,700
July	20	11.2	21,600
1920 Jan.	25	9.1	14,900
Mar.	20	12.8	26,700
1921 Jan.	23	11.0	20,900
Nov.	1	11.5	22,500
1922 Jan.	22	10.0	17,700
Feb.	21	11.3	21,900
Mar.	4	9.5	16,200
	11	12.0	24,100
May	20	10.0	17,700
1923 Mar.	7	9.0	14,600
1924 Jan.	17	14.1	31,000
Mar.	30	10.1	18,000
May	13	19.1	47,500
July	9	11.0	20,900
Sept.	30	15.1	34,300
1925 Jan.	13	7.5	** 10,300
1926 Jan.	19	13.3	28,400

** Below base

Flood stages and discharges of James River at Buchanan, Va.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1926	Jan.	19	13.4	P	28,700		Nov.	19	16.50	P	39,000
	Nov.	17	14.2		31,400	1930	Feb.	5			15,600
	Dec.	22	9.5		16,200			5	10.06		18,000
		27	14.0		30,700	1931	Mar.	30		**	9,780
		27	14.2	P	31,400	1932	Feb.	5			26,800
1927	Feb.	20	14.0		30,700			5	15.30	P	35,000
		24	13.6		29,400		Mar.	29			18,400
	Apr.	10	9.9		17,400			29	12.44	P	25,600
		23	11.0		20,900		May	2			20,000
	Oct.	13			14,900			2	12.33	P	25,300
		13	11.10		21,200		Oct.	18	11.61		23,000
1928	Aug.	16	16.53	P	39,000			18	12.17	P	24,900
		17			29,200		Nov.	10			17,700
	Sept.	20			21,300			10	11.00	P	21,100
		20	12.63		26,100		Dec.	29			21,600
1929	Mar.	1			24,600			29	12.00	P	24,300
		1	13.85	P	30,000	1933	Feb.	21			16,800
		6			24,100			21	10.37	P	19,200
		6	12.74	P	26,400		Mar.	21			22,400
	Apr.	17			20,200			21	12.16	P	24,900
		17	11.77	P	23,500		Apr.	13			14,600
	May	3			18,100			13	10.08	P	18,200
		3	10.98		20,900			17			22,500
	Oct.	3			17,900			17	11.59	P	23,000
		3	10.35	P	19,000	1934	Mar.	5	12.42		25,600
		23			19,200			9	10.02		17,900
		23	11.72	P	23,200			28			23,700
	Nov.	19			28,200			28	14.36	P	32,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Mar. 28 to Apr. 21, 1913.

James River at Cartersville, Va.

Location.- At highway bridge between Pemberton and Cartersville, Cumberland County, 1 mile below Willis River.
Drainage area.- 6,242 square miles.
Records available.- January 1899 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to hundredths twice daily prior to Jan. 1, 1911; to tenths twice daily Jan. 1, 1911, to Sept. 30, 1917; to hundredths twice daily Oct. 1, 1917, to June 3, 1927; recording gage thereafter. All gages set to same datum. Zero of gage is 161.57 feet above mean sea level.
Stage-discharge relation.- Control shifts occasionally at high stages. Bank-full stage, about 20 feet.
Regulation.- Low-water flow regulated by power plants upstream.

Flood stages and discharges
(Base discharge 36,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1899	Jan.	7	19.5		64,000	1902	Feb.	26	21.85	76,000
	Feb.	17	14.0		40,500		Mar.	1	22.90	82,300
		23	16.3		49,800		June	17	14.35	41,900
	Mar.	1	13.90		40,100		Oct.	6	16.85	52,200
		6	24.75		93,800	1903	Jan.	3	16.05	48,800
		20	18.32		58,600		Feb.	18	17.4	54,600
1900	Jan.	20	13.08		37,000		Mar.	2	14.52	42,600
	Mar.	2	15.65		47,200			25	18.7	60,300
	Nov.	28	18.0		57,200		June	8	18.0	57,200
1901	Jan.	14	14.72		43,400	1904	Mar.	8	13.0	36,700
	Apr.	4	14.0		40,500	1905	July	14	16.39	50,200
		15	15.60		47,000		Dec.	22	12.9	36,300
		22	21.05		71,600	1906	Jan.	4	17.0	52,800
	May	23	24.5		92,200		Oct.	5	15.2	45,300
	June	17	17.82		56,400			21	23.3	84,800
	Aug.	7	13.61		39,000	1907	Apr.	10	14.10	40,900
		15	16.3		49,800		June	2	21.00	71,300
	Dec.	16	18.25		58,300			15	16.89	52,400
		30	25.39		97,800		Sept.	24	19.00	61,700
		30	26.7	P	106,000		Dec.	24	13.60	39,000

Flood stages and discharges of James River at Cartersville, Va.--Continued

Date		Gage height (feet)		Discharge (second-feet)
1908 Jan.	8	14.13		41,000
	14	19.35		63,300
Feb.	17	19.65		64,700
Aug.	26	13.84		39,900
1909 Apr.	16	15.68		47,300
1910 June	17	19.89		65,800
1911 Jan.	4	16.2		49,400
1912 Mar.	16	21.4		73,500
	30	19.6		64,500
May	13	21.4		73,500
	17	14.5		42,500
1913 Mar.	15	19.7		64,900
	29	21.6		74,600
Apr.	13	18.0		57,200
May	24	16.3		49,800
Nov.	10	13.5		38,600
	10	13.6	P	39,000
1914 Feb.	2	11.8	**	32,200
1915 Jan.	8	19.1		62,200
	13	16.8		52,000
Feb.	4	20.2		67,300
	4	20.6	P	69,300
	25	13.2		37,400
Oct.	2	18.0		57,200
	2	18.4	P	59,000
1916 June	16	12.6	**	35,200
1917 Mar.	6	19.7		64,900
	6	19.9	P	66,300
1918 Feb.	14	13.57		39,000
	14	13.71	P	39,400
Mar.	15	15.98		48,600
	15	16.68	P	51,500
Apr.	11	14.88		44,100
	11	15.06	P	44,900
	22	16.54		50,700
	22	17.01	P	52,800
Dec.	24	15.73		47,400
	24	16.18	P	49,400
1919 Jan.	4	22.58		80,500
	4	22.98	P	82,900
July	23	17.49		55,000
	23	17.77	P	56,300
1920 Feb.	4	19.62		64,500
	4	20.17	P	67,300
Mar.	21	13.69		39,400
	21	13.72	P	39,400
Aug.	21	17.08		53,200
	21	18.32	P	58,500
	29	15.00		44,500
	29	17.50	P	55,000
Dec.	1	14.33		41,700
	1	14.68	P	43,300
1921 Jan.	15	13.97		40,500
	15	14.25	P	41,300
	24	13.17		37,400
	24	13.47	P	38,600
1922 Mar.	11	14.08		40,900
Mar.	11	14.46	P	42,300
	16	15.25		45,300
	16	15.46	P	46,600
1923 Mar.	17	18.06		58,400
	17	18.46	P	60,200
1924 Jan.	18	17.52		55,600
	18	17.70	P	56,600
May	12	24.68	P	93,500
	13	24.12		90,000
Oct.	1	24.04		89,500
	1	24.38	P	91,800
1925 Feb.	12	11.18	**	29,600
1926 Jan.	20	15.08		44,800
	20	15.25	P	45,300
Nov.	18	14.79		43,500
	18	14.99	P	44,400
Dec.	27	15.92		48,400
	28	16.20	P	49,800
1927 Feb.	21	14.82		43,500
	21	15.68	P	47,600
	25	14.63		42,700
	25	14.93	P	44,000
Apr.	23	13.91		39,900
	23	14.01	P	40,300
1928 Apr.	28			41,500
	28	15.97	P	48,900
Aug.	12			66,600
	12	22.06	P	78,600
	18		*	81,300
	18	23.80	P	88,300
Sept.	7			48,800
	7	17.50	P	55,600
	21			34,300
	21	13.26	P	37,500
1929 Mar.	1			53,600
	1	17.70	P	56,600
	7			43,400
	7	15.12	P	44,800
Apr.	17	17.41		55,200
	17	17.58	P	56,100
Nov.	20			43,000
	20	15.82	P	48,000
1930 Mar.	9			38,500
	9	15.44	P	46,200
1931 Apr.	3	8.86	**	19,500
1932 Mar.	7			47,400
	7	17.13	P	54,800
Oct.	18			67,600
	18	21.54	P	75,400
Dec.	29			49,400
	29	16.70	P	52,800
1933 Mar.	22			42,000
	22	14.95	P	44,800
Apr.	18			67,500
1934 Mar.	5	15.93	P	49,000
	6			45,400
Sept.	17			36,500

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Roanoke River at Roanoke, Va.

Location.- At Walnut Street Bridge, Roanoke, Roanoke County.
Drainage area.- 388 square miles.
Records available.- July 1896 to July 1906, May 1907 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to half-tenths or hundredths once daily prior to Oct. 1, 1918; to hundredths once daily Oct. 1, 1918, to Sept. 30, 1929; to hundredths twice daily thereafter. Zero of gage is 906.84 feet above mean sea level.
Stage-discharge relation.- Control shifts occasionally.

Flood stages and discharges of Roanoke River at Roanoke, Va.
(Base discharge 2,200 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1896	July	10	3.53	#	2,300
1897	Feb.	6	6.82		6,710
		21	4.5		3,580
		23	8.3		8,710
	Mar.	15	3.85		2,710
	May	2	4.0		2,900
1898	May	7	4.9		4,120
	Sept.	23	3.55		2,330
	Oct.	19	3.5		2,260
		22	5.0		4,260
1899	Jan.	7	5.85		5,400
	Feb.	7	4.08		3,010
		17	3.55		2,330
		21	4.5		3,580
		27	5.0		4,260
	Mar.	5	8.15		8,510
		15	4.75		3,920
		19	7.1		7,090
1900	Jan.	20	4.1		3,040
	Feb.	13	4.35		3,380
		22	3.8		2,640
	Mar.	1	3.8		2,640
		20	4.45		3,510
	Apr.	19	3.75		2,580
	Oct.	24	4.75		3,920
	Nov.	26	8.2		8,580
	Dec.	4	4.43		3,490
1901	Jan.	12	4.05		2,970
	Mar.	11	3.95		2,840
	Apr.	3	6.94		6,870
		20	10.45		11,600
	May	22	11.92		13,600
		27	4.61		3,730
	July	14	4.8		3,980
		19	4.0		2,900
	Aug.	6	14.34		16,900
		18	4.32		3,340
	Dec.	15	4.8		3,980
		29	11.9		13,600
1902	Feb.	25	10.06		11,100
		28	8.75		9,320
	Mar.	29	3.5		2,260
1903	Jan.	3	4.10		3,040
	Feb.	17	8.50		8,980
	Mar.	23	6.70		6,550
		30	4.80		3,980
	Apr.	14	3.55		2,330
		27	4.05		2,970
	Sept.	17	6.75		6,620
1904	Aug.	11	3.60		2,390
1905	Mar.	10	3.6		2,390
	May	12	4.72		3,880
		16	3.7		2,520
	July	12	7.9		8,170
	Sept.	2	5.28		4,630
	Dec.	20	4.3		3,310
1906	Jan.	3	4.8		3,980
		23	4.05		2,970
.....	.....	.....	....		.....
1907	June	13	4.3		3,310
	Sept.	23	6.7		6,550
1908	Jan.	12	8.8		9,380
	Apr.	4	3.5		2,260
	Oct.	24	6.70		6,550
		29	3.45		2,200
	Dec.	30	3.65		2,450
1909	Apr.	14	7.5		7,630
	May	21	6.65		6,480
		27	4.6		3,720
1910	Feb.	18	4.6		3,720
	June	13	7.75		7,970
		16	4.3		3,310
	July	18	4.25		3,240
1911	Apr.	5-6	4.0		2,900
	Oct.	18	3.75		2,580
1912	Feb.	22	3.6		2,390
		27	4.2		3,180
	Mar.	14	7.6		7,760
		29	7.2		7,220
	May	12	8.5		8,980
		17	5.0		4,260
1913	Mar.	14	7.7		7,900
		28	3.5		2,260
	May	24	5.7		5,200
1914	Feb.	20	3.7		2,520
	Dec.	5	9.3		10,200
1915	Jan.	7	8.0		8,300
	Feb.	2	6.2		5,880
	Sept.	5	3.5		2,290
	Oct.	1	6.9		6,820
	Dec.	19	5.3		4,660
1916	Feb.	3	3.7		2,540
		25	4.9		4,120
	July	16	5.3		4,660
1917	Mar.	5	6.2		5,870
		18	3.5		2,260
1918	Feb.	13	4.05		2,900
	Apr.	21	4.20		3,180
	May	22	4.40		3,440
	June	19	4.20		3,180
		26	7.50		7,630
	Aug.	1	3.90		2,770
	Oct.	31	3.70		2,510
	Dec.	15	4.28		3,310
		17	6.95		6,960
		23	4.50		3,580
1919	Jan.	3	7.88		8,170
	June	27	4.17		3,180
1920	Feb.	4	5.57		5,060
	Aug.	19	4.50		3,580
	Nov.	30	3.50		2,250
1921	Nov.	1	11.10		12,500
		1	13.20	P	15,300
1922	Jan.	22	3.90		2,770
	Mar.	4	3.65		2,380
		10	5.70		5,200
	May	18	4.75		3,980
	June	5	5.50		4,930
1923	Mar.	7	6.85		6,680
		14	4.25		3,180
	June	13	4.10		3,040
1924	Jan.	15	4.00		2,900
	Mar.	29-31		*	2,450
	May	12	5.74		3,830
	July	7	6.20		4,380
	Sept.	29	6.25		4,380
1925	Jan.	18	3.00	**	1,240
1926	Jan.	18	3.47	**	1,690
	Dec.	22	4.60		2,720
		26	* 8.00	*	6,360
1927	Feb.	19	8.52		6,950
	Apr.	22	5.15		3,280
.....	.....	.....	....		.....
1928	Aug.	16	7.28		5,590
	Sept.	6	8.73		7,190
		6	9.78	P	8,510
		20	10.39		9,230
1929	Feb.	28	6.10		4,270
	Mar.	5	6.98	P	5,260
		6	6.70		4,930
	June	9	5.84		3,940
	Oct.	2	10.20		8,990
		22	10.05	*	6,460
	Nov.	18	5.80	*	2,880
1930	Feb.	5	3.50	**	1,540
1931	Aug.	22	4.24		2,200
		22	5.25	P	3,220
1932	Feb.	3	3.86	**	1,900
	Oct.	17	9.46		8,150
		17	10.17	P	8,990

First day of record; may not be peak.
* Estimated
** Below base

Flood stages and discharges of Roanoke River at Roanoke, Va.--Continued

Date		Gage height (feet)		Discharge (second-feet)
1932 Nov.	10	4.40		2,400
	10	4.75	P	2,800
Dec.	28	5.78		3,880
	28	6.25	P	4,320
1933 Feb.	8	4.28		2,300
	8	4.35	P	2,400
1934 Mar.	28	6.50		4,650
	28	7.45	P	5,640

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Oct. 1, 1927, to Jan. 16, 1928.

Yadkin River near Salisbury, N. C.

Location.- Sept. 24, 1895, to May 31, 1899, and Jan. 1, 1903, to Dec. 31, 1905, at Southern Railway bridge about 6 miles northeast of Salisbury, Rown County; June 1, 1899, to Dec. 31, 1902, and Jan. 1, 1906, to Dec. 31, 1927, at Piedmont Toll Bridge, 1,000 feet upstream from railroad bridge.
Drainage area.- 3,400 square miles.
Records available.- September 1895 to December 1909, September 1911 to December 1927. Estimated flood discharges 1910 and 1928-34.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gages read to half-tenths twice daily (oftener during high water). Gages at highway bridge always within 0.1 foot of same datum. Some uncertainty regarding datum of first gage at railroad bridge. Second gage at railroad bridge set 1.57 feet lower than gage at highway bridge and gages at two locations read same at stage of 3.2 feet but readings differed at other stages.
Stage-discharge relation.- Practically permanent until station was discontinued because of backwater from High Rock Dam.
Regulation.- Low flows regulated by power plants upstream.
Remarks.- Discharge records at highway bridge prior to October 1915 revised from previously published figures. Flood discharges for Mar. 2 and June 15, 1910, estimated from records of Yadkin River near Pee Dee. Estimated flood discharges 1928-34 obtained by adding to flow of Yadkin River at Yadkin College that of South Yadkin River at Cooleemee and increasing the sum 15 percent for flow from intervening drainage area.

Flood stages and discharges
(Base discharge 22,000 second-feet)

Date		Gage height (feet)		Discharge (second-feet)
1896 Feb.	4	6.70		22,700
	7	7.00		24,200
Apr.	2	8.00		29,200
July	10	15.00		64,200
Sept.	30	8.60		32,200
Nov.	6	6.78		23,200
Dec.	1	6.70		22,700
1897 Feb.	7	11.10		34,900
	24	9.50		29,300
Mar.	7	8.30		25,100
Apr.	6	10.20		31,800
Oct.	13	8.50		25,800
1898 Sept.	25	14.80		80,000
1899 Jan.	7	10.20		46,600
Feb.	7	10.10		45,800
	28	7.80		27,700
Mar.	4	8.00		29,100
	16	12.40		64,200
	20	17.80		107,000
	20	18.8	P	115,000
Apr.	8	7.80		27,700
1900 Feb.	14	9.10		33,200
Mar.	2	9.50		35,600
Apr.	20	10.60		42,200
June	24	7.00		21,500
Oct.	25	6.81		20,600
Nov.	27	7.85		25,700
1901 Jan.	13	8.23		27,900
Mar.	27	9.92		38,000
Apr.	4	10.85		43,400
	21	15.90		74,000
May	23	14.83		67,400
June	17	9.00		32,600
July	15	8.08		27,400
Aug.	7	11.38		47,000
	15	10.45		41,000
Dec.	16	8.58		30,200
	31	17.97		86,600
1902 Feb.	26	8.37		29,000
Mar.	1	9.45		35,000
	30	7.80		25,700
June	17	12.48		53,600
1903 Jan.	3	10.40		38,100
Feb.	5	7.20		28,800
	18	10.50		38,600
1903 Mar.	1	7.55		23,600
	24	15.40		76,200
	31	8.80		29,400
Apr.	9	10.65		39,600
June	8	9.40		32,500
1904 May	19	6.60	**	19,300
1905 Feb.	22	8.4		27,500
July	14	9.5		33,800
Aug.	13	7.5		22,900
Dec.	22	9.1		31,500
1906 Jan.	5	9.1		33,200
	24	9.0		32,000
	28	7.2		22,500
Aug.	17	8.2		27,900
	31	11.9		50,000
Oct.	20	9.4		35,000
Nov.	20	8.5		29,600
1907 Jan.	1	7.2		22,500
Sept.	24	8.00		26,800

** Below base

Flood stages and discharges of Yadkin River near Salisbury, N. C.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1907	Dec.	15	7.7		25,200
		24	9.8		37,400
1908	Jan.	8	8.3		28,400
		13	9.1		33,200
	Feb.	16	11.3		46,400
	Mar.	24	7.1		22,000
	Aug.	27	14.1		63,200
		27	15.2	P	69,800
	Oct.	25	7.1		22,000
	Dec.	23	8.3		28,400
1909	May	22	12.2		51,800
	June	5	10.8		43,400
		18	9.1		33,200
	Aug.	3	8.2		27,900
1910	Mar.	2		*	25,000
	June	15		*	40,000
1911	Oct.	19	7.6		24,600
1912	Mar.	16	19.0		92,600
		30	7.9		26,200
	May	13	12.6		54,200
	Sept.	24	7.3		23,000
1913	Jan.	28	7.1		22,000
	Mar.	16	15.4		71,000
	Apr.	13	7.4		23,500
	May	24	7.8		25,700
1914	Jan.	4	7.5		24,000
		4	7.6	P	24,600
	Oct.	17	7.9		26,200
	Dec.	6	11.6		48,200
		26	8.8		31,400
1915	Jan.	8	12.2		51,800
		8	12.8	P	55,400
		19	7.4		23,500
	Feb.	3	7.3		23,000
		25	7.6		24,600
	June	2	9.0		32,600
	Aug.	28	9.0		32,600
	Sept.	6	7.2		22,500
	Oct.	6	7.6		24,600
	Dec.	19	9.2		33,800
		30	10.0		38,600
1916	Feb.	3	12.6		54,200
	May	24	8.4		29,000
	June	7	8.3		28,400
	July	11	7.8		25,700
		17	21.4		107,000
		18	23.8	P	121,000
		23	7.3		23,000
1917	Mar.	5	10.8		43,400
		5	11.2	P	45,800
		25	8.4		29,000
	Apr.	6	7.6		24,600
	Sept.	2	9.3		34,400
1918	Apr.	22	7.1		22,000
		22	7.55	P	24,300
	Oct.	27	9.3		34,400
		31	8.0		26,800
	Dec.	18	7.6		24,600
		23	10.6		42,200
1919	Jan.	4	11.1		45,200
	Mar.	10	9.6		36,200
	July	20	16.9	P	80,000
		21	15.6		72,200
1920	Apr.	3	9.8		37,400
		3	10.23	P	40,000
		6	8.2		27,900
	Aug.	28	7.8		25,200
	Dec.	1	7.4		23,000
		9	7.5		23,500
		15	9.0		32,000
1921	Jan.	15	8.2		27,400
	Feb.	11	10.8		42,800
		11	10.87	P	43,200
	Apr.	18	7.5		23,500
	Nov.	1	7.6		24,400
1922	Feb.	16	7.5		23,900
	May	19	7.7		25,000
		19	7.97	P	26,500
1923	Mar.	18	14.6		66,000
		18	15.03	P	68,600
1924	Jan.	17			35,700
	Oct.	1			62,400
		1	14.3	P	64,200
	Dec.	10	8.58		30,000
1925	Jan.	1			22,300
		12	7.65		24,400
1926	Jan.	19			33,600
		19	9.75	P	37,200
1927	Feb.	21	7.55		24,400
		21	8.10	P	27,200
	Dec.	5		*	26,400
		5		P*	27,800
1928	Aug.	12		*	37,700
		18		*	63,700
	Sept.	7		*	45,600
		20		*	32,600
1929	Mar.	1		*	32,000
		6		*	23,700
	Oct.	3		*	83,400
1932	Oct.	18		*	63,500
	Nov.	2		*	35,000
1934	Mar.	4		*	30,000
	Dec.	2		*	30,500

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Chattahoochee River at West Point, Ga.

Location.- Prior to Oct. 20, 1912, at Montgomery Street Bridge, West Point, Troup County; thereafter 1 mile upstream, just below Oseligee Creek and 5 miles above Langdale Dam.

Drainage area.- 3,550 square miles.

Records available.- July 1896 to September 1933. Gage-height records only 1911.

Source of data.- U. S. Geological Survey.

Gages.- Nonrecording gage read to half-tenths once daily prior to Oct. 20, 1912; to tenths three times daily Oct. 20, 1912, to Jan. 25, 1925; recording gage thereafter. Zero of gage at first location was 555.2 feet above mean sea level. No relation between datums of gages at two locations.

Stage-discharge relation.- Not permanent. Gage moved from first location because of backwater effect from Langdale Dam, which now acts as control for medium high stages at second location. Development in overflow section changed stage-discharge relation for extremely high stages. Bank-full stage, about 20 feet at both locations.

Flood stages and discharges of Chattahoochee River at West Point, Ga.
(Base discharge 20,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1896	Nov.	5	9.2		19,900
1897	Mar.	7	10.95		25,100
		14	14.1		38,500
	Apr.	7	11.0		25,100
	July	21	11.4		26,300
1898	Apr.	7	9.5		20,800
	Aug.	28	10.6		23,900
	Sept.	6	18.2		57,400
	Oct.	6	14.5		40,300
		8	13.0		33,400
1899	Feb.	3	10.2		22,800
		8	13.3		34,800
		28	15.2		43,600
	Mar.	18	13.5		35,700
	Apr.	1	10.0		22,200
1900	Feb.	14	19.50		63,300
	June	25	17.80		55,500
	July	2	9.40		20,500
		30	12.60		31,600
	Sept.	16	12.60		31,600
1901	Jan.	13	15.00		42,600
	Feb.	5	13.80		37,100
	Mar.	29	13.00		33,400
	Apr.	4	10.30		23,100
		14	10.40		23,400
	May	23	17.20		52,800
	Aug.	17	10.40		23,400
		19	10.10		22,500
		24	17.10		52,300
	Sept.	19	12.70		32,000
	Dec.	30	25.00		88,600
1902	Feb.	3	17.10		52,300
	Mar.	1	20.00		65,600
		17	16.20		48,200
		30	14.90		42,200
	Dec.	17	10.10		22,500
1903	Feb.	9	20.1		66,100
		12	14.9		42,200
		18	15.9		46,800
	Mar.	1	11.6		27,000
		13	10.2		22,800
		26	15.2		43,600
		31	13.5		35,700
	Apr.	16	10.1		22,500
	May	15	12.7		32,000
	June	7	11.9		28,400
1904	Aug.	9	12.6		29,300
1905	Jan.	13	12.6		29,300
	Dec.	4	13.6		32,200
		9	9.8		21,200
		21	9.4		20,100
1906	Jan.	4	13.1		30,800
		24	13.4		31,900
	Mar.	17	11.7		26,100
		20	18.9		50,800
	Sept.	6	11.2		24,500
	Oct.	19	12.3		28,100
1907	Feb.	5	12.0		27,100
	Mar.	3	12.5		28,800
	Dec.	24	10.0		20,700
1908	Feb.	1	11.8		26,400
		16	12.6		29,100
		25	12.3		28,100
	Mar.	25	12.3		28,100
	Apr.	26	15.9		40,500
	Dec.	23	11.4		25,200
1909	Feb.	11	12.2		27,800
		16	14.4		35,300
		24	10.7		22,900
	Mar.	13	19.0		51,200
		21	13.0		30,500
	May	3	11.7		26,100
	Aug.	4	15.5		39,100
1910	May	25	11.2		22,800
	July	1	11.1		22,500
1911	Apr.	10	10.4	**	
1912	Jan.	30	14.4		32,800
	Mar.	16	22.7		61,600
		30	13.5		29,900
	Apr.	18	12.6		27,100
		23	14.0		31,500
	June	15	17.7		44,200
		26	12.0		25,200
1913	Jan.	28		*	35,000
	Mar.	15		*	45,000
		22	10.2		20,000
1914	Apr.	17	8.9	**	16,800
	Dec.	6	11.6		23,500
1915	Jan.	25	10.4		20,500
	June	2	10.3		20,200
	Oct.	20	11.6		23,000
	Dec.	19	15.7		33,200
		30	21.8		48,500
1916	July	9	21.9		48,800
		10	22.1	P	49,200
		21	11.9		23,800
1917	Feb.	22	16.8		36,000
		26	10.7		20,800
	Mar.	5	17.9		38,800
		28	19.5		42,800
		28	19.6	P	43,000
	Apr.	6	16.5		35,200
	Sept.	25	10.9		21,200
		29	15.4		32,500
1918	Jan.	12	16.3		34,800
		31	13.1		26,800
	Apr.	9	10.5		20,200
	Nov.	2	12.2		24,500
		29	11.1		21,800
	Dec.	23	21.0		63,700
1919	Jan.	27	12.1		24,200
	Feb.	23	13.6		28,000
	Mar.	9	19.5		54,200
	Dec.	10	30.0		134,000
1920	Jan.	27	18.0		45,700
	Feb.	5	13.4		27,400
	Mar.	13	12.6		25,200
		18	19.4		53,600
		29	19.2		52,400
	Apr.	3	14.5		30,800
		7	10.7		20,500
		23	11.9		23,500
		27	12.9		26,000
	May	4	18.4		47,900
		14	12.1		24,000
	July	22	12.0		23,800
	Aug.	17	12.3		24,500
	Dec.	23	12.1		24,000
1921	Feb.	10	18.9		50,600
		10	19.3	P	53,000
1922	Feb.	16	18.2		46,800
	Mar.	3	12.4		24,800
		8	16.8		39,800
		11	19.5		54,200
		20	13.4		27,400
	Apr.	20	10.6		20,200
	May	5	11.0		21,200
	June	2	14.6		31,100
		7	11.0		21,200
	Dec.	20	12.60		25,200
1923	Jan.	24	10.60		20,200
	Feb.	14	16.20		37,100
		14	16.70	P	39,400
	May	29	10.70		20,500
	June	1	10.80		20,800
1924	Jan.	17	11.7		23,100
	Apr.	19	12.6		25,400
	May	1	10.8		20,800
		29	10.5		20,100
1925	Jan.	12	17.1		41,200
		19	23.9		85,000
		19	24.6	P	90,300
1926	Jan.	6	10.9		20,400
		19	12.0		23,500
	Feb.	20	10.9		20,400
	Apr.	1	13.0		26,400
		1	13.7	P	28,500
	Aug.	2	12.3		24,400

* Estimated
** Below base

Flood stages and discharges of Chattahoochee River at West Point, Ga.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1927 Feb.	14	12.2	P 24,100	Nov.	17	14.35	P 30,900
	15	11.50	22,100	1931 May	11	8.04	** 12,300
1928 Apr.	24	13.23	27,000	Dec.	18	12.48	23,600
May	24	12.67	25,400		22	11.45	20,700
July	15	11.10	20,700	1932 Feb.	4	12.00	22,200
Aug.	19	11.38	21,600		22	13.32	26,400
1929 Feb.	22	11.27	21,300		22	14.24	P 29,200
	28	19.40	50,500	Oct.	17	11.88	21,600
Mar.	5	22.00	63,900	Dec.	18	15.62	33,400
	15-16	23.75	75,500		30	21.58	58,000
	15	25.45	P 87,600		30	21.74	P 58,600
	23-24	19.02	48,600	1933 Feb.	9	12.11	20,800
May	2	13.10	26,700		21	14.42	27,600
	20	11.58	22,200	Mar.	20	13.55	25,100
Sept.	30	12.60	25,200	1934 Feb.	27	* 11.9	* 20,200
Nov.	13	12.60	25,200	Mar.	5	16.05	32,900
	16	12.75	25,800		5	16.52	P 34,700
1930 Mar.	8	12.42	24,600	June	5	13.78	25,700
Nov.	17	13.99	29,500				

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Oostanaula River at Resaca, Ga.

Location.- Prior to Mar. 23, 1919, at Nashville, Chattanooga & St. Louis Railway bridge, Resaca, Gordon County; Mar. 23, 1919, to Oct. 23, 1928, at old highway bridge 600 feet downstream; thereafter at new highway bridge 200 feet below railroad bridge and 3½ miles below confluence of Conasauga and Coosawattee Rivers.
Drainage area.- 1,610 square miles.
Records available.- Daily gage-height records April 1892 to December 1933. Daily discharge records January 1896 to December 1931. Flood estimates only April 1892 to December 1895 and January 1932 to December 1933.
Sources of data.- Gage-height records prior to July 17, 1928, and Jan. 1, 1932, to Dec. 31, 1933, by U. S. Weather Bureau; gage-height records July 17, 1928, to Dec. 31, 1931, and all discharge records by U. S. Geological Survey. Revisions of early records published in Water-Supply Paper 697, U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily prior to July 17, 1928, and Jan. 1, 1932, to Dec. 31, 1933; to hundredths twice daily July 17, 1928, to Dec. 31, 1931. Zero of all gages was 617.30 feet above mean sea level.
Stage-discharge relation.- Practically permanent. Bank-full stage, about 22 feet.
Remarks.- Daily gage readings above 10 feet January 1896 to October 1928 were plotted and mean daily and peak gage-height records determined from a constructed graph.
Historical data.- Flood of Apr. 1, 1886, reached stage of 36.6 feet (data of U. S. Weather Bureau).

Flood stages and discharges
(Base discharge 12,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1892 Apr.	8	32.0	* 39,200	Sept.	4	21.4	P 17,000
1893 Feb.	17	20.9	* 16,400	Oct.	7	23.0	19,400
1894 Mar.	22	10.1	** * 6,710	1899 Feb.	8	26.3	25,400
1895 Jan.	12	26.0	* 24,800		28	19.5	14,800
Mar.	22	19.9	* 15,200	Mar.	17	28.5	30,400
1896 Feb.	7	16.5	12,000		17	29.0	P 31,700
	7	16.7	P 12,200	....	....	....	......
....	....	....	......	1900 Feb.	14	23.2	19,700
1897 Mar.	8	19.1	14,400		14	23.7	P 20,500
	15	26.2	P 25,200	June	27	17.5	12,600
	16	25.9	24,600	....	....	....	......
Apr.	6	20.2	15,600	1901 Jan.	14	26.3	25,400
1898 Jan.	26	16.9	12,300		14	26.9	P 26,800
Apr.	6	17.2	12,600	Mar.	27	25.6	24,000
Sept.	4	21.2	16,800	Apr.	21	20.9	16,300

* Estimated
** Below base

Flood stages and discharges of Oostanaula River at Resaca, Ga.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1901	....		......		......
	May	23	25.21		23,200
	....		.....		......
	Aug.	24	20.1		15,300
	....		.....		......
	Dec.	16	22.6		18,700
		31	26.5		25,900
		31	26.7	P	26,300
1902	Feb.	3	19.2		14,300
	Mar.	2	25.0		22,900
		30	20.5		15,700
1903	Feb.	12	16.9		12,000
		18	21.1		16,500
	Mar.	2	26.9		26,800
		2	27.4	P	27,800
		31	23.5		20,200
	....		....		......
1904	Mar.	24	12.3	**	8,180
1905	Jan.	14	20.0		15,100
	Feb.	10	19.6		14,700
		22	21.8		17,500
		22	22.1	P	17,900
	Dec.	9	18.0		13,000
1906	Jan.	4	17.5		12,600
		23	17.3		12,400
	Mar.	16	21.7		17,400
		16	21.8	P	17,500
		20	19.4		14,700
	June	14	17.4		12,800
	Oct.	3	18.1		13,100
	Nov.	21	29.8		33,700
		21	30.0	P	34,200
1907	Mar.	3	17.8		12,900
1908	Feb.	16	19.8		14,900
		16	20.0	P	15,100
	Mar.	25	19.6		14,700
	Dec.	8	19.5		14,600
1909	Feb.	11	16.8		12,000
		16	18.8		13,800
		24	21.0		16,400
	Mar.	11	19.1		14,200
		14	32.0	P	39,200
		15	31.1		36,900
	May	2	19.9		15,000
	June	6	22.5		18,600
1910	May	21	20.0	P	15,100
		22	19.5		14,600
1911	Jan.	4	19.7		15,000
	Apr.	6	16.5		12,000
		9	21.7	P	17,400
		10	20.9		16,400
1912	Feb.	16	17.0		12,100
		26	18.6		13,600
	Mar.	16	18.8		13,800
		31	24.7		22,300
		31	25.0	P	22,900
1913	Mar.	1	21.3		16,800
		16	25.6		24,000
		16	25.8	P	24,400
		28	19.3		14,400
1914	Apr.	15	14.6	**	10,000
	Dec.	27	19.60		14,700
1915	Feb.	2	21.8	P	17,500
		3	21.0		16,400
	Dec.	19	20.4		15,600
		31	22.6		18,700
1916	Feb.	3	18.9		13,900
	July	12	27.1		27,200
		13	27.2	P	27,400
1917	Feb.	2	17.1		12,200
		21	22.1		17,900
	Mar.	6	29.8		33,700
		6	30.5	P	35,400

Date			Gage height (feet)		Discharge (second-feet)
	Mar.	26	27.8		28,700
1918	Feb.	1	23.2		19,700
		1	23.3	P	19,800
	Oct.	31	18.3		13,300
	Dec.	24	21.3		16,800
		24	21.7	P	17,400
1919	Jan.	3	16.9		12,000
	Feb.	23	20.0		15,100
	Mar.	10	19.4		14,500
	Dec.	11	21.7		17,400
1920	Jan.	26	19.4		14,500
	Feb.	5	20.3		15,500
		24	19.3		14,400
	Apr.	4	31.5		37,900
		4	32.0	P	39,200
	July	4	19.6		14,700
	Aug.	17	23.6		20,300
	Dec.	16	23.9		20,800
		24	18.1		13,100
1921	Feb.	11	32.8		41,400
		11	33.0	P	42,000
1922	Jan.	22	31.2		37,200
		22	32.2	P	39,700
	Feb.	16	19.6		14,700
	Mar.	3	18.3		13,300
		13	23.9		20,800
	Dec.	18	19.15		14,300
		18	20.3	P	15,500
1923	Apr.	15	17.80		12,900
1924	Feb.	28	19.10		14,200
	Mar.	7	21.70		17,400
	Apr.	20	24.80		22,500
		20	25.00	P	22,900
1925	Jan.	20	20.90		16,300
		20	21.20	P	16,600
1926	Jan.	19	17.00		12,100
		19	17.3	P	12,400
	Dec.	29	25.00	P	22,900
		30	24.50		21,900
1927	Mar.	11	18.10		12,800
	Apr.	12	20.00		15,000
	Dec.	17	19.10		14,200
1928	Mar.	31	20.80	P	16,100
	Apr.	1	20.27		15,500
	Sept.	7	19.57		14,700
1929	Mar.	1	20.32		15,400
		6	19.31		14,100
		17	21.91		17,600
		25	22.06		17,900
		25	22.10	P	17,900
	May	10	20.25		15,200
		21	20.08		15,100
	Nov.	17	28.52	P	30,400
		18	28.32		29,900
1930	Mar.	9	22.07		17,900
1931	Apr.	5	18.21	P	13,400
		6	17.56		12,800
	Dec.	16	23.10		19,500
		16	23.30	P	19,800
1932	Feb.	1	23.1	*	19,500
	Apr.	2	19.6	*	15,000
	May	2	20.2	*	15,700
	July	8	18.2	*	13,400
	Nov.	27	18.1	*	13,300
	Dec.	15	26.3	*	25,400
		29	31.2	P*	37,200
		30	30.9	*	36,400
1933	Feb.	9	18.0	*	13,200
		21	17.0	*	12,200
	Mar.	21	16.9	*	12,100

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: May 1 to July 31, 1896; May 1 to Oct. 31, 1899; July 1 to Oct. 31, 1900; May 1 to Oct. 31, 1903. Fragmentary record: May 1 to Nov. 12, 1906.

Allegheny River at Red House, N. Y.

__Location.__- In Red House, Cattaraugus County, about 7 miles below Salamanca and 15 miles above New York-Pennsylvania boundary.
__Drainage area.__- 1,690 square miles.
__Records available.__- September 1903 to September 1934.
__Source of data.__- U. S. Geological Survey.
__Gage.__- Nonrecording gage read once or twice daily prior to Sept. 3, 1917; recording gage thereafter. Zero of gage is 1,319.81 feet above mean sea level.
__Stage-discharge relation.__- Control fairly permanent.

Flood stages and discharges
(Base discharge 12,900 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1904	Jan.	24	9.95		20,900
	Feb.	8	10.70		24,600
	Mar.	4	8.68		15,100
		8	10.50		23,600
		26	11.10		26,800
	Apr.	2	8.35		13,800
		10	8.32		13,600
1905	Mar.	21	11.67		29,900
		27	9.92		20,700
1906	Jan.	24	8.25		13,300
	Mar.	28	8.4		14,000
	Dec.	7	8.60		14,800
		15	8.80		15,700
1907	Mar.	28	8.35		13,800
1908	Feb.	16	10.8		25,100
	Mar.	16	11.2		27,300
		20	9.5		18,800
		30	9.0		16,500
1909	Jan.	6	8.23		13,200
	Feb.	25	9.63		19,400
	May	2	12.53		34,600
1910	Mar.	2	13.6		41,000
	Apr.	26	9.2		17,400
		30	8.6		14,800
1911	Jan.	3	8.8		15,700
		15	8.6		14,800
		28	9.2		17,400
	Aug.	29	8.6		14,800
1912	Mar.	20	9.5		18,300
	Apr.	2	11.0		26,200
1913	Jan.	9	10.3		22,400
		18	9.1		16,400
	Mar.	26	12.7		36,000
	Apr.	29	10.2		21,800
1914	Jan.	30	9.0		15,900
	Mar.	28	11.7		30,000
	Apr.	8	8.4		13,200
	May	13	10.4		22,900
1915	Jan.	9	8.6		14,100
	Feb.	16	9.0		15,900
		25	9.6		18,800
	July	9	8.4		13,300
1916	Jan.	3	8.7		14,600
		6	9.4		17,800
	Mar.	30	12.4		34,200
	Apr.	16	9.8		19,800
		23	9.4		17,800
	May	18	10.7		24,600
1917	Mar.	12	8.8		15,000
	June	9	8.4		13,200
		9		P	13,400
	Oct.	30	10.6		23,900
		30	10.84	P	25,300
1918	Feb.	20	9.6		18,800
		20		P	21,000
	Mar.	3	8.4		13,300
		3	8.47	P	13,500
		15	11.4		28,100
		15	11.7	P	30,000
1919	Apr.	12	8.6		14,100
		12	8.66	P	14,400
	May	11	9.6		18,800
		11	9.70	P	19,300
		23	10.0		20,800
		23	10.12	P	21,400
1920	Mar.	15	11.8		30,700
		15	11.95	P	31,500
1921	Mar.	7	8.3		12,900
		7	8.45	P	13,500
1922	June	12	8.8		15,400
		12	9.00	P	16,200
1923	Mar.	5	10.2		22,200
		5		P	22,800
		13	8.7		14,900
		13		P	15,100
		17	8.3		13,200
		17	8.43	P	13,700
1924	Jan.	12	9.1		16,700
		12		P	18,500
	Apr.	7	8.5		14,000
		7		P	14,700
	Sept.	30			18,000
		30		P	20,400
	Dec.	19		†	12,000
1925	Feb.	7-28		*†	11,000
1926	Mar.	25	9.0		16,200
		25		P	16,900
	Apr.	9	9.1		16,700
		9	9.2	P	17,200
	Nov.	17	8.6		14,400
		17		P	15,600
1927	Mar.	15	9.0		17,000
		15		P	17,200
		22	9.3		18,500
		22	9.3	P	18,500
	May	25	8.7		15,600
		25		P	16,000
	Nov.	18	10.8		26,100
		18		P	26,800
		28	10.3		23,500
		28		P	23,600
	Dec.	1			34,700
		1	12.6	P	36,600
		14			15,900
		14		P	17,400
		17	8.8		15,600
		17		P	16,800
1928	Mar.	29		†	12,800
1929	Jan.	19			25,400
		19	10.9	P	26,500
	Mar.	16	9.6		20,000
		16		P	20,600
		27	8.4		14,200
		27		P	15,900
	Apr.	6			21,800
		6		P	22,400
		24	10.2		23,000
		24		P	24,600
1930	Jan.	10	8.9		16,000
		10		P	17,100
		14	8.8		15,600
		14		P	15,700
	Feb.	26	9.5		19,000
		26	9.6	P	19,500
1931	Apr.	11	8.6		14,800
		11	8.64	P	15,000
	Dec.	15	8.2		13,200
		15		P	13,700
1932	Jan.	18			14,400
		18		P	14,900

† Below base
* Estimated

Flood stages and discharges of Allegheny River at Red House, N. Y.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1932 Feb.	12		12,900	1933 Mar.	15		14,800
	12		P 13,400		15	8.83	P 15,500
Apr.	1	8.6	14,800	1934 Jan.	2		17,400
	1		P 15,000		2	9.52	P 18,800
May	9	9.17	P 17,400	Mar.	5	9.0	15,000
	10		14,400	Apr.	12		15,400

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Allegheny River at Franklin, Pa.

Location.- At Eighth Street Bridge, at Franklin, Venango County.
Drainage area.- 5,982 square miles.
Records available.- April 1905 to September 1934.
Sources of data.- Gage-height record April 1900 to May 1915 by U. S. Weather Bureau; thereafter from Pennsylvania Department of Forests and Waters; collaboration by U. S. Geological Survey 1918-21, 1931-34.
Gage.- Nonrecording gage read to tenths twice daily prior to Aug. 11, 1919, and to hundredths until recording gage was installed Oct. 1, 1932, at datum 2.00 feet lower. Elevation of zero of nonrecording gage is 958.26 feet above mean sea level. All recorded gage heights are at datum of nonrecording gage.
Stage-discharge relation.- Control practically permanent; usually affected by ice. Rating fairly well defined up to 120,000 second-feet by measurements made in 1916.
Historical data.- Maximum known open-water stage, 23.0 feet Mar. 17, 1865, referred to datum of nonrecording gage.

Flood stages and discharges
(Base discharge 40,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1905 July	30	8.7	41,200	Mar.	26	22.5	P 152,000
Nov.	30	8.6	40,500	1914 Jan.	30	11.8	P 62,900
1906 Mar.	28	9.0	43,300	Feb.	1	11.3	59,400
	28	9.6	P 47,500	Mar.	17	11.5	60,800
Dec.	7	9.0	43,300		29	16.3	98,900
	7	9.3	P 45,400		29	17.5	P 108,000
1907 Jan.	5	8.8	41,900	Apr.	9	9.4	46,100
Mar.	16	8.8	41,900	May	13	12.6	69,300
	29	8.9	42,600		13	12.8	P 70,900
Dec.	24	10.6	54,500	1915 Jan.	8	9.1	44,000
1908 Feb.	16	16.2	98,100	Feb.	2	10.4	53,100
	16	16.4	P 99,700		16	9.7	48,200
Mar.	3	8.5	39,800		26	8.6	40,500
	7	8.5	39,800	1916 Jan.	3	10.1	51,000
	16	11.0	57,300		6	11.4	60,100
	19	10.9	56,600	Mar.	29	16.9	104,000
1909 Jan.	7	8.7	41,200	Apr.	15	10.9	56,600
	23	9.2	P 44,700		23	10.1	51,000
	24	8.9	42,600	1917 Jan.	6	9.8	48,900
Feb.	16	9.8	48,900		24	**12.0	
	25	11.7	62,200	Feb.	2	**14.9	
Apr.	30	15.4	P 91,700		27	**20.1	
May	1	15.1	89,300	Mar.	12	11.0	P 57,300
1910 Mar.	4	14.2	82,100		13	10.2	51,700
	7	14.3	82,900		25	8.6	40,500
1911 Jan.	3	9.9	49,600	June	11	8.6	40,500
	15	12.5	68,500	Oct.	28	9.7	48,200
	29	11.3	59,400		30	15.0	72,500
Feb.	19	9.3	45,400	1918 Feb.	15	11.3	59,400
1912 Mar.	20	11.6	61,500		20	14.1	81,300
	30	11.6	61,500	Mar.	1	9.5	46,800
Apr.	3	15.1	89,300		11	8.6	40,500
	8	11.6	61,500		15	15.6	93,300
1913 Jan.	9	14.6	85,300		15	16.1	P 97,300
	9	15.7	P 94,100	1919 May	11	12.60	69,300
	13	11.4	60,100		11	12.70	P 70,100
	19	10.8	55,900		23	9.00	43,300
	24	9.9	49,600	1920 Mar.	13	18.04	113,000
Mar.	26	22.0	148,000		13	18.65	P 118,000

** Ice gorge

Flood stages and discharges of Allegheny River at Franklin, Pa.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1920	Mar.	17	11.47	60,800	1928	Jan.	1	10.35	53,100
1921	Mar.	7	9.9	P 49,600		Mar.	15	8.85	41,900
		8	9.75	48,900			28	8.69	41,200
	Nov.	20	8.68	41,200		June	7	9.19	44,700
1922	Apr.	1	8.93	42,600			25	8.57	40,500
		1	9.05	P 43,300		Dec.	2		44,700
1923	Mar.	5	12.09	65,300	1929	Jan.	19	15.00	P 88,500
		5	12.59	P 69,300			20		82,100
		13	9.76	48,900		Feb.	28		40,500
1924	Jan.	12	11.76	62,900		Mar.	16		55,900
		12	12.55	P 69,300			23		44,700
		17	9.20	44,700			27		42,600
	Mar.	30	9.15	44,700		Apr.	7		44,700
	May	10	8.60	40,500			22		57,300
	Oct.	1	11.01	57,300		May	4		46,100
	Dec.	20	9.80	48,900			16		43,300
1925	Feb.	12	12.43	67,700		Dec.	19		47,500
		12	12.8	P 70,900	1930	Jan.	10		58,700
		24	9.00	43,300			14		58,700
1926	Feb.	27	21.54	40,000		Feb.	26	11.6	P 61,500
	Mar.	24	11.84	62,900			27		56,600
		24	14.0	P 80,500	1931	Mar.	29	9.0	P 43,300
	Apr.	9	10.59	54,500			30		41,200
	Sept.	25	9.66	48,200	1932	Jan.	18		48,400
	Oct.	26	10.21	51,700			23	8.68	41,200
	Nov.	17	11.11	58,000		Mar.	28	8.66	41,200
		17	11.4	P 60,100		Apr.	2	8.56	40,500
1927	Jan.	23	9.34	45,400		May	9	11.03	57,300
	Mar.	15	9.43	46,100			9	12.0	P 64,500
		22	10.54	53,800	1933	Mar.	16	9.77	48,600
	May	26	10.33	52,400			16	10.14	P 50,700
	Nov.	18	13.20	74,100	1934	Jan.	2	11.14	57,700
	Dec.	1	16.55	101,000			2	11.54	P 60,500
		1	17.22	P 107,000		Mar.	5	10.40	52,800
		14	11.10	58,000					

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Ohio River at Pittsburgh, Pa.

Location.- 1858 to Oct. 16, 1907, on Monongahela River at foot of Market Street, Pittsburgh; thereafter U. S. Weather Bureau gage at Point Bridge.

Drainage area.- 19,100 square miles.

Records available.- Gage-height records August 1854 to December 1934. Miscellaneous discharge measurements.

Sources of data.- Gage-height records August 1854 to May 1873 by Corps of Engineers, U. S. Army; May 1873 to July 1891 by U. S. Signal Service; July 1891 to December 1934 by U. S. Weather Bureau. Discharge measurements from Corps of Engineers, U. S. Army. Gage-height records prior to 1872 and many subsequent values for peak gage reading from compilation in Water Resources Inventory Report, Part VIII (1916), Water Supply Commission of Pennsylvania.

Gages.- Nonrecording gage read once daily (oftener during floods) prior to Oct. 16, 1907; recording gage thereafter. Zero of gage prior to Mar. 1, 1926, was 697.2 feet above mean sea level. All gage-height records reduced to present datum, which is 694.0 feet above mean sea level. Flood stage, about 25 feet.

Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river training works involving dams, levees, dredging, etc. Operation of Davis Island Dam influenced low stages 1885-1922; pool elevation with all wickets raised was about 9 feet. Completion of Emsworth Dam in 1922 (minimum pool elevation, 9 feet) caused a permanent shift in rating below stage of about 30 feet.

Remarks.- Discharge measurements made by Corps of Engineers, U. S. Army, at various times, but irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of measurements to determination of discharge for any extended periods before and since measurements were made.

Flood stages of Ohio River at Pittsburgh, Pa.
(Base gage height 20.7 feet)

Date			Gage height (feet)
1762	Jan.	9 P	39.2
1763	Mar.	9 P	41.2
1784		P	38.2
1787	Jan.	P	35.2
1806	Apr.	10 P	37.1
1807	May	18 P	30.1
1810	Nov.	11 P	35.2
1813	Jan.	P	32.2
1816	Feb.	P	36.2
1832	Feb.	10 P	38.2
1840	Feb.	1 P	30.0
1846	Mar.	15 P	28.2
	Dec.	20	23.2
1847	Feb.	2	30.1
	Nov.	25	28.2
	Dec.	12	27.2
		18	21.2
1848	Dec.	22	26.2
1850	Dec.	8	23.2
1851	Sept.	20	34.1
1852	Apr.	16	30.2
		19	35.1
1855	Mar.	18	21.2
	Apr.	14-15	22.7
1856	Apr.	18	21.7
1857	May	6	24.5
	Dec.	11	21.2
1858	May	27 P	29.2
	Dec.	16 P	23.2
1859	Feb.	20	23.2
	Apr.	23	22.4
		27-28	25.2
1860	Jan.	15	21.2
	Apr.	12 P	32.9
	Nov.	4	25.2
1861	Sept.	29	34.2
	Nov.	4	21.2
1862	Jan.	21	33.2
	Apr.	9	22.7
		22	28.6
1863	Dec.	16	21.6
1864	Apr.	11	21.2
	Dec.	18	22.7
		20	22.7
1865	Mar.	4 P	27.7
		19 P	34.6
	Apr.	1	22.2
	May	13 P	24.8
	Dec.	23	21.2
1866	Feb.	14	20.7
1867	Feb.	15-16 P	25.2
	Mar.	13	26.7
1868	Mar.	18 P	25.2
	Sept.	26	21.2
1869	Mar.	31	22.7
1870	Jan.	19	21.2
1871	Jan.	17	21.7
1872	Apr.	11	23.2
		11 P	23.8
1873	Jan.	6	23.4
	May	4	21.7
	Dec.	14	27.7
		14 P	28.9
1874	Jan.	8	25.4
		8 P	25.8
	Dec.	30	23.2
		30 P	24.2
1875	Mar.	16	23.7
	Apr.	3	21.2
	Aug.	3	24.2
		3 P	25.1
	Dec.	28	23.5
		28 P	24.8
1876	Feb.	12	20.7
	Sept.	19	24.0
		19 P	28.2
1877	Jan.	17	25.3
		17 P	27.8
	Nov.	25	21.4
1878	Nov.	28	21.9
	Dec.	11	26.6
		11 P	27.7
1879	Jan.	29	23.0
	Mar.	12	23.1
1880	Feb.	14	24.8
	Dec.	6	21.7
1881	Feb.	11	26.4
	Apr.	14	21.7
	June	10	28.3
		10 P	30.3
1882	Jan.	14	21.2
		28	24.7
	Feb.	22	24.3
	Mar.	22	21.5
1883	Feb.	5	28.0
		8	30.0
		8 P	31.2
		12	23.8
		16	23.9
	Dec.	25	22.0
1884	Feb.	1	23.6
		6	35.1
		6 P	36.5
		12	21.5
		15	24.0
	Mar.	13	22.1
1885	Jan.	17	25.2
		17 P	26.2
1886	Jan.	6	23.4
	Feb.	14	22.7
	Apr.	1	23.2
		7	25.4
		7 P	25.8
1887	Feb.	4	23.2
		9	22.2
		12	25.1
		12 P	25.2
		27	23.5
		27 P	25.2
1888	Jan.	8	24.5
	July	11	24.5
		11 P	25.2
	Aug.	22	26.2
		22 P	29.2
1889	June	1 P	27.2
		2	25.0
1890	Jan.	17	20.8
		17 P	23.2
	Feb.	21	21.5
	Mar.	23 P	27.5
		24	25.7
	Apr.	10	21.8
		10 P	22.0
	May	25	22.7
		25 P	25.2
1891	Jan.	3	26.2
		3 P	26.4
	Feb.	3	21.0
		11 P	22.9
		18 P	34.5
1892	Jan.	15	26.1
		15 P	26.2
1893	Feb.	8	26.3
		8 P	27.2
		11 P	25.2
	Apr.	22	21.3
	May	18	23.0
1894	May	22	25.7
		22 P	26.4
1895	Jan.	8	28.9
		8 P	29.0
	Apr.	11	23.4
1896	Mar.	31	23.8
	July	26	25.0
		26 P	26.2
1897	Feb.	24	32.1
		24 P	32.7
	Mar.	7	21.9
1898	Jan.	17	21.0
		24	22.9
	Mar.	24	31.7
		24 P	32.1
		31	20.7
1899	Mar.	6	24.3
	Mar.	6 P	25.2
		30	22.4
1900	Jan.	22	21.0
	Nov.	27	30.5
		27 P	30.9
1901	Mar.	12	22.6
		12 P	23.0
		28	20.7
	Apr.	7 P	25.3
		8	24.2
		21	30.6
		21 P	30.7
	Dec.	16 P	29.0
1902	Mar.	1 P	35.6
		2	33.5
	Apr.	10 P	23.8
	Dec.	14	20.7
1903	Jan.	31	24.0
		31 P	24.2
	Feb.	5	26.7
		5 P	27.2
		17	24.5
		17 P	25.1
	Mar.	1	30.7
		1 P	32.1
		10	23.2
		10 P	23.3
		25	20.7
1904	Jan.	23	31.9
		23 P	32.1
	Feb.	9	22.4
		9 P	23.0
	Mar.	4	29.7
		4 P	30.1
		8	26.2
		8 P	26.4
		24	21.0
	Apr.	2 P	25.1
1905	Mar.	11	22.6
		11 P	23.6
		22 P	32.2
	Dec.	4	26.3
		4 P	26.7
1906	Jan.	24	21.6
		24 P	21.8
	Apr.	1	21.5
		1 P	22.0
1907	Jan.	15	24.3
		20	26.4
		20 P	26.5
	Mar.	15	38.3
		15 P	38.7
		20	24.2
		20 P	25.6
	Dec.	24 P	21.9
		25	21.4
1908	Jan.	14 P	23.5
	Feb.	16 P	33.9
	Mar.	3 P	23.7
		8 P	24.1
		20 P	30.5
1909	Feb.	17	22.3
		17 P	22.5
		25	25.5
		25 P	25.6
	May	2 P	25.4
1910	Jan.	19	25.2
		19 P	26.0
		22	21.2
	Mar.	1 P	25.2
		2	24.8
		8	21.6
1911	Jan.	15 P	27.0
		31	28.2
		31 P	28.4
	Sept.	16	22.5
		16 P	22.9
1912	Mar.	16 P	22.2
		17	21.1
		22 P	31.3
		31	20.7
	Apr.	3	22.4

Flood stages of Ohio River at Pittsburgh, Pa.--Continued

Date			Gage height (feet)	Date			Gage height (feet)	Date			Gage height (feet)
1912	Apr.	3 P	23.2		Mar.	16 P	21.6		Nov.	19 P	21.4
	July	26	22.2		Apr.	15 P	23.5			29	23.1
		26 P	22.9			16	23.1		Dec.	2	23.0
1913	Jan.	9 P	34.5	1923	Mar.	14	20.7			14 P	30.4
		12 P	29.5		May	13	21.8			15	28.2
		13	28.8			13 P	22.5	1928	Mar.	31	22.5
	Mar.	28 P	33.6		Dec.	24	21.0			31 P	22.6
	Nov.	15	23.4			29	20.7		May	1	23.6
		17 P	25.4			29 P	21.4			1 P	24.9
1914	Mar.	29	23.7	1924	Jan.	4	30.4	1929	Jan.	20	23.0
		29 P	24.4			4 P	30.6			20 P	23.2
1915	Jan.	8	22.6			13	21.2		Feb.	27	24.6
		8 P	23.0			18	22.2			27 P	25.3
	Feb.	3	30.9		Mar.	30	31.5		Mar.	7	21.2
		3 P	31.6			30 P	32.4			7 P	21.9
	Dec.	19	25.8		May	10	22.3		Oct.	3 P	23.9
1916	Jan.	3	23.6			13	29.4			4	22.4
	Mar.	23	22.4			13 P	29.6		Nov.	19	23.4
		29	25.0		June	30	23.3			19 P	23.7
1917	Jan.	23	27.2			30 P	23.7	1930	Feb.	27	23.7
		23 P	28.4		Oct.	1	23.1			27 P	23.9
	Mar.	13	26.2			1 P	23.6	1931	Apr.	4 P	24.6
		13 P	26.3	1925	Feb.	12	23.9			5	23.4
1918	Feb.	16	21.5			13 P	25.1		Dec.	14 P	21.5
		21	30.3	1926	Feb.	26 P	22.3			15	21.3
		27	22.2			27	21.2	1932	Jan.	31	21.2
	Mar.	15	28.0		Mar.	25	21.0			31 P	21.4
		15 P	29.0			25 P	21.9		Feb.	5 P	22.2
1919	Jan.	3	25.6		Sept.	6 P	22.2			6	20.9
		3 P	26.0			7	21.3		Mar.	29-30	21.2
	May	12	20.7		Nov.	17	22.2			29 P	21.8
	Nov.	27	22.4			17 P	22.9		Apr.	1 P	23.8
		27 P	23.2	1927	Jan.	23	29.6			2	22.7
1920	Mar.	13	25.2			23 P	29.7	1933	Mar.	15 P	29.6
		13 P	28.4		Feb.	26	21.6			16	28.9
		18	22.0		Mar.	22	24.0			22	23.1
1921	Mar.	4 **	18.8		May	20	21.1	1934	Jan.	8	21.7
	Nov.	29	27.6			20 P	21.4			8 P	22.3
		29 P	28.6		Oct.	21	22.2		Mar.	6	22.4
	Dec.	25	24.4		Nov.	19	21.2			6 P	25.8
1922	Mar.	16	21.5								

** Below base

Note.- Unless designated by "P" (momentary peak) gage-height values are single daily readings usually taken in morning.

Ohio River at Cincinnati, Ohio

Location.- Prior to Jan. 1, 1908, at Front Street pumping station, Cincinnati, Hamilton County; thereafter at foot of Broadway. Both locations opposite mouth of Licking River, 13 miles above Dam 37.

Drainage area.- 76,580 square miles (U. S. Weather Bureau data).

Records available.- Daily gage-height records June 1858 to December 1934; discharge measurements 1908-10, 1912-14; estimated flood discharges prior to 1914.

Sources of data.- Daily gage-height records by Mississippi River Commission and U. S. Weather Bureau; discharge measurements by U. S. Geological Survey; estimated flood discharges prior to 1914 published in Water-Supply Paper 334, U. S. Geological Survey.

Gages.- Nonrecording gage read at least once daily. Zero of gage is 429.76 feet above mean sea level (datum of Corps of Engineers, U. S. Army).

Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river stabilization works involving dams, dredging, etc. Flood stage, about 52 feet.

Remarks.- Only those gage-height crests which were 3.- feet or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before or since measurements were made.

Historical data.- Flood of Feb. 19, 1832, reached stage of 64.0 feet (Mississippi River Commission). Other early floods had the following estimated stages: 1773, 76 feet; 1792, 63 feet; 1793, 57 feet; 1847, 63.6 feet.

Flood stages
(Base gage height 40.0 feet)

Date				Gage height (feet)
1858	June	16		43.67
	Dec.	19		41.83
1859	Feb.	23		55.33
	Mar.	23		40.33
	May	1		51.25
1860	Jan.	17		47.00
	Apr.	17		49.08
1861	Jan.	20		41.58
	Apr.	20		49.42
	Oct.	2		41.75
1862	Jan.	24		57.33
	Feb.	4		41.58
		25		48.50
	Mar.	5		40.42
		22		43.25
	Apr.	13		51.42
		26		52.17
1863	Feb.	1		41.17
	Mar.	12		42.75
1864	May	20	**	39.83
	Dec.	23		45.08
1865	Mar.	8		56.17
		22		48.50
	Apr.	14		42.67
	May	14		51.25
	Dec.	30		41.50
1886	Sept.	26-27		41.17
1867	Feb.	7		40.00
		22		54.08
	Mar.	15		55.67
1868	Jan.	10		43.25
	Mar.	18		43.67
		30		48.25
	May	19		40.33
	Sept.	29		41.25
1869	Apr.	3		48.67
1870	Jan.	19		55.25
	Apr.	1-2		49.75
		24		47.50
1871	May	13		40.50
1872	Apr.	13		41.75
1873	Feb.	21		41.50
	Dec.	18		44.42
1874	Jan.	13		46.75
	Feb.	26		44.00
	Apr.	13		43.00
	May	2		46.00
1875	Mar.	2		42.58
		20		41.50
	Aug.	6		55.33
	Dec.	30-31		47.67
1876	Jan.	29		51.75
	Feb.	16		44.92
	Mar.	31		40.33
1877	Jan.	20-21		53.25
	Mar.	29		43.00
1878	Sept.	17	**	35.92
	Dec.	15		41.33
1879	Feb.	2		40.17
	Dec.	27		42.75
1880	Jan.	9		42.00
	Feb.	17		53.17
	Mar.	11		45.08
		18		41.17
	Apr.	29		45.42
1881	Feb.	16		50.50
	Apr.	17		42.58
1882	Jan.	1		41.08
		16		48.50
		31		47.67
	Feb.	21		58.58
	Mar.	24		46.92
	May	16		46.42
1883	Feb.	15		66.33
	Apr.	3		43.33
		9		46.50
	Dec.	28		49.50
1884	Feb.	14		71.06
	Mar.	17		49.58
1885	Jan.	20		46.00
	Feb.	18		40.50
	Apr.	9		55.75
1887	Feb.	5		56.25
		18		50.33
		28		54.54
	Mar.	11		40.08
	Apr.	25		49.33
1888	Mar.	31	**	39.75
1889	Feb.	22	**	38.08
1890	Jan.	11		40.2
		21		43.6
	Feb.	10		43.2
	Mar.	1		56.8
	Mar.	25-26		58.9
		26	P	59.1
	May	29		41.9
1891	Jan.	6		48.4
	Feb.	5		47.7
		13		46.3
		25		57.3
	Mar.	12		43.3
	Apr.	6-7		43.4
1892	Jan.	18		41.6
	Apr.	22		43.2
1893	Feb.	21		54.6
	May	7		51.0
1894	Feb.	15	**	35.6
1895	Jan.	14		48.4
1896	Apr.	4		47.7
	Aug.	2		41.8
1897	Feb.	11		44.4
		26		61.1
	Mar.	6		43.2
		12		50.1
1898	Jan.	20		48.3
		26		52.2
	Mar.	28		61.1
		29	P	61.4
1899	Jan.	14		44.4
	Mar.	8		57.3
		23		40.4
		31		51.5
1900	Feb.	16	**	37.4
	Nov.	30		40.0
1901	Apr.	26		59.6
		27	P	59.7
	June	1		40.1
1902	Jan.	3		44.0
	Feb.	2		41.7
	Mar.	5		50.90
	Apr.	15		42.2
	Dec.	18		47.0
1903	Feb.	8		49.4
		20		49.4
	Mar.	5		53.1
		5	P	53.2
		27-28		40.6
	Apr.	19		44.4
1904	Jan.	28		43.6
	Mar.	9		45.9
		27		45.7
	Apr.	7		42.1
1905	Mar.	13		48.1
		13	P	48.3
		27		47.0
	May	16		48.2
	Dec.	7		40.0
1906	Apr.	2		50.2
1907	Jan.	5		43.2
		21		65.1

** Below base
P Momentary peak

Flood stages of Ohio River at Cincinnati, Ohio--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1907 Jan.	21 P	65.2	Mar.	27	43.0	Apr.	3	50.2
Mar.	18 P	62.1	May	31	40.5		3 P	50.4
	19	62.1		31 P	40.8	May	18	48.4
June	17	43.0	1918 Feb.	2	61.0		18 P	48.5
1908 Feb.	20	51.1		2 P	61.8	1925 Feb.	18	42.1
Mar.	11-12	53.2		12	60.3		18 P	42.3
	24	48.9	Mar.	17	51.2	1926 Jan.	25	46.3
Apr.	4	55.7		17 P	51.5	Feb.	19-20	40.4
	14	40.5	1919 Jan.	6	52.0	Nov.	20-21	40.0
May	9	44.1	Nov.	5	45.6		20 P	40.2
1909 Feb.	28	54.6		30	47.2	Dec.	29	46.2
Mar.	11	42.3		30 P	47.4		29 P	46.3
May	6	47.0	Dec.	10 P	49.1	1927 Jan.	27	59.0
1910 Jan.	24	47.9		11	48.9		27 P	59.1
Mar.	7	51.8	1920 Jan.	27	48.4	Feb.	27	46.8
1911 Feb.	3	49.1		27 P	48.6	Mar.	26	46.0
Apr.	14	41.6	Mar.	22	54.6	Dec.	20	50.4
1912 Mar.	2	41.2	Apr.	23	52.6	1928 May	3	41.3
	27	53.2	1921 Mar.	11	41.4	July	2	43.4
Apr.	5-6	51.7		11 P	41.5		2 P	43.8
1913 Jan.	13 P	62.2	Dec.	3	48.7	1929 Jan.	26	42.8
	14	61.9		3 P	48.9	Mar.	4	52.7
Apr.	1	69.8		27	55.9	May	9	43.7
Nov.	20	42.8		27 P	56.1	Nov.	22	44.2
1914 Apr.	4	47.2	1922 Mar.	18	52.1	1930 Jan.	15	41.0
1915 Feb.	7	55.8		18 P	52.2	1931 Apr.	8	44.1
Dec.	22	47.3	Apr.	4	41.7	1932 Feb.	7	50.3
1916 Jan.	3	50.0		19	48.1		7 P	50.4
	14-15	53.1		19 P	48.2	Apr.	1	46.3
Feb.	4	43.7	1923 Feb.	5	47.6	1933 Jan.	25 P	40.7
Apr.	1	53.4	Mar.	17	40.9		26	40.0
	1 P	53.5	Dec.	28	40.5	Mar.	22	63.6
1917 Jan.	10	41.4	1924 Jan.	6	55.6	Apr.	19	45.7
	26	45.9		6 P	55.8	May	15	54.0
	26 P	46.0		17	44.0		15 P	54.1
Mar.	17	55.8	Feb.	24	41.0	1934 Mar.	9	46.6
	17 P	56.1						

P Momentary peak

Ohio River at Louisville, Ky.

Location.- Upper gage of Corps of Engineers, U. S. Army, at locks of Louisville & Portland Canal at Louisville, Jefferson County.

Drainage area.- 91,170 square miles (data of U. S. Weather Bureau).

Records available.- Fragmentary high-water gage-height records 1832-69; daily gage-height records November 1871 to December 1934; discharge measurements 1910-14; estimated flood discharges 1884, 1906-7, 1913.

Sources of data.- Daily gage-height records by Mississippi River Commission and U. S. Weather Bureau; discharge measurements by U. S. Geological Survey 1910-12, 1914; estimated flood discharges prior to 1914 published in Water-Supply Paper 334, U. S. Geological Survey.

Gage.- Nonrecording gage read at least once daily. Zero of gage is 402.54 feet above mean sea level (datum of Corps of Engineers, U. S. Army).

Stage-discharge relation.- Affected by operation of locks and wickets at Dam 41. Normal pool stage, about 9.0 feet prior to November 1927 and about 16.5 feet thereafter. Flood stage, about 28 feet.

Remarks.- Only those gage-height crests which were 3.0 feet or more above preceding and following low points were used in this compilation.

Flood stages
(Base gage height 18.0 feet)

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1832		40.8	1871 Nov.	24	** 6.50	May	3	22.00
1851 Mar.	2	20.3	1872 Apr.	14	20.95	1875 Mar.	3	19.00
1858 June	17	19.1	1873 Feb.	21	**17.10		20	18.00
1859 Feb.	24	33.8	Dec.	19	18.30	Aug.	7	30.30
1866 Jan.	1	18.6	1874 Jan.	13	22.22	1876 Jan.	1	22.00
1867 Mar.	15	37.6	Feb.	26	22.35		30	32.50
1868 Mar.	31	22.3	Apr.	14	19.00	Feb.	17	20.30
1869 Apr.	4	24.3						

** Below base

Flood stages of Ohio River at Louisville, Ky.--Continued

Date	Gage height (feet)	Date	Gage height (feet)	Date	Gage height (feet)
1877 Jan. 21-22	29.90	Mar. 10	32.8	Jan. 26	22.2
1878 Sept. 18	** 12.30	Apr. 2	26.6	Mar. 19	30.5
Dec. 17	** 15.50	1900 Feb. 17	** 13.3	1918 Feb. 14	26.7
1879 Jan. 18	** 17.70	Dec. 1	** 15.4	Mar. 19	23.7
Dec. 29-30	19.60	1901 Apr. 29	33.2	1919 Jan. 7	27.5
1880 Feb. 19	30.00	1902 Feb. 3	18.3	Nov. 6	22.0
Mar. 12	20.90	Mar. 9	24.80	Dec. 1	23.1
May 1	19.20	Dec. 19	24.3	14	27.2
1881 Feb. 17	22.50	1903 Feb. 9	24.0	1920 Jan. 28	25.8
1882 Jan. 16	25.70	21	25.1	Mar. 23	31.5
Feb. 22	37.40	Mar. 9	28.5	Apr. 24	28.5
Mar. 26	20.80	Apr. 20	18.9	1921 Mar. 12	18.2
May 18	20.00	1904 Mar. 11	19.3	Dec. 4	22.9
1883 Feb. 16	43.80	28	22.9	28	32.3
Apr. 9-10	22.30	1905 Mar. 14	21.7	1922 Mar. 19	30.2
Dec. 29	24.30	14	P 22.0	Apr. 20-21	21.9
1884 Feb. 16	46.60	28	19.3	1923 Feb. 6	27.0
Mar. 15	25.30	May 17	21.7	Mar. 17	19.0
1885 Jan. 21	21.70	1906 Apr. 3	26.3	1924 Jan. 27	32.7
1886 Apr. 10	32.70	1907 Jan. 5	22.4	27	P 32.9
1887 Feb. 6	32.55	22	41.2	18	20.7
19	26.85	22	P 41.4	Apr. 5	23.8
Mar. 2	31.90	Mar. 20	35.9	May 20	21.6
Apr. 26	25.60	1908 Feb. 21-22	24.6	1925 Feb. 19	18.3
1888 Apr. 1-2	** 16.05	Mar. 12	28.0	19	P 18.4
1889 Feb. 23	** 13.80	25-26	21.6	1926 Jan. 26	23.0
1890 Jan. 22	19.8	Apr. 6	31.1	Dec. 30	26.1
Feb. 11	19.4	May 10	20.1	1927 Jan. 27	35.6
Mar. 2-3	34.0	1909 Feb. 27	32.9	Feb. 28	22.4
28	35.4	Mar. 11	23.1	Mar. 23	22.3
1891 Jan. 7	21.8	May 7	20.4	Dec. 22	24.5
Feb. 7	22.6	1910 Jan. 17-18	† 27.2	1928 July 3	22.0
27	32.4	18	P† 27.5	3	P 22.1
Mar. 13	20.1	Mar. 8	24.3	1929 Jan. 27	22.0
Apr. 7	18.2	1911 Feb. 5-6	22.8	Mar. 5-6	28.3
1892 Apr. 23	21.6	5	P 22.9	5	P 28.4
1893 Feb. 21	28.7	Apr. 15	20.2	May 10	21.0
21	P 28.89	1912 Mar. 28	28.7	1930 Jan. 16	19.8
May 3	27.4	Apr. 7	28.5	1931 Apr. 8-9	18.9
1894 Feb. 14	** 12.7	1913 Jan. 14-15	39.3	8	P 19.0
1895 Jan. 15	20.6	15	39.5	1932 Feb. 5	29.7
15	P 20.7	Apr. 2	P 44.4	Apr. 2	23.1
1896 Apr. 5	22.4	1914 Apr. 5	22.3	1933 Jan. 26	20.9
1897 Feb. 11	18.0	1915 Feb. 8	29.9	Mar. 23-24	39.0
28	35.3	Dec. 23	25.5	23	P 39.1
Mar. 6	22.5	1916 Jan. 15	31.1	Apr. 20	24.5
13	27.2	15	P 31.2	20	P 24.6
1898 Jan. 26	30.0	Feb. 2	21.6	May 17	30.1
Mar. 30	36.2	Apr. 3	27.2	1934 Mar. 11	21.9
1899 Jan. 16	22.2	1917 Jan. 10	19.3		

† Ice gorge
** Below base
P Momentary peak

Ohio River at Evansville, Ind.

Location.- Gage of Corps of Engineers, U. S. Army, at foot of Main Street, Evansville, Vandenburg County.
Drainage area.- 107,050 square miles (data of U. S. Weather Bureau).
Records available.- Daily gage-height records April 1873 to December 1934; estimated flood discharges 1884, 1906-7, 1913.
Sources of data.- Daily gage-height records by U. S. Signal Service prior to 1890 and by U. S. Weather Bureau thereafter; estimated flood discharges published in Water-Supply Paper 334, U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths at least once daily (oftener during high water). Zero of gage is 329.09 feet above mean sea level (datum of U. S. Coast and Geodetic Survey).
Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river stabilization works involving dams, dredging, etc. Flood stage, about 35 feet.
Remarks.- Only those gage-height crests which were 2.0 feet or more above preceding and following low points were used in this compilation.
Historical data.- Flood of 1832 reached stage of 46.29 feet (data of Mississippi River Commission).

Flood stages of Ohio River at Evansville, Ind.
(Base gage height 29.0 feet)

Date		Gage height (feet)
1873 May 15		30.8
....		....
Dec. 20		34.6
1874 Jan. 15		37.2
30		30.2
Feb. 28		39.2
Apr. 16		37.2
May 5		38.6
1875 Mar. 4-5		35.8
22		36.6
July 19		31.2
Aug. 9-10		41.9
1876 Jan. 3		37.9
31		43.3
Feb. 19		37.8
Apr. 3		35.4
1877 Jan. 23		41.5
Mar. 19		32.3
Apr. 2		32.5
1878 Mar. 17	**	27.8
Dec. 5		30.5
18-19		31.8
1879 Feb. 6		32.2
Apr. 1		33.0
Dec. 30-31		37.3
1880 Jan. 12		37.0
Feb. 21		42.1
Mar. 14		39.0
May 3		35.2
Dec. 9		31.6
1881 Jan. 26		32.2
Feb. 19		38.9
Apr. 20-21		34.8
Dec. 26		33.6
1882 Jan. 18		40.9
Feb. 24		44.9
Mar. 13		37.0
28		38.0
May 20		36.0
June 5		32.7
1883 Feb. 19		47.8
Apr. 11		38.9
27		29.3
....		....
1884 Jan. 1		39.0
Feb. 18-19		48.0
19	P	48.8
Mar. 18-21		39.7
1885 Jan. 23		37.5
Apr. 24-25		29.6
1886 Feb. 21		34.5
Apr. 14		43.4
May 17		29.0
....		....
1887 Feb. 8-9		43.2
Mar. 5		43.1
Apr. 28-29		38.3
....		....
1888 Apr. 3-4		35.2
Nov. 12-13		31.6
1889 Feb. 25		29.0
Nov. 30		29.0
1890 Jan. 24		38.9
Feb. 14		37.0
Mar. 5		43.9
30-31		44.4
May 27-28		32.8
1891 Jan. 8-10		37.0
Mar. 2		42.8
16		38.0
Apr. 9-10		37.2
1892 Jan. 21		30.6
Apr. 4		30.5
25-28		38.2
1893 Feb. 24		41.8
Apr. 21-22		30.8
May 5		40.3
1894 Feb. 19		31.8
1895 Jan. 17-18		35.5
....		....
Mar. 23		29.6
1896 Mar. 25		32.1
Apr. 7-8		38.0
Aug. 6		30.5
1897 Feb. 12-13		35.5
Mar. 2-3		43.6
Apr. 17-18		33.5
1898 Jan. 28		43.1
Apr. 2-3		44.8
1899 Jan. 18		39.1
Feb. 12		32.2
Mar. 12		42.7
Apr. 5		40.4
1900 Feb. 18-19		31.1
Mar. 10		29.7
Dec. 3		33.6
1901 Apr. 11		29.7
Apr.30-May 1		41.8
1902 Jan. 5-6		31.3
Feb. 5		35.8
Mar. 11		40.0
Apr. 19		30.6
Dec. 22		40.0
1903 Jan. 10-11		29.6
Feb. 11		39.8
23		40.7
Mar. 11		42.4
31		30.6
Apr. 22-23		36.0
1904 Jan. 31		31.7
Mar. 14		36.2
Apr. 3-4		39.8
1905 Mar. 17		37.4
30		34.9
May 19-20		35.6
Dec. 9		32.0
1906 Apr. 6		41.1
Nov. 25		31.3
Dec. 23		34.7
1907 Jan. 7-8		40.3
24-25		46.2
Mar. 23		43.8
June 20		32.3
1908 Feb. 10		30.0
24		40.9
Mar. 15		41.5
28		37.1
Apr. 8-9		42.2
May 12-13		37.6
1909 Mar. 2		43.2
13-14		40.6
May 10		35.7
1910 Jan. 27		38.6
Mar. 10		39.7
June 15		29.7
1911 Jan. 8		29.4
23-24		29.9
Feb. 9		38.8
Mar. 13		29.3
Apr. 17		38.4
May 4		31.2
Dec. 22		33.3
1912 Jan. 2-3		33.3
Mar. 3		36.3
31		42.6
May 3		35.4
1913 Jan. 20		46.8
Apr. 5		48.4
Nov. 24		30.8
1914 Feb. 25		33.7
Apr. 8		38.0
1915 Jan. 17		31.2
27		33.0
Feb. 11		42.6
Dec. 26		41.1
1916 Jan. 6-7		41.7
Jan. 18		43.6
Feb. 4		40.2
Apr. 5-6		39.7
1917 Jan. 12		37.7
29		38.5
Mar. 22		42.9
June 4		33.2
1918 Feb. 6		38.0
17		39.8
Mar. 22		37.2
1919 Jan. 9		40.9
Mar. 20		37.4
20	P	37.6
May 18		33.1
30-31		31.0
Nov. 8-9		38.0
8	P	38.2
Dec. 4		39.0
16-17		42.3
1920 Jan. 15		35.6
31		40.3
Mar. 25		42.8
Apr. 28		40.8
1921 Feb. 17		31.3
Mar. 15		36.4
Apr. 1		32.6
Nov. 22		32.1
Dec. 6-7		39.5
6	P	39.6
30		43.1
1922 Feb. 27		34.2
Mar. 21		42.9
Apr. 7-8		36.5
23		37.5
1923 Feb. 8		42.2
Mar. 20		37.8
Apr. 18		30.8
Dec. 17		30.9
1924 Jan. 11		43.5
Feb. 27		33.6
Apr. 7		38.3
May 22		36.5
Dec. 14		30.8
1925 Feb. 21-22		33.4
Mar. 25		29.8
Nov. 17		32.0
1926 Jan. 28-29		38.5
Feb. 10		30.7
22		33.2
Apr. 1-2		29.0
17		29.5
Nov. 4		30.4
24		30.8
1927 Jan. 2		41.4
30		44.8
Mar. 2		37.3
25		39.9
Apr. 16		36.3
16	P	36.4
May 11		30.0
June 5		34.0
Dec. 10		29.9
24		38.7
1928 May 6		32.2
June 15		32.0
July 5		38.3
5	P	38.4
1929 Jan. 29		38.4
Mar. 11		42.1
30-31		33.8
Apr. 14		31.7
May 17		38.5
Nov. 25		32.9
Dec. 22		31.6
1930 Jan. 17-18		39.9
Feb. 11		30.1
Mar. 6-7		31.2
15-16		31.0

** Below base
P Momentary peak

Flood stages of Ohio River at Evansville, Ind.--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1931 Apr.	11	34.7	July	11	30.8	May	20	42.3
Dec.	19-20	34.4	1933 Jan.	3	35.7	1934 Jan.	13	29.5
1932 Jan.	19-20	35.8		28	38.9	Mar.	13-14	38.4
Feb.	7-8	43.1	Feb.	26	32.8		13	P 38.5
	7	P 43.2	Mar.	27	45.2	Apr.	3	31.0
Apr.	5	38.8	Apr.	22	39.6			

P Momentary peak

Note.- Breaks in record: July 5 to Oct. 18, 1873; May 1-31, 1883; Dec. 1-31, 1883; Oct 1 to Nov. 30, 1886; Oct. 1-31, 1887; Feb. 8-22, 1895.

Redbank Creek at St. Charles, Pa.

Location.- At an industrial railroad bridge, St. Charles, Clarion County.
Drainage area.- 528 square miles.
Records available.- October 1909 to September 1934.
Sources of data.- Pennsylvania Department of Forests and Waters; collaboration by U. S. Geological Survey 1918-21, 1931-34.
Gage.- Nonrecording gage read twice daily, to quarter tenths prior to Oct. 1, 1921, and to hundredths thereafter. Zero of gage is 976.24 feet above mean sea level.
Stage-discharge relation.- Permanent except as affected by ice. Banks high and not subject to overflow.
Regulation.- Some regulation at low stages.

Flood stages and discharges
(Base discharge 5,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1910 Jan.	18	10	P* 13,100
	19	7.10	7,730
	22	6.35	6,340
Feb.	28	10.21	* 13,500
	28	10.46	P* 14,000
Mar.	7	7.83	9,080
Dec.	30	7.41	8,300
	30	7.72	P 8,880
1911 Jan.	3	6.09	5,860
	14	7.42	8,320
	14	8.32	P 10,000
Aug.	29	7.35	8,190
Sept.	5	7.31	8,120
	15	8.83	* 10,900
	15	9.81	P* 12,800
Oct.	2	13.01	19,000
	2	13.04	P 19,100
	18	6.49	6,600
Dec.	14	5.77	5,270
1912 Feb.	27	6.11	5,900
Mar.	15	6.15	5,970
	29	5.78	5,290
Apr.	3	7.35	8,190
July	18	7.78	8,990
	18	8.68	P* 10,600
Aug.	26	7.50	8,470
Sept.	3	8.93	* 11,100
	3	9.88	P* 12,800
1913 Jan.	8	11.79	* 16,400
	12	8.45	* 10,200
	18	5.89	5,490
	24	5.75	5,230
Mar.	26	11.89	* 16,600
	26	12.16	P* 17,000
1914 Jan.	30	6.80	7,180
Mar.	17	7.05	7,640
	28	7.50	8,470
May	13	7.72	8,880
	13	8.15	P* 9,670
1915 Jan.	8	9.73	* 12,600
	19	7.63	8,710
Feb.	1	9.09	* 11,400
	1	10.59	P* 14,200
Feb.	15	6.59	6,790
	24	6.52	6,660
Dec.	19	5.7	5,140
1916 Jan.	2	7.7	8,840
	5	6.9	7,360
Mar.	28	11.1	* 15,100
	28	12.0	P* 16,700
Dec.	28	6.2	* 5,850
1917 Feb.	27	5.9	* 5,250
Mar.	12	6.5	* 6,480
	12	7.7	P* 9,080
Oct.	25	6.8	* 7,110
1918 Feb.	13	9.4	* 13,300
	20	11.5	* 18,300
	20	12.2	P* 19,800
	28	6.9	* 7,320
Mar.	14-15	8.1	* 10,000
1919 Jan.	2	6.41	6,270
May	10	7.65	8,850
	10	8.20	P 10,200
	21	7.00	7,530
Oct.	17	5.86	5,250
1920 Mar.	13	9.75	14,300
	13	10.3	P 15,500
June	18	7.50	8,630
1921 Mar.	7	6.66	6,900
	7	7.00	P 7,530
Sept.	22	5.96	5,450
Nov.	2	7.87	9,540
	2	8.50	P 10,900
	28	6.80	7,110
1922 Mar.	11	5.81	5,050
	29	5.80	5,050
1923 Mar.	5	6.29	6,060
May	13	8.83	11,800
	13	9.2	P 12,700
Dec.	28		* 5,000
	31		* 6,000
1924 Jan.	3		* 8,000
June	29	9.69	14,000
	29	11.56	P 18,500
Sept.	30	7.16	7,970
1925 Feb.	10	8.55	11,200

* Estimated

Flood stages and discharges of Redbank Creek at St. Charles, Pa.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1925	Feb.	10	9.50	P 13,500		July	8	5.80	5,050
1926	Jan.	19	6.26	6,060	1929	Jan.	19	7.45	8,410
	Feb.	26	7.76	9,310			19	7.60	P 8,850
	June	15	5.95	5,450		Feb.	27	6.80	7,110
	Sept.	6	9.17	12,700		Apr.	5	6.00	5,450
		6	10.1	P 15,000		May	15	5.80	5,050
	Oct.	25	5.90	5,250		Nov.	17	7.6	P 8,850
1927	Jan.	22	9.10	12,600			18	6.68	6,900
		22	10.1	P 15,000	1930	Jan.	13	6.31	6,070
	Mar.	8	7.29	8,190		Feb.	26	6.80	7,110
		21	7.65	8,850	1931	Apr.	4	6.25	P 5,850
	Nov.	29	6.25	5,850		June	8	5.75	5,050
	Dec.	14	10.61	16,200		Dec.	14	6.75	7,000
		14	12.80	P 21,000	1932	Jan.	18	7.84	9,450
		16	9.00	12,300			18	8.50	P 11,000
1928	Mar.	14	5.77	5,050	1933	Mar.	15	8.44	10,900
		30	6.62	6,690			15	9.30	P* 13,000
	June	6	7.00	7,530		Dec.	21		** 4,020
		9	5.95	5,450					

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kiskiminetas River at Avonmore, Pa.

Location.- At highway bridge, Avonmore, Westmoreland County.
Drainage area.- 1,723 square miles.
Records available.- May 1907 to September 1934. Estimated flood record January 1884 to November 1895 and November 1901 to April 1907.
Sources of data.- Pennsylvania Department of Forests and Waters; collaboration by U. S. Geological Survey 1907-13, 1918-21, 1931-34. Records prior to May 1907 taken from Water Resources Inventory Report, Part VIII (1916), Water Supply Commission of Pennsylvania.
Gage.- Nonrecording gage read to half-tenths twice daily prior to July 27, 1922, and to hundredths thereafter; read more frequently during high stages. Zero of gage is 805.64 feet above mean sea level.
Stage-discharge relation.- Control probably permanent. Left bank low and subject to overflow at high stages.
Regulation.- Storage began in Quemahoning Reservoir in 1913, capacity, about 35,400 acre-feet; controlled area, 96 square miles.
Remarks.- Flood record prior to May 1907 derived from U. S. Signal Service (1884-92) and U. S. Weather Bureau (1893-95, 1901-07) gage readings taken on the Kiskiminetas River at Saltsburg, about 5 miles above Avonmore.

Flood stages and discharges
(Base discharge 20,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1884	Jan.	2	16.2	26,700	1891	Feb.	10	14.5	21,600
	Feb.	1	14.5	21,600			17	30.4	78,900
		6	24.1	54,200		June	22	14.3	21,000
		14	15.1	23,300	1892	Jan.	14	15.1	23,300
	Mar.	9	15.1	23,300	1893	Feb.	7	14.4	21,300
		12	15.8	25,400			11	15.2	23,600
1885	Jan.	17	16.4	27,300	1894	May	20	19.5	37,500
	Apr.	1	15.1	23,300	1895	Jan.	8	19.8	38,600
1886	Jan.	5	19.1	36,200		Mar.	1	15.8	25,400
1887	June	8	13.4	** 18,500		Apr.	10	17.4	30,500
1888	Jan.	8	18.6	34,500			14	16.1	26,400
	Feb.	6	14.3	21,000	....	....	....	....	......
	Aug.	21	31.8	P 84,500	1901	Dec.	15	16.4	27,300
1889	June	1	29.8	76,500	1902	Jan.	27	14.5	21,600
	Dec.	15	15.0	23,000		Mar.	1	26.4	63,200
1890	Feb.	15	14.3	21,000			13	14.3	21,000
	Mar.	23	17.8	31,800		Apr.	9	16.4	27,300
	Apr.	10	17.8	31,800		July	1	16.8	28,600
	Sept.	10	15.1	23,300			4	14.0	20,200

** Below base

Flood stages and discharges of Kiskiminetas River at Avonmore, Pa.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1903	Jan.	30	14.5		21,600	1916	Jan.	2	15.9		23,400
	Feb.	5	14.5		21,600			2	17.0	P	26,700
	Mar.	1	16.4		27,300		Mar.	22	20.0	P	36,600
1904	Jan.	23	21.8		45,600			23	18.2		30,400
	Mar.	4	16.4		27,300			28	18.1		30,100
		8	15.1		23,300	1917	Jan.	22	21.4		41,700
	Apr.	2	16.4		27,300			22	24.0	P	51,800
	July	10	15.8	P	25,400		Mar.	12	17.6		28,500
1905	Mar.	8	20.4	P	40,700	1918	Feb.	13	16.4		24,800
		21	18.0	P	32,500			20	17.4		27,900
	Dec.	3	19.1	P	36,200			20	22.0	P	43,900
1906	Mar.	28	15.1		23,300			26	16.4		24,800
	June	7	19.1		36,200	1919	Jan.	2	15.38		21,900
1907	Jan.	15	17.1		29,500			2	15.47	P	22,200
		20	17.5		30,800		Nov.	27	17.88		29,500
	Feb.	3	17.8		31,800			27	20.3	P	37,700
		21	15.0		23,000	1920	Mar.	13	18.00		29,800
	Mar.	14	33.8	P	92,500		June	18	18.07		30,100
		20	21.1		43,100	1921	Jan.	23	15.12		21,100
	Dec.	24	17.5		30,800			23	15.6	P	22,500
1908	Jan.	13	16.0		26,000		Nov.	29	21.78		43,200
	Feb.	16	21.4		44,200			29	24.65	P	54,200
	Mar.	3	14.1		20,500	1922	Apr.	15	16.41		24,800
		7	17.8		31,800	1923	May	13	15.89		23,400
		19	30.1		77,700			13	18.0	P	29,800
		19	30.8	P	80,500		Dec.	23	15.16		21,300
1909	Feb.	24	15.7		25,100	1924	Jan.	4	16.30		24,600
1910	Jan.	19	19.95		39,200		Mar.	30	21.41		41,700
		22	17.15		29,700			30	24.0	P	51,800
	Feb.	17	23.50		51,900		May	9	15.95		23,700
		17	23.65	P	52,500			13	17.00		26,700
		22	18.95		35,700		June	29	17.96		29,800
	Mar.	1	18.25		33,300	1925	Feb.	12	16.14		24,000
1911	Jan.	15	15.76		25,300			12	17.8	P	29,200
		15	15.91	P	25,800	1926	Feb.	23	14.81		20,300
	Apr.	6	14.02		20,300			26	15.54		22,200
		6	14.09	P	20,500		Sept.	6	17.19		27,300
	Sept.	15	19.5	P	37,500			6	18.5	P	31,400
		16	15.80		25,400	1927	Jan.	22	18.89		32,800
1912	Feb.	27	17.72		31,600			22	21.3	P	41,300
		27	19.30	P	36,500		Mar.	21	15.80		23,100
	Mar.	16	15.65		25,000		June	5	15.00		20,800
		21	23.87		53,300		Oct.	20	22.76		44,400
		21	28.00	P	69,400			20	25.10	P	56,300
	June	17	16.25		26,800		Dec.	14	16.50		25,200
	July	22	16.60		27,900	1928	Mar.	31	14.82		20,300
	Sept.	3	19.06		36,000		May	1	18.27		30,800
		3	22.30	P	47,400	1929	Feb.	26	16.96	P	26,700
1913	Jan.	8	20.21		37,400			27	14.96		20,800
		8	22.21	P	44,700		Apr.	17	15.04		20,800
		12	18.43		31,200	1930	Feb.	25	19.53		34,900
	Mar.	27	15.16		21,200			25	23.3	P	48,800
		27	16.11	P	24,000	1931	Apr.	4	18.03		29,700
1914	Mar.	17	16.18		24,200			4	20.2	P	37,300
1915	Jan.	7	18.06		30,000	1932	Apr.	1	16.90		26,300
		7	19.70	P	35,600			1	18.3	P	30,600
		19	14.95		20,700	1933	Mar.	15	20.50		38,400
	Feb.	2	20.98		40,200			15	23.0	P	47,600
	Dec.	18	18.2		30,400		May	10	19.17		27,100
		18	19.4	P	34,500	1934	Sept.	30		**	17,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Blacklick Creek at Blacklick, Pa.

Location.- At highway bridge about a quarter of a mile north of Pennsylvania Railroad station, Blacklick, Indiana County.
Drainage area.- 390 square miles.
Records available.- August 1904 to December 1905; January 1907 to September 1934.
Sources of data.- Pennsylvania Department of Forests and Waters; collaboration by U. S. Geological Survey 1904-13, 1918-21, 1931-34.
Gage.- Nonrecording gage read twice daily, to quarter tenths prior to July 28, 1922, and to hundredths thereafter.
Stage-discharge relation.- Control may shift occasionally; usually affected by ice. Left bank overflows at a stage of about 12.0 feet.
Regulation.- Some regulation at low stages.

Flood stages and discharges of Blacklick Creek at Blacklick, Pa.
(Base discharge 4,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1904	Dec.	27	6.90	4,960
1905	Mar.	8	7.6	6,410
		19	8.4	8,190
		21	8.6	8,650
	Sept.	11	6.5	4,200
	Nov.	29	7.7	6,630
	Dec.	3	10.7	13,600
		29	6.5	4,200
....			...	.....
1907	Jan.	14	8.4	8,190
		19	9.4	10,500
	Mar.	14	13.2	19,500
		20	9.0	9,570
	Dec.	24	7.25	5,680
1908	Jan.	13	6.8	4,770
	Feb.	15	10.0	11,900
	Mar.	2	6.9	4,960
		7	9.15	9,920
		19	10.8	13,800
	May	17	6.9	4,960
		20	7.0	5,160
1909	Feb.	24	8.63	8,720
		24	8.8	P 9,110
	Mar.	2	7.13	5,420
		2	7.5	P 6,200
	Apr.	14	6.57	4,330
	May	1	7.85	6,960
		1	8.0	P 7,290
1910	Jan.	9	7.63	6,480
		13	6.43	4,070
		18	10.15	12,300
		18	10.97	P 14,200
		22	7.16	5,490
	Feb.	28	9.27	10,200
		28	10.17	P 12,300
	Dec.	30	7.63	6,480
1911	Jan.	14	8.97	9,500
		30	6.50	4,200
	Sept.	15	7.86	6,980
	Oct.	2	7.35	5,880
1912	Feb.	27	8.40	8,440
		27	9.60	P 11,200
	Mar.	15	7.89	7,350
		21	10.20	12,700
		21	11.10	P 15,200
		24	6.39	4,240
		29	6.98	5,440
	June	16	8.10	7,790
		16	9.60	P 11,200
	July	21	7.90	P 7,370
		22	6.38	4,220
	Sept.	3	11.86	17,500
		3	12.90	P 21,000
	Oct.	25	6.60	4,660
		25	7.10	P 5,690
1913	Jan.	8	9.81	11,700
		8	10.50	P 13,500
		12	8.78	9,280
	Mar.	27	8.13	7,850
		27	8.70	P 9,100
	May	27	9.76	11,600
		27	10.41	P 13,300
	Oct.	26	6.31	4,080
1914	Mar.	18	6.58	4,620
		28	6.36	4,180
	Apr.	16	6.59	4,640
		16	6.95	P 5,380
	May	6	6.44	4,340
		6	7.16	P 5,820
1915	Jan.	7	9.32	10,500
		7	10.72	P 14,100
		19	7.22	5,940
	Feb.	2	8.51	8,680
		2	9.47	P 10,900
		15	6.73	4,920
	Oct.	19	9.9	12,000
		19	10.7	P 14,100
	Dec.	18	9.8	11,700
		29	6.3	4,060
1916	Jan.	2	8.6	8,880
	Mar.	22	6.9	5,270
	Mar.	28	8.2	8,000
	June	3	7.3	6,110
1917	Jan.	6	6.3	4,060
		22	9.7	11,400
		22	11.3	P 15,800
	Mar.	12	6.9	5,270
	June	7	7.6	6,740
	Aug.	14	7.3	6,110
	Sept.	8	6.4	4,260
	Oct.	28	6.4	4,260
1918	Feb.	13	8.2	8,000
		15	7.8	7,160
		20	9.0	9,760
		20	10.8	P 14,400
		26	7.2	5,900
	Oct.	31	7.30	6,110
		31	7.90	P 7,370
1919	Jan.	2	7.10	5,690
	May	10	7.40	6,320
	Nov.	2	6.56	4,660
		27	7.07	5,690
1920	Mar.	5	7.47	6,530
		13	7.35	6,320
	Apr.	21	6.32	4,060
	June	17	9.14	9,990
		17	10.5	P 13,700
1921	Jan.	23	6.50	4,460
	Mar.	3	6.30	4,060
	May	5	6.78	5,060
		5	7.3	P 6,110
	Nov.	29	8.87	9,540
		29	9.85	P 11,700
1922	Apr.	15	8.22	8,000
1923	May	13	8.19	8,000
		13	9.5	P 11,000
	Nov.	30		4,000
	Dec.	23		6,500
		29		4,000
		31		4,600
1924	Jan.	3		7,000
		17		4,000
	Mar.	29	8.50	8,660
	May	9		5,500
		12	7.44	6,320
	June	29	8.54	8,660
		29	11.0	P 15,000
1925	Feb.	11	6.85	5,060
		11	7.2	P 5,900
	Nov.	13	6.47	4,460
1926	Feb.	26	6.40	4,200
	Sept.	5	8.23	8,000
		5	8.9	P 9,540
1927	Jan.	22	8.77	9,320
		22	9.40	P 10,700
	Mar.	8	6.97	5,480
		21	8.50	8,660
	May	19	6.95	5,480
	Oct.	20	9.11	9,990
		20	8.80	P 11,700
	Dec.	14	7.60	6,740
1928	Feb.	5	6.88	5,270
		15	6.77	5,060
	Mar.	30	7.72	6,950
	Apr.	30	7.10	5,690
1929	Feb.	26		6,110
		26	8.10	P 7,790
	Apr.	17		4,060
	Nov.	18		4,100
1930	Feb.	25		8,440
		25	9.70	P 11,500
1931	Apr.	4		7,960
		4	9.30	P 10,500
1932	Apr.	1		4,850
		1	7.5	P 6,540
1933	Mar.	15		8,640
		15	9.28	P 11,100
		20		4,240
	May	10		6,420
		14		4,130
	Dec.	18		4,910
1934	Mar.	4		5,040

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Tygart River at Fetterman, W. Va.

Location.- At highway bridge at Fetterman, Taylor County, three-quarters of a mile above Otter Creek.
Drainage area.- 1,340 square miles.
Records available.- June 1907 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read twice daily 1907 to Oct. 14, 1932; recording gage thereafter. Zero of gages is 957.86 feet above mean sea level.
Stage-discharge relation.- Practically permanent. Rating curves well defined to about 25,000 second-feet.

Flood stages and discharges
(Base discharge 15,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1907	June	14	13.3		18,000
	July	18	19.8		33,600
1908	Jan.	13	14.1		19,800
	Feb.	16	14.3		20,300
	Mar.	2	13.35		18,100
		9	12.1		15,300
	May	6	13.0		17,300
		8	13.45		18,300
		10	12.55		16,300
1909	Apr.	15	11.5	**	14,000
	Oct.	24	12.75		16,700
1910	Jan.	3	13.4		18,200
		7	12.95		17,200
		19	13.8		19,100
	June	17	14.5		20,800
		20	12.7		16,600
1911	Jan.	14	14.8		21,400
		30	20.35		35,000
	Sept.	17	15.05		22,000
	Oct.	8	14.70		21,200
1912	Jan.	20	12.1		15,300
	Feb.	27	14.0		19,600
	Mar.	16	14.8		21,400
	May	17	12.8		16,900
	July	23	12.3		15,700
		25	24.4		45,300
		25	29.1	P*	57,600
	Dec.	31	12.2		15,300
1913	Jan.	8	14.3		20,100
	Mar.	28	12.8		16,600
	May	24	14.3		20,100
		28	15.2		22,100
	Nov.	16	22.0		39,100
1914	Feb.	20	13.6		18,700
	Apr.	21	12.4		15,900
		27	12.8		16,800
	Dec.	21	13.6		19,300
1915	Jan.	19	12.3		16,200
	Feb.	3	15.0		22,600
	Dec.	18	15.9		24,800
		30	13.2		18,300
1916	Jan.	2	14.2		20,700
		12	19.2		33,100
		12	20.2	P	35,600
	Feb.	13	16.6		26,600
	Mar.	8	13.4		18,800
		23	13.7		19,500
	Dec.	29	12.55		16,900
1917	Jan.	22	20.30		35,800
		22	21.10	P	37,800
	Mar.	9	15.58		24,100
		13	18.50		31,400
	May	28	16.65		26,600
1918	Jan.	29	16.2		25,600
	Feb.	10	12.9		17,600
		20	12.4		16,400
		26	15.1		22,900
	Mar.	13	24.1	P	45,400
		14	22.55		41,600
	May	26	13.95		20,200
	Dec.	11	13.36		18,800
1919	Jan.	2	21.25		38,100
		2	22.72	P	41,800
	July	17	13.23		18,300
	Nov.	2	15.21		23,100
		27	12.18		15,900
	Dec.	8	14.61		21,700
		14	13.72		19,500
1920	Jan.	10	13.24		18,300
		23	17.17	P	28,100
		23-24	16.17		25,600
	Mar.	20	15.16		23,100
	Apr.	21	13.31		18,600
1921	May	30	16.65		26,100
		30	17.10	P	27,400
	Nov.	25	12.03		15,300
		29	14.73		21,500
	Dec.	24	19.60		33,600
		24	20.4	P	35,600
1922	Jan.	20	13.76		19,300
	Feb.	12	12.08		15,500
	Mar.	15	14.17		20,300
	Apr.	15	12.77		17,100
1923	Jan.	29	12.00		15,300
	Feb.	2	16.60		26,100
		2	17.0	P	27,100
		13	12.98		17,500
	Dec.	24	15.43		23,300
		29	14.03		19,800
1924	Jan.	1	15.43		23,200
		3	15.68		23,900
	Feb.	20	19.18		32,600
	Mar.	29	17.42		28,100
	May	12	22.6	P	41,100
		13	20.62		36,100
	Oct.	1	12.20		15,700
		1	12.80	P	17,100
1925	Mar.	20	12.16		15,700
	Oct.	17	14.05		19,800
		26	13.70		19,100
1926	Jan.	19	13.10		17,700
		22	15.55		23,600
		22	16.60	P	26,100
	Feb.	15	15.65		23,600
	Aug.	21	12.85		17,100
	Dec.	22	15.57		23,600
		26	12.27		16,000
1927	Jan.	21	15.61		23,600
	Feb.	7	15.74		23,900
		7	16.39	P	25,600
	May	1	14.10		20,000
	Oct.	20	12.28		16,000
	Dec.	14	13.66		19,100
1928	May	1	17.84		29,100
		1	19.15	P	32,600
	June	21	14.44		20,800
	Dec.	1	13.56		18,900
		1	15.54	P	23,400
1929	Feb.	27	14.49		21,000
	Mar.	7	14.02		19,800
	May	30	12.64		16,600
	Oct.	3	21.18		37,600
		3	21.68	P	38,800
	Nov.	19	14.32		20,500
1930	Feb.	6	9.66	**	10,300
1931	May	23	12.09		15,500
		23	12.12	P	15,500
1932	Jan.	31	13.20		17,500

* Estimated
** Below base

Flood stages and discharges of Tygart River at Fetterman, W. Va.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1932	Feb.	4	22.6	P	39,100
		5	20.70		34,700
	Mar.	18	18.25		29,000
		28	15.20		22,100
	Apr.	1	12.52		16,000
1933	Mar.	15			19,600
		20			18,200
	May	12			20,200
		12	16.60	P	25,300
		17	13.73		18,600
	Dec.	17	14.15		19,800
1934	Jan.	7	12.20		15,300
	Mar.	4	17.06		26,400
		4	17.18	P	26,700

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

West Fork River at Butcherville, W. Va.

Location.- At trolley bridge at Butcherville, Lewis County, about a quarter of a mile above the Butcherville store, about 1 mile above Freemans Creek, and about 3 miles north of Weston.
Drainage area.- 181 square miles.
Records available.- April 1915 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths twice daily.
Stage-discharge relation.- Probably permanent. Rating curve fairly well defined to 2,500 second-feet.
Historical data.- Maximum stage known, about 27 feet in 1888.

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1915	Aug.	3	10.74	**	2,010
	Oct.	1	16.15		4,310
	Dec.	18	16.50		4,440
		29	14.30		3,520
1916	Jan.	12	21.07		6,370
	Feb.	13	18.70		5,360
		25	15.56		4,060
	Mar.	22	14.52		3,600
	Dec.	28	16.70		4,520
1917	Jan.	22	19.90		5,870
	Mar.	8	17.29		4,780
		12	19.16		5,570
	May	28	16.85		4,570
1918	Jan.	29	15.78		4,150
	Feb.	20	15.00		3,810
		26	16.30		4,360
	Mar.	13	21.28		6,460
	May	26	16.98		4,650
		28	13.86		3,350
1919	Jan.	2	21.94		6,710
	June	26	16.56		4,480
	Oct.	15	13.22		3,050
	Nov.	2	15.67		4,100
		26	13.15		3,050
	Dec.	7	18.11		5,110
		14	15.17		3,890
1920	Jan.	23	17.79		4,990
	Apr.	21	14.61		3,640
	July	25	16.16		4,310
1921	Mar.	3	11.36	**	2,300
	Nov.	1	15.40		3,980
		17	13.18		3,050
		29	15.53		4,020
	Dec.	24	19.76		5,830
1922	Mar.	15	17.36		4,820
	June	18	15.80		4,150
	Dec.	17	17.12		4,690
1923	Jan.	1	13.46		3,180
	Feb.	1	13.85		3,310
		13	15.71		4,100
	Apr.	14	14.24		3,470
	Dec.	23	15.02		3,810
		31	14.41		3,560
1924	Jan.	3	17.82		4,990
	Feb.	20			6,000
	Mar.	29	14.74		3,680
	May	12	21.49		6,540
	Sept.	30	16.30		4,360
1925	Jan.	20	14.66		3,680
	Mar.	19	15.38		3,980
	May	11	13.27		3,100
	......	...	.....		.....
	Oct.	17	14.92		3,770
		25	16.50		4,440
1926	Jan.	22	15.85		4,150
	Feb.	14	14.48		3,600
	July	7	14.58		3,640
	Nov.	16	21.87		5,870
		16	22.87	P	7,130
	Dec.	21	14.81		3,730
		26	13.62		3,220
1927	Jan.	21	15.62		4,060
	Feb.	19	16.52		4,440
	Apr.	30	16.08		4,270
	Aug.	1	14.08		3,430
	Dec.	14	13.50		3,180
1928	Apr.	30	15.85		4,150
	Dec.	15	13.89		3,350
1929	Feb.	26	16.92		4,610
	Oct.	3	19.47		5,700
	Nov.	3	13.10		3,010
		18	17.12		4,690
1931	Apr.	2	9.90	**	1,640
1932	Jan.	30	18.98		5,490
	Feb.	4	16.08		4,270
	Mar.	18	13.47		3,180
		28	17.93		5,030
1933	Mar.	15	15.68		4,100
		19	15.42		3,980
		21	13.62		3,220
	May	11	15.19		3,890
		28	14.15		3,470

** Below base

Flood stages and discharges of West Fork River at Butcherville, W. Va.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1933	Dec.	17	15.03		3,810		Jan.	7	18.56	P	5,320
1934	Jan.	7	18.17		5,150		Mar.	3	16.19		4,310

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: July 1 to Sept. 30, 1925.

Big Sandy Creek at Rockville, W. Va.

Location.- At highway bridge at Rockville, Preston County, 5 miles above mouth and 6 miles below Bruceton Mills.
Drainage area.- 202 square miles.
Records available.- May 1909 to March 1918; April 1921 to September 1929.
Sources of data.- U. S. Geological Survey records 1909-18, except gage-height records and discharge measurements 1909-14, which were furnished by West Virginia Development Co. Records 1921-29 and determinations of floods of 1888 and 1907 furnished by West Virginia Power & Transmission Co.
Gages.- Nonrecording gage read twice daily 1909-18 and twice daily except Sundays 1921 to Oct. 3, 1924; recording gage thereafter.
Stage-discharge relation.- Practically permanent. Rating curves fairly well defined to about 7,000 second-feet.
Regulation.- Low flows regulated by Bruceton Mills.
Historical data.- Maximum stages known, between 20 and 20.5 feet July 10, 1888, and July 17, 1907 (discharge, between 28,000 and 30,000 second-feet).

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1910	Jan.	3	10.5		6,920		Dec.	29	9.4		4,760
		18	11.0		7,970	1916	Jan.	2	9.6		5,130
	Feb.	22	9.4		4,760		Feb.	1	8.6		3,390
	Mar.	1	8.4		3,080		Mar.	22	12.8		11,900
	June	19	11.5		9,020			22	14.85	P	16,700
	Dec.	30	9.2		4,400		Dec.	27	10.50		6,920
1911	Jan.	13	15.6		18,600	1917	Jan.	22	13.48		13,400
		30	10.8		7,550			22	14.98	P	17,000
	Apr.	5	9.3		4,580		Feb.	24	8.98		4,060
	June	18	9.3		4,580		Mar.	12	10.72		7,340
	Aug.	30-31	9.1		4,230		May	28	8.56		3,390
	Sept.	16	8.5		3,230		June	7	10.51		6,920
	Oct.	18	8.9		3,890	1918	Feb.	9	9.25		4,400
	Dec.	27	8.9		3,890			13	10.70		7,340
1912	Feb.	27	9.5		4,940			15	10.50		6,920
	Mar.	15	9.2		4,400			20	11.00		7,970
		21	13.5		13,500			26	11.35		8,810
	June	30	8.9		3,890			26	12.8	P	11,900
	July	24	12.1		10,300		Mar.	14	8.95		4,060
		24	18.	P	21,300		....	....	.....		.....
	Sept.	2	8.8		3,720	1921	May	5	8.55		3,390
1913	Jan.	8	10.8		7,550			25	11.40		8,810
		12	11.2		8,390			29			8,000
	Mar.	27	9.6		5,130		Aug.	4	9.15		4,400
	May	23	9.4		4,760		Nov.	25	8.42		3,080
		28	8.8		3,720			28	10.17		6,300
		31	9.2		4,400		Dec.	18			5,000
	Nov.	14	10.6		7,130			24	12.16		8,300
		16	11.9		9,880	1922	Mar.	15	9.88		4,330
1914	Feb.	19	8.7		3,550		Apr.	15	9.71		4,050
	Mar.	17	9.1		4,230	1923	Jan.	1	8.96		3,130
	Apr.	2	9.2		4,400		Feb.	13	8.90		3,010
		16	8.8		3,720		Apr.	14	10.08		4,620
		26	8.8		3,720		Dec.	28			3,640
	Dec.	21	9.9		5,700	1924	Jan.	3			7,120
1915	Jan.	7	8.9		3,890		Mar.	29			8,300
		19	8.8		3,720		May	12			4,050
	Feb.	1	11.2	P	8,390	1925	May	11			3,050
		2	10.7		7,340		July	22			5,400
	May	22	8.6		3,390			22	10.26		4,570
	Nov.	15-16	8.6		3,390		Oct.	17			4,410
	Dec.	18	11.4		8,810			25			3,940

Flood stages and discharges of Big Sandy Creek at Rockville, W. Va.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1925	Oct.	25	11.95	P	7,090		Nov.	28			3,080
1926	Feb.	26		**	2,960		Dec.	14			3,550
1927	Jan.	21			4,570	1928	Apr.	30			4,820
	Oct.	20			6,140	1929	Feb.	26	9.93	P	4,590
		20	11.39	P	7,150			27			3,610

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Youghiogheny River at Connellsville, Pa.

Location.- At highway bridge between New Haven and Connellsville, Fayette County.
Drainage area.- 1,326 square miles.
Records available.- July 1908 to September 1934. Estimated flood record November 1890 to July 1908.
Sources of data.- Pennsylvania Department of Forests and Waters; collaboration by Geological Survey 1918-21, 1931-34. Fragmentary record prior to 1908 taken from Water Resources Inventory Report, Part VIII (1916) Water Supply Commission of Pennsylvania.
Gages.- Nonrecording gage read to half-tenths twice daily prior to Apr. 1, 1921, and to hundredths until recording gage was installed Aug. 15, 1928. Zero of gages is 860.13 feet above mean sea level.
Stage-discharge relation.- Control permanent; affected by ice. Banks not subject to overflow.
Storage.- Storage began in 1925 in Deep Creek Reservoir, capacity, 93,000 acre-feet; controlled area, 65 square miles.
Remarks.- Gage-height records November 1890 to August 1895 derived from U. S. Weather Bureau gage readings taken at West Newton and September 1895 to July 1908 from readings taken at pumping plant of Trotter Water Co., located about 2 miles above Connellsville. Rating curve at Connellsville applied to obtain discharge record.

Flood stages and discharges
(Base discharge 15,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1860	Apr.	12	16.5		47,000		Feb.	28	12.7		32,100
....	.....		....		......	1904	Jan.	22	12.9	P	32,900
1888	Aug.	21-22	17.8		52,000		Mar.	1	13.7		36,000
....	.....		....		......			4	10.3		22,800
1891	Feb.	2	10.1		22,000	1905	Mar.	10	9.4		19,300
		11	9.7		20,400			21	12.0	P	29,400
		17	14.7	P	39,900		Dec.	4	9.6		20,000
	June	8	9.6		20,000	1906	Jan.	23	10.9	P	25,100
1892	Jan.	15	10.2		22,400		Mar.	31	9.4	P	19,300
1893	Feb.	11	9.8		20,800		Aug.	10	9.4		19,300
1894	Feb.	10	8.9		17,400	1907	Jan.	15	12.8	P	32,500
1895	Jan.	8	12.0		29,400			20	13.5	P	35,200
	Mar.	2	9.4		19,300		Mar.	14	18.4	P	54,400
	Apr.	10	9.8		20,800			19	14.3	P	38,400
1896	July	25	15.0	P	41,100		Dec.	24	9.4		19,300
		28	9.5	P	19,600	1908	Feb.	15	14.4		38,800
1897	Feb.	23	16.7	P	47,700		Mar.	7	11.5	P	27,400
	Mar.	6	9.0		17,800			19	12.7	P	32,100
1898	Mar.	23	11.0	P	25,500		May	7	10.3		22,800
	Aug.	11	11.2	P	26,300	1909	Feb.	24	9.04		17,900
1899	Jan.	15	9.1		18,100			24	9.36	P	19,100
	May	18	13.0	P	33,300		Apr.	22	8.77		16,900
1900	Nov.	26	11.7		28,200			22	9.04	P	17,900
1901	Mar.	11	10.4	P	23,200	1910	Jan.	3	9.68		20,400
	Apr.	6	11.5		27,400			19	10.28		22,800
		21	10.5	P	23,600			19	11.23	P	26,900
	May	27	9.9		21,200		Mar.	1	8.83		17,100
	Dec.	15	11.7		28,200			1	9.01	P	17,800
1902	Feb.	28	15.8	P	44,200		June	19	11.66		28,800
	Mar.	13	10.3		22,800			19	13.09	P	36,300
	Apr.	12	10.0	P	21,600	1911	Jan.	14	10.71		24,600
	Dec.	12	9.9	P	21,200			30	12.20		31,400
		17	9.6		20,000			30	12.68	P	33,900
1903	Jan.	30	11.0	P	25,500		Apr.	6	9.57		19,900
	Feb.	14	12.0		29,400		Aug.	30	8.65		16,500

Flood stages and discharges of Youghiogheny River at Connellsville, Pa.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1911	Aug.	31	9.20	P	18,500
	Sept.	16	9.48		19,600
		16	10.08	P	22,000
1912	Feb.	27	11.76		29,300
		27	12.81	P	34,700
	Mar.	16	10.40		23,300
		21	16.03	*	59,200
		21	17.28	P*	88,000
	July	22	8.79		17,000
		25	11.26		27,000
		25	11.59	P	28,500
	Sept.	3	8.34		15,300
		3	9.22	P	18,600
1913	Jan.	8	12.91		35,200
		8	13.50	P*	38,800
		12	11.05		26,100
	May	24	8.68		16,600
		28	8.90		17,400
	Nov.	14	9.52		19,700
		16	10.40		23,300
1914	Mar.	17	8.78		17,000
		17	9.07	P	18,000
	Apr.	2	8.70		16,700
1915	Jan.	7	11.56		28,400
		7	12.13	P	31,100
		19	9.33		19,000
	Feb.	2	11.43		27,800
		15	8.98		17,700
	May	23	8.36		15,400
		23	9.81	P	20,900
	Dec.	18	11.0		25,900
1916	Jan.	2	10.7		24,600
	Feb.	13	10.2		22,400
	Mar.	15	9.5		19,600
		22	11.3		27,200
		22	15.0	P*	41,600
	Dec.	28	8.6		16,300
1917	Jan.	22	14.6	*	40,000
		22	15.2	P*	42,400
	Mar.	12	12.6		33,500
	June	7	9.0		17,800
1918	Feb.	13	11.1		26,200
		15	10.6		24,300
		20	13.4		35,000
		20	14.0	P	37,400
		26	11.5		27,700
	Mar.	14	8.3		15,900
	Apr.	17	8.1		15,200
1919	Jan.	1	11.51	P	27,700
		2	9.78		21,300
....			.....		......
	Nov.	2	8.67		17,300
		27	9.60		20,500
1920	Mar.	13	10.07		22,400
		13	12.13	P	30,000
		17	8.94		17,800
	June	17	10.6		24,300
1921	Jan.	23	8.66		17,300
	Mar.	3	9.03		18,400
		3	10.1	P	22,400
	Nov.	29	10.46		23,900
	Dec.	24	9.90		21,600
		24	11.50	P	27,700
1922	Mar.	16	8.25		15,500
	Apr.	15	8.83		17,600
1923	Feb.	2	8.22		15,500
		2	8.9	P	18,000
	Dec.	23	8.22		15,500
1924	Jan.	4			28,000
	Mar.	29	16.01		45,400
		29	20.5	P	65,900
	Apr.	7	8.15		15,500
	May	9	8.06		15,200
		12	11.36		27,300
	June	29	9.34		19,400
1925	Feb.	9			15,000
	Oct.				19,200
1926	Jan.	19	9.60		19,600
	Feb.	23	10.4		23,000
1927	Jan.	22	11.30		27,000
	June	5	8.78		16,400
	Jan.	22	11.8	P	29,100
	Oct.	20	12.30		31,600
	Dec.	14	10.30		22,600
1928	May	1	12.00		30,000
		1	13.70	P	39,000
1929	Feb.	27			16,800
		27	10.17	P	19,200
	Oct.	3			25,100
		3	12.00	P	30,700
1931	Apr.	4			17,700
		4	9.95	P	21,400
1932	Apr.	1			21,800
		1	11.00	P	25,900
1933	Mar.	14			36,100
		14	14.9	P	46,900
		20	8.45		15,200
	May	10			20,100
1934	Jan.	8			18,500
	Mar.	4			18,000
		4	10.77	P	25,000

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Feb. 21 to July 20, 1919.

Shenango River at Sharon, Pa.

Location.- At Chestnut Street highway bridge, Sharon, Mercer County.
Drainage area.- 608 square miles.
Records available.- August 1909 to September 1934.
Sources of data.- Pennsylvania Department of Forests and Waters; collaboration by U. S. Geological Survey 1918-21, 1931-34.
Gages.- Nonrecording gage read twice daily August 1909 to Mar. 31, 1915; May 24, 1919, to Nov. 7, 1919; Oct. 31, 1920, to Apr. 13, 1927. Recording gage Apr. 1, 1915, to May 23, 1919; Nov. 8, 1919, to Oct. 30, 1920; Apr. 14, 1927, to Sept. 30, 1934. Zero of all gages is 840.00 feet above mean sea level.
Stage-discharge relation.- Practically permanent. Little ice effect except during extremely cold winters. Bank-full stage, about 12 feet.
Storage and regulation.- At Pymatuning Reservoir (drainage area 167 square miles).
Remarks.- Discharge records prior to 1913, from revisions made in 1915 and not published prior to this report.

Flood stages and discharges of Shenango River at Sharon, Pa.
(Base discharge 2,900 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1910	Mar.	2	12.81		13,400
	Dec.	31	8.80		5,230
1911	Jan.	3	9.12		5,610
		15	9.85		7,130
		29	8.68		5,030
	Feb.	16	6.95		2,850
		18	7.80		3,540
	Sept.	16	12.48		12,100
	Oct.	2	8.71		5,050
		18	8.04		4,050
	Dec.	15	8.18		4,170
1912	Jan.	1	7.41		2,810
	Feb.	27	7.94		3,880
	Mar.	19	9.38		6,940
		24	8.40		4,500
		30	9.80		7,560
	Apr.	3	9.78		7,220
		8	8.00		3,580
		15	7.97		3,460
		30	7.90		3,640
	Oct.	25	9.32		6,560
1913	Jan.	9	11.23		10,700
		12	9.85		7,490
		18	9.97		7,740
		24	8.46		4,740
	Mar.	26	18.05		24,300
		26	18.1	P*	25,200
	Nov.	16	9.03		4,680
1914	Jan.	30	8.63		4,210
	Mar.	17	9.40		5,140
		30	9.65		5,480
	Apr.	8	9.11		4,780
		26	8.94		4,570
	May	13	11.52		9,080
1915	Jan.	8	7.23		2,910
	Feb.	2	11.69		9,460
		16	7.91		3,550
	Aug.	5	7.67		3,320
	Dec.	18	7.80		3,450
1916	Jan.	3	10.58		6,890
	Mar.	8	7.58		3,230
		28	11.86		8,980
	Apr.	23	7.93		3,570
1917	Jan.	6	10.10		6,180
	Mar.	12	8.64		4,300
	June	10	8.47		4,120
	Oct.	25	9.40		5,210
		30	9.35		5,140
1918	Feb.	15	9.49		5,330
		20	9.66		5,560
	Mar.	1	7.47		3,130
		10	7.34		3,010
		15	12.60		10,400
1919	May	11	11.97		10,200
		11	12.5	P	11,300
		18	8.00		3,650
1920	Mar.	13	12.95		12,500
		13	13.3	P	13,200
	June	18	8.08		3,750
1921	Mar.	7-8	7.62		3,380
		29	8.4	P	4,230
		30	8.1		3,900
	Nov.	3	8.65		4,450
		3	8.80	P	4,690
		20	8.5		4,340
1922	Mar.	12	7.7		3,480
	Apr.	1	8.65		4,450
		1	8.8	P	4,690

Date			Gage height (feet)		Discharge (second-feet)
	Apr.	15	7.2		3,000
1923	Jan.	22	8.7		4,570
		22	8.9	P	4,810
	Mar.	13	7.4		3,180
	Dec.	7	7.95		3,790
1924	Jan.	12	10.65		7,040
		12	10.80	P	7,340
		17	9.55		5,660
	Feb.	6	7.35		3,180
	Mar.	30	7.31		3,090
	May	10	7.75		3,580
	Oct.	1	9.27		5,290
	Dec.	20	8.12		3,900
1925	Feb.	10	11.3	P	8,130
		11	10.69		7,190
		24	8.58		4,450
	Nov.	28	7.27		3,090
1926	Feb.	27	9.45		5,410
		27	9.64	P	5,660
	Mar.	25	8.98		4,930
	Apr.	9	9.00		4,930
	Sept.	26	8.98		4,930
	Oct.	25	9.42		5,410
	Nov.	17	8.19		4,010
1927	Jan.	22	10.01		6,180
		22	10.50	P	6,890
	Mar.	22	10.05		6,180
	Dec.	2	11.80		8,930
		2	12.30	P	9,760
		14	10.47		6,890
1928	Jan.	1	9.20		5,170
	Feb.	9	9.38		5,410
		15	8.10		3,900
	June	7	9.04		4,930
	Dec.	1-2	7.82		3,570
1929	Jan.	20	11.20		7,970
	Feb.	27	9.70		5,790
	Mar.	17	8.10		3,900
		23	8.32		4,120
		27	8.50		4,340
	Apr.	1	7.75		3,570
		5	12.00	P	9,250
		6	11.50		8,450
	May	3	10.62		7,040
		15	8.22		4,010
		22	7.68		3,460
	Nov.	19	8.52		4,340
	Dec.	19	8.15		4,010
1930	Jan.	3	7.83		3,590
		10	8.58		4,450
		14	10.35		6,760
		14	10.5	P	6,900
	Feb.	27	7.14		2,910
	Mar.	9	7.52		3,290
	Apr.	18	7.20		3,000
1931	Apr.	4	7.07		2,910
		4	7.15	P	3,000
1932	Jan.	18	8.77		4,680
		18	8.82		4,680
		23	7.53		3,290
	May	10	7.75		3,590
1933	Mar.	15	10.46		6,900
		15	10.65	P	7,050
		21	7.37		3,190
	Apr.	12	8.72		4,560
	May	25	7.23		3,030
1934	Mar.	6	7.36		3,190
		6	9.62	P	5,670

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Little Beaver Creek near East Liverpool, Ohio

Location.- At Grimms Bridge, 4 miles northeast of East Liverpool, Columbiana County, and 4 miles above mouth.
Drainage area.- 505 square miles.
Records available.- May 1915 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to hundredths twice daily prior to Sept. 22, 1926; recording gage thereafter.
Stage-discharge relation.- Affected by ice. Control probably permanent.
Historical data.- Highest known flood reached a stage of about 20 feet.

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1915	Dec.	30	7.92		3,600
1916	Jan.	2	9.74		5,400
		13	8.93		4,600
	Mar.	8	8.76		4,500
		23	7.96		3,700
		26	8.87		4,600
	June	3	8.10		3,800
1917	Jan.	6	7.93		3,600
	Mar.	12	7.48		3,200
	Oct.	25	7.95		3,700
1918	Feb.	13	8.74		4,400
		15	7.92		3,600
		20	10.40		6,100
		20	11.2	P	6,900
1919	Jan.	2	7.38		3,100
	Mar.	9	7.29		3,000
	May	10	8.99		4,700
	Dec.	13	7.41		3,100
1920	Mar.	5	10.39		6,100
		12	10.01		5,700
		17	7.39		3,100
	Apr.	17	7.37		3,100
		21	8.41		4,100
	June	17	10.24		5,900
1921	Mar.	8	8.28		4,000
	Apr.	30	9.50		5,200
		30	9.67	P	5,400
	Nov.	17	7.85		3,500
		28	7.64		3,300
1922	Mar.	28-29	7.32		3,000
	Apr.	1	8.32		4,000
		15	9.22		4,900
		15	9.45	P	5,100
1923	May	13	11.30		8,600
		13	13.1	P	12,400
	Dec.	23	7.7		3,140
1924	Jan.	1	7.6		3,040
		11	8.1		3,560
		16	13.7	P	16,300
		17	9.7		5,750
	Mar.	5	9.3		5,150
		27	7.7		3,140
		30	8.7		4,280
	May	13	7.7		3,140
	June	30	9.3		5,150
1925	Feb.	8-9	8.0		3,440
		8	8.4	P	3,920
		23	7.7		3,140
1926	Feb.	1	8.7		4,280
		26	10.5		7,100
	Sept.	5	8.9		4,560
	Sept.	24			6,550
		24	11.3	P	8,600
	Oct.	25	8.2		3,850
	Nov.	16			3,480
1927	Jan.	19	11.6	P	10,800
		20			7,440
		22			8,160
	Feb.	24	7.9		3,430
	Mar.	21	10.6		8,310
	May	19			4,820
	Nov.	17			3,890
	Dec.	1	10.1		7,170
		14	10.9		9,030
		14	11.7	P	11,000
		16	9.4		5,790
1928	Feb.	15	10.3		7,610
	Mar.	14			3,910
		27	7.6		3,070
		30			5,430
	June	22			4,100
	July	20			3,580
1929	Jan.	19	7.68		3,190
		25			3,290
	Feb.	26			10,700
		26	14.4	P	18,200
	May	3			10,400
		21			3,800
	Nov.	18			6,620
	Dec.	19			3,140
1930	Jan.	3	7.94		3,430
		14	9.24		5,430
	Feb.	26		*	10,600
		26	13.14	P	14,700
	Mar.	8		*	4,600
1931	June	8	7.61		3,070
		8	8.31	P	3,990
	Dec.	14	7.92		3,430
1932	Jan.	2	7.63		3,070
		16			3,470
		18	8.91		4,910
		18	9.46	P	5,970
		23	8.35		4,130
	Mar.	22			3,310
1933	Mar.	15	13.17		14,900
		15	15.01	P	20,000
		21	9.15		5,430
	Apr.	12	8.17		3,850
1934	Mar.	4	8.43	*	3,850
	Apr.	4			4,740
		4	10.48	P	8,070

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Hocking River at Athens, Ohio

Location.- At Mill Street Bridge, three-quarters of a mile east of business section of Athens, Athens County, and 3½ miles below Margaret Creek.
Drainage area.- 944 square miles.
Records available.- May 1915 to September 1934.
Sources of data.- U. S. Geological Survey records except gage-height records prior to Oct. 1, 1930, which were furnished by Corps of Engineers, U. S. Army.
Gages.- Nonrecording gage read to half-tenths twice daily prior to July 26, 1922; to hundredths twice daily July 26, 1922, to August 1931; recording gage thereafter. Zero of gages is 615.59 feet above mean sea level.
Stage-discharge relation.- Control probably permanent. Slight ice effect. Bank-full stage, about 17 feet.
Historical data.- Highest known stage, 26.7 feet January 1907.

Flood stages and discharges
(Base discharge 6,920 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1915	June	16	13.4	7,850
	Sept.	7	14.2	8,640
	Dec.	18	17.50	12,100
		29	16.40	10,900
1916	Jan.	13	15.85	10,300
	Feb.	1	14.30	8,740
		13	13.90	8,340
	Mar.	29	14.60	9,050
	May	8	15.95	10,500
	Dec.	28	13.80	8,240
1917	Jan.	6	13.70	8,140
		23	16.15	10,700
	Mar.	12	12.40	6,930
		14	13.60	8,040
	Apr.	7	15.55	10,100
	May	29	14.55	9,050
	June	2	14.10	8,540
1918	Feb.	13	15.4	9,900
		20	14.0	8,630
		26	12.6	7,370
	Mar.	14	17.6	12,100
1919	Jan.	2	14.6	9,170
	May	12	13.6	8,270
	Nov.	3	16.9	11,400
		28	18.5	13,200
	Dec.	7	13.3	8,000
		10	13.2	7,910
		14	16.2	10,700
1920	Jan.	9	14.9	9,440
	Mar.	17	14.2	8,810
	Apr.	21-22	18.2	12,800
	May	14	15.6	10,100
1921	Mar.	8	16.2	10,700
		29	15.0	9,530
	Nov.	25	13.0	7,730
		28	14.6	9,170
	Dec.	25	20.6	17,100
1922	Mar.	16	19.2	14,300
	Apr.	1	14.6	9,170
		15	21.1	18,400
	Aug.	26	12.4	7,190
1923	Jan.	22	12.06	6,920
	Mar.	24	12.09	6,920
	Dec.	7	15.7	10,200
	Dec.	23	16.2	10,700
1924	Jan.	1	15.2	9,710
		4	16.4	10,900
		12	16.0	10,500
		17	13.7	8,360
	Feb.	21	16.8	11,300
	Mar.	6	13.2	7,910
		22	12.3	7,100
		30	18.2	12,800
	May	13	15.8	10,300
	June	10	14.3	8,900
1925	May	12	12.9	7,640
1926	Feb.	15	16.4	10,900
	Aug.	19	17.2	11,700
1927	Jan.	22	18.3	13,000
	Feb.	24	14.0	8,630
	Mar.	21	16.1	10,600
	Apr.	2	13.5	8,180
	June	12	17.0	11,500
		15	13.8	8,450
		19	12.3	7,100
	Dec.	15	16.0	10,500
1928	June	22	18.0	12,700
		25	13.7	7,010
1929	Feb.	27	14.5	7,700
	Mar.	7	13.6	6,940
	Apr.	11	14.2	7,410
	May	3	15.1	8,320
	Nov.	16	15.0	8,210
		19	17.1	11,000
1930	Jan.	10	14.2	7,410
		15	13.7	7,010
	Mar.	9	17.4	11,500
1931	Apr.	4	16.50	10,000
		23	14.82	8,000
	Dec.	14	14.30	7,500
		14	14.66	P 7,900
1933	Mar.	15	19.13	15,800
		20	19.29	16,300
	May	11		9,950
		15	19.64	17,100
		15	19.93	P 18,000
1934	Mar.	4		6,930
		4	15.04	P 8,250

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

New River at Eggleston, Va.

<u>Location</u>.- At highway bridge at Eggleston, Giles County.
<u>Drainage area</u>.- 2,945 square miles.
<u>Records available</u>.- October 1914 to September 1934.
<u>Source of data</u>.- U. S. Geological Survey.
<u>Gages</u>.- Nonrecording gage read to hundredths twice daily October 1914 to June 30, 1916; recording gage thereafter. No datum changes.
<u>Stage-discharge relation</u>.- Practically permanent. Rating curves well defined to 35,000 second-feet.
<u>Regulation</u>.- Flow regulated at all but high stages by operation of power plants at Byllesby, 73 miles upstream.
<u>Historical data</u>.- Flood of 1878 reached a stage of about 40 feet on present gage.

Flood stages and discharges
(Base discharge 13,000 second-feet)

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1915	Dec.	3	8.30	14,000	8.45	14,400
		5	13.04	33,000	14.2	38,000
1915	Jan.	7	12.32	30,100	13.00	33,000
	Feb.	2	11.20	25,400	13.25	33,800
	Sept.	6	11.15	25,400	11.25	25,400
	Oct.	2	10.00	20,500	10.69	23,400
	Dec.	19	11.13	25,000	11.78	28,000
		30	10.46	22,500	10.87	24,200
1916	Jan.	8	9.42	18,100	9.45	18,100
	Feb.	3	9.94	20,100	10.42	22,100
		25	8.21	13,700	8.44	14,400
	July	11	9.77	19,700	9.88	20,100
		16	29.60	108,000	39.5	152,000
	Aug.	16	7.96	13,000	8.32	14,000
	Oct.	20	7.98	13,000	8.25	13,700
1917	Mar.	5	11.56	27,100	11.86	28,400
1918	Jan.	30	8.20	13,700	8.30	14,000
	June	26	8.80	15,900	8.93	16,300
	Oct.	27	21.66	69,500	31.1	109,000
		31	11.55	27,100	11.80	28,000
	Dec.	18	8.67	15,500	8.82	15,900
		23	12.62	31,300	13.37	34,700
1919	Jan.	3	11.41	26,300	11.87	28,400
	May	22	7.96	13,000	7.98	13,000
1920	Apr.	3	10.27	21,700	10.57	22,800
	Nov.	29	8.54	14,900	8.96	16,800
	Dec.	15	10.11	21,200	10.47	22,800
1921	Jan.	24	8.19	13,800	8.23	13,800
	Feb.	11	10.19	21,600	10.25	21,600
	Nov.	1	11.55	27,300	11.7	27,700
1922	Jan.	22	7.99	13,100	8.01	13,100
	Feb.	16	8.81	16,000	8.85	16,000
	Mar.	4	8.46	14,900	8.52	14,900
		11	8.55	15,300	8.66	15,600
		16	9.02	16,800	9.26	18,000
	May	19	8.96	16,800	8.97	16,800
	June	6	9.55	19,200	11.10	25,200
	Oct.	12	8.46	14,900	8.61	15,300
1923	Feb.	3	9.18	17,600	9.27	18,000
	Mar.	17	9.51	18,800	9.54	18,800
	June	13	11.25	25,600	11.4	26,400
1924	Jan.	6	8.52	14,900	9.76	20,000
		12	11.88	28,500	12.56	31,400
		17	13.70	35,900	14.98	41,200
	July	8	9.90	20,400	10.40	22,400
	Oct.	1	16.21	46,200	17.02	49,600
	Dec.	9	9.00	16,800	9.20	17,600
1925	Jan.	12	7.45	** 11,100		
1926	Jan.	19	12.60	31,400	15.1	41,600
	Nov.	16			13.13	33,400
		17		19,900		
	Dec.	26		16,200	9.72	19,600
		29		13,600	8.50	14,900
1927	Feb.	20		14,200	8.52	14,900
		24		18,000	10.18	21,600
	Apr.	22	10.26	22,100	11.95	28,900
	Oct.	13		13,500	9.62	19,200
	Dec.	17		13,600	8.32	14,200

** Below base

Flood stages and discharges of New River at Eggleston, Va.--Continued

Date			Average Gage height (feet)	Average Discharge (second-feet)	Momentary peak Gage height (feet)	Momentary peak Discharge (second-feet)
1928	Aug.	17	16.54	47,600	18.04	53,800
	Sept.	3		14,100	8.57	15,300
		7	11.40	26,500	13.98	37,100
		20		20,500	11.10	25,200
1929	Feb.	28			12.20	29,700
	Mar.	1		24,700		
		6		21,200	10.37	22,400
		15		16,700	9.49	18,800
	June	10		19,000	10.47	22,800
		27		15,800	10.03	20,800
	Oct.	2	14.95	42,100	22.44	72,300
		23		28,300	15.32	42,500
	Nov.	18		21,000	12.12	29,300
1930	Feb.	5		** 11,000		
1931	Aug.	23	8.74	15,800	9.15	17,600
1932	Feb.	5		13,200	8.40	14,600
	May	2		16,000	8.99	16,800
	Oct.	18		26,400	12.77	32,200
	Dec.	29	9.90	20,300	10.28	22,000
1933	Feb.	9		14,200	8.70	15,700
	Apr.	17		14,100	9.09	17,200
1934	Mar.	4		18,700		
		28		25,300	12.71	29,200
	Sept.	17		18,300		

** Below base

Kanawha River at Kanawha Falls, W. Va.

Location.- Prior to Oct. 27, 1928, half a mile below Kanawha Falls, Fayette County, and 1 3/4 miles below junction of Gauley and New Rivers, where the Kanawha is formed; thereafter three-quarters of a mile below Kanawha Falls.
Drainage area.- 8,367 square miles.
Records available.- March 1877 to September 1934.
Sources of data.- U. S. Geological Survey records, except gage-height records prior to Oct. 27, 1928, which were furnished by Corps of Engineers, U. S. Army.
Gages.- Prior to Oct. 27, 1928, nonrecording gage read to tenths once daily except sometimes during floods, when hourly and half-hourly readings were taken; recording gage thereafter. Zero of present gage is 622.78 feet above mean sea level.
Stage-discharge relation.- Control considered permanent. Seldom affected by ice. Rating curves well defined up to about 100,000 second-feet.
Regulation.- Slight regulation at low water.

Flood stages and discharges
(Base discharge 60,000 second-feet)

Date			Average Gage height (feet)	Average Discharge (second-feet)	Momentary peak Gage height (feet)	Momentary peak Discharge (second-feet)
1877	Apr.	10	12.9	64,300	13.1	65,700
	Nov.	25	26.5	175,000	30.2	206,000
1878	Jan.	11	16.9	95,200	17.3	98,400
	Feb.	10	12.5	61,400	13.0	65,000
		23	12.5	61,400	14.9	79,400
	Mar.	14	13.5	68,700	13.7	70,200
	Aug.	20	14.1	73,300	14.5	76,400
	Sept.	14	33.0	230,000	37.8	270,000
	Nov.	28			16.2	89,600
		29	14.5	76,400		
	Dec.	11	19.2	114,000	19.4	116,000
1879	Jan.	9			15.0	80,200
		10	14.1	73,300		
		13	20.2	122,000	21.2	131,000
	Dec.	25	13.9	71,700		
		26			14.9	79,400
1880	Feb.	14	17.5	100,000	17.5	100,000
	Mar.	8	14.5	76,400	14.7	77,900
		17	15.5	84,100	15.6	84,900
	Apr.	26	14.5	76,400	16.5	92,000

Flood stages and discharges of Kanawha River at Kanawha Falls, W. Va.--Continued

Date			Average		Momentary peak	
			Gage height (feet)	Discharge (second-feet)	Gage height (feet)	Discharge (second-feet)
1880	May	1	12.7	62,800	13.1	65,700
1881	Jan.	22	14.5	76,400		
	Feb.	11	17.1	96,800		
		13	15.2	81,800		
	Dec.	24	12.5	61,400		
		28	12.5	61,400		
1882	Jan.	14	13.8	71,000	14.0	72,500
		22	17.4	99,200	18.3	107,000
	Feb.	10	16.0	88,000		
		11			16.4	91,200
		14	12.6	62,100		
		15			14.0	72,500
		17	15.8	86,400		
	Mar.	21	13.1	65,700	14.0	72,500
	Sept.	12	14.1	73,300		
1883	Jan.	21	14.2	74,000		
	Feb.	7	13.8	71,000		
		8			16.0	88,000
		12	12.7	62,800	13.0	65,000
	Apr.	1	17.4	99,200	18.2	106,000
		7	14.7	77,900	16.0	88,000
		24	14.2	74,000	14.5	76,400
	Dec.	25	12.6	62,100	13.0	65,000
1884	Feb.	1	14.4	75,600	15.8	86,400
		6	13.6	69,400		
		7			13.8	71,000
		10	18.0	104,000	19.5	116,000
		15	12.3	60,000	12.6	62,100
		18	15.9	87,200		
		19			16.6	92,800
	Mar.	9	18.0	104,000	18.3	107,000
		21	16.7	93,600		
		26	13.0	65,000		
		27			14.1	73,300
	June	27	12.6	62,100	13.4	68,000
1885	Jan.	17	13.0	65,000	13.2	66,500
	May	30	12.2	59,300		
1886	Jan.	5	24.6	159,000		
	Feb.	14	12.7	62,800		
	Apr.	1	30.0	204,000		
		6	24.2	156,000		
	May	8	14.0	72,500		
1887	Jan.	25	17.1	96,800		
	Feb.	4	14.6	77,100		
		25	15.5	84,100		
	Apr.	24	14.7	77,900		
		30	13.2	66,500		
1888	Sept.	17			16.5	92,000
		18	12.7	62,800		
	Oct.	27	15.0	80,200	15.3	82,500
1889	Jan.	7	13.4	68,000	14.0	72,500
	Feb.	19	17.8	102,000		
	June	1	24.8	161,000	24.8	161,000
1890	Feb.	26	20.0	121,000	20.0	121,000
	Mar.	20	13.1	65,700	13.1	65,700
		23	14.6	77,100	14.8	78,700
1891	Jan.	2			18.1	105,000
		3	17.0	96,000		
	Feb.	2	15.5	84,100	15.5	84,100
		11	17.0	96,000	17.8	102,000
		23	13.0	65,000		
		26	13.4	68,000	14.05	72,500
	Mar.	9	16.9	95,200		
		14	13.9	71,700	14.0	72,500
	Apr.	1			15.2	81,800
		2	13.0	65,000		
		3			13.7	70,200
		4	13.5	68,700		
		12	17.9	103,000	19.2	114,000
1892	Jan.	15	21.95	137,000	22.0	137,000
	Apr.	23	18.1	105,000	18.3	107,000
1893	Feb.	18	19.4	116,000	20.0	121,000
	May	4	18.5	108,000	20.95	129,000
	Oct.	15	14.1	73,300	14.30	74,800
1894	Feb.	4			14.25	74,000
		5	13.25	66,500		
1895	Jan.	12	13.4	68,000	13.4	68,000
	Mar.	3	14.7	77,900	14.7	77,900
	Apr.	9	23.5	150,000	24.00	154,000
1896	Mar.	31	19.4	116,000	19.60	117,000

Flood stages and discharges of Kanawha River at Kanawha Falls, W. Va.--Continued

Date			Average Gage height (feet)	Average Discharge (second-feet)	Momentary peak Gage height (feet)	Momentary peak Discharge (second-feet)
1896	Apr.	2	17.50	100,000	18.60	109,000
	July	10	17.9	103,000	19.40	116,000
	Nov.	6	12.35	60,700	14.70	77,900
1897	Feb.	7			17.85	102,000
		8	14.8	78,700		
		23	28.25	189,000	28.50	192,000
	May	14	17.2	97,600	17.35	99,200
1898	Mar.	31	13.9	71,700		
	Aug.	10			20.75	127,000
		11	17.85	102,000		
	Oct.	23	16.9	95,200	18.90	111,000
1899	Jan.	7			13.30	67,200
		8	12.9	64,300		
	Feb.	7	16.0	88,000	16.0	88,000
		28	14.3	74,800		
	Mar.	5	30.5	209,000	30.60	210,000
		20	15.3	82,500		
		29	15.9	87,200	16.10	88,800
1900	Feb.	14	13.0	65,000	13.10	65,700
	Mar.	2	12.60	62,100	12.60	62,100
		21	15.90	87,200	15.90	87,200
	Oct.	24			18.90	111,000
		25	13.90	71,700		
	Nov.	26			24.60	159,000
		27	22.50	142,000		
1901	Jan.	13	13.50	68,700	13.9	71,700
	Apr.	4	18.70	110,000	18.70	110,000
		21	29.60	201,000	30.00	204,000
		25	12.60	62,100	12.90	64,300
	May	23	33.30	232,000	34.50	242,000
		28	18.30	107,000	18.50	108,000
	June	17			15.10	81,000
		18	13.90	71,700		
		23			22.10	138,000
		24	18.45	107,000		
	Dec.	16	25.50	167,000	26.90	178,000
		30	30.20	206,000	30.20	206,000
1902	Jan.	27			14.30	74,800
		28	13.55	69,400		
		30			15.5	84,100
		31	13.95	72,500		
	Feb.	26	17.45	99,200	18.1	105,000
	Mar.	1	29.1	197,000	29.25	198,000
		30	12.5	61,400	12.85	63,500
1903	Jan.	4	14.1	73,300	15.80	86,400
	Feb.	5	13.00	65,000	13.50	68,700
		18	16.90	95,200	19.25	114,000
	Mar.	1	16.50	92,000	17.25	97,600
		24	25.80	169,000	26.0	171,000
1904	Mar.	9	10.1	** 44,800		
1905	Mar.	10	17.8	102,000	18.00	104,000
	May	13	18.65	110,000	19.1	113,000
	July	13			20.10	121,000
		14	17.2	97,600		
1906	Jan.	24	22.8	144,000	23.1	147,000
	Oct.	21	15.7	85,700		
	Nov.	20	20.0	121,000		
1907	Jan.	17	16.9	95,200	17.8	102,000
	Mar.	15	13.0	65,000	13.5	68,700
	June	14	23.7	152,000		
1908	Jan.	13	19.35	116,000	19.6	117,000
	Feb.	16	22.0	137,000	23.1	147,000
	Mar.	7	14.2	74,000		
	Apr.	1	18.6	109,000	20.9	122,000
1909	Apr.	15	12.3	60,000	13.3	67,200
1910	June	17	17.2	97,600	17.8	102,000
1911	Jan.	4	13.5	68,700		
		30			17.0	96,000
		31	16.0	88,000		
	Mar.	7	12.6	62,100	13.9	71,700
	Apr.	6	12.8	63,500	12.9	64,300
	Oct.	19	13.8	71,000	13.8	71,000
1912	Mar.	16	16.5	92,000	19.7	118,000
		30	16.8	86,400	15.8	86,400
	Apr.	3	12.7	62,800	12.7	62,800
	May	13	14.7	77,900		
		17	15.4	83,300		
1913	Jan.	8			13.7	70,200

** Below base

Flood stages and discharges of Kanawha River at Kanawha Falls, W. Va.--Continued

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1913	Jan.	9	12.5	61,400		
	Mar.	15			14.8	78,700
		16	14.5	76,400		
		28	26.3	173,000	27.5	184,000
	May	25	12.5	61,400		
1914	Feb.	21	12.1	** 58,600		
	Dec.	6	13.3	67,200	13.3	67,200
1915	Jan.	8	21.0	129,000	21.5	133,000
		19	13.2	66,500	14.3	74,800
	Feb.	3	20.95	129,000	20.95	129,000
	Dec.	19	13.0	65,000		
		30	14.0	72,500		
1916	Mar.	8	12.5	61,400		
	July	17	23.0	146,000	31.7	219,000
1917	Feb.	25	12.5	61,600	13.2	66,500
	Mar.	5	22.0	134,000		
		14	13.1	63,400		
		25	13.6	66,900		
1918	Jan.	29	17.0	85,600	19.0	112,000
	Mar.	13			25.4	166,000
		14	20.0	120,000		
	June	27	13.5	64,200	14.6	77,100
	Oct.	27	18.0	112,000		
	Nov.	1	15.9	91,000		
	Dec.	24	14.5	77,300	16.0	92,000
1919	Jan.	2	21.6	148,000	24.2	174,000
	June	27	13.0	63,800		
	Nov.	2	12.9	63,000		
	Dec.	8	15.5	87,000		
1920	Jan.	23	16.5	97,000		
	Mar.	20	16.0	92,000		
1921	Feb.	12	12.5	** 59,800		
	Nov.	2	14.0	72,800		
	Dec.	24	14.2	74,600		
1922	Jan.	22	13.3	66,500		
	Feb.	21			14.6	78,200
		22	13.5	68,300		
	Mar.	11	13.6	69,200		
1923	Jan.	29	13.2	65,600		
	Feb.	3			17.2	104,000
		4	16.8	100,000		
	Mar.	8	12.8	62,200		
	June	14	13.7	70,100		
	Aug.	13	14.8	80,000		
1924	Jan.	18	16.2	94,000		
	Mar.	30	15.5	87,000		
	May	13	19.4	126,000		
	Sept.	30			16.9	
	Oct.	1	16.6	98,000		
1925	Feb.	16		** 41,700		
1926	Jan.	20	14.4	76,400		
		22	15.8	90,000		
	Feb.	15	13.2	65,600		
	Nov.	16	19.7	129,000		
	Dec.	22	16.7	98,000		
		26	13.5	68,300		
1927	Feb.	20	15.7	89,000		
		24	15.8	90,000		
	Apr.	23	13.5	68,300		
1928	May	1	15.3	74,000		
	Aug.	18	15.0	66,900		
1929	Mar.	1	15.3	102,000	16.04	110,000
		6	13.99	88,500		
	Oct.	3	18.80	139,000	21.35	168,000
	Nov.	19	16.00	110,000		
1930	Feb.	6	9.30	** 46,100		
1931	Apr.	5	9.90	** 50,300		
1932	Feb.	5	15.15	101,000	16.08	111,000
	Mar.	29		72,300		
	May	2		60,300		
	July	5		64,700	16.30	113,000
	Dec.	29	11.06	60,900		
1933	Mar.	20	12.50	73,500	12.97	78,500
1934	Mar.	5	20.07	153,000	21.43	168,000
		29	13.20	80,500		

** Below base

Greenbrier River at Alderson, W. Va.

Location.- Prior to Oct. 15, 1929, at highway bridge at Alderson, Monroe County, half a mile above mouth of Muddy Creek; thereafter 400 feet above bridge.
Drainage area.- 1,320 square miles.
Records available.- July 1895 to June 1906, May 1907 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths once daily prior to Apr. 1, 1910; to half-tenths twice daily Apr. 1, 1910, to Dec. 31, 1911; to hundredths twice daily Jan. 1, 1912, to Oct. 14, 1929; recording gage thereafter. Zero of gages is 1,528.97 feet above mean sea level.
Stage-discharge relation.- Control shifts occasionally. Affected during 1914-15 by construction of new highway bridge at station. Sometimes affected by ice. Rating well defined to about 25,000 second-feet.

Flood stages and discharges
(Base discharge 15,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1896	Mar.	30	10.5		25,600
	Nov.	6	9.5		21,800
1897	Feb.	23			51,500
		23	17.5	P	54,000
	May	14	12.2		32,300
1898	Jan.	16	7.8		15,700
	Mar.	30	8.0		16,400
	May	7	8.0		16,400
	Aug.	11	14.8		42,900
	Oct.	22	9.8		23,000
1899	Jan.	7	8.6		18,600
	Feb.	27	8.6		18,600
	Mar.	5	15.4		45,300
1900	Feb.	14	7.9		16,000
	Mar.	21	8.2		17,100
	Nov.	26	18.2		56,800
1901	Jan.	12	9.3		21,100
	Apr.	21	9.1		20,400
	May	23	8.4		17,800
		28	8.8		19,300
	June	17	9.0		20,000
	Dec.	15	13.3		36,700
		30	11.1		28,000
1902	Feb.	26			17,800
	Mar.	1	11.8		30,700
		14	7.8		15,700
		17			15,000
		30	7.8		15,700
1903	Jan.	3	9.9		23,100
	Feb.	5	8.9		19,600
		17	10.3		24,900
	Mar.	1	10.0		23,800
		24	11.9		31,100
1904	Jan.	23	7.7		15,400
	May	19	7.8		15,700
1905	Mar.	10	10.5		25,600
		22	7.6		15,000
	May	12	11.2		28,400
1906	Jan.	23	9.3		21,100
......	......		....		......
1907	June	14	14.4		41,200
	Dec.	11	7.8		15,700
		24	8.9		19,600
1908	Jan.	12	9.5		21,800
	Feb.	16	14.0		39,600
	Mar.	7	10.4		25,300
	Apr.	1	10.6		26,000
	May	8	9.4		21,500
1909	Apr.	15	7.6		15,000
1910	June	17	12.8		34,500
1911	Jan.	4	9.9		23,100
		30	12.9		35,100
	Apr.	5	8.4		17,800
	Oct.	18	8.5		18,200
1912	Feb.	22	8.1		16,800
		27	8.4		17,800
	Mar.	16	11.9		31,100
		29	8.3		17,500
	May	13	8.3		17,500
		17	8.5		18,200
1913	Mar.	15	8.2		17,100
	Mar.	27	14.7		42,500
	Apr.	13	8.8		19,300
		15			17,100
	May	28	7.8		15,700
	Nov.	17		**	14,300
1914	Feb.	20		**	14,000
1915	Jan.	7	11.7		26,300
	Feb.	2	12.2		27,800
		2	14.5	P	34,900
	Oct.	2	9.11		18,500
		2	11.3	P	25,100
	Dec.	30	9.09		18,500
1916	Dec.	29	8.0		15,200
1917	Mar.	4			27,200
		4	14.2	P	34,000
		13	9.8		20,600
1918	Feb.	14	8.00		15,200
		16	8.14		15,500
		21	8.30		16,100
	Mar.	14	18.62		48,000
		14	22	P	58,900
	June	26	9.00		17,600
		26	10.8	P	23,600
	Oct.	31	11.15		24,100
		31	11.9	P	26,900
	Dec.	23	8.99		17,600
		23	11.0	P	24,200
1919	Jan.	2	15.90		39,400
		2	16.3	P	40,700
	Dec.	7	14.0	P	33,300
		8	10.52		22,200
1920	Jan.	25	9.49		19,200
	Mar.	20	10.41		21,900
	Dec.	15	6.68	**	10,600
1921	Nov.	1	9.12		17,900
		29	8.68		16,700
	Dec.	25	9.25		18,200
1922	Feb.	21	10.00		20,700
		21	10.5	P	22,200
1923	Feb.	2	8.96		17,600
		2	9.58	P	19,500
1924	Jan.	4	8.18		15,100
		17	10.22		21,300
	Mar.	30	9.68		19,800
	May	12	11.40		25,000
		12	13.60	P	32,000
1925	Mar.	20	7.75	**	13,900
1926	Jan.	20	9.72		19,800
		20	9.95	P	20,700
		22	8.48		16,000
	Feb.	15	8.68		16,700
	Nov.	17	8.15		15,100
	Dec.	22	10.68		22,900
		26	13.11		30,400
		26	14.50	P	34,900
1927	Feb.	6	9.38		18,800
		20	9.02		17,600
		23	8.28		15,400
	Apr.	10	8.25		15,100
1928	May	1	8.66		16,400
		1	9.0	P	18,000

** Below base

Flood stages and discharges of Greenbrier River at Alderson, W. Va.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1928	Dec.	1	9.95		21,400
1929	Feb.	28	12.22		29,100
		28	13.15	P	32,700
	Mar.	6	9.70		20,400
	May	21	8.70		17,300
	Nov.	18			26,600
		18	14.20	P	36,300
1930	Feb.	6	6.05	**	8,700
1931	Apr.	5	7.74	**	13,800
1932	Feb.	5			37,100
		5	16.96	P	46,400
	Mar.	18			16,000
		29			19,300
	May	2			21,800
1933	Feb.	21			15,400
	Mar.	20	10.64		23,400
		20	11.68	P	27,300
1934	Mar.	5	12.76		32,200
		5	13.21	P	33,800
		9			16,000
		28	10.85		24,600

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Raccoon Creek at Adamsville, Ohio

Location.- On line between secs. 25 and 26, T. 6 N., R. 16 W., at highway bridge at Adamsville, Gallia County.
Drainage area.- 587 square miles.
Records available.- June 1915 to September 1934.
Sources of data.- U. S. Geological Survey records except gage-height records prior to Oct. 1, 1926, which were furnished by Corps of Engineers, U. S. Army.
Gage.- Nonrecording gage read to hundredths twice daily. Zero of gage is 570.85 feet above mean sea level.
Stage-discharge relation.- Control permanent. Ice effect slight.
Historical data.- Maximum known stage, 24.5 feet, occurred prior to installation of gage; exact date not known.

Flood stages and discharges
(Base discharge 3,650 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1915	Oct.	1	16.50	5,580
	Dec.	20	18.32	6,510
		31	14.49	4,540
1916	Jan.	13	16.46	5,580
	Feb.	1	16.55	5,630
		14	15.29	4,950
	Mar.	29	16.64	5,630
	Dec.	29	13.45	4,000
1917	Jan.	22	17.55	6,150
	Mar.	14	17.90	6,310
		25	13.30	3,950
	May	29	16.95	5,840
1918	Feb.	12	16.00	5,250
		22	14.25	4,350
	Mar.	15	18.47	6,500
1919	Jan.	2	15.68	5,100
	May	10	13.23	3,850
	Nov.	27-28	17.74	6,100
	Dec.	7	17.24	5,850
		16	13.65	4,050
1920	Jan.	9	12.85	3,650
		24	15.15	4,850
	Mar.	20	15.22	4,850
	Apr.	22	20.57	7,650
1921	Feb.	3-4	13.10	3,800
	Mar.	12	13.42	3,950
	May	4	14.12	4,300
	Nov.	28-29	14.72	4,600
	Dec.	25	20.01	7,320
1922	Mar.	18	18.68	6,600
	Apr.	18	17.68	6,100
1923	Feb.	3	12.9	3,700
	Apr.	15-16	15.0	4,750
	Dec.	6	12.8	3,650
		24	13.0	3,750
1924	Jan.	3-4	19.6	7,100
		13	13.4	3,950
	Feb.	22	15.4	4,950
	Mar.	31	12.8	3,650
	June	29	17.2	5,850
1925	May	13	12.8	3,650
1926	Jan.	22	13.4	3,950
	Feb.	4	14.4	4,450
		16-17	15.0	4,750
	Aug.	20-21	17.7	6,100
1927	Jan.	23	19.8	7,210
	Feb.	25	13.4	3,950
	Mar.	23	15.4	4,950
	May	1	13.8	4,150
	Dec.	18	15.1	4,800
1928	Mar.	31	13.4	3,950
	Apr.	24	13.1	3,800
	June	23	15.7	5,100
		30	14.3	4,400
1929	Feb.	28	13.1	3,800
	Mar.	7	14.7	4,600
	May	3	14.9	4,700
	Nov.	18-19	14.2	4,350
1930	Mar.	10	14.5	4,500
1931	Apr.	6	17.40	5,950
		24	13.30	3,900
	Dec.	15	13.95	4,250
1932	Jan.	30	14.65	4,550
	Feb.	5	13.30	3,900
	Apr.	1	12.75	3,650
	Mar.	16	15.65	5,050
		21	18.35	6,450
	May	14-15	18.25	6,350
1933	Mar.	16	15.65	5,050
		21	18.35	6,450

Flood stages and discharges of Raccoon Creek at Adamsville, Ohio--Continued

Date		Gage height (feet)		Discharge (second-feet)	Date		Gage height (feet)		Discharge (second-feet)
1933 Mar.	21	18.50	P	6,500	1934 Mar.	5	12.80		3,650
May	14-15	18.25		6,350		29	12.95		3,750
	14	18.50	P	6,500		29	13.00	P	3,750

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Miami River at Sidney, Ohio

Location.- At North Street Bridge, at Sidney, Shelby County.
Drainage area.- 545 square miles.
Records available.- February 1914 to September 1934.
Sources of data.- U. S. Geological Survey records except gage-height records prior to Aug. 20, 1925, which were from U. S. Weather Bureau, and discharge records prior to Nov. 1, 1921, which were from Miami Conservancy District.
Gages.- Nonrecording gage read to tenths once daily prior to Sept. 2, 1922; read to hundredths once daily Sept. 2, 1922, to Aug. 20, 1925 (sometimes oftener during high water); recording gage thereafter. Datum lowered 1.72 feet Sept. 18, 1919, making zero of gage 924.74 feet above mean sea level.
Stage-discharge relation.- Often affected by ice. Control fairly permanent, but shifts at extremely high water. Bank-full stage, about 12 feet.
Storage, regulation, and diversions.- Water diverted to feed Miami & Erie Canal, 4½ miles above gage, until about 1926. No diversions thereafter. Some storage in Indian Lake, 29 miles upstream.
Historical data.- Flood of March 1913 reached a height of 19.6 feet (present datum), discharge, estimated, 44,000 second-feet.

Flood stages and discharges
(Base discharge 2,500 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)		Discharge (second-feet)
1914 Mar.	16	4.1	2,680	Apr.	18	9.4		6,890
	28	5.1	3,780	1923 Mar.	23	6.40		2,700
Apr.	2	5.4	4,110	May	13	8.40		5,080
	8	6.2	5,050		15	8.40		5,080
1915 Feb.	3	5.6	3,840	Dec.	14	7.40		3,720
	6	5.9	4,180		23	6.75		3,080
	13	4.8	2,980	1924 Jan.	11	9.50		7,090
July	8	5.7	4,490		30	6.30		2,610
	17	5.1	3,720	Mar.	26	7.8		4,210
	21	4.5	3,020		29	12.6		14,900
1916 Jan.	2	10.2	11,800	June	8	10.5		9,300
	13	6.6	5,750		11	7.4		3,720
	31	9.6	10,700		13	7.2		3,500
Mar.	23	6.5	5,600	1925 Mar.	14		**	2,430
	27-28	8.0	7,950	Nov.	13	6.8		3,080
May	7	9.5	10,600	1926 Feb.	25			2,560
1917 Mar.	14	5.9	3,980	Mar.	23	6.7		2,980
July	14	6.1	4,230	Apr.	8			6,700
1918 Feb.	13	6.5	4,790	Sept.	5			8,100
1919 Mar.	17	7.3	6,150		5	11.1	P	10,800
Apr.	17	5.3	3,300		9			3,740
Nov.	30	7.0	3,280		23	7.8		4,210
1920 Mar.	5	7.2	3,500	Oct.	5			7,100
	12	6.5	2,790		29			4,380
Apr.	17	9.1	6,310	1927 Jan.	22			5,640
	21	12.1	13,500		31	7.0		3,280
Nov.	23	9.5	7,090	Feb.	6	6.4		2,700
1921 Feb.	8	6.7	2,980	Mar.	20	14.4	P	20,700
Mar.	7	7.8	4,210		21			17,400
	9	9.6	7,300	Apr.	2	6.8		3,080
	13	6.2	2,520	May	19			8,400
	28	9.6	7,300		25	6.2		2,520
May	27	7.6	3,960	June	4			3,150
Nov.	19	7.1	3,390		22			2,610
Dec.	24	7.5	3,840	Dec.	1			8,180
1922 Feb.	2	6.2	2,520		14			8,580
Mar.	15	7.6	3,960		14	10.7	P	9,780
Apr.	1	8.3	4,920	1928 Feb.	15	6.7		3,070
	11	9.0	6,120	Mar.	30	6.9		3,250
	15	10.0	8,160	June	6	7.2		3,550

** Below base

Flood stages and discharges of Miami River at Sidney, Ohio--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1929 Jan.	19		11,200	Feb.	26		9,480
	25	8.5	5,240	1931 Apr.	4	5.62	** 2,120
Feb.	26		14,600	1932 Jan.	17	7.54	P 3,870
	26	15.6	P 18,000		18		3,260
Apr.	10		3,100		23	6.82	3,160
May	15	6.7	3,070	Dec.	25	6.90	3,250
Dec.	14	7.15	3,550		31	10.00	8,160
	18	7.67	4,100	1933 Mar.	19		3,490
1930 Jan.	3		3,880		27	6.25	2,620
	9-10	11.4	11,600	Apr.	19	6.55	2,980
	13	12.2	P 13,800	May	13	13.48	P 17,700
	14	11.8	12,600		14		14,200
Feb.	13	6.20	2,620	1934 Mar.	3	5.32	** 1,890

** Below base

Note - All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Miami River at Dayton, Ohio

Location.- At Main Street Bridge, Dayton, Montgomery County, half a mile below mouth of Mad River and 0.8 of a mile above mouth of Wolf Creek.
Drainage area.- 2,510 square miles.
Records available.- December 1892 to September 1934. Only records prior to 1920 used in this report (see Remarks).
Sources of data.- Gage-height records by U. S. Weather Bureau; discharge determined from data published by Miami Conservancy District and U. S. Geological Survey records.
Gage.- Nonrecording gage read to tenths once daily. Datum lowered 2.73 feet Dec. 6, 1922. Zero of original gage is 723.73 feet above mean sea level. All readings refer to datum of original gage.
Stage-discharge relation.- Affected by ice; probably permanent for high stages prior to April 1919. Channel improvements materially affect stage-discharge relation thereafter. Bank-full stage, about 18 feet.
Regulation and diversions.- Some water diverted past station. Prior to 1921 slight regulation upstream; four retarding basins completed during 1920 and 1921 considerably reduce high flows.
Remarks.- Winter discharge records may not be reliable prior to 1914 because of lack of knowledge of ice conditions. Records after 1919 not used as they do not represent natural run-off.
Historical data.- Flood of Sept. 19, 1866, reached stage of 21.3 feet. Flood of Feb. 5, 1883, reached estimated stage of 19 feet and was augmented by backwater from ice.

Flood stages and discharges
(Base discharge 12,100 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1893 Feb.	7	10.5	27,800	Mar.	28	9.1	21,900
	10	8.6	20,000	Dec.	21	7.4	15,700
	16	8.0	17,800	1899 Jan.	5	7.3	15,400
Apr.	21	7.4	15,700		15	10.5	27,800
	27	8.3	18,900	1900 Jan.	21	6.8	13,700
May	2	15.8	56,000	Mar.	7	8.6	20,000
June	5	7.9	17,500	1901 Mar.	11	7.0	14,400
1894 Feb.	19	6.4	12,400	1902 July	1	6.3	12,100
1895 Jan.	22	5.6	** 10,000	Dec.	17	6.7	13,400
1896 July	25	8.9	21,100	1903 Jan.	30	7.3	15,400
	31	7.0	14,400	Feb.	4	7.1	14,700
Oct.	1	9.1	21,900	Mar.	1	11.8	33,800
1897 Mar.	6	16.3	59,100		9	7.9	17,500
	10	6.9	14,100		11	8.0	17,800
	20	6.5	12,800	1904 Jan.	22	12.5	37,300
Apr.	10	7.1	14,700	Feb.	8	9.2	22,300
1898 Jan.	13	6.7	13,400		29	6.4	12,400
	21	9.4	23,100	Mar.	4	9.4	23,100
	23	9.4	23,100		27	13.2	41,000
Mar.	16	6.6	13,100	Apr.	2	11.0	30,000
	23	18.3	72,000	1905 Jan.	2	8.8	20,800

** Below base

Flood stages and discharges of Miami River at Dayton, Ohio--Continued

Date			Gage height (feet)		Discharge (second-feet)
1905	May	12	9.3		22,700
1906	Mar.	28	11.9		34,300
		31	8.7		20,400
1907	Jan.	5	11.7		33,300
		9	7.3		15,400
		20	12.0		34,800
	Mar.	14	15.2		52,400
	June	8	6.5		12,800
		11	7.9		17,500
		14	7.0		14,400
	July	12	7.3		15,400
	Dec.	24	6.5		12,800
		31	6.6		13,100
1908	Feb.	6	9.1		21,900
		15-16	13.0		40,000
	Mar.	3	13.3		41,600
		6	11.7		33,300
		20	10.8		29,100
		22	8.8		20,800
	Apr.	9	6.4		12,400
	May	8	9.4		23,100
1909	Feb.	25	12.1		35,300
	Mar.	10	7.3		15,400
	May	10	10.1		26,000
		27	7.8	P	17,100
		28	7.3		15,400
	Dec.	14	7.7		16,800
1910	Jan.	14	10.2		26,400
		19	12.0		34,800
	Feb.	17	6.5		12,800
		28	15.0		51,200
	Oct.	7	16.1		57,900
	Dec.	30	7.3		15,400
1911	Jan.	15	7.0		14,400
		31	8.6		20,000
	Apr.	5	8.4		19,300
	May	2	6.7		13,400
	Oct.	8	9.5		23,500
		18	6.9		14,100
	Nov.	19	6.6		13,100
	Dec.	13	7.8		17,100
1912	Jan.	19	8.7		20,400
	Feb.	20	7.0		14,400
		27	14.0		45,400
	Mar.	16	10.0		25,600
		21	7.8		17,100
		25	6.8		13,700
		30	13.8		44,300
	Apr.	3	9.9		25,200
		30	6.7		13,400
1913	Jan.	8	10.0		25,600
		12	10.0		25,600
		18	10.3		26,900
		21	10.0		25,600
		24	9.9		25,200
	Feb.	28	6.9		14,100
	Mar.	25	29.0	P*	250,000
		26	28.1		
	Apr.	5	10.2		26,400
		11	8.7		20,400
		14	9.7		24,300
1914	Mar.	28	7.5		16,100
		28	8.0	P	17,800
	Apr.	2	7.6		16,400
		8	8.7		20,400
		8	9.0	P	21,500
1915	Feb.	3	8.5		17,800
		6	9.2		21,300
		6	9.8	P	24,300
		13	7.0		12,000
	July	9	11.0		30,000
		16	7.4		13,400
		19	6.5		10,300
		21	6.9		11,600
1916	Jan.	3	13.1		40,500
		13	10.4		27,300
	Feb.	1	14.0		45,400
		1	14.7	P	49,400
	Mar.	23	8.2		17,900
		28	11.6		32,800
		28	12.3	P	36,300
	May	8	11.1		30,500
		8	11.8	P	33,800
1917	Jan.	6	8.9		19,300
	Mar.	12	6.4		10,000
		14	10.5		27,800
		14	10.9	P	29,600
	June	29	7.4		13,400
	July	15	9.0		20,300
1918	Feb.	13	11.5		32,400
	Mar.	14	6.8		11,300
	May	13	8.2		16,500
	Dec.	15	6.8		10,800
1919	Jan.	2	6.9		11,100
	Mar.	17	13.4	P	42,100
		18	12.7		38,400
	Apr.	17	8.8	*	15,800
	Nov.	2	9.1	*	12,900
		30	9.3	*	18,800

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Mad River near Springfield, Ohio

<u>Location</u>.- Jan. 1, 1904, to Mar. 31, 1906, at highway bridge about 500 feet below Red Mill Dam and 3 miles west of Springfield, Clark County; Feb. 1, 1914, to Feb. 29, 1924, in NW¼ sec. 10, R. 9, T. 4, 800 feet below Cleveland, Cincinnati, Chicago & St. Louis Railway bridge, a third of a mile below Buck Creek, about 1 mile west of Springfield, and about 2 miles upstream from first location; Mar. 1, 1924, to July 31, 1925, in NW¼ sec. 16, R. 9, T. 4, at highway bridge just above Rock Run, about 1.6 miles downstream from second location and about 3 miles west of Springfield; thereafter about 150 feet below Rock Run, 300 feet below third location, and about a third of a mile above first location.

<u>Drainage area</u>.- January 1904 to March 1906, about 485 square miles; February 1914 to February 1924, 460 square miles; thereafter, 485 square miles.

<u>Records available</u>.- January 1904 to March 1906, February 1914 to September 1934.

<u>Sources of data</u>.- U. S. Geological Survey records except gage-height records February 1914 to July 1925, which were furnished by U. S. Weather Bureau, and discharge measurements February 1914 to July 1921, which were made by Miami Conservancy District.

<u>Gages</u>.- Nonrecording gage read to tenths once daily prior to Nov. 8, 1921, and to hundredths once daily Nov. 8, 1921, to July 31, 1925 (sometimes oftener during high water); recording gage thereafter. Zero of gage was 887.81 feet above mean sea level February 1914 to February 1924 and 881.47 feet above mean sea level thereafter.

<u>Stage-discharge relation</u>.- Not permanent; not seriously affected by ice. Bank-full stage, about 10 feet at station used prior to March 1924, and about 11 feet at station used thereafter.

<u>Remarks</u>.- Records Mar. 1, 1924, to July 31, 1925, include discharge of Rock Run.

<u>Historical data</u>.- Flood of Mar. 25, 1913, reached a stage of 16.9 feet (present gage datum) with an estimated discharge of 55,400 second-feet.

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1904	Jan.	22	14.10		5,000
	Feb.	7	10.90		3,020
	Mar.	26	15.40		6,320
	Apr.	1	13.50		5,200
1905	May	13	10.9		3,400
	June	5	11.6		3,600
1906	Mar.	27	15.0		6,500
		30	11.0		3,600
....			.....		.....
1914	Feb.	7	6.3		3,140
	Mar.	28	7.3		4,040
	Apr.	8	6.5		3,320
1915	Feb.	2	7.0		3,770
		6	7.0		3,770
	July	8	7.2		3,950
1916	Jan.	2	8.2		5,600
		13	8.3		5,810
		30	6.8		3,500
	Mar.	22	7.2		3,980
		27	8.9		7,240
	May	7	8.4		6,030
1917	Jan.	5	6.6		3,380
	Mar.	14	6.5		3,280
	July	14	6.9		3,680
1918	Feb.	13	7.4		4,260
		20	6.2		3,000
	May	13	7.5		4,400
1919	Mar.	16	7.4		4,260
		18	6.6		3,380
1920	Mar.	5	6.9		3,680
		12	6.6		3,380
	Apr.	17	7.2		4,020
		21	10.1		10,800
	Aug.	22	10.2		11,100
	Nov.	23	6.6		3,380
1921	Mar.	7	6.5		3,280
		9	7.4		4,260
		28	8.3		5,780
	June	23	6.5		3,280
	Nov.	17	7.0		3,780
	Dec.	24	8.0		5,200
1922	Mar.	15	6.5		3,280
	Apr.	11	7.0		3,780
		15	9.0		7,500
	May	20	6.2		3,000
	Sept.	3	6.5		3,280
1923	Jan.	28	6.5		3,280
	Mar.	16	6.5		3,280
1924	Mar.	29	10.9		10,600
	June	6	5.6		3,650
		8	9.0		7,920
1925	Apr.	22	5.5		3,540
		22	5.50	P	3,540
1926	Mar.	23			3,110
	Apr.	8			3,160
		8	6.4	P	4,600
	Oct.	6			4,100
		29			3,440
1927	Jan.	19	10.5	P	10,000
		20			6,010
		22			5,590
	Mar.	21			6,940
	May	19			3,280
	June	5			5,030
	Dec.	1			5,730
		1	8.51	P	7,270
		14			4,660
1928	June	20			5,080
1929	Jan.	19			7,720
		25			6,330
	Feb.	26			14,500
		26	14.9	P	18,000
	Apr.	10			3,480
	May	15			5,160
1930	Jan.	8			6,750
		8	9.10	P	8,060
		13	8.00		6,620
	Feb.	13			3,360
		26			5,740
1931	Apr.	4		**	1,140
	Dec.	13			4,280
1932	Jan.	17			4,110
		17	8.94	P	7,790
		22			3,190
	June	27			3,140
	Dec.	31			7,370
1933	Mar.	19			5,690
	Apr.	18			5,090
	May	11			6,510
		13	11.18	P	11,300

** Below base

Flood stages and discharges of Mad River near Springfield, Ohio--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1933 May	14		7,860	Mar.	3	7.18	P 5,580
1934 Mar.	3		3,700				

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kentucky River at Lock 10 near Winchester, Ky.

Location.- Above dam at Lock 10, in Madison County, 8 miles southwest of Winchester, Clark County.
Drainage area.- 3,990 square miles.
Records available.- October 1909 to September 1934.
Sources of data.- Gage-height records furnished by Corps of Engineers, U. S. Army. Discharge records by U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths three times daily prior to October 1928 and twice daily thereafter. Zero of gage is 558.6 feet above mean sea level.
Stage-discharge relation.- Permanent. Rating curves well defined to 45,000 second-feet.

Flood stages and discharges
(Base discharge 25,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1910 Jan.	8	19.4	34,200	Feb.	21	18.1	27,900
Feb.	19	19.4	34,200	Apr.	10	18.8	31,400
May	26	18.2	28,400	May	15	18.1	27,900
June	11	17.6	25,300	1919 Jan.	3	26.9	56,100
1911 Jan.	3	18.5	29,900	May	10	18.4	29,400
	31	18.3	28,900	Nov.	3	22.3	45,300
Feb.	6	19.8	36,000		27	19.5	34,600
	11	17.7	25,800	Dec.	9	23.9	49,700
Mar.	9	19.6	35,100		15	20.9	40,500
Apr.	7	22.4	45,600	1920 Jan.	10	27.6	57,400
May	2	19.7	35,600		25	31.7	64,000
Dec.	28	20.6	39,300	Mar.	21	22.5	45,900
1912 Jan.	20	18.3	28,900	Apr.	4	19.5	34,600
	31	17.8	26,400	June	6	17.9	26,900
Feb.	27	18.4	29,400	1921 Apr.	18	18.4	29,400
Mar.	15	21.6	43,000	Dec.	25	19.5	34,600
	25	18.8	31,400	1922 Feb.	22	26.9	56,100
Apr.	4	25.2	52,700	Mar.	3	20.47	38,500
	29	20.8	40,100		12	22.6	46,200
May	8	17.6	25,300		17	21.5	42,600
	12-13	18.0	27,400	Dec.	18	19.6	35,100
1913 Jan.	9	28.5	59,000	1923 Jan.	23	18.6	30,400
	26	17.7	25,800	Feb.	5	28.6	59,100
Mar.	15-16	18.5	29,900		15	18.6	30,400
	29	35.1	68,500	Mar.	8	21.8	43,700
1914 Mar.	13	19.1	32,800		14	19.8	36,000
Apr.	1	20.0	36,900	June	14	20.8	40,100
	21	18.8	31,400	1924 Jan.	6	28.8	59,500
Dec.	31	18.4	29,400		12	18.9	31,900
1915 Jan.	13	17.7	25,800	Feb.	21	19.5	34,600
	20	18.2	28,400	Mar.	30	18.1	27,900
Feb.	2	20.3	38,100	May	31	18.6	30,400
July	13	18.2	28,400	Dec.	10	24.3	50,700
Nov.	16	20.2	37,700	1925 Jan.	13	17.6	25,300
Dec.	20	33.6	66,600	Feb.	17	21.9	44,000
	31	21.0	40,900	May	13	18.5	29,900
1916 Jan.	9	17.8	26,400	1926 Jan.	23	23.0	47,400
	13	21.0	40,900	Feb.	16	18.1	27,900
Mar.	30	19.8	36,000	May	17	19.4	34,200
Dec.	30	18.9	31,900	Dec.	24	28.7	59,300
1917 Jan.	7	26.5	55,400	1927 Jan.	22	20.1	37,300
	22	21.8	43,700	Feb.	1	18.4	29,400
Feb.	21	18.8	31,400		20	18.5	29,900
	25	19.2	33,300		25	18.7	30,900
Mar.	5	23.5	48,700	Mar.	9	19.0	32,400
9	18-19	19.3	33,800		15	17.7	25,800
	25	20.0	36,900	Apr.	1	18.1	27,900
Apr.	7	17.8	26,400		11	19.5	34,600
1918 Jan.	30	31.6	63,800		16	18.9	31,900

Flood stages and discharges of
Kentucky River at Lock 10 near Winchester, Ky.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1927	Apr.	23	18.5	29,900		Dec.	14	20.15	43,000
	May	10	17.8	26,400	1932	Feb.	1	28.30	59,900
	June	2	24.0	50,000			6	21.50	47,400
	Nov.	18	18.8	31,400		Mar.	29	22.70	50,400
1928	Apr.	30	18.1	27,900		July	7	18.05	28,500
	June	30	22.2	45,000	1933	Jan.	23	19.70	40,500
	Nov.	21	19.4	38,300		Feb.	16-17	18.60	32,500
1929	Jan.	20	17.6	26,000			22	21.90	48,400
		27	18.5	31,800		Mar.	17	17.60	26,000
	Feb.	28	24.4	53,700			21	19.50	39,000
	Mar.	7	21.8	48,200		May	12	17.55	26,000
		26	30.6	63,000	1934	Jan.	8	18.20	29,800
	May	4	20.2	43,000		Feb.	27-28	18.80	33,900
		8	19.2	36,800		Mar.	5	26.00	56,400
	Nov.	19	17.80	27,200			5	26.3 P	56,900
1930	Feb.	6	17.90	27,800			10	18.65	32,500
1931	Mar.	30	17.95	28,500			22	17.95	28,500
	Apr.	24	20.15	43,000			25	20.05	42,100

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Embarrass River at Ste. Marie, Ill.

Location.- In sec. 30, T. 6 N., R. 14 W., at highway bridge in Ste. Marie, Jasper County.
Drainage area.- 1,540 square miles.
Records available.- October 1909 to December 1912 (except October 1912), August 1914 to December 1924, April 1925 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths once daily prior to Feb. 15, 1931, and twice daily thereafter except 1920, when gage was read to half-tenths. Zero of gage is 447.14 feet above mean sea level.
Stage-discharge relation.- Considerably affected by ice. Control shifts. Bank-full stage, about 16 feet. Wide overflow section at high stages.
Historical data.- Flood, spring of 1908, reached a stage of 22.5 feet.

Flood stages and discharges
(Base discharge 5,800 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1910	Mar.	1	18.7	5,860		Nov.	20	18.10	7,320
	July	18	18.9	5,940		Dec.	26	18.29	7,690
	Oct.	7	18.7	5,860	1922	Mar.	16	20.85	17,400
1911	Oct.	3	19.55	6,210		Apr.	1	18.77	8,810
.....	.....	.....	.....	.....			10	19.20	9,970
1915	May	29-31	18.8	5,900			18	21.78	22,600
	Aug.	23	20.0	6,500	1923	Mar.	18	20.26	14,700
1916	Jan.	31	20.0	6,320		Dec.	15	17.41	6,270
1917	June	3	16.75	5,860	1924	Feb.	6	17.21	6,020
		6	21.11	13,600		Mar.	31	18.86	9,070
1918	Feb.	14	18.63	7,240	.....	.....	.....	.....	.....
	Apr.	22	17.56	6,220	1925	June	27	10.44 **	2,860
		30	18.64	7,240	1926	Feb.	27	16.80	6,760
	May	13	17.56	6,220		Apr.	9	17.80	7,740
	July	10	17.61	6,220		Sept.	15	18.60	8,990
	Dec.	16	18.50	7,120		Oct.	6-7	19.40	11,200
		22	18.50	7,120	1927	Feb.	2	17.79	7,740
1919	Mar.	17	18.10	6,680		Mar.	21	22.66	27,600
	June	27	18.48	7,120		Apr.	3	18.94	9,690
		30	17.55	6,220			10	16.24	6,280
	Nov.	2-3	18.2	6,500			15	16.54	6,520
	Dec.	1	17.8	6,120			21	17.84	7,740
1920	Feb.	23	18.0	6,300		May	20	17.09	7,020
	Mar.	27	17.7	6,040			30	24.25	38,300
	May	14	17.5	5,880			30	24.3 P	39,000
		18	17.7	6,040		Oct.	14	16.32	6,590
1921	Mar.	30	17.94	6,210		Dec.	3	19.20	10,600

** Below base

Flood stages and discharges of Embarrass River at Ste. Marie, Ill.--Continued

Date		Gage height (feet)	Discharge (second-feet)
1927 Dec.	16	19.15	10,600
1928 Jan.	20	16.40	7,220
Feb.	7	18.85	9,860
	16	17.80	8,570
Mar.	30	15.80	6,740
May	18	17.00	7,750
June	9	14.70	5,970
	20	14.80	6,040
1929 Jan.	21	18.30	7,560
Mar.	28	17.40	6,880
Apr.	10	19.97	9,550
May	6	18.20	7,480
	16	20.10	9,740
	20	21.75	15,300
June	14	17.20	6,740
Dec.	20	19.59	8,670
1930 Jan.	4	18.64	7,820
	10	20.12	9,260
	14	21.92	15,900
Feb.	27	17.71	7,090
1931 Sept.	19	11.11	** 3,270
Nov.	22	15.97	6,550
Dec.	13	17.61	7,830
1932 Jan.	1	17.21	7,510
	18	16.54	6,950
	24	18.18	8,340
1933 Jan.	1	16.88	7,270
	23	16.53	6,950
Feb.	27	16.66	7,110
Mar.	20-21	18.19	9,300
	26	16.63	7,070
Apr.	1	16.02	6,450
	17	16.80	7,310
May	7	16.90	7,430
	15	21.13	18,800
	24	17.31	7,910
1934 Mar.	28	11.34	** 3,650

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

West Fork of White River near Noblesville, Ind.

Location.- Prior to June 30, 1922, in sec. 16, T. 19 N., R. 5 E. second principal meridian, at steel highway bridge known as Conners Bridge, 4½ miles northeast of Noblesville, Hamilton County; thereafter in sec. 4, T. 19 N., R. 5 E. at highway bridge near Strawtown, 2 miles upstream from Conners Bridge.

Drainage area.- 800 square miles.

Records available.- May 1915 to September 1934.

Sources of data.- Gage-height records furnished by Noblesville Heat, Light & Power Co. May 1915 to September 1927 and by Department of Conservation, State of Indiana, October 1927 to September 1929. Discharge records by U. S. Geological Survey.

Gages.- Nonrecording gage read to hundredths twice daily prior to April 1928; to hundredths once daily April 1928 to September 1933; to hundredths twice daily October 1933 to Nov. 21, 1933; recording gage thereafter.

Stage-discharge relation.- Practically permanent for both locations of gage except for effect of aquatic growth at low stages. Subsequent to July 1922 control for high stages has been a dam 2 miles downstream. Rating curves defined to about 14,000 second-feet. Overflow on east bank starts at about gage height 12.5 feet.

Remarks.- An intermittent gage-height record has been obtained by U. S. Weather Bureau at Noblesville beginning Jan. 1, 1919.

Historical data.- Flood of March 1913 reached a stage of 21.5 feet on gage used 1915-22 (discharge not determined).

Flood stages and discharges
(Base discharge 4,920 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1916 Jan.	3	13.46	15,700
	13	7.95	6,090
Feb.	1	14.5	17,700
	1	15.0	P* 18,700
Mar.	28	7.45	5,220
1917 Mar.	14	9.71	8,760
Apr.	7	7.17	4,960
1918 Feb.	11	9.57	8,600
	13	8.39	6,690
Dec.	15	8.30	6,540
	22	8.60	7,000
1919 Mar.	17	13.10	14,900
Oct.	29	9.40	8,280
Nov.	2	8.80	7,320
1920 Apr.	17	10.20	9,600
	21	10.2	9,600
1921 Jan.	31	7.20	4,960
Mar.	29	11.07	11,200
Nov.	20	11.95	12,200
1922 Apr.	1	10.41	9,440
	12	11.48	11,300
	15	13.39	14,800
	18	13.00	14,000
1923 Mar.	13		5,440
	17		12,000
May	16		11,100
Aug.	29		7,300
Dec.	6		4,920
	12		8,150
1924 Jan.	11		5,580
	31		5,440
Mar.	26		5,440
	30		15,300
June	9		16,400
Dec.	20		11,400
1925 Mar.	15		6,050
Nov.	9		5,730
	14		10,500

* Estimated

Flood stages and discharges of
West Fork of White River near Noblesville, Ind.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1926	Jan.	21		5,300	1930	Jan.	3	12.25	8,150
	Feb.	26		6,050			10	14.51	15,000
	Apr.	8		14,200			14	14.57	15,300
	Oct.	3		5,890		Feb.	27	12.03	7,700
1927	Mar.	21	16.05	20,800		Apr.	4	7.98	** 2,540
	Apr.	19		4,920	1931	Dec.	12	10.28	4,920
	May	20		16,000	1932	Jan.	18	12.05	7,700
	Dec.	4	11.74	7,100			18	12.08	P 7,900
		16	11.21	6,210			23	10.46	5,170
1928	Apr.	3	12.29	8,400		Dec.	8	10.42	5,040
...	...	...	.....	......			25	11.20	6,210
1929	Jan.	20	12.57	9,150	1933	Jan.	1	12.81	9,650
	Feb.	27	12.38	8,650		Mar.	21	13.20	10,800
	Apr.	11	10.79	5,580		Apr.	18	11.13	6,050
...	...	...	.....	......		May	14	15.10	17,100
	May	15	12.54	8,900			14	15.47	P 18,700
	July	3	12.5	8,900	1934	Mar.	28	8.97	** 3,500
	Dec.	19	11.04	5,890					

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Apr. 26 to May 27, 1928; Apr. 14 to May 13, 1929.

Little Wabash River at Wilcox, Ill.

Location.- In SE$\frac{1}{4}$ sec. 3, T. 2 N., R. 8 E., at highway bridge at Wilcox, Clay County, a quarter of a mile below mouth of Big Muddy Creek.
Drainage area.- 1,130 square miles.
Records available.- August 1914 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths once daily prior to Feb. 15, 1931; twice daily thereafter.
Stage-discharge relation.- Affected by ice. Control practically permanent. Bank-full stage, about 18 feet.
Remarks.- Discharge record 1915-31 revised from previously published figures.
Historical data.- Greatest known flood occurred in March 1898, covering the valley to a depth of 5 to 9 feet.

Flood stages and discharges
(Base discharge 4,400 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1915	Feb.	3	20.6	6,880	1920	Mar.	14	19.60	5,380
		25	19.1	4,630			27	20.10	6,130
	May	30	21.6	8,410		Apr.	22	19.80	5,680
	June	23	19.7	5,530		May	20	19.80	5,680
	July	14	19.7	5,530	1921	Mar.	30	20.65	6,880
	Aug.	23		* 16,300		Nov.	21	20.95	7,480
	Dec.	20	19.8	5,680		Dec.	26	20.50	6,730
1916	Jan.	7	19.7	5,530	1922	Mar.	16	23.10	10,800
		15	22.5	9,830		Apr.	1	21.50	8,260
	Feb.	1	24.9	13,800			13	21.10	7,640
1917	Jan.	7-8	19.56	5,380			19	23.33	11,100
	Mar.	16	19.25	4,780	1923	Mar.	17	22.15	9,350
	May	3	19.77	5,680		Apr.	16	19.00	4,480
	June	8	22.17	9,350		May	17	20.25	6,280
1918	Feb.	15	20.09	6,130		Dec.	16	19.08	4,630
	Apr.	23	22.78	10,300	1924	Apr.	2	19.81	5,680
		29	20.28	6,430		May	31	19.50	5,230
	May	13	21.38	8,100		Dec.	26	19.76	5,680
		17	19.18	4,780	1925	Dec.	8	19.14	4,630
	Dec.	15	21.71	8,560	1926	Feb.	16	18.98	4,480
		24	20.48	6,730		Mar.	24	18.98	4,480
1919	Mar.	18-19	20.12	6,130		Apr.	8	22.24	9,350
	June	27	21.57	8,410		Oct.	6	19.55	5,380
	Oct.	31-Nov. 1	21.40	8,100	1927	Jan.	22	19.25	5,680
	Dec.	2	19.80	5,680			31	19.75	5,680

* Estimated

Flood stages and discharges of Little Wabash River at Wilcox, Ill.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1927	Feb.	5	19.35	5,080
	Mar.	21	23.70	11,900
	Apr.	3	19.85	5,680
		16-17	19.75	5,680
	June	1	20.90	7,330
	Dec.	5	20.60	6,880
		16	20.60	6,880
1928	Jan.	21	19.40	5,080
	Feb.	8	21.6	8,410
		16	19.2	4,780
	Mar.	31	19.2	4,780
	June	23-24	19.5	5,230
	Dec.	19	20.06	6,130
1929	Jan.	20-21	20.30	6,430
	Feb.	28	19.40	5,080
	Mar.	16	19.07	4,630
	Apr.	11	21.26	7,940
	May	6	21.80	8,720
		16	21.54	8,260
		20	22.90	10,500
	June	16	19.87	5,830
	Dec.	20	21.46	8,260
1930	Jan.	14	23.29	11,100
	Feb.	27	19.80	5,680
1931	Sept.	4	19.63	5,380
	Nov.	22-23	19.06	4,630
	Dec.	14	20.12	6,130
1932	Jan.	2	20.78	7,180
		18	20.38	6,580
		23	21.42	8,100
1933	Jan.	2	20.24	6,280
		23	20.95	7,480
	Mar.	20-21	21.29	7,940
	Apr.	2	20.14	6,130
		18	19.90	5,830
	May	7	19.55	5,380
		11	19.51	5,230
		16	22.28	9,510
1934	July	16	16.60	** 2,870

** Below base

Note.- All discharge quantities are average daily flows.

Cumberland River at Cumberland Falls, Ky.

Location.- 1907-11 at Cumberland Falls post office, Whitley County, 700 feet above falls and 13 miles east of Cumberland Falls railroad station. 1915-33, 300 feet downstream.

Drainage area.- 2,010 square miles.

Records available.- August 1907 to December 1911, April 1915 to October 1931, July 1932 to September 1933.

Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records.

Gage.- Nonrecording gage read to hundredths twice daily except Mar. 19 to Dec. 19, 1911, when it was read once daily. Zero of present gage is 825.49 feet above mean sea level; that of gage used 1907-11 not determined.

Stage-discharge relation.- Practically permanent. Rating curves fairly well defined.

Flood stages and discharges
(Base discharge 20,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1908	Feb.	11	* 7.0	22,100
		15	* 7.5	25,000
1909	Jan.	16	* 7.5	25,000
	Feb.	17	* 7.0	22,100
		25	* 9.5	37,600
	Mar.	10	* 8.0	28,000
		25	* 7.0	22,100
	Apr.	21	* 7.0	22,100
	May	2	* 7.0	22,100
1910	Jan.	8	* 8.5	31,200
	Feb.	18	* 7.0	22,100
1911	Jan.	3	* 9.0	34,400
	Feb.	9	* 8.0	28,000
	Mar.	8	* 9.5	37,600
	Apr.	6	* 10.5	44,300
		16	* 7.0	22,100
	May	1	* 11.0	47,600
....			....	......
1915	July	14	7.00	21,700
	Nov.	15	8.31	30,200
	Dec.	18	10.22	43,500
		18	10.45 P	45,200
		30	8.20	29,500
1916	Jan.	8	8.12	28,800
	Dec.	29	7.42	24,200
1917	Jan.	5	9.32	37,200
	Feb.	21	7.24	23,000
	Mar.	4	10.46	45,600
		4	10.66 P	47,000
		13	7.40	24,200
		18	8.61	32,300
		25	7.37	24,200
1918	Jan.	28	12.2	57,500
		28	12.50 P	59,600
		31	12.1	56,800
	Apr.	9	7.5	24,900
1919	Jan.	2-3	9.3	37,200
	Nov.	2	7.7	26,200
1920	Jan.	23	10.2	43,500
	Feb.	23	7.1	22,300
	Mar.	13	8.0	28,200
		20	7.2	23,000
	Apr.	3	8.4	30,900
1921	Apr.	17	7.95	28,200
1922	Feb.	21	9.40	37,900
		21	9.5 P	38,600
	Mar.	2	8.60	32,300
		10	8.70	33,000
		16	7.00	21,700
	Apr.	29	7.40	24,200
1923	Jan.	29	7.1	22,300
	Feb.	3-4	8.2	29,500

* Estimated

Flood stages and discharges of Cumberland River at Cumberland Falls, Ky.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1923	Feb.	3, 4	8.40	P	30,900
		14-15	7.2		23,000
	Mar.	7-8	7.7		26,200
		13	7.2		23,000
1924	Jan.	3	9.0		35,100
	Feb.	21	7.3		23,600
	May	30	7.0		21,700
	Dec.	9	7.80		26,800
1925	Jan.	12	7.05		21,700
	Feb.	16	8.4		30,900
1926	May	17			25,600
	Dec.	10	7.0		21,700
		22	10.0		42,100
		25	11.2		50,500
		25	11.4	P	51,900
1927	Feb.	24	7.8		26,800
	Mar.	10	7.0		21,700
	May	30	7.2		23,000
1928	Apr.	22	7.22		23,000
	June	30	8.45		30,900
	June	30	8.5	P	31,600
	Nov.	20	8.70		33,000
1929	Jan.	26	7.70		26,200
	Feb.	26	8.30		30,200
	Mar.	6	7.60		25,600
		23	12.0	P	56,100
		24	11.50		52,600
	Apr.	29	7.55		25,600
	May	8	7.55		25,600
		22	6.77		20,400
	Nov.	18	7.25		23,000
1931	Apr.	23	7.70		26,200
		23	7.80	P	26,800
.....	.....	.....	....		......
1932	Dec.	29	7.25		23,000
		29	7.3	P	23,600
1933	Feb.	21	7.20		23,000
		21	7.3	P	23,600
	Mar.	21	7.24		23,000

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Cumberland River at Burnside, Ky.

Location.- Prior to Jan. 1, 1915, at Burnside, Pulaski County, on South Fork of Cumberland River 200 feet above mouth; thereafter 700 feet above mouth.

Drainage area.- 4,890 square miles.

Records available.- December 1884 to September 1933; gage-height record only prior to October 1914.

Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Gage-height records by U. S. Weather Bureau except October 1914 to September 1918 and October 1926 to Feb. 18, 1932.

Gage.- Nonrecording gage read once daily or oftener during high stages except October 1914 to September 1918, when it was read twice daily. Zero of gage is 585.60 feet above mean sea level.

Stage-discharge relation.- Control practically permanent except for mud deposits that wash away at high stages. Low-water control is crest of dam 21, which was completed in 1911. Crest is at gage height 1.47 feet. Rating curves are not well defined above about 50,000 second-feet.

Remarks.- U. S. Weather Bureau reports, "The old river gage was changed on several unknown dates and by amounts that are uncertain, so that readings prior to Jan. 1, 1915, are not comparable by from 0.1 to 0.7 foot."

Flood stages
(Base gage height 25.0 feet)

Date			Gage height (feet)
1885	Jan.	17	50.8
	May	30	29.2
.....	.....	.....	....
1886	Feb.	13	47.5
	Mar.	28	27.5
		31	62.0
	Apr.	4	54.5
	May	8	44.6
	June	23	27.3
.....	.....	.....	....
1887	Jan.	25	29.5
		30	33.7
	Feb.	4	42.5
		16	28.4
		25	52.6
		27	41.4
	Mar.	8	33.9
.....	.....	.....	....
1888	Mar.	27	29.6
		29	27.8
	Apr.	11	27.8
.....	.....	.....	....
1889	Feb.	18	33.6
	June	15	27.0
.....	.....	.....	.....
1890	Jan.	22	38.0
	Feb.	9	49.0
		26	61.8
	Mar.	1	52.5
		15	29.0
		23	52.0
	May	20	36.5
	Dec.	27	29.9
1891	Feb.	2	34.1
		4	30.6
		11	38.2
		26	28.1
	Mar.	5	33.3
		9	57.2
1892	Jan.	15	40.5
	Mar.	24	43.7
	Apr.	9	29.4
		23	41.0
.....	.....	.....	.....
1893	June	7	38.0
1894	Feb.	5	39.5
.....	.....	.....	....
1895	Jan.	12	33.0
	Jan.	17	32.0
.....	.....	.....	....
	Mar.	21	34.0
1896	Mar.	17	37.3
		20	29.0
	Apr.	2	54.6
	July	17	37.5
	Nov.	29	35.0
1897	Feb.	22	51.5
	Mar.	11	48.1
		15	37.3
		20	33.8
	Apr.	5	58.1
	May	14	37.4
1898	Jan.	16	32.4
		23	32.6
1899	Jan.	7	52.4
	Feb.	6	45.6
		28	32.3
	Mar.	5	56.5
		20	30.5
		29	49.5
	Apr.	8	29.0
	May	8	35.0

Flood stages of Cumberland River at Burnside, Ky.--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1900 Feb.	10	25.3	Mar.	27	31.4	Feb.	9	33.0
	14	25.5	1905 Feb.	10	28.8	Mar.	8	37.5
Nov.	26	46.1	Mar.	11	35.0	Apr.	6	46.0
1901 Jan.	13	28.3	1906 Mar.	31	38.5		16	25.5
Apr.	3	32.3	Nov.	20	31.6	May	1	50.3
	20	52.0	Dec.	18	32.2	Dec.	28	38.9
May	23	26.0	1907 Jan.	1	28.7	1912 Jan.	30	27.4
Aug.	16	45.6		19	30.5	Feb.	22	30.5
Sept.	18	29.5	Feb.	26	34.0		27	28.9
Dec.	15	42.0	Mar.	3	36.0	Mar.	16	41.1
	30	29.9		15	31.4		25	29.8
1902 Jan.	28	34.5	Apr.	7	32.6		30	31.4
	31	41.3	June	9	34.1	Apr.	3	60.0
Mar.	6	35.4	1908 Feb.	16	25.4		28	38.7
	30	58.9	1909 Jan.	16	28.7		30	38.2
Dec.	17	34.4	Feb.	17	26.2	1913 Jan.	8	61.5
1903 Feb.	5	38.8		25	41.3		13	27.1
	17	39.9	Mar.	11	33.3		25-26	28.0
Mar.	1	55.1	1910 Jan.	7	41.0	Feb.	28	27.7
	10	28.8		19	31.6	Mar.	15	38.2
Apr.	9	42.6	May	26	28.9		28	58.0
	14	40.7	1911 Jan.	3	35.8	1914 Mar.	31	44.8
1904 Mar.	24	28.6						

Flood stages and discharges of Cumberland River at Burnside, Ky.
(Base discharge 40,000 second-feet)

Date		Gage height (feet)		Discharge (second-feet)	Date		Gage height (feet)		Discharge (second-feet)
1914 Oct.	16	27.3		47,300	1923 Jan.	24	25.7		42,800
Dec.	30	27.8		48,600		29	27.5		47,400
1915 Jan.	13	27.8		48,600	Feb.	4	46.1		97,600
	19	30.5		55,600		4	48.2	P	103,000
Feb.	2	37.2		74,000		14	29.4		52,500
	2	37.4	P*	74,600	Mar.	8	37.1		73,300
Nov.	16	41.8		86,700		13	32.3		60,400
Dec.	18	48.18		105,000	1924 Jan.	1	26.0		42,600
	19	53.8	P*	120,000		4	53.8		110,000
	30	38.59		77,700		17	25.3		41,100
1916 Jan.	8	35.3		68,900	Feb.	21	34.6		62,400
	14	30.56		56,000	May	30	31.0		53,900
Dec.	29	36.30		71,500	Dec.	9	45.0		93,600
1917 Jan.	5	51.05		112,000		9	46.0	P	96,100
	5	51.36	*	113,000	1925 Jan.	12	28.1		51,400
	23	32.75		61,800	Feb.	16	37.0		73,600
Feb.	21	32.34		60,500	1926 Jan.	22	36.5		69,800
	25	24.92		41,200		22	37.8	P	73,000
Mar.	4	44.45		94,000	Aug.	26	34.5		64,800
	13	27.39		47,500	Dec.	22	55.5		117,000
	18	40.45		82,800		26	59.2		126,000
	25	31.65		58,700		26	59.3	P	127,000
1918 Jan.	29	66.60		149,000		29	42.5		84,800
	29	69.5	P*	157,000	1927 Jan.	31	25.4		42,700
Apr.	9	32.65		61,100	Feb.	24	32.1		58,800
1919 Jan.	2	53.9		116,000	Mar.	9	28.5		50,100
	2	58.0	P*	127,000		15	26.2		44,600
Nov.	2	41.4		83,900	May	30	25.5		43,000
	27	31.0		56,900	Nov.	18	35.8		68,000
Dec.	8	30.0		54,300	1928 Jan.	1	28.0		48,900
	14	32.0		59,500	Apr.	23	26.9		46,300
1920 Jan.	10	31.5		58,200	June	5	32.0		58,500
	24	50.2		107,000		30	51.0		106,000
Feb.	5	27.0		46,500	Nov.	20	41.3		81,900
	23	33.0		62,100	1929 Jan.	20	26.0		44,100
Mar.	13	36.0		69,900		26	38.7		75,200
	20	36.0		69,900	Feb.	27	48.0		99,500
Apr.	3	41.0		82,900	Mar.	7	31.2		56,600
1921 Apr.	18	31.5		58,200		15	27.0		46,500
Dec.	25	25.0		41,000		24	67.9		158,000
1922 Feb.	21	44.8		94,100		24	69.3	P	163,000
Mar.	2	42.9		89,000	Apr.	29	29.0		51,300
	11	46.3		98,200	May	8	33.1		61,200
	11	48.0	P	103,000	Nov.	18	28.6		50,300
	16	34.5		66,300	1931 Mar.	29	28.6		50,300
Apr.	29	31.8		59,000	Apr.	23	27.4		47,500
Dec.	18	31.5		58,200	Dec.	15	26.0		44,100

* Estimated

Flood stages and discharges of
Cumberland River at Burnside, Ky.--Continued

Date		Gage height (feet)	Discharge (second-feet)
1932 Jan.	31	50.5	106,000
Feb.	5	44.2	89,400
Mar.	29	31.2	56,600
Dec.	29	27.0	46,500
1933 Jan.	1	30.0	53,700
Jan.	23	32.0	58,500
1933 Feb.	16	31.0	56,100
	21	41.0	81,100
Mar.	20	32.8	60,500
May	11	35.6	67,500

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: July 1 to Nov. 30, 1885; Aug. 1 to Nov. 30, 1886; Aug. 1 to Nov. 30, 1887; Aug. 1 to Nov. 30, 1888; Aug. 1-16, 1889; Feb. 1-28, 1893; June 1 to Nov. 30, 1894; Feb. 11-21, 1895.

Cumberland River at Nashville, Tenn.

Location.- At municipal wharf at Broad and First Streets, Nashville, Davidson County, 2½ miles above Lock and Dam 1.
Drainage area.- 12,860 square miles.
Records available.- Daily discharge records October 1887 to September 1931. Gage-height records since August 1873. Flood discharge records extended back to August 1873 for this report.
Sources of data.- Gage-height records by Mississippi River Commission 1873-1904 and by U. S. Weather Bureau thereafter. Discharge records 1888-1924 from Tennessee Division of Geology Bulletin 34 and 1925-31 from U. S. Geological Survey records. Flood data prior to 1873 from compilation of Corps of Engineers, U. S. Army.
Gage.- Nonrecording gage read twice daily prior to October 1904 and once daily thereafter. No datum changes.
Stage-discharge relation.- Since October 1904 control for medium and low stages is dam at Lock 1 and for high stages navigation dams farther downstream. Condition of control prior to closing of Dam 1 is unknown but was probably permanent. Banks are high but subject to overflow during extreme floods.
Regulation.- Little regulation unless pool is lowered for repairs to lock and dam.
Historical data.- Flood data from 1838 to 1873 give annual maximum elevation referred to gage datum and probably include all flood peaks of 40 feet or above. Intermittent records from 1808 to 1837 give three outstanding flood heights. Estimates of discharge for these early records are based on assumption that stage-discharge relation at times was not materially different from that defined by measurements made from 1901 to 1904.

Flood stages and discharges
(Base discharge 65,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1808		54	184,000
....		....	....
1815		53	176,000
....		....	....
1826 Mar.	1	53.1	177,000
1827 Feb.	11	45	134,000
....		....	....
1838 May	26	35	95,000
1839 Feb.	12	34	93,000
1840 May	4	40	115,000
1841 Feb.	5	40	115,000
1842 Feb.	10	48.0	147,000
Mar.	8	41	119,000
1843 Jan.	15	38	108,000
1844 Feb.	9	40	115,000
1845 Mar.	13	40	115,000
1846 Mar.	8	42	123,000
1847 Mar.	17	50.2	158,000
Dec.	19	54.9	192,000
1848 Mar.	25	48.0	147,000
1849 Jan.	22	46.5	140,000
Dec.	24	43.0	127,000
1850 Jan.	30	45.0	134,000
Mar.	23	50.0	157,000
1851 Feb.	27	43	127,000
1852 Mar.	3	43	127,000
1853 Jan.	1	42	123,000
1854 Jan.	29	49	152,000
1855 Dec.	19	32	86,000
1856 May	11	40	115,000
1857 Dec.	15	49	152,000
1858 Apr.	25	34	93,000
1859 Feb.	22	45.0	134,000
Dec.	12	48.0	147,000
1860 Jan.	18	41	119,000
1861 Jan.	20	39.0	112,000
1862 Mar.		52.2	170,000
1863 Mar.	3	41	119,000
	30	44	130,000
1864 Dec.	25	44	130,000
1865 Mar.	10	52.1	170,000
Apr.	18	51.4	165,000
1866 Jan.	1	42	123,000
1867 Mar.	13	51.2	163,000
1868 Jan.	11	38	108,000
1869 Jan.	5	36	100,000
1870 Jan.	19	45	134,000
1871 Mar.	1	37	104,000
1872 Apr.	16	40.0	115,000
1873 Feb.	21	39	112,000
Dec.	9	26.7	67,000
1874 Jan.	12	32.5	88,000
Feb.	24	36.5	102,000
Mar.	25	37.9	107,000
Apr.	17	49.6	154,000
1875 Jan.	5	30.2	79,000
Feb.	2	41.0	119,000
Mar.	2	41.5	121,000
	21	35.5	98,000
Apr.	6-7	27.6	70,000
May	3	34.2	93,000
July	19	29.9	78,000
	28	28.0	72,000
1876 Jan.	1	28.9	75,000
	22	32.1	86,000
	29	34.4	94,000

Flood stages and discharges of Cumberland River at Nashville, Tenn.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1876	Feb.	18	26.6	67,000
	Mar.	21	27.7	71,000
		29	32.1	86,000
1877	Jan.	22	40.5	117,000
	Apr.	12	34.8	96,000
		24	28.8	74,000
		30	27.0	68,000
1878	Apr.	26	27.3	69,000
1879	Jan.	19	41.6	121,000
	Dec.	16	34.4	94,000
		28	35.4	98,000
1880	Feb.	19	44.5	132,000
	Mar.	4	38.0	108,000
		20	46.5	140,000
	Apr.	20	27.2	69,000
	July	5	30.7	81,000
	Deo.	6	27.1	68,000
1881	Jan.	25	33.0	89,000
	Feb.	23	30.3	80,000
	Apr.	16	31.8	85,000
	Dec.	26	31.2	83,000
1882	Jan.	22	55.1	194,000
	Feb.	22	38.3	109,000
	Mar.	13	46.1	139,000
	Apr.	12	30.8	81,000
1883	Jan.	25	30.3	80,000
	Feb.	14	41.6	121,000
	Apr.	7	35.8	99,000
		23	32.8	89,000
	June	14	27.6	70,000
	Dec.	28	33.7	92,000
1884	Jan.	17	31.7	84,000
	Feb.	15	47.2	143,000
	Mar.	15-16	48.3	148,000
		26	30.7	81,000
1885	Jan.	21	37.8	107,000
	June	3	27.8	71,000
	Nov.	11	27.0	68,000
1886	Feb.	18	35.3	98,000
	Apr.	10-11	49.3	153,000
	May	13	28.9	75,000
1887	Jan.	30	37.2	104,000
	Feb.	5	41.5	121,000
		19	34.2	94,000
	Mar.	2	44.2	131,000
		8	35.4	98,000
1888	Mar.	30	39.2	112,000
	Apr.	13-14	29.8	78,300
	Nov.	13	26.7	67,100
1889	Feb.	21	35.8	99,900
1890	Jan.	22	36.0	101,000
	Feb.	12-13	38.0	108,000
	Mar.	6	50.7	154,000
		15	32.9	89,400
		28	41.0	119,000
	May	24	28.4	73,200
1891	Feb.	15	41.2	119,000
		27	29.0	75,400
	Mar.	13-14	49.2	148,000
	Apr.	4	26.4	66,000
1892	Jan.	19	30.3	80,100
	Mar.	28	34.4	94,800
	Apr.	11	36.9	104,000
		26	38.8	111,000
1893	Feb.	22	40.8	118,000
	June	2	31.3	83,700
		10	29.6	77,600
1894	Feb.	9	42.0	122,000
1895	Jan.	17	30.0	79,000
	Mar.	25	31.6	84,800
	Apr.	19	28.0	71,800
1896	Mar.	22	35.2	97,700
	Apr.	7	42.8	125,000
	July	22	28.8	74,700
	Dec.	1	28.9	75,000
1897	Feb.	28	37.5	106,000
	Mar.	20	48.8	147,000
	Apr.	10	42.3	123,000
	May	18	28.2	72,200
1898	Jan.	23	38.6	110,000
1899	Jan.	14	39.9	114,000
	Feb.	11	40.6	117,000
	Mar.	12	39.0	111,000
		23	33.2	90,500
	Apr.	4	37.6	106,000
		12	31.4	83,700
	May	13	29.6	76,800
1900	Feb.	13	26.1	65,500
	Nov.	30	33.1	90,900
1901	Jan.	16	27.4	69,600
	Apr.	6	29.5	77,600
		25	37.8	107,000
	Aug.	21	39.6	114,000
	Dec.	19	28.9	75,400
1902	Jan.	3	29.4	76,500
	Feb.	4	40.8	118,000
	Mar.	10	32.3	87,300
	Apr.	3-4	46.0	137,000
	Dec.	21	33.3	91,600
1903	Feb.	9	30.5	80,400
		21	37.5	106,000
	Mar.	8	39.8	116,000
	Apr.	13	34.2	94,100
	June	5	25.8	68,600
1904	Mar.	27	37.3	106,000
1905	Feb.	13	29.6	73,200
	Mar.	14	31.4	80,400
1906	Jan.	23	30.4	76,400
	Apr.	3	34.4	92,600
	Nov.	24	28.0	66,800
	Dec.	22	29.3	72,000
1907	Jan.	4	35.4	96,800
		23-24	28.0	66,800
	Mar.	3	38.5	111,000
		18	31.6	81,200
	May	11	29.4	72,400
	June	13	28.0	66,800
1908	Feb.	16	29.4	72,400
1909	Jan.	20	29.2	71,600
	Feb.	28	40.0	116,000
	Mar.	14	33.8	90,100
		30	28.2	67,600
1910	Jan.	11	30.4	76,400
	Feb.	22	35.0	95,100
1911	Jan.	6	34.0	91,000
	Feb.	12	35.9	98,900
	Mar.	13	30.4	76,400
	Apr.	10-11	38.6	110,000
	May	6	33.6	89,300
	Dec.	28	38.4	110,000
1912	Jan.	1	41.4	122,000
	Feb.	27	37.5	106,000
	Mar.	19	37.9	107,000
		29	32.8	86,000
	Apr.	7-8	46.5	144,000
	May	3	43.0	129,000
1913	Jan.	13-14	48.4	153,000
		28	38.6	110,000
	Feb.	28	30.4	76,400
	Mar.	2-3	30.8	78,000
		18	31.0	78,800
	Apr.	2	44.9	137,000
1914	Apr.	5	36.3	101,000
	Dec.	30	33.2	87,700
1915	Jan.	16	29.2	71,600
		23	31.2	79,600
	Feb.	5	37.9	107,000
	Nov.	20	41.4	122,000
	Dec.	23	39.8	116,000
1916	Jan.	4-5	42.4	127,000
	July	14	29.0	70,800
1917	Jan.	1	33.2	87,700
		11	39.5	114,000
		26	32.7	85,600
	Feb.	24-25	32.8	86,000
	Mar.	9-10	45.6	140,000
		21	39.9	116,000
	Apr.	6	33.0	86,800
1918	Feb.	5	49.8	159,000
	Apr.	12	34.5	93,000
1919	Jan.	7	44.9	137,000
	Mar.	9	33.2	87,700
		18	30.2	75,600
	Nov.	6-7	31.6	81,200

Flood stages and discharges of Cumberland River at Nashville, Tenn.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1919	Nov.	27	32.2	83,600		Feb.	21	33.6	86,500
	Dec.	1	37.6	106,000		Nov.	13	29.6	70,600
		17	35.6	97,600	1926	Jan.	26	34.8	89,300
1920	Jan.	13	30.2	75,600		Aug.	29	28.9	68,000
		30	44.1	134,000		Dec.	1	28.3	65,900
	Feb.	26	35.4	96,800			15	31.2	76,300
	Mar.	16	35.7	98,000	1927	Jan.	1	56.2	203,000
		23	32.7	85,600		Feb.	4	31.5	77,400
	Apr.	7	42.1	125,000			27	31.4	77,000
	June	8	28.1	67,200		Mar.	14	40.0	109,000
1921	Feb.	14	32.9	86,400		Apr.	14	30.4	73,400
	Apr.	20	32.7	85,600	1928	Jan.	4	29.5	70,200
1922	Feb.	27	35.5	89,300		Mar.	20	28.3	65,900
	Mar.	16	45.1	120,000		Apr.	26	35.5	91,800
	May	3	31.8	77,500		June	8	32.2	79,900
	Dec.	21	35.9	94,700			15	30.2	72,700
1923	Feb.	9	43.5	122,000		July	5	42.9	120,000
		17	32.2	81,400		Nov.	24	31.3	76,700
	Mar.	13	41.7	116,000	1929	Jan.	29	36.9	97,000
		24	31.9	80,300		Mar.	6	41.0	113,000
1924	Jan.	8	44.0	124,000			31	50.9	159,000
		20	29.4	71,400		May	10	34.9	89,600
	Feb.	25-26	32.7	83,200			20	28.1	65,200
	May 31-June 1		31.0	77,100		Nov.	20	29.6	70,600
	Dec.	14	31.1	77,500	1930	Feb.	17	32.0	79,200
1925	Jan.	15	27.8	65,800	1931	Apr.	2	30.4	73,400

French Broad River at Asheville, N. C.

Location.- Sept. 2, 1895, to Dec. 31, 1901, at old Bingham School Bridge, 2¼ miles below Southern Railway station at Asheville, Buncombe County; Mar. 19, 1903, to July 15, 1916, at old Smith Bridge 1½ miles upstream; Jan. 1 to Nov. 21, 1917, a temporary gage just above old Smith Bridge site; Nov. 22, 1917, to Sept. 30, 1922, on new bridge at site of old Smith Bridge; thereafter at new Bingham School Bridge.
Drainage area.- 949 square miles.
Records available.- September 1895 to December 1901, March 1903 to July 1916, January 1917 to September 1933.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Gage-height records by U. S. Weather Bureau 1903 to November 1922.
Gages.- Nonrecording gage read once daily 1903 to Sept. 30, 1922, and twice daily until recording gage was installed Aug. 9, 1930. Gage probably read once daily 1895-1901 Elevation of zero of gage used 1895-1901 approximately 1.5 feet above present zero, which is 1,950.3 feet above mean sea level. Gage-height records 1903 to Sept. 30, 1922, reduced to a common datum, elevation 1,961.8 feet above mean sea level.
Stage-discharge relation.- Practically permanent for each gage location except when changed by construction of Southern Railway bridge in 1907-8. In general, rating curves are well defined.

Flood stages and discharges
(Base discharge 7,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1896	Jan.	24	6.50	7,700		Mar.	19	11.25	28,100
	July	8	9.85	21,600			27	5.60	9,230
1897	Feb.	6	7.90	12,500		Apr.	3	5.80	9,860
		23	6.85	8,500			12	6.45	11,800
	Mar.	7	7.25	9,660		Dec.	12	6.35	11,800
		14	7.00	9,060	1900	Feb.	13	7.95	17,200
		16	6.40	7,440			22	4.90	7,080
	Apr.	5	7.60	11,100		Mar.	1	7.40	15,200
	May	1	7.10	9,350			8	4.90	7,080
1898	July	14	7.00	9,060		Apr.	22	7.40	15,200
	Aug.	4	8.55	15,800		June	16	7.23	12,800
		12	7.20	9,660			24	6.60	10,600
	Sept.	4	6.33	7,180		Oct.	23	8.50	17,600
		23	7.30	9,990		Nov.	26	6.45	9,910
	Oct.	4	8.10	13,400	1901	Jan.	12	7.40	13,500
		22	7.00	9,060		Mar.	26	9.92	22,800
1899	Feb.	4	8.20	13,900		Apr.	3	8.15	16,500
		27	8.80	16,800			20	7.95	15,800
	Mar.	15	11.50	29,800		May	22	10.40	24,700

Flood stages and discharges of French Broad River at Asheville, N. C.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1901	June	15	6.81	11,300
		21	5.67	7,560
	Aug.	6	8.75	16,800
		17	9.40	19,700
		24	7.55	11,100
		29	8.57	15,800
	Dec.	15	9.98	22,600
		29	10.93	26,900
....			.....	......
1903	Mar.	23	6.1	19,000
		30	4.4	12,400
	Apr.	9	3.8	10,400
		14	3.6	9,720
	June	7	4.4	12,400
		11	3.4	9,080
1904	Mar.	7-8	3.4	9,080
1905	Jan.	13	3.4	9,080
	May	28	3.0	7,890
	June	17	3.0	7,890
		19	3.0	7,890
	July	13	6.0	18,600
	Aug.	12	3.9	10,700
	Dec.	3	2.8	7,320
		9	2.8	7,320
1906	Jan.	4	4.0	11,000
		23	7.8	25,800
	Apr.	15	3.2	8,480
	June	16	4.2	11,700
	July	19	2.9	7,600
	Aug.	31	3.2	8,480
	Sept.	19	5.7	17,400
	Oct.	4	5.3	15,800
	Nov.	19	5.0	14,600
1907	Jan.	1	2.8	7,320
	May	1	3.2	8,480
	Nov.	24	2.9	7,040
	Dec.	15	3.2	7,890
		24	3.5	8,780
1908	Jan.	12	5.9	15,200
	Feb.	15	5.9	15,200
	Aug.	26	4.9	12,100
	Oct.	24	3.4	7,690
		30	3.6	8,230
1909	May	1	3.4	7,690
		10	4.5	10,800
		21	4.5	10,800
	June	4	5.9	15,200
		10	3.4	7,690
		20	3.6	8,230
	Dec.	14	3.5	7,960
1910	May	9	3.2	7,160
	Aug.	31	8.8	25,100
1911	Apr.	6	3.9	9,070
		15	3.4	7,690
1912	Mar.	16	4.2	9,940
		29	4.0	9,360
1913	Mar.	15	6.2	16,200
		27	5.2	13,000
	Apr.	12	3.7	8,510
	May	24	3.2	7,160
1914	Apr.	15	3.4	7,690
	Oct.	16	6.6	17,600
	Dec.	2	5.6	14,300
		5	5.2	13,000
		26	4.3	10,200
1915	Jan.	8	3.9	9,070
		19	3.9	9,070
	Feb.	2	4.2	9,940
	Nov.	19	3.4	7,690
	Dec.	18	5.2	13,000
		29	5.9	15,200
1916	Feb.	3	4.0	9,360
	May	24	4.3	10,200
	July	11	8.8	25,100
		16	* 23.1	* 110,000
....			....	....
1917	Mar.	5	4.2	9,770
		25	4.2	9,770
	Apr.	6	3.2	7,020
	Sept.	1	3.2	7,020
1918	Jan.	28	5.0	P 12,200
		29	4.4	10,400
	Oct.	26	5.6	14,100
		30	8.0	22,100
	Dec.	15	4.0	9,190
		17	4.5	10,600
		23	8.9	25,200
		23	9.0	P 25,600
1919	Jan.	3	4.0	9,190
	Mar.	9	4.0	9,190
	Dec.	10	3.2	7,020
1920	Feb.	4	3.8	8,620
	Mar.	29	3.5	7,800
	Apr.	2	6.5	17,000
	Dec.	14	4.4	10,400
1921	Jan.	15	3.3	7,580
	Feb.	11	4.3	10,200
	Apr.	17	4.3	10,200
1922	Mar.	11	3.3	7,580
		29	3.3	7,580
1923	Mar.	17	5.0	8,940
		30	6.0	8,940
	May	30	6.30	P 13,300
		30	5.0	8,940
1924	Jan.	11	4.9	7,850
		16	5.35	P 9,600
		17	4.95	8,690
	Apr.	19	4.28	7,010
	Dec.	9	5.0	8,690
		9	5.20	P 9,210
1925	Jan.	20	4.55	7,730
1926	Jan.	18	5.65	P 10,300
		19	4.8	8,210
	Nov.	16	4.60	7,730
		16	5.00	P 8,720
1928	May	8	4.58	7,730
	Aug.	16		34,600
		16	13.27	P 42,700
	Sept.	3	5.60	10,300
		6	5.65	10,300
1929	Feb.	28	5.35	9,770
	Mar.	5		8,540
		14	7.12	P 15,100
		15	6.76	14,000
		24	4.36	7,250
	Sept.	27	5.75	10,900
	Oct.	2	6.86	14,400
		2	7.06	P 15,100
		22	5.42	9,770
1930	Apr.	22	4.31	P 7,010
1931	Apr.	23	3.94	** 6,090
1932	Jan.	1	3.90	** 6,090
	Oct.	18	6.85	14,000
		18	7.33	P 15,800
	Nov.	1	4.46	7,490
	Dec.	26	5.29	9,500
		28	5.76	10,900

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Tennessee River at Knoxville, Tenn.

Location.- Feb. 1, 1883, to Jan. 16, 1899, at old county highway bridge at Gay Street, in Knoxville, about 4 miles below junction of French Broad and Holston Rivers; Jan. 17 to Dec. 31, 1899, a temporary gage on Knoxville & Augusta Railroad bridge about 2,000 feet downstream; Jan. 1, 1900, to Dec. 31, 1908, just below mouth of West Knoxville Bayou, about 2,200 feet below Gay Street Bridge; Jan. 1, 1909, to Aug. 8, 1925, at new Gay Street Bridge; thereafter at Knoxville Water Co.'s intake, half a mile above Gay Street Bridge.

Drainage area.- 8,990 square miles.

Records available.- Fragmentary flood record 1875-76. Winter gage height and estimated discharge records only, 1883-99. Continuous records of gage height and discharge October 1899 to September 1934.

Sources of data.- Gage-height records from 1883-89 by U. S. Signal Service; 1890 to August 1925 by U. S. Weather Bureau; August 1925 to September 1934 by U. S. Geological Survey. Discharge records from 1867-97 from unpublished estimates by W. R. King; subsequent records from Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey.

Gages.- Nonrecording gage read once daily until Aug. 9, 1925; recording gage thereafter. Zero of gages used since January 1909 is 797.45 feet above mean sea level and of the gage used January 1900 to December 1908 is 795.6 feet above mean sea level. Zero of original gage was about 797.9 feet and zero of the temporary gage used in 1899 was about 798.5 feet above mean sea level. Corrections of plus 0.6 foot have been applied to the 1899 readings in U. S. Geological Survey publications.

Stage-discharge relation.- Fairly permanent except for channel improvements in 1918 which probably affected only the low water relations. In general rating curves are well defined up to about 100,000 second-feet. Right bank of main channel is overflowed at extremely high stages.

Historical data.- Greatest known flood occurred on Mar. 10, 1867, gage height 44.4 feet (estimated discharge, 245,000 second-feet). The 1891 Annual Report of the Chief Signal Officer states that this flood was 12 feet higher than the 1847 flood and was highest for previous 90 years.

Flood stages and discharges
(Base discharge 44,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1875	Jan.	30	20.1	* 101,000
	Feb.	26	43.2	* 238,000
	Mar.	4	26.1	* 137,000
		16	17.1	* 83,500
		21	24.3	* 126,000
	Dec.	29	16.6	* 80,500
1876	June	19	23.1	* 119,000
....			....	....
1884	Feb.	2	15.4	* 73,400
		10	16.1	* 77,000
		19	15.6	* 74,600
	Mar.	7	22.3	* 114,000
		13	14.0	
		21	18.9	* 94,100
1886	Jan.	6	11.8	
	Mar.	31	29.6	* 157,000
1887	Jan.	25	13.4	
	Feb.	4	14.3	
		25	12.4	
	Mar.	9	11.8	
1888	Jan.	18	12.6	
	Mar.	30	13.3	
1889	Feb.	19	15.0	* 71,100
1890	Feb.	28	23.0	* 130,000
	Mar.	24	14.6	
1891	Feb.	4	11.0	
		11	21.9	* 111,000
		23	19.0	* 93,500
		27	10.0	
	Mar.	6	13.7	
		10	16.9	* 81,100
1892	Jan.	15	23.3	* 121,000
1893	Feb.	1	11.0	
		12	14.7	
		18	18.0	
1894	Feb.	5	15.4	* 73,400
1895	Jan.	11	18.5	* 91,700
	Mar.	3	11.8	
		22	14.2	
1896	Apr.	3	28.7	* 152,000
	Dec.	1	10.0	
1897	Feb.	8	11.2	
		24	26.0	* 136,000
	Mar.	7	13.8	
		11	22.5	* 115,000
		15	17.0	
		21	13.5	
1899	Feb.	7	22.50	
	Mar.	6	19.20	
		16	20.40	
		20	28.00	
		29	12.20	
1900	Feb.	14	13.0	58,500
	Mar.	3	11.1	49,000
		22	13.2	59,500
1901	Jan.	13	16.0	74,500
	Mar.	27	16.0	74,500
	Apr.	4	17.1	80,600
		22	16.2	75,600
	May	23	32.0	169,000
		23	34.8	P 188,000
	Aug.	7	12.9	58,000
		15	17.2	81,100
	Dec.	16	21.0	103,000
		31	31.0	163,000
1902	Feb.	2	12.2	54,500
	Mar.	1	34.4	183,000
		1	36.4	P 197,000
		18	10.6	46,500
		30	18.5	88,200
1903	Feb.	18	19.9	96,400
	Mar.	1	14.6	66,800
		9	11.2	49,500
		23	24.6	P 128,000
		24	24.0	121,000
	Apr.	1	10.9	48,000
		9	24.1	122,000
		9	24.6	P 128,000
		14	13.9	63,000
1904	Mar.	25	12.6	56,500
1905	Jan.	14	10.8	47,500
	Feb.	10	10.8	47,500

* Estimated

Flood stages and discharges of Tennessee River at Knoxville, Tenn.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1905	Feb.	22	11.0		48,500
	May	17			44,000
	July	13	12.0		53,500
1906	Jan.	24	20.1		97,600
		24	22.4	P	115,000
	Sept.	20	10.9		48,000
	Nov.	20	23.0		115,000
	Dec.	30	10.9		48,000
1907	June	10			44,000
		16	12.2		54,500
	Sept.	25	10.5		46,000
	Dec.	31	10.3		45,000
1908	Jan.	13	16.9		79,400
	Feb.	16	15.2		70,100
	Mar.	25	11.0		48,500
	Apr.	4	11.9		53,000
		27	10.8		47,500
	Dec.	9	11.1		49,000
1909	Feb.	11	8.9		45,600
		25	8.8		45,100
	Mar.	11	11.1		58,100
		29	11.9		62,900
	May	2	13.6		73,100
		22	11.2		58,700
	June	5	13.9		74,900
	Aug.	17	9.9		51,000
1910	Sept.	1-2	8.1	**	41,700
1911	Jan.	4	11.5		60,500
	Feb.	10	13.1		70,100
	Mar.	9	14.4		77,900
	Apr.	7	14.1		76,100
1912	Mar.	17	12.7		67,700
		30	13.7		73,700
	Apr.	3	16.9		92,900
		3	17.1	P	94,400
		30	11.4		59,900
1913	Jan.	28	12.0		63,500
	Feb.	28	9.4		48,200
	Mar.	16	19.1		106,000
		28	20.8		116,000
		28	21.6	P	121,000
	May	25	11.9		62,900
		29	8.6		44,100
1914	Apr.	1	8.5	**	43,600
	Oct.	17	8.9		45,600
	Dec.	5	9.5		48,800
		26	16.2		88,700
		26	17.3	P	95,600
1915	Feb.	3	12.7		67,700
	Dec.	19	17.4		95,900
		19	17.7	P	98,900
		30	14.9		80,900
1916	Jan.	9	13.6		73,100
	Feb.	3	13.9		74,900
	July	12	11.5		60,500
		18	29.9		171,000
		22	10.0		51,500
1917	Jan.	6	11.7		61,700
		30	8.9		45,600
	Feb.	21	12.0		63,500
	Mar.	5	28.2		161,000
		13	10.1		52,100
		18	11.2		58,700
		25	13.9		74,900
1918	Jan.	15			44,100
		30			128,000
		30	24.2	P	137,000
	Oct.	27	12.0		63,800
		27	12.1	P	64,400
		31	18.7		104,000
	Dec.	24	13.0		69,800
1919	Jan.	4	16.2		89,000
		27	9.7		50,100
1920	Jan.	25	9.4		48,300
	Mar.	14	11.9		63,200
		18	10.1		52,400
		20	13.0		69,800
	Apr.	3	26.7		152,000
	Dec.	15	11.3		59,600
1921	Feb.	11	17.0		93,800
		11	17.8	P	98,600
	July	22	9.8		50,600
	Aug.	16	9.0		46,000
1922	Jan.	22	19.0		107,000
	Feb.	17	14.0		75,800
	Mar.	4	10.8		56,600
		12	13.0		69,800
		17	10.4		54,200
	Apr.	30	11.9		63,200
	May	6	10.7		56,000
	Dec.	18	12.4		66,200
1923	Jan.	29	11.5		60,800
	Feb.	5	16.8		92,600
		15	13.9		75,200
	Mar.	8	11.6		61,400
		12	9.6		49,500
		18	13.4		72,200
	June	15	8.7		44,300
1924	Jan.	13	9.3		47,700
	Mar.	7	10.0		51,800
	Dec.	9	11.2	P	59,000
		10	10.8		56,600
1925	Jan.	13	9.8		50,600
1926	Jan.	20	9.8		46,900
	Apr.	14	9.8		46,900
		14	10.3	P	49,700
	Dec.	24	11.3		55,300
		27	14.5		74,000
1927	Feb.	25	19.3		103,000
		25	19.9	P	106,000
	Mar.	10	12.6		62,800
	Apr.	23	9.9		47,200
	June	1	12.6		65,900
1928	May	9	9.50		45,200
	June	30	17.47		92,000
		30	18.80	P	99,800
	Aug.	17	14.09		71,600
	Sept.	4	11.71		57,600
		7	11.93		58,700
1929	Mar.	1	14.59		78,800
		6	14.56		78,800
		16	11.65		61,600
		24	16.45		89,000
		24	17.20	P	93,600
	May	8	10.72		56,500
		21	11.58		61,600
1930	Mar.	20	9.12		44,700
1931	Apr.	6	14.78		73,700
		6	15.20	P	75,700
1932	Jan.	31	13.20		65,300
	Feb.	5	17.25		88,000
		5	18.25	P	94,500
		13	10.63		51,800
	May	3	10.74		52,300
	Dec.	29	19.56		102,000
		29	20.2	P	106,000
1933	Feb.	9	10.80		52,900
		16	18.70		96,900
		21	9.80		47,700
1934	Mar.	5	16.10		78,700
		5	16.67	P	82,000
		29	10.09		46,900

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Tennessee River at and near Chattanooga, Tenn.

Location.- At Walnut Street Bridge, in Chattanooga, Hamilton County, 3 miles above mouth of Chattanooga Creek, 4 miles below mouth of South Chickamauga Creek, and 33 miles above Hales Bar Lock and Dam. Stations below Hales Bar Lock and Dam used since July 1, 1930.

Drainage area.- 21,400 square miles at Chattanooga and 22,000 square miles at Hales Bar.

Records available.- April 1874 to June 1930 at Chattanooga; July 1930 to September 1934 at Hales Bar.

Sources of data.- Tennessee Division of Geology Bulletin 34 1874-1924; U. S. Geological Survey records 1925-34. Gage-height records at Chattanooga furnished by U. S. Weather Bureau.

Gages.- Nonrecording gage read once daily or oftener during high water from April 1874 to Dec. 30, 1902; recording gage thereafter.

Stage-discharge relation.- Prior to Oct. 22, 1913, Chattanooga gage alone was used. On this date gage became affected by backwater from Hales Bar Dam, and it was necessary to use another gage in conjunction with Chattanooga gage and to determine river slopes to compute discharges. Oct. 22, 1913, to Feb. 28, 1915, and Oct. 1, 1918, to Jan. 5, 1921, gage-height records at Bridgeport, Ala., were used with measurements made at Chattanooga to determine Chattanooga discharges. Channel and control practically permanent prior to construction of Hales Bar Dam; thereafter control formed by dam. In general, rating curves are well defined up to about 200,000 second-feet; higher flood determinations probably not subject to gross error.

Historical data.- U. S. Weather Bureau reports a stage of 58.6 feet Mar. 11, 1867, referred to Chattanooga gage (discharge, about 393,000 second-feet). Stage was 15.5 feet higher than flood of 1847 and highest since 1777 (Annual Report of Chief Signal Officer, U. S. Army, 1891, p. 246).

Flood stages and discharges
(Base discharge 112,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1874	Apr.	17	24.2	159,000
	May	1	29.6	195,000
1875	Jan.	31	32.5	215,000
	Mar.	1	54.0	361,000
		18	28.1	185,000
		23	34.0	225,000
	Apr.	4	20.5	133,000
	May	1	20.7	135,000
	July	16	20.0	130,000
	Dec.	31	34.2	227,000
1876	Feb.	17	21.9	143,000
	Mar.	18	21.1	137,000
	May	10-11	20.0	130,000
	June	20	23.4	153,000
1877	Jan.	23	27.0	178,000
	Apr.	11	28.7	189,000
1878	Feb.	25	19.2	125,000
	Nov.	29	18.0	116,000
1879	Jan.	15	38.0	252,000
	Feb.	19	18.8	122,000
	Dec.	16	17.9	116,000
		26	21.9	143,000
1880	Feb.	16	26.8	176,000
	Mar.	18	38.3	254,000
	Dec.	3	26.5	174,000
		7	18.1	117,000
1881	Jan.	23	18.8	122,000
	Feb.	13	22.4	146,000
	Mar.	20	19.3	125,000
	Apr.	15	18.0	116,000
	Dec.	16	17.4	112,000
		23	20.2	131,000
1882	Jan.	19	40.2	267,000
		31	30.3	200,000
	Feb.	6	24.4	160,000
		13	23.6	154,000
	Mar.	3	22.0	144,000
		11	21.1	137,000
	Sept.	14	22.8	149,000
1883	Jan.	23	38.2	254,000
	Feb.	10	17.6	114,000
	Apr.	3	26.2	172,000
		14	18.7	121,000
		26	32.5	215,000
1884	Feb.	4	25.5	167,000
		11	36.8	244,000
	Mar.	10	42.8	285,000
		23	27.6	182,000
1885	Jan.	14	17.6	114,000
		18	26.5	174,000
	June	1	18.6	120,000
	Nov.	9	30.4	201,000
	Dec.	16	21.4	140,000
1886	Jan.	5	22.1	144,000
	Apr.	3	52.2	349,000
1887	Jan.	26	21.8	142,000
	Feb.	7	21.8	142,000
	Feb.	28-Mar. 1	27.3	180,000
	Mar.	11	24.0	157,000
	Apr.	27	21.2	138,000
1888	Jan.	19	25.7	169,000
	Mar.	27	22.6	148,000
		31	27.0	178,000
	Apr.	12	22.4	146,000
	Oct.	28	20.0	130,000
	Nov.	12	21.0	137,000
1889	Feb.	18	29.6	195,000
1890	Feb.	10	20.4	133,000
	Mar.	2	42.5	283,000
		25	27.2	179,000
	Apr.	20	20 4	133,000
1891	Feb.	5	22.6	148,000
		14	37.5	249,000
		25	29.0	191,000
	Mar.	11	38.9	259,000
1892	Jan.	17	37.9	252,000
	Apr.	10	34.3	227,000
1893	Feb.	14	23.6	154,000
		20	33.4	221,000
	May	7	30.0	198,000
	June	8	20.7	135,000
1894	Feb.	6	25.5	167,000
1895	Jan.	12	32.1	212,000
	Mar.	5	19.9	122,000
		23	22.7	148,000
1896	Apr.	5	40.5	269,000
	July	12	21.6	141,000
1897	Feb.	26	34.8	231,000
	Mar.	8	25.1	165,000
		14-15	37.9	252,000
		22	33.3	220,000
	Apr.	6	30.4	201,000
	May	15	22.4	146,000
1898	Jan.	27	18.2	118,000
	Apr.	2	17.8	115,000
	Sept.	5	24.6	164,000
1899	Jan.	7	18.8	122,000
	Feb.	9	38.2	254,000
	Mar.	1	19.2	125,000
		9	27.7	182,000

Flood stages and discharges of
Tennessee River at and near Chattanooga, Tenn.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1899	Mar.	22	40.0		266,000
		31	22.8		149,000
	Apr.	8	18.0		116,000
1900	Feb.	15	24.3		157,000
	Mar.	23	17.4		112,000
1901	Jan.	14	28.1		185,000
	Mar.	28	22.3		146,000
	Apr.	4	24.1		158,000
		21	26.5		174,000
	May	26	32.5		215,000
	Aug.	17	32.8		217,000
	Dec.	17	28.6		190,000
1902	Jan.	2	40.8		271,000
	Feb.	3	23.2		152,000
	Mar.	4	38.0		252,000
	Apr.	1	30.9		205,000
1903	Feb.	6	19.6		127,000
		19	29.3		193,000
	Mar.	2	31.0		205,000
		10	24.2		159,000
		26	28.8		190,000
	Apr.	1	17.4		112,000
		11	31.8		210,000
		16	21.9		143,000
1904	Mar.	25	21.8		142,000
1905	Feb.	11	22.4		146,000
		22	21.4		140,000
	Mar.	12	17.3		112,000
1906	Jan.	26	21.4		140,000
	Oct.	2	19.2		125,000
	Nov.	22	33.3		220,000
1907	Jan.	1	20.5		133,000
	Mar.	4	18.4		119,000
1908	Jan.	1	18.6		120,000
		15	20.3		132,000
	Feb.	17	24.7		162,000
1909	Feb.	12	18.0		116,000
		18	19.9		129,000
		25	21.6		141,000
	Mar.	15	24.6		161,000
		31	18.2		115,000
	May	3	24.8		160,000
		24	21.4		137,000
	June	6	25.3		163,000
	July	10	18.5		117,000
1910	Feb.	20	13.9	**	85,900
1911	Jan.	5	24.9		161,000
	Feb.	12	23.9		154,000
	Mar.	11	20.0		127,000
	Apr.	9	29.9		195,000
	Dec.	29	18.7		118,000
1912	Mar.	17	23.9		144,000
		31	31.3		190,000
	Apr.	5	30.2		183,000
	May	2	26.0		157,000
1913	Jan.	29	23.2		140,000
	Mar.	1	22.4		135,000
		17	31.3		190,000
		30	33.1		202,000
1914	Apr.	3	21.4	**	102,000
	Dec.	7	22.8		112,000
		28	33.1		183,000
1915	Feb.	5	26.1		139,000
	Dec.	20	32.8		183,000
		31	31.8		168,000
1916	Jan.	10	26.2		130,000
	Feb.	4	24.9		133,000
	July	12	28.6		146,000
		20	30.2		161,000
1917	Jan.	8	25.8		141,000
	Feb.	22	27.6		150,000
	Mar.	8	47.4		310,000
		15	22.4		113,000
		19	27.9		151,000
		28	34.1		196,000
1918	Feb.	2	42.5		266,000
	Nov.	2	29.5		163,000
	Dec.	24	26.1		149,000
1919	Jan.	5	32.0		189,000
	Mar.	10	23.2		128,000
	Dec.	11	23.0		124,000
1920	Jan.	26	25.7		147,000
	Mar.	21	26.2		148,000
	Apr.	5	43.5		275,000
	Aug.	17	28.3		165,000
	Dec.	16	28.2		151,000
1921	Feb.	12	34.1		210,000
	Apr.	18	28.4		135,000
1922	Jan.	23	34.3		229,000
	Feb.	17	27.4		155,000
	Mar.	3	29.5		165,000
		12	32.3		194,000
	Dec.	19	28.6		164,000
1923	Feb.	2	23.6		136,000
		7	32.1		188,000
		16	26.9		145,000
	Mar.	9	24.8		130,000
		13	21.9		124,000
		19	25.9		141,000
1924	Jan.	5	26.9		143,000
	Mar.	9	20.8		124,000
	Apr.	19	25.3		136,000
	Dec.	10	22.1		138,000
1925	Jan.	3	21.1		134,000
		12	20.6		125,000
1926	Apr.	16	20.65	**	92,900
1926	Dec.	14	21.7		112,000
		29	38.35		248,000
		29	38.4	P	249,000
1927	Feb.	26	30.16		182,000
	Mar.	11	28.08		165,000
1928	July	2	30.36		181,000
		2	30.8	P	184,000
	Sept.	5	23.31		123,000
1929	Jan.	27	23.23		120,000
	Mar.	2	30.41		180,000
		8	29.39		172,000
		16	28.29		163,000
		26	38.22		246,000
		26	38.5	P	248,000
	May	8	24.42		135,000
		10	26.35		149,000
		22	28.35		166,000
	Nov.	19	28.67		167,000
		19	28.95	P	180,000
1930	Mar.	21	21.12	**	108,000
1931	Apr.	8			123,000
		8		P	125,000
	Dec.	16			116,000
1932	Feb.	2			188,000
		3		P	192,000
		7			184,000
		17			117,000
	Dec.	16			127,000
1933	Jan.	1			261,000
		1		P	264,000
	Feb.	18			210,000
		22			156,000
	Mar.	22			128,000
1934	Mar.	6	28.80		229,000
		6	28.90	P	231,000
		27	23.97		168,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Tennessee River at Florence, Ala.

Location.- November 1871 to Apr. 2, 1926, at Southern Railway bridge at lower end of Pattons Island, 1 mile south of Florence, Lauderdale County, and 3 miles below site of Wilson Dam; thereafter 700 feet upstream.
Drainage area.- 30,800 square miles.
Records available.- November 1871 to September 1933. Gage-height records and flood estimates only prior to October 1894.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Gage-height records by Mississippi River Commission 1871 to 1918 and by U. S. Weather Bureau 1919 to April 1926. Discharge measurements prior to 1913 by Corps of Engineers, U. S. Army.
Gages.- Prior to installation of recorder on Apr. 3, 1926, a nonrecording gage was read once daily except February 1887 to September 1921 and July 1925 to Apr. 2, 1926, when two readings a day were made. Zero of gages is 400.85 feet above mean sea level.
Stage-discharge relation.- Practically permanent. Rating curves well defined to about 300,000 second-feet.
Regulation.- Flow regulated at Wilson Dam after July 6, 1924.

Flood stages and discharges
(Base discharge 140,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1872	Apr.	14	11.5	** *	118,000
	Dec.	25	16.4	*	188,000
1873	Feb.	22	22.9	*	289,000
1874	Mar.	7	13.5	*	144,000
		24	18.4	*	219,000
	Apr.	17	26.0	*	338,000
1875	Feb.	4	18.9	*	226,000
	Mar.	8	29.4	*	395,000
		29	22.6	*	285,000
1876	Jan.	4	19.8	*	240,000
	Mar.	20	15.2	*	168,000
	Apr.	3	15.1	*	167,000
	May	13	13.7	*	147,000
1877	Jan.	25-26	15.8	*	178,000
	Apr.	10	19.4	*	234,000
		29	15.5	*	173,000
1878	Apr.	26	13.6	*	145,000
1879	Jan.	19-20	21.4	*	266,000
	Feb.	21	13.7	*	146,000
	Dec.	15	14.4	*	158,000
		27-28	15.0	*	166,000
1880	Jan.	10	14.3	*	157,000
	Feb.	20	14.3	*	157,000
	Mar.	18	24.5	*	315,000
	Apr.	5	15.3	*	171,000
	Dec.	6	18.1	*	213,000
1881	Jan.	25	13.4	*	143,000
	Feb.	16	13.8	*	148,000
	Mar.	21	17.4	*	203,000
	Apr.	15-17	13.6	*	146,000
	Dec.	26	15.4	*	173,000
1882	Jan.	22	29.6	*	397,000
	Feb.	5	21.8	*	273,000
		14	19.9	*	242,000
	Mar.	10	18.0	*	212,000
1883	Jan.	28	20.3	*	248,000
	Apr.	7	14.9	*	165,000
		13	14.5	*	159,000
		29-30	17.5	*	204,000
1884	Jan.	25	13.4	*	143,000
	Feb.	15	24.2	*	310,000
	Mar.	14-15	25.2	*	325,000
	Apr.	15	14.2	*	154,000
1885	Jan.	20	17.8	*	209,000
	Nov.	13	16.5	*	188,000
1886	Jan.	8-9	15.3	*	171,000
	Apr.	8	28.1	*	372,000
1887	Jan.	30	16.3	*	186,000
	Feb.	8	13.3	*	142,000
	Feb.	28-Mar. 1	17.5	*	204,000
	Mar.	13	14.3	*	157,000
1888	Apr.	22	16.5	*	188,000
	Mar.	29	20.5	*	251,000
	Apr.	14	13.8	*	148,000
	Nov.	13	13.4	*	143,000
1889	Feb.	20	19.7	*	238,000
1890	Feb.	10	17.2	*	200,000
	Mar.	3	23.3	*	217,000
		11	21.8	*	272,000
		28	16.1	*	182,000
1891	Feb.	18	21.8	*	273,000
	Mar.	15	22.2	*	278,000
	Apr.	1	14.0	*	151,000
1892	Jan.	21	20.0	*	243,000
	Apr.	8	23.9	*	305,000
		23	15.7	*	177,000
1893	Feb.	17-20	20.7	*	254,000
	Apr.	15	18.2	*	215,000
	May	10	17.1	*	198,000
	June	6-7	14.0	*	151,000
1894	Feb.	9	17.6	*	205,000
1895	Jan.	17	17.4		213,000
	Mar.	25	14.9		173,000
1896	Feb.	4	13.7		155,000
	Mar.	21-22	12.7		141,000
	Apr.	9	19.8		254,000
1897	Mar.	2	17.1		208,000
		19	31.6	*	430,000
		19	32.5	P	444,000
	Apr.	10	18.1		225,000
	May	17	13.5		152,000
1898	Jan.	16	13.4		151,000
		20	13.4		151,000
		28-29	13.8		157,000
1899	Jan.	9	14.1		161,000
	Feb.	14	20.4		264,000
		28	16.6		200,000
	Mar.	11	15.3		179,000
		20	25.1		325,000
	Apr.	10-11	13.4		151,000
1900	Feb.	17	14.6		168,000
	Apr.	20	19.2		243,000
	June	28	12.8		142,000
1901	Jan.	16-17	16.2		193,000
	Mar.	31	13.5		152,000
	Apr.	7	15.4		181,000
		23	16.3		195,000
	May	28-29	16.1		192,000
	Aug.	22	18.9		238,000
	Dec.	19-20	16.0		190,000
1902	Jan.	6	20.8		272,000
	Feb.	3	16.5		198,000
	Mar.	8-9	20.9		273,000
		29	19.8		254,000
1903	Feb.	9	16.6		200,000
		22	17.7		218,000

* Estimated
** Below base

Flood stages and discharges of Tennessee River at Florence, Ala.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1903	Mar.	6	18.8	236,000
		29	15.2	178,000
	Apr.	14	18.2	226,000
1904	Mar.	27	17.2	210,000
......	......	......	.....	....
1905	Feb.	12-13	16.7	201,000
		24	15.7	185,000
	Mar.	13	12.8	142,000
1906	Jan.	24	13.6	154,000
		28	13.7	155,000
	Oct.	5	15.9	189,000
	Nov.	25	16.7	201,000
1907	Jan.	3	14.1	161,000
	Mar.	5	14.5	167,000
1908	Jan.	17	12.8	142,000
	Feb.	19-20	17.0	206,000
	Mar.	25	13.6	154,000
1909	Feb.	16	15.4	181,000
		26	19.0	240,000
	Mar.	15	19.6	250,000
	May	5-6	14.8	172,000
		26	12.9	143,000
	June	7-8	15.6	184,000
1910	Feb.	22	11.7	** 127,000
1911	Jan.	5-6	17.0	206,000
	Feb.	13	16.0	190,000
	Apr.	10	22.0	293,000
		21	16.8	203,000
	Dec.	31	18.3	228,000
1912	Feb.	27	15.5	182,000
	Mar.	17	16.3	195,000
	Apr.	3	19.6	250,000
	Apr.	30-May 1	17.4	213,000
1913	Jan.	10	15.0	175,000
		29	17.0	206,000
	Mar.	2	15.2	178,000
		21	18.5	231,000
	Apr.	3	17.9	221,000
1914	Apr.	4	12.2	** 127,000
	Dec.	31	19.2	231,000
1915	Feb.	4	17.0	196,000
	Dec.	24	16.7	191,000
1916	Jan.	3	19.3	232,000
		14	15.2	169,000
		25-26	14.5	159,000
	Feb.	7	13.6	146,000
	July	12	23.0	292,000
		23	15.0	166,000
1917	Jan.	10	13.9	150,000
	Feb.	3	13.9	150,000
		25	16.1	182,000
	Mar.	12	24.6	317,000
		28	20.6	253,000
	Apr.	6	17.8	208,000
1918	Feb.	6	21.9	274,000
	Apr.	10-11	14.2	154,000
	Nov.	5	14.7	162,000
	Dec.	27	14.4	158,000
1919	Jan.	8	17.5	204,000
	Mar.	9	19.2	231,000
	Mar.	18	14.4	158,000
	Dec.	14	15.4	172,000
1920	Jan.	29	15.4	172,000
	Feb.	25	13.5	145,000
	Mar.	14	17.6	205,000
	Apr.	10	23.5	300,000
	Aug.	19	16.35	186,000
1921	Feb.	13	18.7	223,000
	Apr.	19	18.0	212,000
1922	Jan.	28	19.1	229,000
	Feb.	20	16.0	181,000
	Mar.	5	20.0	244,000
		11	21.2	263,000
	Apr.	2	13.8	149,000
	May	9	13.7	148,000
	Dec.	21-22	15.4	172,000
1923	Jan.	28	13.4	144,000
	Feb.	11	18.2	215,000
	Mar.	13	15.5	174,000
		24	17.0	196,000
1924	Jan.	6	17.0	196,000
		20	13.5	145,000
	Feb.	29	14.3	156,000
	Mar.	7	16.5	188,000
	Apr.	22	15.9	180,000
1925	Jan.	16	13.5	145,000
1926	Jan.	23	13.5	149,000
	Dec.	16	14.2	156,000
		29-30	26.4	342,000
		29	26.5	P 344,000
1927	Mar.	2	16.4	187,000
		13	21.0	256,000
	Apr.	15	15.0	167,000
1928	Apr.	24	18.1	212,000
		24	18.4	P 217,000
	June	7	14.0	153,000
	July	5	14.8	164,000
1929	Jan.	28	16.4	194,000
	Mar.	7	18.0	218,000
		16	19.0	233,000
		25	22.7	290,000
		25	22.9	P 293,000
	May	11	17.6	212,000
		25	15.4	180,000
	Nov.	19	19.7	244,000
		19	20.0	P 248,000
1930	Mar.	9	14.7	170,000
1931	Apr.	9	12.8	143,000
		10	12.95	P 146,000
	Dec.	18	13.4	152,000
1932	Feb.	4	19.60	242,000
		4	19.70	P 244,000
		18	17.27	208,000
	Apr.	3	12.98	146,000
	Dec.	16	16.69	202,000
1933	Jan.	5	20.52	261,000
	Feb.	21	21.00	269,000
	Mar.	22	14.31	166,000
	May	13	14.07	162,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Sept. 1 to Nov. 30, 1904.

Tennessee River at and near Johnsonville, Tenn.

Location.- October 1875 to October 1926 at Nashville, Chattanooga, & St. Louis Railway warehouse 1,000 feet below railway bridge at Johnsonville, Humphreys County; October 1926 to September 1931 at railroad bridge and thereafter at bridge on U. S. highway 70 about 6 miles upstream from Johnsonville and 19 miles below mouth of Duck River.
Drainage area.- 38,500 square miles.
Records available.- Gage-height records October 1875 to March 1877, March 1879 to October 1880, January 1882 to April 1883, and February 1884 to September 1934. Discharge records since October 1889 except for periods of backwater effect from Ohio River, for which gage heights for peak stages above 19.0 feet are given.
Sources of data.- Gage-height records furnished by U. S. Weather Bureau prior to October 1926. Discharge records from Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Estimates of peak discharge for the climatic years 1876 to 1890 are listed as given in 71st Cong., 2d sess., H. Doc. 328, p. 148, 1930.
Gages.- Nonrecording gage read once daily until October 1926; recording gage thereafter. Zero of gage near Johnsonville is 319.82 feet above mean sea level. Other gages at independent datums.
Stage-discharge relation.- Practically permanent except for periods of backwater from Ohio River. Rating curves are well defined to about 300,000 second-feet. Right bank not subject to overflow. Left bank is overflowed at extreme high water.

Flood stages and discharges
(Base discharge 150,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1876	Jan.	6	29.0	
	Feb.	5-6	21.8	
		21	20.3	
	Mar.	22	23.0	
		27-28	22.6	
	Apr.	5	25.8	
	May	9	22.6	
	June	16	24.6	
1877	Jan.	24	24.7	
......			....	
1879	Dec.	20	27.5	
		30-31	27.7	
1880	Jan.	14	23.0	
	Feb.	16	24.9	
		22	23.0	
	Mar.	2	23.0	
		22-23	37.7	
	Apr.	9	26.0	
	May	3-4	19.0	
......			....	
1882	Jan.	31	43.8	
	Feb.	7	40.7	
	Mar.	9	29.4	
		30-31	21.3	
	May	10	22.0	
	Sept.	24-25	19.9	
1883	Feb.	2-3	29.0	
	Mar.	3-4	23.4	
	Apr.	25-26	26.8	
......			....	
1884	Feb.	28-29	44.3	
	Apr.	7-9	43.7	
1885	Jan.	23	30.0	
	Nov.	15	23.0	
1886	Jan.	10	25.1	
		30	19.8	
	Feb.	13	21.4	
	Apr.	15-16	42.1	
	June	23	19.6	
1887	Feb.	1	27.8	
		28	31.4	
	Mar.	7	30.5	
1888	Jan.	24	24.8	
	Apr.	1	33.3	
		16	22.6	
	Nov.	16	19.8	
1889	Feb.	26	29.3	
......			....	
1890	Jan.	18	22.0	
		23	21.6	
	Feb.	11	30.2	
	Mar.	8-9	37.7	
		13	37.4	
		17	34.2	
	Apr.	1	28.0	
1891	Jan.	29	20.0	158,000
	Feb.	23	36.1	302,000
......			....	....
	Mar.	12	38.2	
	Apr.	3	27.0	
1892	Jan.	26	29.0	239,000
......			....	....
	Apr.	14-15	35.8	
	July	12	22.1	176,000
1893	Feb.	22	33.6	280,000
	Apr.	12	19.9	157,000
		18	29.9	247,000
	May	13	27.0	221,000
	June	4	26.0	212,000
		9	24.9	202,000
1894	Feb.	13-14	31.1	258,000
1895	Jan.	19	25.5	207,000
	Mar.	23	24.7	200,000
1896	Feb.	6	26.5	216,000
	Mar.	23	20.9	166,000
	Apr.	12	28.3	232,000
1897	Mar.	5	26.0	212,000
		24	48.0	410,000
......			....	....
	May	19-20	19.5	153,000
1898	Jan.	24	29.1	* 240,000
......			....	....
	Apr.	7	21.7	
1899	Jan.	14	23.9	193,000
	Feb.	17	29.6	244,000
	Mar.	5	26.6	217,000
		31	39.7	335,000
......			....	....
1900	Feb.	20	21.3	169,000
	Apr.	14	19.3	151,000
		23	29.1	240,000
	June	30	29.5	243,000
1901	Jan.	19	24.0	194,000
	Apr.	10	22.6	181,000
		27	24.7	200,000
	May	31	22.7	182,000
	Aug.	26	27.6	226,000
	Dec.	22	22.8	183,000
1902	Jan.	9-10	28.5	234,000
	Feb.	4	27.5	225,000
	Mar.	13-14	30.8	255,000
	Apr.	2-3	35.6	298,000
......			....	....
	Dec.	18	19.9	* 157,000
1903	Feb.	21	29.2	240,000
......			....	....
	Mar.	11	33.7	

* Estimated

Flood stages and discharges of
Tennessee River at and near Johnsonville, Tenn.--Continued

Date	Gage height (feet)	Discharge (second-feet)
1903 Apr. 1	22.2	177,000
18	26.9	220,000
1904 Mar. 30	28.1	230,000
....	....	....
1905 Feb. 14	20.7	194,000
26-27	23.9	193,000
Mar. 13	21.2	168,000
May 27	20.1	158,000
1906 Jan. 26	22.2	177,000
....	....	....
Apr. 2	22.0	
Oct. 9	25.3	205,000
Nov. 28	24.8	201,000
....	....	....
1907 Jan. 6	24.1	* 190,000
Feb. 5	22.5	
Mar. 5	25.4	206,000
....	....	....
Mar. 17	22.5	
May 16	22.1	176,000
1908 Jan. 7	21.0	167,000
....	....	....
Feb. 22	27.1	
Mar. 30	22.4	
....	....	....
1909 Feb. 18	27.1	222,000
Feb. 28-Mar. 1	32.9	274,000
Mar. 21	30.0	248,000
May 8	22.5	180,000
June 11	23.0	185,000
1910 Feb. 23-24	21.2	168,000
1911 Jan. 9	24.9	202,000
Feb. 15-16	25.7	209,000
Apr. 17	36.1	302,000
Dec. 17	22.4	179,000
1912 Jan. 3	31.0	257,000
Feb. 29	25.9	211,000
....	....	....
Mar. 1	26.2	
26	29.2	
Apr. 6	35.4	
May 2-3	32.3	
....	....	....
1913 Jan. 12	30.1	
Feb. 1	30.1	
15	19.2	150,000
Mar. 3	26.3	214,000
....	....	....
Mar. 29	33.3	* 250,000
Apr. 6	31.7	
1914 Apr. 5-6	19.8	156,000
1915 Jan. 2	27.4	226,000
26	22.0	176,000
Feb. 6	30.0	248,000
....	....	....
Dec. 27	25.9	196,000
1916 Jan. 5	31.7	263,000
28	24.9	168,000
July 17	30.5	252,000
....	....	....
1917 Jan. 12	21.1	
....	....	....
Jan. 26	22.2	
Feb. 5	21.1	* 168,000
27	24.0	194,000
....	....	....
Mar. 18	38.8	* 300,000
Apr. 6	36.1	
1918 Feb. 10	30.6	253,000
Apr. 12-13	20.2	159,000
21	19.2	150,000
Nov. 7	20.4	161,000
Dec. 29	20.4	161,000
1919 Jan. 6	28.0	230,000
Mar. 12	30.7	254,000
19	35.3	295,000
Dec. 2	20.3	160,000
17	26.4	215,000
1920 Jan. 27	24.5	198,000
Feb. 27	20.7	164,000
Mar. 17	29.0	239,000
Apr. 14	35.9	301,000
22	22.8	183,000
28	24.9	202,000
Aug. 22	23.5	189,000
1921 Feb. 14-15	29.3	241,000
Apr. 21	28.0	230,000
1922 Jan. 30	27.3	223,000
Feb. 23	24.0	194,000
Mar. 15	36.4	305,000
Apr. 3	24.4	204,000
29	19.7	162,000
May 6	22.9	184,000
Dec. 23-24	21.9	175,000
1923 Feb. 16	30.2	249,000
Mar. 26	31.1	258,000
May 18	19.3	151,000
1924 Jan. 7	29.7	245,000
20	23.2	186,000
Mar. 1	25.1	204,000
11	24.4	197,000
Apr. 24	22.1	176,000
May 5	20.0	158,000
June 1	19.7	155,000
1925 Feb. 24	21.1	160,000
1926 Jan. 25	21.9	168,000
Dec. 18	21.0	161,000
22	23.9	186,000
1927 Jan. 2-4	40.5	342,000
Feb. 6-7	19.8	150,000
20	19.9	151,000
Mar. 4	25.1	196,000
16	35.9	297,000
Apr. 16	31.8	258,000
1928 Apr. 27	28.1	223,000
June 9	21.8	167,000
July 7	22.0	169,000
1929 Jan. 30	25.6	201,000
Mar. 29	36.4	302,000
May 12-13	28.4	226,000
28	24.9	195,000
Nov. 23-24	28.0	222,000
1930 Mar. 12	25.0	196,000
1931 Apr. 3	19.1	** 144,000
Dec. 17	24.3	171,000
26	23.8	166,000
1932 Jan. 13	25.3	179,000
Feb. 6-8	34.8	263,000
7	34.9	P 264,000
20	33.3	250,000
Apr. 4	23.8	166,000
May 2	24.2	170,000
Oct. 19	23.9	167,000
Dec. 18-19	27.4	197,000

* Estimated
** Below base

Flood stages and discharges of
Tennessee River at and near Johnsonville, Tenn.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1933 Jan.	8	33.5	252,000	Apr.	3	27.8	185,000
Feb.	23-24	36.3	277,000	May	14	29.1	212,000
	24	36.45	P 278,000	1934 Mar.	10	33.67	253,000
Mar.	23	28.6	207,000		30	30.78	227,000

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Periods of backwater from Ohio River during which there is no record or only blanket estimates: Jan. 16 to Apr. 19, 1890; Mar. 1 to Apr. 23, 1891; Apr. 6 to May 7, 1892; Apr. 1-23, 1897; Jan. 18 to Feb. 7, Mar. 25 to Apr. 15, 1898; Apr. 1-17, 1899; Dec. 18-30, 1902; Mar. 1-31, 1903; Apr. 1-15, 1904; Apr. 1-16, 1906; Jan. 3 to Feb. 14, Mar. 8-31, 1907; Feb. 15 to Apr. 23, May 10-23, 1908; Mar. 1 to May 16, 1912; Jan. 10 to Feb. 12, Mar. 22 to Apr. 23, 1913; Feb. 11-23, 1915; Jan. 1-18, Jan. 26 to Feb. 5, Mar. 1 to Apr. 20, 1917.

South Fork of Holston River at Bluff City, Tenn.

Location.- At old highway bridge at Bluff City, Sullivan County, 300 feet below Virginia & Southwestern Railroad bridge and 1 mile below Indian Creek prior to Aug. 19, 1928; 100 feet upstream and 50 feet above new highway bridge thereafter.
Drainage area.- 828 square miles.
Records available.- July 1900 to September 1934.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records.
Gage.- July 17, 1900, to Aug. 18, 1928, nonrecording gage read once daily and sometimes oftener during high water; recording gage thereafter. Zero of both gages is 1,368.09 feet above mean sea level.
Stage-discharge relation.- Not permanent. Rating curves only fairly well defined. Banks not subject to overflow.
Regulation.- Slight diurnal regulation, flood stages not affected.

Flood stages and discharges
(Base discharge 6,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1901 Jan.	12	6.6	9,430	Jan.	23	5.3	6,380
Mar.	29	5.0	6,000		31	5.8	7,410
Apr.	3	6.5	9,190	Feb.	10	6.7	9,410
	20	9.4	16,200	Mar.	8	7.8	12,000
May	22	15.0		Apr.	6	6.1	8,050
	29	5.6	7,200	1912 Mar.	16	7.2	10,600
June	17	5.0	6,000		30	6.3	8,490
	23	8.9	15,000	Apr.	3	8.1	12,700
Aug.	6	5.00	6,000	1913 Jan.	28	5.5	6,780
	15	6.0	8,060	Mar.	15	7.4	11,100
Dec.	15	6.0	8,060		27	9.1	15,100
	27	6.7	9,670	May	24	6.6	9,180
	29	12.55	23,800		28	6.1	8,050
1902 Jan.	31	5.4	6,790	1914 Mar.	12	5.5	6,780
Feb.	28	11.45	21,000		31	6.3	8,490
Mar.	29	6.0	8,060	Dec.	25	6.2	P 8,720
June	28	8.0	12,800		26	5.3	6,380
1903 Feb.	17	9.4	16,200	1915 Feb.	2	5.9	7,620
Mar.	1	5.0	6,000	Dec.	19	7.6	11,500
	23	7.5	11,600		30	5.2	6,180
1904 Mar.	24	5.7	7,200	1916 Jan.	7	10.0	P 17,300
1905 Feb.	9	5.4	6,580		8	9.6	16,300
July	13	6.2	8,270	Feb.	3	6.0	7,830
1906 Jan.	23	10.0	17,300	July	17	6.3	8,490
Oct.	20	6.0	7,830	Aug.	16	8.1	12,700
Nov.	20	5.8	7,410	Dec.	29	5.4	6,580
Dec.	29	5.5	6,780	1917 Jan.	5	6.4	8,720
1907 June	14	11.7	21,400		23	5.5	6,780
July	13	5.4	6,580	Mar.	5	8.7	14,200
Sept.	24	6.2	8,270		5	9.3	P 15,600
1908 Jan.	12	8.9	14,700		18	5.8	7,410
Apr.	2	7.0	10,100		25	6.0	7,830
Dec.	8	5.9	7,620	1918 Jan.	29	9.1	15,100
1909 Mar.	29	5.4	6,580		31	6.7	9,410
May	1	6.4	8,720	Oct.	26	7.7	11,800
1910 July	8	5.6	6,990		31	6.2	8,270
1911 Jan.	4	5.4	6,580	1919 Jan.	3	7.0	10,100

Flood stages and discharges of
South Fork of Holston River at Bluff City, Tenn.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1919	May	26	6.4		8,720	1925	Jan.	12	5.7		6,150
	Dec.	14	5.3		6,380	1926	Jan.	19	5.70		6,150
1920	Jan.	23	6.1		8,050		Feb.	15	6.8		8,000
		25	5.3		6,380		Dec.	10	7.10		8,540
	Mar.	13-14	5.4		6,580			22	9.20		12,300
		20	7.2		10,600			26	8.55		11,200
	Apr.	2	8.0		12,500			29	6.40		7,320
	Dec.	15	5.42		6,240	1927	Feb.	20	7.10		8,540
1921	Jan.	15	5.86		7,110			23	11.4	P	16,300
	Feb.	11	7.56		10,900			24	10.20		14,100
	Aug.	18	5.72		6,830		Apr.	22	7.80		9,800
1922	Jan.	20	8.90		14,100		May	30	6.40		7,320
		22	8.30		12,600		Dec.	16	5.9	P	6,470
	Feb.	16	6.50		8,470			17	5.70		6,150
	Mar.	2	6.20		7,820	1929	Feb.	28	7.46		8,480
		11	6.40		8,250		Mar.	6	7.68		8,890
		16	6.60		8,690			6	8.39	P	10,400
	Apr.	28	7.60		11,000		June	26	6.60		6,720
	Dec.	16	7.3		8,900		July	2	6.50		6,540
		18	6.2		6,980	1930	Apr.	7	5.57	**	4,930
1923	Jan.	28	7.6		9,440	1931	Apr.	5	7.39		8,210
	Feb.	3	9.3		12,500			5	8.44	P	10,300
		3	11.3	P	16,100	1932	Jan.	30	6.44		6,300
		14	7.8		9,800		Feb.	4	9.00		12,400
	Mar.	7	6.8		8,000			4	10.00	P	15,300
		17	6.5		7,490			13	6.35		6,300
	June	13	10.7		15,000		Dec.	28	9.30	P	13,200
1924	Jan.	1	6.2		6,980			29	7.94		9,500
	June	11	5.8		6,310	1933	Feb.	8	7.21		7,900
		14	6.6		7,660			15	7.71		9,020
		14	7.1	P	8,540		May	11	6.33		6,150
	Sept.	30	6.9		8,180	1934	Mar.	4			7,010
	Dec.	9	5.8		6,310						

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Holston River near Rogersville, Tenn.

Location.- Prior to October 1923 U. S. Weather Bureau gage at Virginia & Southwestern Railroad bridge near Austin Mill, half a mile below county highway bridge, 2 miles downstream from mouth of Dodson Creek, and 3 miles south of Rogersville, Hawkins County; October 1923 to May 16, 1934, at county highway bridge; thereafter 300 feet downstream from highway bridge.

Drainage area.- 3,060 square miles.

Records available.- March 1902 to September 1934.

Sources of data.- Gage-height records by U. S. Weather Bureau to October 1923 and by U. S. Geological Survey thereafter. Discharge records from Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records.

Gages.- Nonrecording gage read once daily prior to October 1923 and twice daily from November 1923 to October 1926; recording gage thereafter. Zero of U. S. Weather Bureau gage at railroad bridge is 1,053.86 feet above mean sea level (data of U. S. Weather Bureau). Zero of gages at highway bridge is 1,057.04 feet above mean sea level. Gage established May 16, 1934, set to same datum but reads about 0.1 foot lower than gage at highway bridge.

Stage-discharge relation.- Control practically permanent. Rating curves at high stages poorly defined prior to 1917 and well defined up to about 35,000 second-feet thereafter.

Regulation.- No regulation at high stages.

Historical data.- Maximum known stage, 38.4 feet Mar. 10, 1867, determined by U. S. Weather Bureau.

Flood stages and discharges
(Base discharge 16,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1902	Mar.	30	10.6	33,800	1905	Mar.	11	6.3	16,600
	June	28	10.4	33,000		July	13	6.3	16,600
1903	Feb.	18	13.3	44,600	1906	Jan.	24	15.0	51,400
	Mar.	1	8.2	24,200		July	31	6.2	16,200
		24	14.3	48,600		Oct.	20	6.7	17,800
	Apr.	9	9.9	31,000		Nov.	20	11.5	37,400
1904	Mar.	24	7.00	19,400		Dec.	29-30	6.8	18,600

Flood stages and discharges of Holston River near Rogersville, Tenn.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1907	June	12	8.4		25,000
		15	14.0		47,400
	Sept.	24	9.0		27,400
	Dec.	31	6.5		17,400
1908	Jan.	13	11.5		37,400
	Feb.	16	8.8		26,600
	Mar.	7	6.6		17,800
	Apr.	3	12.7		42,200
		26	6.5		17,400
	Dec.	8	7.3		20,600
1909	Feb.	11	7.4		21,000
	Mar.	11	7.4		21,000
		29	8.6		25,800
	May	2	9.8		30,600
	June	5	6.2		16,200
1910	July	9	5.5	**	13,400
	Dec.	7	6.0	**	15,400
1911	Jan.	4	8.8		25,800
		31	7.1		19,000
	Feb.	9	9.5		28,600
	Mar.	8	11.0		34,600
	Apr.	6	8.7		25,400
		10	6.6		17,000
1912	Jan.	31	6.4		16,200
	Mar.	10	6.5		16,600
		16	8.8		25,800
		30	10.1		31,000
	Apr.	3	14.4		48,200
		30	6.6		17,000
1913	Jan.	28	7.8		21,800
	Mar.	16	12.2		39,400
		28	19.1		67,000
	May	25	7.0		18,600
		28	6.8		17,800
1914	Mar.	13	6.9		18,200
		31	9.5		28,600
	Dec.	26	10.7		33,400
1915	Jan.	8	7.7		21,400
	Feb.	3	9.6		29,000
	Dec.	19	15.2		49,000
		30	9.4		27,000
1916	Jan.	8	12.3		38,000
	Feb.	3	9.0		25,500
		26	6.7		16,900
	July	17	15.4		49,800
		23	7.1		18,400
	Aug.	17	8.9		25,100
	Dec.	29	6.5		16,100
1917	Jan.	6	11.0		33,100
		23	8.2		22,400
		30	6.8		17,200
	Feb.	21	7.8		21,000
		25	7.3		19,100
	Mar.	5	17.1		56,300
		13	6.7		16,900
		18	9.1		25,900
		25	10.1		29,700
1918	Jan.	29	17.7		58,600
		29	20.0	P	70,900
	Oct.	26	8.2		22,500
		31	8.8		25,000
1919	Jan.	3	12.2		38,900
	May	26	7.3		18,800
	Dec.	15	8.5		23,800
1920	Jan.	24	7.4		19,200
	Mar.	14	9.0		25,800
		20	10.2		30,700
	Apr.	3	14.5		48,400
		3	15.0	P	50,400
	Dec.	15	9.3		27,000
1921	Feb.	11	11.2		34,800
		11	12.2	P	38,900
	Aug.	19	7.4		19,200
1922	Jan.	22	12.7		41,000
		22	13.3	P	43,400
	Feb.	16	11.2		34,800
	Mar.	3	8.7		24,600
	Mar.	11	9.0		25,800
		16	8.8		25,000
	Apr.	29	13.0		42,200
	May	20	6.6		16,000
	Dec.	16	11.7		36,900
		18	8.0		21,700
1923	Jan.	2	6.7		16,400
		29	11.4		35,600
	Feb.	1	7.5		19,600
		4	16.6		57,000
		4	17.0	P	58,600
		14	13.0		42,200
	Mar.	8	9.0		25,800
		18	9.0		25,800
	June	14	11.5		36,000
1924	Jan.	4	7.32		20,000
		12	7.16		19,600
	Feb.	21	7.05		18,800
	Mar.	6	6.35		16,500
	June	14	10.86	P	35,400
		15	7.48		20,800
	Oct.	1	7.9		22,400
	Dec.	9	7.7		21,600
		9	8.55	P	25,000
1925	Jan.	12	8.2		23,600
	Feb.	16	6.7		17,600
1926	Jan.	19	8.00		22,800
		19	8.03	P	22,900
	Apr.	13	6.4		16,500
	Nov.	17	6.96		19,400
	Dec.	10	7.59		21,900
		23	11.66		39,800
		26	11.03		36,700
		29	9.04		27,800
1927	Feb.	21	7.92		23,100
		24	15.38		56,500
		24	16.96	P	63,700
	Mar.	9	6.98		19,400
	Apr.	23	8.99		27,800
	May	31	11.28		38,000
	June	3	7.20		20,200
	Dec.	17	7.20		20,200
1928	June	30	6.47		17,500
	Sept.	3	7.15		20,200
		6	7.10		19,800
		6	8.4	P	25,200
1929	Mar.	1	9.46		30,000
		6	10.34		33,600
		6	10.92	P	36,200
		24	9.26		29,100
	May	8	6.11		16,000
		21	7.48		21,400
		31	6.88		19,100
	June	27	7.27		20,600
	July	3	6.89		19,100
1930	Mar.	20	6.59		17,900
1931	Apr.	5	9.82		31,300
		5	10.30	P	33,600
1932	Jan.	31	9.30		29,100
	Feb.	4	12.82		44,800
		4	14.60	P	52,900
		13	8.03		23,500
	Mar.	5	6.10		16,000
	May	2	8.45		25,200
	Dec.	29	11.76		36,900
		29	12.4	P	39,600
1933	Feb.	9	8.25		21,900
		16	10.90		33,000
		21	7.41		19,000
	May	11	6.60		16,300
1934	Mar.	4	9.63		27,400
		4	12.2	P	38,700
		25-26	7.36		19,000
		29	7.25		18,300
	Apr.	10			19,900

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Little Tennessee River at Judson, N. C.

Location.- June 1896 to June 30, 1905, at Southern Railway bridge at Judson, Swain County, about half a mile below mouth of Sawyer Branch; July 1, 1905, to Sept. 30, 1913, about 100 feet upstream; thereafter a quarter of a mile below highway bridge at Judson and a quarter of a mile above mouth of Sawyer Branch.
Drainage area.- 668 square miles.
Records available.- September 1895 to September 1933.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Records of daily discharge Apr. 16, 1912, to Oct. 20, 1918, discharge measurements June 1912 to October 1914, and gage-height records Dec. 15, 1918, to Sept. 30, 1924, by the Knoxville Power Co.
Gages.- Nonrecording gage read once daily prior to December 1918; twice daily December 1918 to June 5, 1934, except for period Oct. 1, 1913, to Oct. 20, 1918, when record was from nonrecording and recording gages intermittently; recording gage thereafter. Zero of gage used 1905-13 was 0.5 foot higher than zero of previous gage. Relation between datums used before and after Sept. 30, 1913, is unknown. Zero of gage used since Sept. 30, 1913, is 1,520.7 feet above mean sea level.
Stage-discharge relation.- Practically permanent for each location. Rating curves not well defined above 10,000 second-feet.
Regulation.- Probably not appreciable effect on high stages.

Flood stages and discharges
(Base discharge 6,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1896	July	9	8.80	14,400
		11	8.95	15,100
	Nov.	30-Dec. 1	7.70	11,000
1897	Feb.	2	6.40	7,400
		23	8.60	13,800
	Mar.	12	9.20	15,800
		20	8.90	14,800
		22	8.50	13,500
	Apr.	3-4	7.91	11,600
1898	Mar.	29	8.30	12,800
	July	15	6.81	8,450
	Aug.	4	10.38	19,900
		13	9.02	15,100
	Sept.	3	11.93	25,300
	Oct.	5	13.50	31,100
		18	6.95	9,000
1899	Feb.	4	11.38	23,500
		7	11.40	23,500
		27	10.25	19,200
	Mar.	14	9.55	17,100
		16	8.93	14,800
		19	13.00	29,300
		30	5.90	6,180
	June	13-14	6.71	8,180
	Dec.	14	8.40	13,200
1900	Feb.	13	11.35	23,500
	Mar.	1	6.33	7,150
		9	6.40	7,400
	Apr.	13	5.92	6,180
	Oct.	24	6.71	8,180
	Dec.	4	6.07	6,650
1901	Jan.	11	8.40	13,200
	Mar.	26	10.54	20,300
	Apr.	2	8.40	13,200
		20	8.46	13,500
	May	20	12.32	26,800
	June	15	6.41	7,400
	Aug.	7	7.32	9,850
		15	7.28	9,850
		17	9.54	16,800
		23	10.32	19,600
		28-29	7.42	10,100
	Dec.	11	5.92	6,180
		15	13.59	31,500
		29	13.92	32,500
1902	Jan.	28	5.91	6,180
	Feb.	1	6.72	8,180
		28	16.19	40,800
	Mar.	29	9.32	16,100
1903	Feb.	12	6.40	7,400
		28	10.63	20,700
	Mar.	10	7.40	10,100
		15	6.42	7,400
	Mar.	23	10.30	19,600
	Apr.	2	7.15	9,560
		6	8.70	14,100
		14	6.55	7,920
1904	Mar.	7	6.25	6,900
	May	8		6,000
1905	Jan.	12	8.2	12,500
	Feb.	9	8.0	11,900
		21	6.8	8,450
	July	12	7.6	7,370
	Dec.	3	8.00	8,030
		9	6.9	6,250
1906	Jan.	5	8.0	8,030
		23	9.0	9,730
	July	18	6.80	6,090
	Sept.	19	7.10	6,570
		30	12.00	14,800
	Oct.	6	7.9	7,860
	Nov.	19	13.5	17,400
1907	Sept.	23	7.00	6,410
1908	Jan.	12	8.5	8,880
	Feb.	15	10.9	13,000
	Mar.	24	7.5	7,210
	Apr.	25-26	7.0	6,410
	Dec.	8	8.4	8,710
1909	Feb.	11	7.4	7,050
		23	6.8	6,090
	Mar.	10	8.0	8,030
		13	9.5	10,600
		26	6.9	6,250
	May	2	7.6	7,370
		23	7.8	7,690
	June	6	9.8	11,100
1910	Jan.	7	6.7	** 5,930
1911	Jan.	3	7.9	7,860
	Apr.	4	10.1	11,600
		9	7.5	7,210
1912	Jan.	30	8.0	6,620
	Feb.	26	8.6	7,680
	Mar.	15	10.4	10,900
		24	7.8	6,280
		30	12.1	14,000
1913	Mar.	15	25.70	13,600
		27	26.00	14,300
1914	Apr.	15	20.40	** 3,640
	Nov.	30	22.60	7,780
	Dec.	4	23.50	9,690
		26	23.10	8,830
1915	Feb.	2	22.80	8,200
	Dec.	18	24.20	11,200
		29	24.45	11,700
1916	Feb.	2	23.12	8,870
	May	23	22.62	7,810

** Below base

Flood stages and discharges of Little Tennessee River at Judson, N. C.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1916	July	10	25.96		15,000
		17	22.68		7,940
1917	Feb.	20	22.60		7,780
	Mar.	4		*	30,000
		24		*	11,000
		27	23.38		9,430
1918	Jan.	28	24.35		11,500
	Oct.	30		*	13,000
	Dec.	22	27.4		19,600
1919	Jan.	3	22.4		7,310
	Dec.	10	22.9		8,310
1920	Mar.	29	22.0		6,550
	Apr.	2	26.0		15,900
		4	24.6		12,200
	Dec.	14	24.7		12,500
1921	Feb.	10	23.8		10,300
1922	Jan.	21	26.1		16,100
	Feb.	15	22.6		7,700
	Mar.	2	22.3		7,120
		11	22.6		7,700
		15	21.8		6,170
		28	22.0		6,550
	Dec.	17	24.0		10,800
1923	Feb.	6	21.8		6,170
	Mar.	17	21.8		6,170
	May	30	21.8		6,170
1924	Jan.	11	22.40		7,310
		11	22.7	P	7,900
	Apr.	18	22.20		6,930
	Dec.	8	24.2	P	11,200
		9	21.78		6,170
1925	Jan.	19	21.82		6,170
1926	Jan.	18			6,580
	Jan.	18	23.00	P	8,520
	Dec.	26	23.50		9,620
		28	24.10	P	11,000
		29	23.12		8,740
1927	Mar.	8	22.20		6,930
	Dec.	16	22.72		7,900
1928	Mar.	30	24.45		11,800
		30	24.80	P	12,800
	Aug.	16			11,000
	Sept.	3	22.20		6,930
		6	22.48		7,500
1929	Feb.	28			8,270
	Mar.	5			10,600
		15	24.45		11,800
		24	22.18		6,930
	May	7	22.36		7,310
		20	21.96		6,550
	Sept.	26			12,700
		26	25.30	P	14,100
1929	Nov.	15	21.68	**	5,990
1930	Mar.	7	21.40	**	5,460
1931	Apr.	22	21.64	**	5,810
	Dec.	14	22.66		7,900
		14	23.20	P	8,960
1932	Jan.	30	22.10		6,740
	May	1	22.45		7,310
	Oct.	17	21.95		6,550
	Dec.	12	22.20		6,930
		14	22.55		7,700
		17	22.68		7,900
		28	26.90		18,400
		28	27.10	P	19,000
1933	Feb.	15	22.34		7,120

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momsntary peak).

Little Tennessee River at McGhee, Tenn.

Location.- September 1904 to November 1905 at old railroad bridge 500 feet below present Louisville & Nashville Railroad bridge, half a mile below mouth of Tellico River, and half a mile south of McGhee, Monroe County; December 1905 to Sept. 17, 1925, at present railroad bridge; Sept. 18, 1925, to Sept. 4, 1929, at junction of Little Tennessee and Tellico Rivers, 250 feet above Niles Ferry; thereafter 100 feet above site of gage used 1925-29.
Drainage area.- 2,470 square miles.
Records available.- November 1904 to September 1934.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Gage-height records from U. S. Weather Bureau 1904 to 1918.
Gages.- Nonrecording gage read once daily 1904 to Sept. 17, 1925, three times daily from then to Sept. 4, 1929; recording gage thereafter. Zero of gages since Oct. 1, 1918, 760.07 feet above mean sea level, 0.80 foot lower than that used in 1913. Graduated minus corrections have been applied to gage heights from 1914 to 1918 to make them comparable with 1913 record. Zero of gage prior to Dec. 1, 1905, was 0.30 foot lower than that of succeeding gage.
Stage-discharge relation.- Nearly permanent for each location; possibly some backwater from flood stages of Tennessee River. Rating curves fairly well defined.
Regulation.- By power developments upstream, begun in 1918. Effect on flood flows is probably small.
Remarks.- Records 1914 to 1918 may be subject to considerable error.
Historical data.- Maximum known stage, 39.0 feet March 1867.

Flood stages and discharges
(Base discharge 23,300 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1905	Jan.	13	13	35,000
	Feb.	9	14	38,800
		21	13.7	37,700
1906	Jan.	4	12.5	33,200
	Jan.	23	14.0	38,800
	Oct.	1	13.3	36,200
	Nov.	19	22.2	70,000
1907	Nov.	24	9.8	23,500

Flood stages and discharges of Little Tennessee River at McGhee, Tenn.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1908	Jan.	12	10.8		27,000
	Feb.	16	11.0		27,700
	Mar.	24	10.6		26,300
1909	Feb.	16	11.0		27,700
		23	12.2		32,100
	Mar.	14	13.6		37,300
	May	1	13.8		38,100
		23	13.2		35,800
	June	4	14.1		39,200
	July	9	10.0		24,200
1910	June	6	9.5	**	22,500
	Dec.	6	10.0		24,200
1911	Jan.	4	12.2		32,100
	Feb.	9	11.2		28,400
	Apr.	6	14.4		40,300
	Oct.	18	9.8		23,500
	Dec.	27	10.2		24,900
1912	Jan.	30	10.9		27,400
	Feb.	22	10.3		25,300
		27	11.5		29,500
	Mar.	16	12.6		33,500
		29	15.0		42,600
	Apr.	2	11.3		28,800
		23	11.0		27,700
		28	10.2		24,900
		30	12.1		31,700
1913	Jan.	25	10.1		24,600
		28	10.4		25,600
	Feb.	12	10.3		25,300
		28	15.1		43,000
	Mar.	15	17.5		52,100
		28	17.4		51,700
	May	24	13.5		36,900
1914	Apr.	20	7.95	**	17,500
	Oct.	16	13.75		38,100
	Dec.	5	13.15		35,800
		26	19.55		60,100
1915	Feb.	2	14.7		41,500
	Dec.	18	18.2		54,800
		30	15.7		45,300
1916	Jan.	23	10.45		25,600
	Feb.	3	13.66		37,300
	May	24	10.8		27,000
	July	10	13.1		35,400
		17	9.8		23,500
	Dec.	29	11.35		29,200
1917	Feb.	21	13.5		36,900
	Mar.	5	27.2		89,000
		18	10.7		26,700
		25	16.3		47,600
		28	14.3		40,000
	Apr.	6	10.9		27,400
1918	Jan.	29	20.15		62,400
		31	17.35		51,700
	Feb.	17	9.85		23,500
	Oct.	30	19.6		63,000
	Dec.	23	18.8		59,000
1919	Jan.	3	14.3		37,600
	Mar.	6	11.1		24,800
	Dec.	10	15.6		43,600
1920	Jan.	25	13.2		32,900
	Mar.	13	11.6		26,600
		17	15.8		44,500
	Mar.	20	11.4		25,800
	Apr.	2	30.5	P*	92,000
		3	24.8		89,000
	Aug.	15	14.7		39,400
	Sept.	13	11.2		25,100
	Dec.	14	16.2		46,400
		23	12.4		29,600
1921	Feb.	11	19.0		60,000
	Apr.	17	14.0		36,300
1922	Jan.	20	17.6		53,100
		22	23.7		83,500
	Feb.	16	15.5		43,100
	Mar.	3	13.7		35,000
		11	17.4		52,100
	Apr.	20	10.9		24,000
	Dec.	16	13.4		33,700
		18	17.3		51,600
1923	Jan.	24	11.6		26,600
	Feb.	4	12.4		29,600
		6	12.4		29,600
		14	13.2		32,900
	Mar.	7	11.8		27,300
		17	14.6		39,000
	Apr.	14	10.8		23,700
1924	Jan.	4	11.9		28,000
		17	11.7		27,200
	Mar.	6	12.2		29,200
	Apr.	19	12.7		31,200
	Dec.	9	16.5		48,200
1925	Jan.	1	10.9		24,100
1926	Apr.	13	10.5	**	21,000
	Dec.	26	20.67		58,300
		26	20.9	P	59,000
		29	18.80		50,700
1927	Feb.	24	13.41		29,600
	Mar.	8	13.60		30,300
	Dec.	16	13.69		29,600
1928	Aug.	16	14.11		30,900
	Sept.	3	16.37		38,900
		3	17.9	P	44,200
		6	12.79		26,600
1929	Feb.	28	13.05		25,800
	Mar.	5	15.06		33,400
		15	16.68		40,400
		23	18.50	P	49,100
		24	15.95		37,200
	May	7	13.66		28,200
		20	12.70		24,900
	Nov.	18	12.36		23,300
		18	13.2	P	25,800
1930	Mar.	8	10.87	**	19,400
1931	Apr.	5	12.43		23,300
		5	14.6	P	30,300
	Dec.	14	12.92		25,200
1932	Jan.	30	18.18		43,500
		30	20.6	P	52,600
	May	1	14.63		30,600
	Dec.	15	13.56		26,200
		29	23.58		61,000
		29	27.0	P	75,200
1933	Feb.	8	13.00		24,800
		15	19.41		45,100
1934	Mar.	4	20.01		47,300
		4	21.97	P	58,400

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Tuckasegee River at Bryson, N. C.

Location.- Nov. 7, 1897, to Feb. 2, 1914 on old highway bridge in Bryson, Swain County, half a mile below mouth of Deep Creek; Feb. 3, 1914, to May 17, 1920, about 200 feet downstream; May 18, 1920, to June 27, 1927, at new highway bridge located at site of old bridge; thereafter about 400 feet downstream.
Drainage area.- 673 square miles.
Records available.- November 1897 to September 1934. Only gage-height record and flood estimates prior to October 1899.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Discharge measurements 1912-14, daily discharges October 1913 to December 1919, gage-height records January 1920 to September 1924 furnished by Knoxville Power Co.
Gages.- Nonrecording gage read once daily November 1897 to August 1912; twice daily September 1912 to Feb. 2, 1914, and May 18, 1920, to June 27, 1927. Recording gage Feb. 3, 1914, to May 17, 1920, and subsequent to June 28, 1927. Zero of gages subsequent to 1914, 0.1 foot higher than zero of original gage.
Stage-discharge relation.- Fairly permanent. Rating curves well defined to about 15,000 second-feet.
Regulation.- Slight regulation due to power plant on Oconalufty River has no effect at high water.

Flood stages and discharges
(Base discharge 6,000 second-feet)

Base			Gage height (feet)		Discharge (second-feet)
1898	Jan.	25	4.50	*	6,800
	Mar.	29	6.70	*	12,200
	Aug.	4	7.80	*	14,800
		11	5.30	*	8,800
	Sept.	3	8.50	*	16,500
		5	6.00	*	10,500
		22	4.30	*	6,300
	Oct.	4	7.60	*	14,300
		17	5.30	*	8,800
1899	Feb.	4	9.00	*	17,700
		27	7.00	*	12,900
	Mar.	15	9.60	*	19,100
		19	11.00	*	22,500
	Dec.	12	6.50		11,500
1900	Feb.	13	8.00		15,100
	Mar.	23	6.45		11,500
	June	24	4.30		6,440
	Oct.	23	5.20		8,600
	Nov.	26	4.80		7,640
1901	Jan.	11	7.10		13,200
	Mar.	26	6.75		12,400
	Apr.	2	5.60		9,560
		20	4.30		6,440
	May	21	8.25		15,800
	Aug.	6	7.00		12,900
		15	5.00		8,120
		17	5.15		8,600
		22	5.00		8,120
	Dec.	14	8.80		17,200
		29	9.90		19,900
1902	Feb.	28	9.90		19,900
	Mar.	16	5.25		8,600
		29	6.25		11,000
1903	Feb.	4	5.75		10,000
		11	4.20		6,210
		16	5.00		8,120
		28	7.80		14,800
	Mar.	8	4.35		6,680
		11	4.20		6,210
		23	8.20		15,800
		30	4.30		6,440
	Apr.	8	6.50		11,700
		13	4.75		7,640
1904	Jan.	22	5.40		9,080
	Mar.	7	4.80		7,640
1905	Jan.	12	6.4		11,500
	July	12	5.2		8,600
	Dec.	3	5.2		8,600
1906	Jan.	3	5.5		9,320
		23	8.8		8,120
	Mar.	30	4.2		6,210
	Sept.	30	6.2		11,000
	Oct.	2	4.8		7,640
		6	4.2		6,210
	Nov.	19	10.0		20,100
1907	Sept.	23	4.2		6,210
	Dec.	30	4.30		6,440
1908	Jan.	12	4.6		7,160
	Feb.	15	6.6		12,000
	Mar.	24	4.6		7,160
	Apr.	25	4.9		7,880
	Dec.	7	5.0		8,120
1909	Feb.	10	4.5		6,920
		16	4.2		6,210
	Mar.	10	4.6		7,160
		14	4.4		6,680
		25	4.2		6,210
		28	4.3		6,440
	May	1	4.6		7,160
		20	4.2		6,210
		22	4.4		6,680
	June	4	6.5		11,700
1910	Mar.	1	3.85	**	5,290
1911	Jan.	3	5.5		9,320
	Apr.	5	6.9		12,700
	Dec.	27	4.20		6,210
1912	Jan.	29	4.2		6,210
	Feb.	26	4.4		6,680
	Mar.	15	6.0		10,500
		29	6.4		11,500
1913	Feb.	27	5.6		9,560
	Mar.	14	7.0		12,900
		27	9.3		18,400
1914	Apr.	20	3.10	**	3,400
	Nov.	30	4.96		6,570
	Dec.	4	4.66		6,060
		25	5.36		7,250
1915	Feb.	2	4.95		6,550
	Dec.	18	7.60		13,100
		29	6.20		8,960
1916	Feb.	2	5.28		7,110
	July	10	5.30		7,140
1917	Jan.	22	5.16		6,710
	Feb.	20	4.85		6,380
	Mar.	4	10.70		23,200
		24	5.75		7,960
		27	5.23		7,030
1918	Jan.	28	7.00		11,300
		28	10.3	P	21,200
	Oct.	29	7.00		11,300
	Dec.	22	8.10		14,600
		22	8.6	P	16,100

* Estimated
** Below base

Flood stages and discharges of Tuckasegee River at Bryson, N.C.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1919	Jan.	2	5.40		7,320
	Dec.	9	5.0		6,640
1920	Mar.	14	4.5		6,560
		17	4.6		6,780
		29	4.5		6,560
	Apr.	2	10.9		22,500
		4	6.3		10,800
	Dec.	14	6.3		10,800
1921	Feb.	10	5.7		9,320
1922	Jan.	21	7.7		14,200
	Feb.	15	5.0		7,690
	Mar.	2	5.6		9,080
		10	5.2		8,150
		15	4.3		6,120
	Dec.	17	5.6		9,080
1923	Feb.	13	4.4		6,340
	Mar.	17	4.3		6,120
1924	Jan.	11	4.66		6,920
	Dec.	8			6,290
		8	6.00	P	9,960
1925	Jan.	1		**	3,750
1926	Jan.	18	5.10		7,800
		18	6.20	P	10,400
	Dec.	26			7,740
		26	5.80	P	9,480
		29			7,320
1927	Mar.	8			7,080
	Dec.	16	4.50		6,480
1928	June	30	4.32		6,040
	Aug.	16			11,800
		16	9.15	P	18,300
	Sept.	3	4.68		6,920
1929	Feb.	28	5.15		8,040
	Mar.	5			9,290
		14			9,050
		14	6.85	P	12,000
		23			6,040
	May	7	4.45		6,260
	Sept.	26			6,120
	Nov.	15	3.50	**	4,680
1930	Mar.	19	3.34	**	4,380
1931	Apr.	4			6,340
		4	5.36	P	8,660
	Dec.	14			6,000
1932	Jan.	30			7,010
		30	5.90	P	9,760
	May	1			6,770
	Dec.	28			15,600
		28	9.25	P	18,300
1933	Feb.	8			6,040
		15			7,020
1934	Mar.	4			10,300

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Clinch River at Clinton and near Coal Creek, Tenn.

Location.- October 1903 to June 1920 at Southern Railway bridge at Clinton, Anderson County, about 13 miles below mouth of Coal Creek; July 1920 to September 1927 at a highway bridge 1,000 feet downstream; thereafter at Massengill store, 300 feet upstream from a highway bridge, three-quarters of a mile above mouth of Coal Creek, and 3½ miles east of Coal Creek, Anderson County.

Drainage area.- 3,090 square miles at Clinton and 2,960 square miles near Coal Creek.

Records available.- Flood records 1886-97 for stages of 30 feet or more and 1893-1903 for stages of 15 feet or more. Daily discharge records October 1903 to September 1927 at Clinton and May 1927 to September 1934 near Coal Creek. Gage-height records for winters only December 1884-97 and for complete years starting July 1, 1897.

Sources of data.- Gage-height records prior to May 7, 1924, by U. S. Weather Bureau; discharge records 1903-24 from Tennessee Division of Geology Bulletin 34 and 1925-34 from U. S. Geological Survey records.

Gages.- Nonrecording gage at Clinton; recording gage near Coal Creek. Zero of gage July 1, 1920, to Sept. 30, 1927, was 776.61 feet above mean sea level and was 0.10 foot lower than that of previous gage. Zero of recording gage is 808.95 feet above mean sea level. Gage read once daily prior to 1925, twice daily 1925-27. Gage readings prior to 1918 are subject to some uncertainty.

Stage-discharge relation.- Permanent. Right bank at Clinton station overflows at gage height about 30 feet. Curves fairly well defined by measurements made subsequent to 1921; previous measurements for low stages only.

Remarks.- Discharge records at Clinton for gage heights 25.0 feet and above for 1904-26 were revised and additional discharge records for stages 15.0 feet and above for July 1, 1897, to Sept. 30, 1903, were computed for this report.

Flood stages and discharges
(Base discharge 17,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1886	Mar.	31	45.0	
	Apr.	7	38.0	
1890	Feb.	28	35.5	
1893	Feb.	19	32.5	
1896	Apr.	2	37.0	
1897	Feb.	23	37.5	
1898	Apr.	1	16.0	19,600
	Aug.	7	15.4	18,400
		12	21.0	31,800
1899	Jan.	8	21.5	33,200
	Feb.	6-7	28.0	51,100
		27	17.0	21,900
	Mar.	7	26.0	45,500
		16	14.8	17,000

Flood stages and discharges of
Clinch River at Clinton and near Coal Creek, Tenn.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1899	Mar.	21	26.5	46,900
		30	26.0	45,500
	May	9	15.0	17,500
1900	Feb.	15	20.0	29,200
	Mar.	22	20.5	30,500
	Nov.	28	23.3	38,000
1901	Jan.	13	20.5	30,500
	Mar.	29	15.0	17,500
	Apr.	4	16.0	19,600
		22	19.2	27,200
		27	17.4	22,800
	May	24	26.0	45,500
	June	25	15.0	17,500
	Aug.	15	26.7	47,500
	Dec.	17	22.5	35,800
		31	31.0	60,100
1902	Feb.	1	22.0	34,500
	Mar.	2	32.5	64,600
		7	19.9	29,000
		30	29.5	55,600
1903	Feb.	6	20.0	29,200
		18	26.0	45,500
	Mar.	2	22.4	35,600
		10	19.6	28,200
		25	22.5	35,800
	Apr.	10	21.1	32,000
		15	21.0	31,800
1904	Mar.	25	16.0	20,000
1905	Jan.	14	18.7	26,300
	Feb.	11	19.0	27,000
	Mar.	12	18.4	25,600
	May	17-18	15.0	17,800
1906	Jan.	25	13.0	** 13,600
	Nov.	21	31.0	60,000
	Dec.	31	18.0	24,600
1907	Mar.	4	21.0	31,800
	Apr.	9	15.0	17,800
	May	9	17.0	22,300
	June	10	16.0	20,000
		16	25.6	44,300
	Nov.	12	21.5	33,000
		26	19.0	27,000
1908	Jan.	1	19.4	28,000
	Feb.	17	19.5	28,200
	Apr.	4	21.6	33,300
1909	Jan.	18	20.5	30,600
	Feb.	12	18.4	25,600
		25-26	15.5	18,900
	Mar.	12	18.4	25,600
		30	15.3	18,500
	May	2	21.5	33,000
	July	9	15.0	17,800
		15	16.6	21,400
	Aug.	17	19.5	28,200
1910	Feb.	20	15.3	18,500
1911	Jan.	4	21.0	31,800
	Feb.	10	24.4	40,300
	Mar.	9	25.0	42,700
	Apr.	7	25.2	43,200
		17	14.8	17,400
	May	2	15.4	18,700
	Dec.	29	16.0	20,000
1912	Feb.	1	16.8	21,900
		23	16.0	20,000
		27	15.0	17,800
	Mar.	1	15.4	18,700
		16	20.0	29,400
		27	15.0	17,800
		31	22.0	34,300
	Apr.	4	31.0	60,000
		30	25.5	44,000
1913	Jan.	9	23.4	37,800
		26	21.0	31,800
	Mar.	2	15.4	18,700
		16	21.0	31,800
		29	29.9	56,800
	May	26	15.8	19,600
1914	Apr.	1	23.1	37,000
		22	17.0	22,300
	Dec.	26	18.0	24,600
1915	Jan.	14	15.2	18,300
		27	16.4	21,000
	Feb.	4	18.3	25,300
	Oct.	3	19.1	27,200
	Nov.	17	14.6	17,000
	Dec.	19	29.7	56,300
		31	23.5	38,000
1916	Jan.	9	22.0	34,300
		15	15.4	18,700
	Feb.	4	15.5	18,900
	Aug.	4	15.2	18,300
		18	17.3	23,000
	Dec.	30	21.1	32,000
1917	Jan.	7	31.5	61,600
		24	17.6	23,700
	Feb.	22	22.6	36,800
		26	18.0	24,600
	Mar.	5	38.0	80,800
		13	17.0	22,300
		15	16.0	20,000
		19	24.0	39,300
		26	23.9	39,000
1918	Jan.	30	37.6	79,600
	Apr.	11	15.5	18,900
	Nov.	1	24.0	39,300
	Dec.	17	15.2	18,300
1919	Jan.	4	31.0	60,000
	Mar.	7	15.5	18,900
	May	27	14.7	17,200
	Dec.	10	16.4	21,000
		16	17.5	23,500
1920	Jan.	25	29.0	54,200
	Feb.	22-23	16.5	21,200
	Mar.	15	25.8	45,000
		21	20.0	29,400
	Apr.	3-4	22.0	34,300
	Aug.	17	15.85	19,700
	Dec.	16	17.85	24,300
1921	Feb.	12	17.75	24,100
	Apr.	17	18.9	26,800
	Dec.	1	17.2	22,800
		27	19.4	28,000
1922	Jan.	23	21.0	31,800
	Feb.	18	16.8	21,900
		22	21.6	33,300
	Mar.	3	22.0	34,300
		12	24.3	40,000
		18	18.9	26,800
	Apr.	30	19.7	28,700
	May	7	18.3	25,300
	Dec.	18	18.0	24,600
1923	Jan.	25	16.8	21,900
		30	20.7	31,100
	Feb.	5	32.2	63,600
		5	32.7 P	65,200
		15	23.2	37,300
	Mar.	9	21.1	32,000
		13	15.5	18,900
		19	16.5	21,200
		25	18.0	24,600
	June	15	17.8	24,200
1924	Jan.	3	23.5	38,000
		13	15.0	17,800
		19	15.2	18,300
	Feb.	22	19.4	28,000
	Mar.	31	14.6	17,000
	May	30	20.9	31,600
	Dec.	10	23.8	38,800
		10	24.6 P	40,800
1925	Jan.	9	18.1	24,900
		13	21.2	32,300
	Feb.	18	20.8	31,300
1926	Jan.	24	18.6	25,100
	Feb.	17	16.6	20,300
	Nov.	18	15.24	17,200
	Dec.	12	16.35	19,800
		24	31.82	62,900
		24	32.30 P	64,400
		26	31.31	61,400
1927	Feb.	25	25.44	43,800

** Below base

Flood stages and discharges of
Clinch River at Clinton and near Coal Creek, Tenn.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1927	Mar.	10	19.81		28,000	1930	Feb.	7	11.28	**	16,000
	Apr.	24	18.81		25,400	1931	Apr.	24	11.82		17,100
	June	1	23.59		38,500			24	12.5	P	18,700
1928	Apr.	1	12.76		19,300		Dec.	16	11.86		17,300
		22	12.22		18,000	1932	Feb.	1	25.60		50,700
		30	11.97		17,600			1	28.2	P	57,200
	June	30	23.48	P	45,400			5	22.88		44,000
		30	23.9		46,400			14	13.43		20,700
	Nov.	20	17.55		30,700		Mar.	30	13.00		19,800
1929	Jan.	21	14.34		22,800		Dec.	30	21.00		39,200
		26	15.55		25,900			30	21.65	P	40,700
	Feb.	28	19.74		36,000	1933	Feb.	10	12.70		19,100
	Mar.	7	18.75		33,700			17	16.06		27,100
		23	30.7	P	63,400			21	19.28		35,000
		24	27.75		56,200		Mar.	21	17.43		30,300
	May	4	14.34		22,800	1934	Feb.	28	15.28		24,500
		8	16.24		27,400		Mar.	5	20.82		38,500
		21	23.50		45,400			10	13.49		20,300
	Nov.	19	17.00		29,300			25	20.69		38,200
		19	17.7	P	31,000			25	22.49	P	43,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Hiwassee River at Murphy, N. C.

Location.- June 1896 to Jan. 29, 1921, at old highway bridge at Murphy, Cherokee County, half a mile above mouth of Valley River; Jan. 30, 1921, to Nov. 7, 1926, at new highway bridge just above old location; thereafter 500 feet downstream.
Drainage area.- 410 square miles.
Records available.- July 1896 to August 1897; October 1897 to June 1917; October 1918 to September 1933. Only gage-height records and flood estimates prior to October 1897.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records.
Gages.- Nonrecording gage read once daily 1896 to 1917 and twice daily 1918 to Nov. 7, 1926; recording gage thereafter. Zero of gage raised 2.0 feet Jan. 30, 1921. Zero of recording gage is 0.20 foot higher than zero of gage used 1921-26, elevation 1,510.3 feet above mean sea level.
Stage-discharge relation.- Subject to slight shifts. Fish trap constructed about August 1922 became part of control for gage at highway bridge. In general, rating curves are well defined to about 10,000 second-feet.
Regulation.- Small diurnal fluctuation caused by power-plant operation since 1924; no effect on flood flows.

Flood stages and discharges
(Base discharge 4,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1897	Feb.	23	7.92	*	4,200		Dec.	12	9.10	6,330
	Mar.	6	9.20	*	6,600	1900	Feb.	13	12.60	13,100
		12	9.90	*	7,900	1901	Jan.	12	9.20	6,940
	Apr.	5	8.20	*	4,800		Feb.	4	7.55	4,060
	July	25	10.85	*	9,600		Mar.	26	10.80	9,820
....			.....		.....		Apr.	2	7.65	4,060
1898	Mar.	29	11.10		9,930			20	11.40	10,900
	Apr.	5	8.75		5,790		May	22	10.60	9,460
	Aug.	4	9.80		7,590		Aug.	6	7.65	4,060
		11	10.00		7,950			14	7.95	4,780
	Sept.	3	13.97		15,200			18	8.45	5,500
	Oct.	4	14.40		15,900			23	12.70	13,200
		18	9.20		6,510		Dec.	15	9.10	6,760
1899	Feb.	4	14.00		15,200			29	13.30	14,300
		7	9.90		7,770	1902	Feb.	2	9.10	6,760
		27	9.10		6,330			28	14.15	15,900
	Mar.	15	10.80		9,390		Mar.	29	10.90	10,000
		19	18.40		23,100	1903	Feb.	8	7.60	4,060
		23	8.15		4,710			17	9.15	6,940

* Estimated

Flood stages and discharges of Hiwassee River at Murphy, N. C.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1903	Feb.	28	12.00	12,000
	Mar.	8	7.95	4,780
		11	9.95	8,380
		23	11.80	11,600
		30	7.85	4,420
	Apr.	14	7.65	4,060
1904	Mar.	7	7.80	** 3,990
1905	Feb.	9	8.75	5,790
		21	8.2	4,710
	July	12	10.3	8,490
	Dec.	3	10.0	7,950
		9	8.7	5,610
1906	Jan.	4	8.2	4,710
		23	9.5	7,050
	July	17	8.20	4,710
	Aug.	30	8.7	5,610
	Sept.	30	9.60	7,230
	Nov.	19	15.8	18,400
1907	Mar.	2	8.3	4,890
	July	30	8.7	5,610
	Sept.	23	11.4	10,200
1908	Jan.	6	8.0	4,050
		12	9.2	6,210
	Feb.	15	10.6	8,730
	Mar.	24	9.9	7,470
	Apr.	25	8.1	4,230
	Dec.	7	9.9	7,070
1909	Feb.	10	8.8	5,090
		16	8.9	5,270
	Mar.	10	8.8	5,090
		13	10.8	8,690
		25	9.1	5,630
		28	8.4	4,370
	May	1	10.5	8,330
		10	8.8	5,270
		22	10.3	7,970
	June	4	10.2	7,790
	July	7	8.2	4,190
1910	May	8	8.4	4,550
		21	8.4	4,550
1911	Jan.	3	8.8	5,270
	Apr.	5	8.9	5,450
		9	8.5	4,730
1912	Mar.	15	9.1	5,810
		29	11.7	10,500
		31	9.5	6,530
	July	16	9.0	5,450
		19	9.4	6,170
1913	Mar.	14	13.0	12,600
		27	11.8	10,500
1914	Apr.	20	7.7	** 3,110
	Nov.	30	8.8	5,090
	Dec.	5	8.7	4,910
		26	9.0	5,450
1915	Dec.	18	12.6	11,900
		29	12.8	12,300
1916	Feb.	2	9.9	7,070
	May	24	9.0	5,450
	July	10	11.5	9,950
		19	9.4	6,170
1917	Feb.	1	8.2	4,010
		20	9.4	6,170
	Mar.	4	12.8	12,300
		4	14.7	P* 15,800
		24	14.5	15,400
		27	9.3	5,990
......	......		....	.....
1918	Oct.	30	10.6	8,320
	Dec.	22	13.4	13,100
	Dec.	22	14.15	P 14,400
1919	Jan.	2	8.3	4,110
	Dec.	9	9.4	6,280
1920	Jan.	24	8.7	5,090
		26	8.1	4,070
	Mar.	29	8.1	4,070
	Apr.	2	13.4	13,100
		2	14.6	P 15,100
		4	10.0	7,300
	Aug.	14	8.1	4,070
	Dec.	14	11.0	9,200
		14	12.8	P 12,400
1921	Feb.	10	8.6	7,560
1922	Jan.	21	12.5	13,800
		21	14.2	P 16,500
	Feb.	15	7.6	5,960
	Mar.	9	7.6	5,960
	May	4	6.8	4,680
	Dec.	15	6.7	4,180
		17	9.9	9,940
		17	11.85	P 13,400
1923	Jan.	1	6.8	4,360
	Feb.	5	6.8	4,360
		13	7.2	5,080
	Mar.	17	6.6	4,010
	May	30	6.7	4,180
1924	Mar.	5	6.60	4,010
		5	8.35	P 7,150
	Apr.	18	6.9	4,540
1925	Jan.	18	6.85	4,360
		18	6.90	P 4,540
1926	Jan.	18	7.00	4,820
		18	7.4	P 5,500
	Dec.	26		5,550
		28		6,560
		28	8.45	P 10,300
1927	Mar.	8		4,800
	Dec.	16	6.12	5,870
1928	Mar.	30	11.72	P 17,400
		30		10,400
	Aug.	16		4,050
	Sept.	3		4,020
		6		4,590
1929	Feb.	28		6,180
	Mar.	5		5,960
		15		6,960
		24		4,310
	May	7		4,940
		20		5,680
	Sept.	26	10.31	P 14,300
		26		12,300
	Nov.	3		4,670
		3	6.90	P 7,330
		13		4,170
		15	5.90	5,530
1930	Mar.	7		** 3,570
1931	Apr.	4		4,540
		4	7.51	P 8,500
		22		4,970
	Dec.	14		7,200
		14	8.26	P 10,100
1932	Jan.	30		5,580
	Feb.	3		4,000
	Mar.	31		4,750
	May	1		4,940
	Dec.	12		6,390
		14		5,700
		17		6,190
		28		16,500
		28	12.20	P 18,700

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Toccoa River near Dial, Ga.

Location.- Half a mile above Shallow Ford, 1 mile above Stanley Creek, and 4 miles northwest of Dial, Fannin County.
Drainage area.- 175 square miles.
Records available.- January 1913 to September 1934.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Discharge measurements for 1913-15 and gage-height records furnished by Tennessee Electric Power Co.
Gage.- Recording. Zero of gage is 1,781.12 feet above mean sea level.
Stage-discharge relation.- Slightly shifting. Rating curves well defined to about 4,000 second-feet.

Flood stages and discharges
(Base discharge 1,500 second-feet)

Date		Gage height (feet)		Discharge (second-feet)
1913 Feb.	27	3.9		1,940
Mar.	14	6.6		5,140
	21	3.45		1,550
	27	6.0		4,360
Apr.	3	4.4		2,450
May	23	5.0		3,160
1914 Apr.	14	3.05	**	1,260
Nov.	30	3.7		1,760
Dec.	4	4.6		2,680
	25	4.6		2,680
1915 Feb.	1	4.3		2,340
Dec.	18	5.65		3,660
	29	7.10		5,430
1916 Feb.	2	4.20		2,200
May	23	3.80		1,840
June	15	3.85		1,880
July	9	10.0	P	9,200
	10	8.30		6,990
	16	3.80		1,840
	19	3.80		1,840
1917 Feb.	1	3.5		1,580
	20	4.2		2,200
Mar.	4	6.47		4,700
	21	3.5		1,580
	24	6.3		4,460
	27	4.9		2,900
Apr.	5	4.45		2,450
1918 Jan.	28	3.85		1,880
	30	3.40		1,500
Oct.	29	5.52		3,570
Dec.	14	3.40		1,510
	16	3.75		1,800
	22	7.68		6,080
1919 Jan.	2	4.02		2,040
Feb.	22	4.00		2,020
Mar.	5	3.80		1,840
	9	3.54		1,620
	27	3.60		1,680
Apr.	11	3.54		1,620
May	7	4.03		2,050
Dec.	9	6.15		4,280
1920 Jan.	24	3.42		1,530
	26	3.62		1,690
Feb.	4	3.90		1,930
Mar.	29	3.84		1,880
Apr.	2	6.05		4,160
	2	7.20	P	5,560
	4	4.72		2,720
Aug.	10	3.78		1,830
	14	5.30		3,330
	20	4.57		2,570
Sept.	9	3.60		1,680
Dec.	14	6.25		4,400
1921 Feb.	10	7.45		5,880
	10	9.25	P	8,220
	20	3.52		1,600
1922 Jan.	21	6.2		4,340
	21	8.00	P	6,600
Feb.	15	3.85		1,880
Mar.	10	4.35		2,350
Mar.	27	3.6		1,660
Apr.	19	3.65		1,700
May	4	4.9		2,900
Dec.	17	4.7		2,810
	17	5.5	P	3,550
1923 Apr.	29	3.75		1,800
May	29	3.95		1,980
June	7	3.35		1,510
1924 Jan.	11	3.7		1,760
	16	3.4		1,550
Feb.	27	3.4		1,520
Mar.	5	4.25		2,390
	5	6.00	P	4,100
Apr.	18	4.7		2,710
1925 Jan.	18	3.8		1,840
1926 Jan.	18	3.75		1,840
	18	4.4	P	2,400
Dec.	26	4.15		2,060
	28	4.45		2,360
	28	5.40	P	3,400
1927 Mar.	9	3.15	**	1,240
1928 Mar.	30	3.85		1,800
	30	4.05	P	1,980
Aug.	16	3.55		1,550
1929 Feb.	28	4.30		2,220
Mar.	5	4.32		2,220
	14	5.47		3,540
	23	5.30		3,300
Apr.	28	4.03		1,980
May	1	3.90		1,860
	7	4.55		2,470
	19	3.93		1,900
June	27	4.41		2,320
Sept.	25	5.12		3,060
	25	7.10	P	5,600
Nov.	3	4.32		2,220
	15	5.28		3,300
1930 Mar.	7	4.72		2,620
	7	5.61	P	3,660
1931 Apr.	4	3.92		1,760
	4	4.57	P	2,400
	22	3.64		1,560
Dec.	14	6.29		4,580
	14	8.05	P	7,120
1932 Jan.	6	3.76		1,640
	13	3.80		1,680
	30	4.22		2,040
Feb.	3	4.18		2,040
Mar.	22	4.04		1,900
	31	5.03		2,960
May	1	3.99		1,850
Dec.	12	4.81		2,670
	17	4.42		2,240
	25	4.82		2,670
	28	7.51		6,300
	28	8.10	P	7,200
	31	5.00		2,900
1933 Jan.	9	3.94		1,800
May	5			2,280
1934 Mar.	3			4,040
	3	7.05	P	5,560
June	18			1,590

** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Ocoee River at Emf, Tenn.

Location.- January 1913 to June 7, 1924, 600 feet below plant 2 of Tennessee Electric Power Co., half a mile upstream from Emf, Polk County, and 1½ miles downstream from mouth of Goforth Creek; thereafter 10C feet farther downstream.
Drainage area.- 530 square miles.
Records available.- January 1913 to September 1933.
Sources of data.- Tennessee Division of Geology Bulletin 34 and U. S. Geological Survey records. Discharge measurements prior to 1915 and gage-height records prior to 1925 furnished by Tennessee Electric Power Co.
Gage.- Recording. Zero of gage is 830.00 feet above mean sea level.
Stage-discharge relation.- Not permanent. Rating curves fairly well defined to about 8,000 second-feet.
Storage and regulation.- Blue Ridge Reservoir on Toccoa River, drainage area 231 square miles, available capacity, 159,000 acre-feet, completed in December 1930. Entire flow above dam was impounded from Dec. 6, 1930, to Mar. 3, 1931, and almost completely regulated thereafter.

Flood stages and discharges
(Base discharge 3,500 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1913	Jan.	27	6.5		4,780
	Feb.	12	6.5		4,780
		27	8.4		8,870
	Mar.	14	10.5		14,000
		21	7.0		5,740
		27	11.4		16,200
	May	23	7.4		6,590
1914	Apr.	14	5.77		3,540
	Dec.	4	6.94		5,620
		25	8.12		8,230
1915	Feb.	1	7.00		5,740
	Oct.	5	5.81		4,110
	Dec.	18	9.60		12,400
		25	5.50		3,500
		29	10.02		13,200
1916	Feb.	2	7.00		6,630
	May	24	6.45		5,480
	June	15	6.49		5,580
	July	10	10.48		14,300
		10	13.7	P	21,400
	Dec.	28	5.66		3,600
1917	Feb.	1	5.72		3,900
		20	7.74		8,170
	Mar.	1	6.34		5,260
		4	12.66		19,200
		7	7.95		8,830
		17	5.87		4,220
		25	7.76		8,390
	Apr.	5	6.9		6,420
1918	Jan.	12	5.85		4,220
		30	7.5		7,730
	Oct.	30	8.50		9,930
	Dec.	15	5.50		3,500
		22	10.40		14,100
1919	Jan.	2	6.76		6,130
		26	5.70		3,900
	Feb.	22	6.35		5,260
	Mar.	5	6.60		5,790
		9	6.60		5,790
		27	5.75		4,000
	May	8	5.90		4,320
	June	26	5.60		3,700
	July	6	5.85		4,220
	Oct.	23	5.70		3,900
	Dec.	9	7.20		7,070
1920	Feb.	4	5.80		4,110
	Mar.	29	6.50		5,580
	Apr.	2	11.70		17,000
		4	8.62		10,200
		21	6.22		4,990
	Aug.	10	6.61		4,180
		14	7.62		5,880
		20	6.55		4,080
	Dec.	14	10.43		12,000
		22	6.42		3,880
1921	Feb.	10	9.90		10,700
		10	10.75	P	12,800
	Apr.	17	6.35		3,780
1922	Jan.	21	10.30		11,900
		21	12.5	P	17,200
	Feb.	15	7.37		5,430
	Mar.	2	7.36		5,450
		10	9.25		9,660
		15	7.19		5,120
		17	5.67		5,250
	May	4	7.65		6,030
	Dec.	17	9.5		9,670
		17	10.0	P	10,700
1923	Jan.	24	6.25		3,710
	Feb.	13	6.2		3,770
	Apr.	14	6.35		3,860
	May	16	6.2		3,660
		29	6.35		3,870
	June	12	6.2		3,630
		28	6.6		4,310
	July	17	6.25		3,960
1924	Jan.	3	6.35		3,870
		11	6.35		3,870
	Feb.	27	6.7		4,440
	Mar.	5	6.7		4,440
	Apr.	18	8.6		7,880
		18	9.4	P	9,470
		30	6.4		3,950
	Dec.	8	6.2		3,920
		8	9.1	P	8,870
1925	Jan.	18	6.15		3,570
1926	Jan.	18	7.1		5,890
		18	7.9	P	7,680
	Dec.	25	6.82		4,610
		28	8.38	P	7,500
		29	6.92		4,780
1927	Mar.	9	6.42		3,950
	Dec.	16	6.70		4,460
1928	Mar.	30	8.20		7,320
		30	10.3	P	11,300
	July	27	6.17		3,650
	Sept.	3	7.03		5,060
		6	6.40		3,960
1929	Feb.	28	6.90		4,780
	Mar.	5	7.08		5,120
		14	7.34		5,470
		23	7.05		4,950
	Apr.	16	6.30		3,790
	May	2	7.00		4,950
		6	9.75	P	10,300
		7	8.20		7,120
		19	7.27		5,470
	June	27	6.25		3,710
	Sept.	26	6.70		4,440
	Nov.	3	6.30		3,790

Flood stages and discharges of Ocoee River at Emf, Tenn.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1929	Nov.	14	7.50		5,830		May	1			4,790
		14	7.75	P	6,370		Dec.	12			3,770
		17	7.03		4,950			14			4,300
1930	Mar.	7	7.32		5,470			17			3,600
1931	Apr.	4		**	3,390			28	9.40		9,470
	Dec.	14			4,490			28	9.71	P	10,100
1932	Jan.	30			4,960	1933	Jan.	9	6.55		4,270
	Feb.	3			3,770		Feb.	8			3,630
		12			4,300			20		*	4,200
	Apr.	30	9.25	P	9,050						

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Part 4. St. Lawrence River Basin

Fox River at Berlin, Wis.

<u>Location</u>.- In sec. 16, T. 17 N., R. 13 E., lower gage at Government lock and dam 2 1/3 miles upstream from Berlin, Green Lake County.
<u>Drainage area</u>.- 1,430 square miles.
<u>Records available</u>.- January 1898 to December 1934.
<u>Source of data</u>.- Corps of Engineers, U. S. Army.
<u>Gage</u>.- Nonrecording gage read to hundredths three times daily, noon reading generally being used to determine daily discharge. Zero of gage is 744.52 feet above mean sea level.
<u>Stage-discharge relation</u>.- Considerably affected by ice. Control permanent. Both banks low and subject to overflow.
<u>Storage and regulation</u>.- Natural storage in Swan, Buffalo, Puckaway, and Green Lakes and Puckeyan Marsh. Natural regulation from large swamp area.

Flood stages and discharges
(Base discharge 2,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1898	Mar.	16	11.4	2,730	1916	Mar.	28	14.9	6,400
1899	Apr.	9	12.3	2,800		Apr.	23		2,750
1900	Apr.	2	11.7	2,830		May	17	11.2	2,450
1901	Mar.	29	13.8	4,800		June	13-15	11.8	2,910
1902	Mar.	13		2,000		Nov.	5		2,040
	May	25	11.2	2,450			19		2,040
1903	Mar.	12	11.7	2,600			25-26		2,040
		24-25	11.5	2,670	1917	Mar.	27	14.4	5,650
	Aug.	29	11.2	2,450		Apr.	22-25		2,750
	Sept.	10-16		2,240		June	13-14	11.3	2,520
1904	Mar.	27	14.4	5,400		July	4-8		2,380
	Apr.	29		2,170	1918	Mar.	21-23	14.7	6,050
	May	14-16		2,310		May	13-14		2,100
1905	Mar.	29-Apr. 2	13.5	4,560			20		2,830
	May	18-21	11.3	2,520			23	13.1	4,120
	June	10-11	14.6	5,920	1919	Mar.	20-21	11.5	2,670
1906	Mar.	10-12		2,900		Apr.	23		2,170
		30	13.4	4,450	1920	Mar.	29	14.0	5,150
	Nov.	30-Dec. 2		2,200	1921	May	1-2	11.2	2,450
1907	Mar.	15		2,200	1922	Mar.	16	14.6	5,920
		28-31	11.3	2,520		Apr.	12-13		4,450
	Apr.	13-16		2,240			18-19		4,560
1908	Mar.	14-15	13.0	4,020		June	15-17	11.2	2,450
	May	1-2	11.7	2,830	1923	Apr.	12	14.7	6,050
1909	Mar.	27	11.5	2,670	1924	Apr.	9-10		4,020
	May	3-6	11.8	2,910		May	13-14		2,670
1910	Mar.	17	12.0	3,080		Aug.	22-24		3,350
	Apr.	29		2,380	1925	Mar.	23		2,520
1911	Feb.	26-27	11.6	2,600	1926	Apr.	1-2		3,440
	June	8		2,240		June	1		2,100
	Dec.	11-12		2,050	1927	Mar.	12		3,170
1912	Mar.	31-Apr. 1	13.1	4,100		June	2-3		2,910
	May	30-June 3	11.7	2,830	1928	Mar.	23-24		5,920
	Sept.	6	12.5	3,530	1929	Mar.	21		6,620
		23-27		2,380		Apr.	7		4,910
1913	Mar.	19-20		4,000		May	1		3,170
		25-27		4,200	1930	Mar.	5		3,000
		31	13.3	4,340		Apr.	22-23		2,040
	May	31	11.7	2,830	1931	Apr.	5		** 1,140
1914	June	11-12	11.6	2,750	1932	Jan.	10		** 1,910
1915	Mar.	18	11.9	3,000	1933	Apr.	11		2,600
	Sept.	20-21	11.7	2,830		May	17-18		2,520
	Nov.	28-29		2,310	1934	Apr.	6-8		** 1,910

** Below base
<u>Note</u>.- All discharge quantities are average daily flows.

Wolf River at New London, Wis.

Location.- In sec. 12, T. 22 N., R. 14 E., at New London, Waupaca County, three-quarters of a mile below Embarrass River.
Drainage area.- 2,240 square miles.
Records available.- March 1896 to December 1934.
Sources of data.- Gage-height records by Corps of Engineers, U. S. Army; discharge records based on measurements made by U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths once daily. Zero of gage is 749.37 feet above mean sea level (New York City datum).
Stage-discharge relation.- Affected by ice. Control shifts. Banks overflow at high stages.
Storage and regulation.- Flow at all stages affected by natural storage in numerous lakes and swamps but only at low stages by power plants above stations.
Historical data.- Flood of Apr. 16, 1888, reached stage of 11.6 feet.
Remarks.- During flood stages some water from Embarrass River flows around station and enters Wolf River below. Flood measurements in early records did not include this overflow.

Flood stages and discharges
(Base discharge 3,360 square miles)

Date			Gage height (feet)	Discharge (second-feet)
1896	May	7-9		3,420
1897	Mar.	27		4,390
1898	Apr.	1-4		** 2,860
1899	Apr.	15-18		4,650
	May	6-6		5,430
	July	26-27		** 2,750
	Oct.	13		5,810
	Nov.	6-8		4,390
1901	Apr.	1		6,230
1902	May	13		** 3,050
1903	Mar.	26		5,100
1904	June	1-4		5,160
1905	Apr.	1		6,470
	June	17		4,280
1906	Apr.	1-6		7,250
	Dec.	2-4		4,580
1907	Mar.	30-31		5,100
1908	Mar.	18		4,350
	May	5		4,050
1909	May	23		3,420
1910	May	1-4		3,500
1911	May	25-26		** 3,120
	Oct.	14		4,980
	Dec.	18		4,790
1912	Apr.	3		4,960
	May	30		4,960
	July	30		9,180
	Sept.	9		6,020
1913	Mar.	19		8,170
	Apr.	7		7,250
1914	May	6-7	7.4	3,760
	June	9-10	9.9	8,490
1915	Mar.	27	7.6	4,260
	Apr.	14-18	6.9	3,700
1916	Apr.	4	9.7	8,960
		26	9.2	7,510
	May	22	7.2	4,050
	June	12-13	9.7	8,960
1917	Apr.	1	9.45	8,060
	May	3-7	7.4	4,270
	June	15	6.95	3,850
1918	Mar.	22	9.3	6,740
	May	30-31	9.5	7,270
1919	Mar.	21-22	8.6	6,150
	Apr.	14-15	8.7	6,350
	May	11-12	7.3	4,130
	Nov.	12	6.6	3,510
		18-19	6.5	3,430
1920	Mar.	28-29	10.3	10,800
	Apr.	28-30	6.5	3,430
1921	Mar.	28-30	7.9	4,900
	May	3	8.8	6,560
1922	Apr.	13	11.4	15,500
	June	14-15	8.3	4,960
	July	17-18	7.6	4,170
1923	Apr.	24	10.2	10,100
1924	Apr.	11	8.7	5,950
		23	9.1	6,790
	May	16-18	9.3	7,280
	Aug.	25-26	7.8	4,680
1925	June	19-20	7.4	4,270
1926	Mar.	30	8.0	* 3,660
	Apr.	16-17	7.4	4,270
	May	1-3	7.6	4,470
		31	6.4	3,430
	June	21	7.5	4,370
	Sept.	26	6.8	3,740
	Oct.	7-8	6.3	3,360
1927	Mar.	16-19	8.9	6,340
	May	15-17	6.7	3,660
1928	Mar.	26-27	9.5	7,810
	Apr.	15	8.9	6,340
		21-24	8.2	5,150
	Aug.	30	6.9	3,820
	Sept.	22	8.1	5,020
	Oct.	25-26	8.2	5,150
1929	Mar.	21-22	11.0	11,300
	Apr.	10-12	10.3	9,400
	May	3-4	8.3	5,290
1930	Mar.	18-21	5.6	** 2,900
1931	June	25-26	4.3	** 2,160
1932	Apr.	15	7.4	4,260
	May	14		3,490
1933	Apr.	5-6	7.9	5,320
	May	9-11	6.3	3,490
1934	Apr.	8-9	8.4	6,000

* Estimated
** Below base
Note.- All discharge quantities are average daily flows.

Black River at and near Watertown, N. Y.

Location.- Feb. 22, 1897, to Dec. 31, 1901, about 500 feet above Huntingtonville dam near Watertown, Jefferson County; Aug. 29, 1902, to Mar. 23, 1917, at dam of Lefevre Paper Co., formerly owned by Black River Traction Co., 1 mile above Felts Mills and about 8 miles above first site; Mar. 24, 1917, to July 17, 1920, about a quarter of a mile below highway bridge and below village of Black River; thereafter about 150 feet below Vanduzee Street Bridge, in Watertown, and about 7 miles above mouth of river.

Drainage area.- Feb. 22, 1897, to Dec. 31, 1901, 1,870 square miles; Aug. 29, 1902, to Mar. 23, 1917, 1,828 square miles; Mar. 24, 1917, to July 17, 1920, 1,858 square miles; thereafter 1,876 square miles.

Records available.- February 1897 to September 1934. Flood estimates only Jan. 1 to Aug. 28, 1902.

Sources of data.- U. S. Geological Survey except records for Felts Mills Jan. 1, 1914, to Mar. 23, 1917, when that station was maintained by New York State engineer.

Gages.- Nonrecording gages read twice daily prior to Sept. 3, 1921; recording gage thereafter.

Stage-discharge relation.- Discharge at Felts Mills dam includes water through wheels, water over dam, and leakage. Controls probably permanent.

Storage, regulation, and diversions.- Storage of 21,000 acre-feet prior to 1925 and 105 acre-feet thereafter in Stillwater Reservoir, 23,000 acre-feet in Old Forge and Sixth Lake Reservoirs, and about 40,000 acre-feet in 8 canal reservoirs above Forestport. Some regulation of flood flows. Diversion of water out of drainage area via Forestport feeder and Black River Canal (about 200 second-feet May to November) not included in discharges. Diversion of water for water supply of city of Watertown not included in Huntingtonville and Watertown records.

Remarks.- Station formerly known as Black River at Huntingtonville Dam near Watertown (1897-1901), Black River near Felts Mills (1902-17), and Black River at Black River (1917-20).

Historical data.- Flood of April 1869 estimated at 39,700 second-feet at Watertown.

Flood stages and discharges
(Base discharge 10,000 second-feet)

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1897	Mar.	24	6.48	16,500		
	Apr.	9-10	5.60	11,500		
		28	6.07	14,100		
1898	Mar.	15	8.10	27,900		
		22	5.97	13,600		
	Apr.	27	5.33	10,100		
1899	Jan.	5	5.38	10,400		
	Apr.	24	7.72	25,000		
1900	Feb.	16		14,000		
	Apr.	8		12,200		
		21		30,000	8.41	30,200
	Nov.	29		13,900		
1901	Mar.	28	6.82	18,800	6.85	19,000
	Apr.	4	5.58	11,400	5.60	11,500
		10	5.58	11,400	5.60	11,500
		24	7.70	24,800	7.70	24,800
	Dec.	16	10.15	47,000	10.4	49,000
1902	Mar.	5		* 10,000		
		19		* 30,000		
		31		* 16,000		
1903	Mar.	4	592.48	10,200	592.5	10,300
		12	593.90	17,800	593.90	17,800
		25	596.25	34,000	596.30	34,400
	Oct.	12	594.00	18,400	594.10	19,000
		20-21	592.55	10,600	592.60	10,800
1904	Mar.	27-28	593.15	13,900	593.20	14,200
	Apr.	5	592.55	10,700	592.6	11,000
		12	594.15	19,200	594.30	20,200
	May	2		* 24,000		
		4		* 26,000		
1905	Apr.	1	593.95	18,200	594.00	18,400
		7	594.00	18,400	594.00	18,400
		24	592.55	10,800	592.60	11,100
	June	21	592.60	11,100	592.60	11,100
	Sept.	7	592.45	10,300	592.60	11,100
1906	Jan.	26	593.80	19,000	593.90	19,500
	Apr.	18	592.90	14,200	593.00	14,700
1907	Apr.	1	593.30	16,900	593.60	18,500
	May	5	592.85	12,600	592.90	12,900
	Dec.	29	592.55	11,100	592.60	11,300
1908	Mar.	30-31	593.10	15,500		

* Estimated

Flood stages and discharges of
Black River at and near Watertown, N. Y.--Continued

Date			Average		Momentary peak	
			Gage height (feet)	Discharge (second-feet)	Gage height (feet)	Discharge (second-feet)
1908	Mar.	31			593.20	16,100
	Apr.	12	592.55	11,300	592.60	11,500
	May	2	592.55	12,600	592.60	
1909	Apr.	9	593.30	17,300	593.30	17,300
		16	594.35	22,800	594.40	23,100
	May	5	592.45	13,000	592.50	13,200
		13	592.50	13,200	592.60	13,800
1910	Mar.	7	592.90	15,100	592.90	15,100
		27	592.55	12,200	592.60	12,500
	Apr.	2-3	593.05	15,000	593.10	15,300
1911	Apr.	10	593.50	17,600	593.50	17,600
		17	593.80	19,400	593.90	20,000
	May	4	593.85	19,700	594.0	20,600
	Dec.	15	593.30	16,300	593.3	16,300
1912	Apr.	7	595.00	24,800	595.0	24,800
		18	595.45	28,000	595.4	28,500
		25	594.05	19,900	594.1	20,200
	May	24	592.15	10,500	592.2	10,700
	June	1	592.80	13,700	592.9	13,900
1913	Jan.	21	594.15	15,300	594.2	15,400
	Mar.	16	594.05	18,600	594.1	18,800
		28	596.25	32,800	596.3	33,100
1914	Apr.	1	593.8	18,600	594.0	19,600
		11	592.05	10,200	592.10	10,300
		22	594.8	24,600	594.9	25,200
	May	1-2	592.40	11,600	592.40	11,600
1915	Feb.	27	593.80	11,800	593.70	12,100
	Apr.	14	594.9	18,100	595.0	18,700
1916	Jan.	28	593.00	13,900	593.20	14,800
	Apr.	2	594.0	19,600	594.0	19,600
		25	592.7	12,800	592.7	12,800
	May	19	594.5	22,600	594.6	23,100
1917	Mar.	29	13.0	18,100	13.11	18,400
	Apr.	4	13.4	19,300	13.41	19,300
		23	12.2	16,000	12.41	16,600
	June	14-15	10.3	11,500		
		14			10.51	12,000
	Nov.	2	10.8	12,600	10.9	12,900
1918	Mar.	24-25	10.1	11,100		
		24			10.2	11,300
	Apr.	4	12.2	16,000	12.3	16,300
1919	Mar.	19	9.8	10,400	9.9	10,600
	Apr.	14	12.7	17,300	12.7	17,300
1920	Mar.	29	12.4	17,300	12.6	17,900
	Apr.	6	11.6	15,100	11.7	15,400
		17	9.7	10,600	9.75	10,700
		27-28	10.9	13,400		
		28			11.0	13,600
	Dec.	6-7	5.4	10,200		
		6			5.5	10,500
		17	6.8	15,200	6.90	15,600
1921	Mar.	11	8.7	22,800	8.78	23,100
		23	8.0	20,000	8.10	20,400
1922	Mar.	16	5.4	10,200	5.47	10,400
		31	6.8	15,200	6.90	15,600
	Apr.	13-14	9.2	25,000	9.45	26,200
	June	25	6.9	15,600	6.96	15,800
	July	2-3	5.4	10,200		
		2			5.48	10,500
1923	Apr.	9	8.4	21,600	8.50	22,000
		25	6.9	15,600	6.95	15,800
1924	Jan.	14	8.1	20,400	8.50	22,000
	Apr.	8	8.9	23,600	9.08	24,400
		17	6.6	14,400	6.65	14,600
		21	6.6	14,400	6.67	14,700
	May	4	6.3	13,200	6.30	13,200
		16	5.5	10,500	5.58	10,800
	Oct.	3	6.6	15,200	6.63	15,300
1925	Feb.	12	5.7	11,600	6.04	13,000
		15	5.8	12,000	5.80	12,000
		26	6.1	13,200	6.18	13,500
	Mar.	16	5.5	11,000	5.65	11,500
		22	5.8	12,000	5.84	12,200
		30	6.3	14,000	6.37	14,300
	Apr.	18	5.5	11,000	5.50	11,000
	Nov.	17	6.3	14,000	6.42	14,500
	Dec.	9	5.3	10,300	5.38	10,500
1926	Apr.	16	6.4	14,400	6.42	14,500
		26	9.9	29,900	10.3	31,900
	May	5	7.9	20,800	8.00	21,300

Flood stages and discharges of
Black River at and near Watertown, N. Y.--Continued

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1926	Nov.	19	6.6	14,000	6.78	14,800
1927	Mar.	20	7.2	16,600	7.2	16,600
	Nov.	17			6.34	13,000
		18		11,600		
	Dec.	2	7.2	16,600	7.27	16,900
		11	6.1	12,100	6.12	12,100
		15	6.2	12,400	6.26	12,700
1928	Mar.	29	6.7	14,400	6.85	15,000
	Apr.	9		30,700	10.6	33,900
	May	8	5.5	10,000	5.61	10,400
1929	Jan.	21-22	6.4	13,200		
		21			6.58	13,900
	Mar.	18	6.9	15,300	6.98	15,600
		26	6.7	14,400	6.72	14,500
	Apr.	9	6.6	14,000	6.76	14,700
	May	6		16,200	7.4	17,500
1930	Jan.	10-11	7.9	20,800		
		11			8.2	22,300
	Feb.	24-25	5.7	11,300		
		24			5.80	11,600
	Apr.	9	6.7	15,200	6.80	15,600
		16	6.2	13,100	6.23	13,300
1931	Apr.	13	6.8	15,600	6.87	15,900
1932	Jan.	18		13,600	6.67	15,100
	Apr.	12			7.62	19,400
		13		18,300		
	May	3-4	5.9	12,000		
		4			6.10	12,800
	Oct.	8		23,300	8.90	26,000
1933	Apr.	9	6.6	14,800	6.70	15,200
		20	7.1	16,900	7.30	17,900
1934	Apr.	3			7.01	16,500
		4		14,400		
		14		11,800		
		19		11,800		

Moose River at Moose River and McKeever, N. Y.

Location.- June 5, 1900, to Dec. 31, 1922, at Moose River, Lewis County, 5 miles below below mouth of South Branch of Moose River; thereafter half a mile west of McKeever, Herkimer County, about 2 miles below mouth of South Branch of Moose River and about 3 miles above first location.

Drainage area.- June 5, 1900, to Dec. 31, 1922, 368 square miles; thereafter 365 square miles.

Records available.- June 1900 to September 1934.

Source of data.- U. S. Geological Survey.

Gages.- Nonrecording gage read twice daily prior to November 1920; once daily November 1920 to December 1922; recording gage installed at McKeever Nov. 2, 1922, but record not used until Jan. 1, 1923. Gage datum at Moose River lowered 5.00 feet Jan. 1, 1913.

Stage-discharge relation.- Control probably permanent.

Storage and regulation.- About 23,000 acre-feet storage in Old Forge and Sixth Lake Reservoirs. Slight regulation.

Historical data.- Discharge for flood of April 1869 estimated at 11,000 second-feet at Moose River.

Flood stages and discharges
(Base discharge 4,000 second-feet)

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1901	Apr.	22	7.2	5,800	7.6	6,470
	Dec.	16	* 9.2	* 9,500	* 11.0	* 14,500
1902	Mar.	18		* 8,500	* 9.17	* 9,500
		30	6.6	4,860	6.8	5,160
1903	Mar.	13		* 4,000	* 6.05	* 4,050

* Estimated

Flood stages and discharges of
Moose River at Moose River and McKeever, N. Y.--Continued

Date			Average: Gage height (feet)	Average: Discharge (second-feet)	Momentary peak: Gage height (feet)	Momentary peak: Discharge (second-feet)
1903	Mar.	24		* 11,000		* 11,500
	Apr.	4	6.7	5,010	7.1	5,640
	Oct.	10	* 8.5	* 8,100	* 9.7	* 10,800
1904	Apr.	10	6.15	4,190	6.2	4,260
		30	6.50	4,700	6.60	4,860
	May	2	6.95	5,400	7.00	5,480
	Sept.	30	6.05	4,050	6.10	4,120
1905	Mar.	31	6.6	4,860	6.7	5,010
	Apr.	6	6.2	4,260	6.5	4,700
		22	7.1	5,640	7.5	6,300
	June	18	6.5	4,700	7.3	5,960
	Sept.	4	6.65	4,930		
		5			7.3	5,960
1906	Jan.	24	7.65	6,560	7.8	6,810
	May	14	6.13	4,160	6.23	4,300
1907	May	1	6.15	4,580	6.25	4,740
	Oct.	9	5.90	4,220	6.25	4,740
	Dec.	11	6.10	4,510	6.25	4,740
1908	Apr.	28	7.2	6,220	7.2	6,220
		30	6.6	5,260	6.7	5,420
1909	Apr.	14			8.23	7,870
		15	7.48	6,700		
		20	7.38	6,510	7.43	6,590
	May	2	5.98	4,330	6.23	4,700
		8	6.28	4,780	6.53	5,160
		11	7.18	6,190	7.23	6,270
1910	Mar.	1	7.1	6,060	7.1	6,060
		26-27	6.35	4,880		
		27			6.50	5,110
		29	6.30	4,810	6.30	4,810
1911	Apr.	15	6.4	# 4,540	6.8	5,020
	May	2	8.6	7,200	9.1	7,780
	Dec.	13	7.0	5,260	7.2	5,500
1912	Apr.	17	8.5	7,060	9.0	7,660
		23	9.0	7,660	9.2	7,900
1913	Mar.	27	15.5	12,900	16.3	15,500
	Nov.	10	11.2	4,230	11.3	4,360
1914	Apr.	20	14.4	10,200	14.4	10,200
1915	Apr.	12	12.0	5,320	12.1	5,470
1916	May	18	13.0	7,060	14.0	9,250
1917	Apr.	3	11.4	4,490	11.5	4,620
		21	12.2	5,630	12.4	5,960
	June	12	12.6	6,310	13.2	7,460
	Oct.	31	11.9	5,170	12.8	6,680
1918	Apr.	18	10.3	** 3,170		
1919	Apr.	12	14.0	9,250	14.5	10,400
	Dec.	1	9.0	** 1,910		
....			....	.....	....	......
1920	Dec.	15	12.0	5,320	13.0	7,060
1921	Mar.	10	12.2	5,630	12.6	6,310
		21	12.5	6,130	13.2	7,460
		26	11.8	5,030	12.0	5,320
1922	Apr.	12	14.2	9,700	14.5	10,400
		18-19	11.7	4,890		
		18			11.9	5,170
	June	22			* 15.1	11,900
		23	* 13.0	7,060		
1923	Apr.	6			9.0	5,500
		7	8.4	4,800		
		22	8.5	5,000	9.50	6,050
	Dec.	1		4,330	8.56	5,060
1924	Jan.	12		6,880	12.0	8,900
	May	1		4,650	8.88	5,380
		5		4,850	9.28	5,810
	Oct.	1		7,030	11.53	8,340
1925	Feb.	13	7.6	4,000	8.32	4,820
	Mar.	28		4,280	8.41	4,910
	Apr.	26		4,450	8.74	5,240
1926	Apr.	25	11.5	8,780	12.14	9,680
	May	4	10.0	6,830	10.57	7,570
	Nov.	17		4,410	8.7	5,240
1927	Mar.	19	7.7	4,130	7.89	4,330
	Dec.	1		4,260	8.09	4,570
		8			* 10.0	* 6,830
		9		* 4,740		
1928	Apr.	8	12.7	10,400	13.14	11,100
	May	5	* 9.0	* 5,600	* 9.3	* 5,960

* Estimated
** Below base
# First daily reading after frozen period; may not be peak.

Flood stages and discharges of
Moose River at Moose River and McKeever, N. Y.--Continued

Date		Average		Momentary peak	
		Gage height (feet)	Discharge (second-feet)	Gage height (feet)	Discharge (second-feet)
1929 Jan.	20	9.4	4,400	10.75	* 5,900
Mar.	16			8.64	5,170
	17		4,340		
	24		4,890	8.95	5,540
Apr.	6			10.02	6,860
	7		5,620		
May	4		4,930	9.20	5,840
1930 Jan.	9		8,760	12.70	10,500
Apr.	8		4,520	8.91	5,490
	13-14	7.8	4,250		
	13			8.13	4,610
1931 Apr.	11		4,910	9.34	6,010
1932 Jan.	16		4,480	8.62	5,150
May	1		4,740	8.65	5,180
Oct.	7		8,230	12.77	10,600
1933 Apr.	18		5,740		
	19			9.47	6,160
1934 Apr.	17		4,900	8.78	5,340

* Estimated

Part 5. Hudson Bay and upper Mississippi River Basins

St. Mary River near Kimball, Alberta

Location.- Sept. 1, 1902, to June 4, 1908, a quarter of a mile north of international boundary near Cardston, Alberta, and 6 miles below Kennedy Creek; July 27, 1908, to Dec. 31, 1912, half a mile north of international boundary; thereafter in SW¼ sec. 25, T. 1 N., R. 25 W. fourth meridian, 1½ miles southwest of Kimball, Alberta, and 5 miles north of international boundary.

Drainage area.- 1902-12, about 475 square miles; thereafter, 497 square miles.

Records available.- September 1902 to September 1934.

Sources of data.- Dominion Water Power and Hydrometric Bureau, Department of the Interior, Canada, and U. S. Geological Survey.

Gages.- Nonrecording gages read to half-tenths once daily prior to January 1913; recording gage during open water and nonrecording gage during ice periods thereafter. Zero of recording gage is 3,917.00 feet above mean sea level (Canadian Government datum).

Stage-discharge relation.- Affected by ice. Control shifts, and one bank subject to overflow at locations used prior to 1913; control shifts slightly at high stages, and banks do not overflow at present location.

Storage, regulation, and diversions.- Natural storage and regulation from several lakes including Upper and Lower St. Mary Lakes. Subsequent to 1915 artificial regulation for irrigation at Sherburne Lake Reservoir on Swift Current Creek. Subsequent to July 1917 diversions of 500 to 700 second-feet through St. Mary Canal during irrigation season (June to October).

Flood stages and discharges
(Base discharge 2,600 second-feet)

Date	Gage height (feet)		Discharge (second-feet)
1903 May 27	5.95		3,060
June 8	7.15		6,180
17	7.00		5,720
29	6.85		5,280
1904 May 24	6.05		3,270
June 7	6.15		3,900
18	6.05		3,380
July 8	5.70		2,690
1905 June 7	6.05		3,270
1906 June 5-6	5.75		2,660
12	5.75		2,660
1907 May 18	6.2		3,490
June 3	6.6		4,450
8	6.75		4,830
23	7.05		5,620
29	6.9		5,220
1908 May 15	6.10		3,260
27	6.30		3,720
June 1	6.95		5,360
5	12.75		18,000
July 6			3,050
1909 June 4-8	6.85		5,380
21	6.85		5,380
July 5-6	5.35		3,210
28-29	6.6		5,010
1910 Apr. 27	4.7		2,820
May 9	4.6		2,860
May 27-June 2	4.7		2,960
1911 May 16	5.8		3,810
25-26	4.9		2,930
June 4	5.8		3,810
13-14	5.8		3,890
25	5.6		3,750
1912 May 21-22	5.2		3,480
June 14	4.6		2,900
1913 June 2	6.09		5,380
28	5.65		4,250
1914 May 20	4.78		2,830
June 4	5.00		3,120
20	4.62		2,630
1915 June 26	4.21		2,670
26	4.8	P	2,930
1916 June 22	7.80		8,620
22	8.08	P	8,930
30	7.07		6,730
1917 May 17	5.85		3,220
30	6.34		3,950
June 11	6.91		5,200
11	6.93	P	5,230
1918 May 8	5.61		3,380
June 14	6.35		4,970
1919 May 30	6.09		4,310
30	6.13	P	4,380
1920 May 21	5.31		2,760
June 18	6.20		4,440
18	6.28	P	4,600
1921 May 26	6.45		4,910
26	6.68	P	5,310
June 9	6.17		4,400
1922 May 22	5.35		3,050
29	5.98		4,180
June 7	6.54		5,250
7	6.55	P	5,260
1923 May 27	5.41		3,250
June 11	5.52		3,440
11	5.56	P	3,510
1924 May 19	5.11		2,810
June 8	5.18		2,920
17	5.22		2,980
17	5.25	P	3,030
1925 May 23	6.09	P	4,990
24	6.00		4,780
June 24	5.56		3,820
Oct. 13	4.02	**	1,280
1926 May 3	3.90	**	1,090
1927 May 24	5.86		4,360
29	6.31		5,300
June 11	7.30		7,480
11	7.43	P	7,770
July 5	5.43		3,480
Sept. 14	5.00		2,630
1928 May 27	6.47	P	5,330
27	6.43		5,250
July 2	5.83		4,090
1929 May 25	5.49	P	3,750
26	5.42		3,610
June 14-15	5.09		2,960
1930 May 4	4.88		2,620
June 4	5.04		2,900
June 12	5.18	P	3,160
12-13	5.12		3,050
1931 May 18	4.60	**	2,340
1932 May 23	5.14		2,840
June 18	5.28		3,040
1933 June 6	5.91		4,120
9	5.95	P	4,180
18	5.70		3,760
1934 May 10	5.19		3,030
18	5.35		3,320
31	5.17		3,000
June 8	6.11		4,790
8	6.18	P	4,930

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Red River at Fargo, N. Dak.

Location.- Prior to Aug. 31, 1914, at highway bridge connecting Front Street, Fargo, N. Dak. with Main Street, Moorhead, Minn., half a mile below Island Park Dam; thereafter in sec. 7, T. 139 N., R. 48 W., just above Island Park Dam; Fargo, Cass County, and 10 miles above mouth of Sheyenne River.
Drainage area.- 6,420 square miles.
Records available.- May 1901 to September 1934. No winter records prior to 1918.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily prior to September 1914; to half-tenths or hundredths once daily September 1914 to October 1924; to tenths once daily October 1924 to September 1930; to hundredths once daily thereafter. Zero of gage was 861.33 feet above mean sea level (1929 adjustment) May 27, 1901, to Aug. 31, 1914; 873.70 feet above mean sea level (1912 adjustment) Sept. 1, 1914, to Aug. 1, 1928; 870.00 feet above mean sea level (1912 adjustment) thereafter.
Stage-discharge relation.- Control shifts at first location. Dam is control for ordinary stages at present location. Dam settled 0.7 foot during high water of 1916 and at various other times, causing changes in stage-discharge relation; rebuilt and crest raised to 877.29 feet above mean sea level (1912 adjustment). Little effect from ice or debris at dam. Bank-full stage, about 25 feet at first location.
Remarks.- Independent gage-height records obtained by U. S. Weather Bureau since May 1901 at Front Street highway bridge and published as at Moorhead, Minn.
Historical data.- Flood of Apr. 7, 1897, reached stage of 40.1 feet at Front Street highway bridge (data of U. S. Weather Bureau).

Flood stages and discharges
(Base discharge 750 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1902	Mar.	17	10.30	1,100
		29	10.00	1,000
	May	23	10.50	1,180
	June	10	10.10	1,040
	July	7-8	9.50	850
1903	Apr.	6	13.90	2,450
		11	12.80	2,010
1904	Apr.	8	12.4	1,810
		20	21.3	5,220
	June	10	10.6	1,110
		28	14.8	2,830
1905	Mar.	31	9.5	850
	May	17	18.4	4,250
	June	8	10.0	1,000
		24	10.0	1,000
	July	13	10.4	1,140
		31	10.3	1,100
	Aug.	18	11.5	1,520
	Sept.	23-28	9.8	940
1906	Apr.	9	15.5	3,050
		18	15.0	2,840
		23	11.8	1,570
	May	6	11.4	1,430
		17	14.0	2,430
		31	12.9	1,990
	July	5	12.7	1,910
	Aug.	6	11.5	1,460
		30	11.3	1,390
	Sept.	25	10.8	1,230
	Oct.	29	10.6	1,160
	Nov.	30	11.0	* 978
1907	May	1	12.1	1,640
	June	1	11.3	1,370
		17	19.3	4,420
1908	Apr.	7	12.9	1,920
	May	22	10.2	1,010
	June	13	14.7	2,600
		28	12.9	1,920
	July	27	10.5	1,100
1909	Mar.	31	13.0	* 1,250
	Apr.	17	11.0	* 1,120
		30	9.8	911
	May	8-9	9.8	911
		30	12.5	1,780
	Aug.	12	9.6	853
		18	9.6	853
		29	9.6	853
	Sept.	28-29	10.0	970
1910	Mar.	20	22.9	* 4,700
	Apr.	12	11.7	1,500
		24	13.0	1,960
1911	Apr.	11	8.7	** 608
1912	Apr.	8	10.4	1,040
	May	14	10.6	1,100
1913	Apr.	15	10.0	870
	July	8	11.9	1,460
	Sept.	16	9.9	839
1914	Apr.	4-5	9.5	790
	May	2	13.7	2,220
	June	12	15.9	3,060
		30	14.3	2,440
1915	Apr.	9	5.2	2,430
	May	9-11	3.6	906
		20-21	3.5	836
	June	18	5.4	2,620
	July	2	6.0	3,110
		19	4.8	2,020
	Oct.	6-14	3.50	836
1916	Apr.	7	19.6	* 7,440
		26	13.9	6,360
	May	20	5.4	2,620
	June	2	5.4	2,620
		6	5.3	2,520
		13	5.2	2,430
	July	11	17.3	7,720
	Aug.	14	4.9	2,120
		26	6.0	3,110
	Sept.	18	4.30	1,510
	Oct.	1	3.95	1,240
1917	Apr.	3	14.0	* 5,200
	May	4	5.6	2,800
1918	Mar.	30-31	3.1	750
	May	25	3.1	750
1919	Apr.	5-7	2.7	** 630
1920	Mar.	27	13.3	6,120
	Apr.	10	3.5	1,060
		28	3.4	1,000
	May	17	3.5	1,060
		24	3.6	1,120
	June	14	4.4	1,690
	July	2	4.0	1,370
1921	Mar.	26	3.2	890
	Apr.	6	4.7	1,970
	June	4	3.65	1,150
1922	Mar.	27	9.5	4,600
		28	9.6	P
	Apr.	11	11.0	5,200
	May	11	4.0	1,370

* Estimated
** Below base

Flood stages and discharges of Red River at Fargo, N. Dak.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1922	June	17	3.1	835	1928	Mar.	29	9.6	* 3,840
1923	Apr.	13	4.6	1,870		June	21	3.4	974
		18	5.4	2,650	1929	Mar.	20	12.8	4,440
	June	29	7.9	3,960			29	7.3	1,100
1924	Apr.	30	2.5	** 530	1930	Mar.	17	10.0	* 1,340
1925	June	20-22	3.2	885		Apr.	5	9.0	780
1926	Mar.	24	4.3	1,600		May	16	9.5	1,120
1927	Mar.	19	5.4	2,650	1931	Apr.	3	8.55	** 365
	Apr.	5	4.4	1,690	1932	Apr.	11	9.44	868
		19-20	3.3	912	1933	Apr.	5	9.04	** 605
	June	18	3.1	794	1934	Apr.	10	8.55	** 323

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Red River at Grand Forks, N. Dak.

Location.- Prior to Oct. 16, 1926, at Northern Pacific Railway bridge between Grand Forks, N. Dak., and East Grand Forks, Minn., half a mile below mouth of Red Lake River; thereafter in sec. 34, T. 152 N., R. 50 W., at Grand Forks, Grand Forks County, 2 miles below mouth of Red Lake River.
Drainage area.- 25,500 square miles.
Records available.- May 1901 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to quarter-tenths once daily prior to 1923; to tenths once daily 1923 to Nov. 3, 1933; recording gage thereafter. Zero of gage at present location is 778.42 feet above mean sea level (1929 general adjustment). Zero of gage at first location was about 0.4 foot higher than that at present location. Dam which drowned out gage constructed below first location in 1926; gage at first location would have read same as second gage for same discharge if dam had not been constructed.
Stage-discharge relation.- Affected by ice and occasionally by aquatic growth. Control shifts slightly. Bank-full stage, about 25 feet.
Historical data.- Corps of Engineers, U. S. Army, kept intermittent gage-height records and made few discharge measurements 1873-1921. U. S. Weather Bureau has published gage-height records since 1916. Datum of U. S. Geological Survey is 5 feet lower than that used in above-mentioned records. Dates and stages of important early floods were as follows: Apr. 21, 1882, 49.5 feet; Apr. 28, 1883, 40.6 feet; Apr. 24, 1893, 45.5 feet; Apr. 10, 1897, 50.2 feet (estimated discharge, 43,000 second-feet).

Flood stages and discharges
(Base discharge 4,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1902	Mar.	31	25.9		1907	Apr.	7	39.8	30,300
1903	Apr.	11	27.95	18,800		June	18	20.35	10,600
	May	29	15.25	7,140	1908	Apr.	11	32.75	20,500
1904	Apr.	27	40.62	32,900			29	13.65	5,360
	June	12	14.90	6,750		May	25	19.1	9,520
	July	1	14.21	6,270		June	13	17.85	8,480
1905	Apr.	7	16.20	7,660	1909	Apr.	13	16.00	* 5,180
	May	16	26.0	16,700		June	3	13.20	5,050
	June	11	13.2	5,370		July	30	18.80	9,260
	July	2	13.90	5,880		Aug.	17	17.30	8,040
		8	13.70	5,720	1910	Mar.	22	30.70	18,500
		21	14.70	6,480		Apr.	27	20.58	10,800
		30	15.10	6,780	1911	June	12	10.65	** 3,500
	Aug.	20	19.90	10,900	1912	Apr.	9	12.7	4,710
	Sept.	23	12.80	5,090	1913	Apr.	13	20.4	11,200
1906	Apr.	8	33.3	* 24,100	1914	Apr.	17	11.12	4,020
		18	36.0	27,600		May	5	12.22	4,750
	May	20	17.2	8,520		June	17	18.15	9,200
		29	17.35	8,640		July	3	14.65	6,450
	July	6	14.65	6,530	1915	Apr.	11		9,950

* Estimated
** Below base

Flood stages and discharges of Red River at Grand Forks, N. Dak.--Continued

Date		Gage height (feet)		Discharge (second-feet)	Date		Gage height (feet)		Discharge (second-feet)
1915 May	20			4,740	1923 Apr.	22			15,900
June	21			8,240		22	26.15	P	16,200
July	3	30.8		21,500	July	2			5,000
1916 Apr.	23			29,000	1924 May	2	8.2	**	2,530
May	30			8,730	1925 Apr.	1	15.2		6,770
June	6			8,990	June	12	19.0		9,690
July	14			14,700	1926 Mar.	28	18.1	*	7,720
Aug.	21			5,080	Apr.	13	13.6		5,090
	30			5,490	1927 Mar.	20	21.6		7,790
Sept.	16			4,670	Apr.	6	19.0		9,690
1917 Apr.	8			20,200		13	20.0		10,600
	8	33.9	P	21,600	May	14	18.7		9,440
1918 Mar.	28	11.3		4,480		28	18.5		9,280
1919 Apr.	5			7,980	1928 Apr.	2	21.8		12,200
July	8			13,400	June	22	11.0		4,140
	8	23.2	P	13,600	1929 Mar.	24	28.0	*	17,100
Aug.	18			4,780	Apr.	9	12.0		4,730
1920 Mar.	31		*	30,300	1930 Mar.	20	18.7	*	6,770
June	17			7,030	Apr.	7	18.9		9,610
July	4			4,540	May	18	14.7		6,430
1921 Mar.	29		*	4,180	1931 Apr.	10	6.44	**	1,580
Apr.	10	20.9		11,500	1932 Apr.	10	21.80	*	10,200
1922 Apr.	11			16,600		10	22.07	P*	10,400
May	14			11,700	1933 Apr.	3	15.17	*	4,380
					1934 Apr.	12	9.90	**	3,150

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Red Lake River at Crookston, Minn.

Location.- Prior to July 1, 1909, on highway bridge connecting Robert Street and St. Paul Street, Crookston, Polk County; thereafter 300 feet downstream and a quarter of a mile below dam of Crookston Light, Water & Power Co.
Drainage area.- 5,320 square miles.
Records available.- May 1901 to September 1934. No winter records prior to 1908.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths once daily July 1, 1909, to Sept. 27, 1911, and Oct. 1, 1919, to Sept. 30, 1922; to tenths once daily Oct. 1, 1922, to Sept. 26, 1930; recording gage Sept. 28, 1911, to Sept. 30, 1919, and subsequent to Sept. 26, 1930. Zero of gage is 832.36 feet above mean sea level (1929 adjustment).
Stage-discharge relation.- Affected by ice and by aquatic growth. Control shifts. Bankfull stage, about 20 feet.
Storage and regulation.- Natural storage in and regulation by Red Lake, numerous small lakes, and a large swamp area. Flood flows not affected by power plant regulation.
Historical data.- Flood of Apr. 11, 1897, reached stage of 25.2 feet and was augmented by backwater from ice. Serious inundations caused by backwater from ice occurred in 1824, 1825, 1826, and 1852. In 1826 and 1852 river rose about 66 feet above low water (from information in files of Crookston Times).

Flood stages and discharges
(Base discharge 2,500 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1901 May	18		3,660	May	8-10	11.90	6,420
June	6		2,580		23	9.82	4,650
	14		2,780	June	9	8.85	3,820
	18		3,200		19	8.60	3,620
	26		5,270	1905 Apr.	3	9.7	6,650
July	7		5,970		9	7.1	2,540
1902 Mar.	28	9.85	5,020	May	13	14.10	8,390
Apr.	8	7.25	2,660	June	30	7.8	3,100
May	3	9.95	5,120	July	7	7.25	2,660
	21	10.00	5,170		18	9.20	4,220
June	9	9.80	4,970		29	9.30	4,310
1903 May	25	8.44	3,690	Aug.	5	8.60	3,740
1904 Apr.	7	18.30	11,900		18	10.00	4,900
	12	17.90	11,500	Sept.	4	8.00	3,260
	19	14.85	8,900		20-21	8.70	3,820
	24	20.32	13,600	Oct.	23	7.35	2,740

Flood stages and discharges of Red Lake River at Crookston, Minn.--Continued

Date		Gage height (feet)		Discharge (second-feet)
1906 Apr.	5	15.3		9,410
	15	20.97		14,200
June	2	8.15		3,380
1907 Mar.	28	10.35		4,100
Apr.	4	11.95		6,260
	18	9.7		4,400
	23	11.2		5,630
June	13	8.9		3,760
	17	8.55		3,490
1908 Apr.	7	16.6		10,300
	28	8.15		3,180
May	23	12.2		6,470
June	8	9.0		3,840
Sept.	1	8.55		3,490
1909 Apr.	5	8.30		3,290
July	21	8.71		3,630
Aug.	14	7.60		2,740
	26	8.25		3,250
1910 Mar.	20	13.8		7,830
	26	11.0		5,460
Apr.	1	10.9		5,380
	22	11.1		5,540
1911 June	10	8.15		3,380
1912 Sept.	29	6.8	**	2,120
1913 Apr.	8	12.4		6,920
	16	9.5		4,480
	19	9.0		4,060
1914 June	12-13	7.3		2,550
1915 Apr.	9	8.0		2,980
May	19	7.4		2,550
June	18-19	7.8		2,830
	29	13.9		7,860
1916 Apr.	17	21.5		14,400
May	29	9.5		4,150
June	5-10		*	3,600
July	1-5		*	3,800
1917 Apr.	1	10.3	*	2,900
	11	11.9	*	5,320
1918 Apr.	1-2	6.2	**	1,760
....		....		.....
1919 Apr.	2	7.7		2,760
July	5	20.8		14,400
	5	21.1	P	14,700
Aug.	15	8.6		3,430
....		....		......
1920 Mar.	25	23.3	*	10,100
Apr.	10	10.3		4,800
	16	10.8		5,230
....		....		......
1921 Apr.	7		*	3,500
1922 Apr.	8	10.0		4,550
	10	11.0		5,400
	18	8.4		3,280
May	13	13.0		7,100
	21	8.2		3,120
1923 Apr.	20	12.5	*	5,820
1924 Apr.	23	5.1	**	1,090
1925 June	9	13.5		7,550
1926 Mar.	24	12.3		6,500
June	23	8.6		3,430
1927 Apr.	6	8.7		3,510
	13	13.2		7,280
	13	14.0	P	8,000
May	6	10.1		4,640
	11	12.5		6,680
	25-26	13.3		7,370
1928 Apr.	2	8.9	*	3,050
	7	9.1		3,830
June	23	8.7		3,430
1929 Mar.	19	14.9	*	7,910
Apr.	8	7.5		2,620
1930 Apr.	7	9.5	*	3,490
May	12	9.8		4,370
1931 Apr.	8-9	4.23	**	730
1932 Apr.	9	9.42		4,070
	9	9.78	P	4,390
1933 Apr.	2		**	1,210
1934 Apr.	9		**	1,270

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Nov. 1, 1918, to Mar. 24, 1919; Oct. 1, 1919, to Mar. 24, 1920; June 1 to Aug. 23, 1920; Nov. 1, 1920, to Mar. 31, 1921.

Mississippi River at Elk River, Minn.

Location.- Prior to July 18, 1932, in sec. 10, T. 121 N., R. 23 W. fifth principal meridian, on highway bridge at Elk River 2,500 feet below mouth of Elk River; thereafter in SE¼ sec. 34, T. 33 N., R. 26 W. fourth principal meridian, on opposite side of river and 75 feet downstream.
Drainage area.- 14,500 square miles.
Records available.- July 1915 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to hundredths twice daily prior to July 18, 1932; recording gage thereafter. Zero of gages is 847.92 feet above mean sea level (1912 adjustment).
Stage-discharge relation.- Permanent during open-water seasons; considerably affected by ice. Rating curves well-defined to 12,400 second-feet and fairly well defined to 26,300 second-feet.
Regulation and storage.- Regulation from power plants above station and storage in the following reservoirs: Winnebigoshish, Leech Lake, Pokegama, Sandy Lake, Pine River, Gull Lake; combined capacity, 2,230,000 acre-feet; controlled area, 4,540 square miles. Storage negligible 1932-34 owing to drought.
Remarks.- An ice and log jam caused a stage of 14.8 feet on Apr. 8, 1916. Maximum discharge occurred during period Apr. 1-10, 1917, when gage was not read; probably about Apr. 5; estimated on basis of power-plant records, 34,000 second-feet.
Historical data.- On Apr. 1, 1907, there was a flood estimated as 29,800 second-feet (73d Cong., 1st sess., H. Doc. 66, p. 22).

Flood stages and discharges
(Base discharge 7,700 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1915	July	22	6.8	13,400
	Oct.	8-10	4.7	9,200
	Nov.	13-15	5.8	10,200
		28	5.1	7,930
	Dec.	11-12	5.4	8,880
1916	Apr.	7	10.8	27,000
		25	9.8	23,500
	May	26	9.4	22,200
	June	27	6.1	11,100
	July	4-5	9.2	21,500
	Aug.	24-26	6.0	10,800
	Sept.	10	5.5	9,200
		17-20	6.2	11,400
.....	.....	.....	...	......
1917	Apr.	11	8.52	19,100
		25-26	8.63	19,400
	May	24	5.08	7,930
1918	May	27	5.56	9,520
	June	2	6.12	11,100
		9	5.81	10,200
1919	Apr.	2	5.88	10,500
		15	7.18	14,700
		15	7.23	P 14,800
		27		9,520
	May	5	5.14	7,930
		13	5.67	9,840
	June	16	5.8	10,200
		27-29	5.30	8,560
1920	Mar.	28	9.56	22,800
		28	9.77	P 24,100
	Apr.	26-30	6.41	12,100
	May	12	6.89	13,700
		24-25	5.78	10,200
	June	2	5.78	10,200
		15-17	8.32	18,400
	July	2-3	8.62	19,400
1921	Apr.	9		10,200
	May	1	5.11	7,930
	June	15	6.61	12,700
		15	6.66	P 12,900
1922	Mar.	31	8.07	17,700
	Apr.	5	7.15	14,700
		10-11	10.06	24,600
		13	5.95	10,800
1923	Apr.	23	5.57	9,520
		23	5.80	P 10,200
	May	3-5	5.47	9,200
1924	Aug.	9	4.35	† 5,800
1925	June	14	4.30	† 5,500
1926	Mar.	26	6.63	12,700
	Sept.	19	5.11	7,930
	Oct.	8	5.08	7,930
		10		7,930
1927	Mar.	15	6.68	13,000
		18	7.23	14,700
		28	5.17	8,240
	Apr.	9	7.70	16,400
		9	7.8	P 16,700
		21	7.55	16,000
	May	22	5.53	9,200
		30	5.10	7,930
	June	1		7,930
		12	5.29	8,560
1928	Mar.	27	7.21	14,700
		27	7.46	P 15,700
	Apr.	6	6.11	11,100
		13	5.60	9,520
		16	5.06	7,930
		26	6.16	11,400
	May	5	5.26	8,560
		10	5.15	8,240
	Sept.	27	6.08	11,100
	Oct.	15	5.81	10,200
		23	6.03	10,800
		28	5.77	10,200
1929	Mar.	21	8.43	18,800
		21	9.92	P 23,900
		26		11,800
	Apr.	6-7	5.14	7,930
		9-10	5.20	8,240
		18	5.12	7,930
1930	May	16	7.07	14,300
1931	June	16-17	5.60	8,980
1932	May	13	5.17	7,750
		13	5.30	P 8,050
1933	June	2	6.37	11,500
1934	Apr.	19	4.14	† 4,940

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Apr. 1-10, 1917.

Mississippi River at St. Paul, Minn.

<u>Location.</u>- In sec. 6, T. 28 N., R. 22 W., at St. Paul, 6 miles below mouth of Minnesota River. Position of gage changed slightly several times during period of record but always within reach of river bounded by Wabasha and Jackson Streets.

<u>Drainage area.</u>- 36,800 square miles.

<u>Records available.</u>- September 1866 to December 1869, April 1872 to September 1934. No daily discharge records prior to March 1892. Discharge measurements 1867-68, 1889-97, and 1904-34. No winter gage-height records prior to 1903-4 (except 1896-97); no winter discharge estimates prior to 1914-15 (except 1896-97).

<u>Sources of data.</u>- Gage-height records 1866-69 obtained in 1874 by Gen. A. W. Greely, Signal Service, U. S. Army, probably from St. Louis & St. Paul Packet Co.; 1872 to March 1925 from U. S. Signal Service and U. S. Weather Bureau; subsequent gage-height records and all discharge records from U. S. Geological Survey. Discharge measurements from Corps of Engineers, U. S. Army, 1867-68, 1889-97, and from U. S. Geological Survey 1904-34.

<u>Gages.</u>- Nonrecording gage read to tenths once daily prior to Mar. 17, 1925; recording gage Mar. 17, 1925, to Apr. 7, 1931. Weekly gage readings only during winters 1903-4 to 1911-12. Zero of all gages was 684.16 feet above mean sea level (1912 adjustment).

<u>Stage-discharge relation.</u>- Affected by ice. High-water control permanent; low-water control shifted, owing to construction of wing dams, dredging, and other channel improvements. Subsequent to Apr. 7, 1931, navigation dam at Hastings controlled all except extremely high stages, and discharge records have been computed from records of Ford Motor Co. power plant and Minnesota River. Flood stage, about 14 feet.

<u>Storage and regulation.</u>- Low-water regulation from power plants above station and storage in the following reservoirs: Winnibigoshish (1884), Leach Lake (1884), Pokegama (1884), Pine River (1886), Sandy Lake (1895), Gull Lake (1912); combined capacity, 2,230,000 acre-feet; controlled area, 4,540 square miles. Figures in parentheses give dates when reservoirs began operating. Regulation from reservoirs negligible 1932-34 owing to drought.

<u>Remarks.</u>- An important flood occurred in March 1870, during period when no continuous gage-height records were available.

Flood stages
(Base gage height 6.2 feet)

Date			Gage height (feet)
1867	Apr.	22	17.4
	May	25	10.3
	June	14	16.2
	July	1	17.0
		23	18.6
1868	Mar.	23	8.3
	Apr.	4	9.3
	May	6-8	8.4
	June	7	6.9
1869	Apr.	7	15.6
		26-29	14.4
	Sept.	24-27	16.1
....			....
1872	May	19-22	7.7
	July	8-9	6.4
1873	Mar.	24	8.6
	Apr.	2	10.1
		9	9.2
		21	16.4
	May	22	11.4
	June	1	15.7
		13	15.5
1874	Apr.	10	† 8.9
		27	9.0
	June	22-23	9.7
	July	2	11.6
1875	Apr.	16	18.0
	June	8	10.9
	Sept.	9	8.3
1876	Apr.	10	11.0
		19	9.9
	May	22-23	10.4
1877	Apr.	21-23	7.0
	May	25-26	7.7
	July	8-9	7.1
1878	Mar.	17-18	6.4
	Apr.	27	6.7
1879	July	11	10.8
1880	Apr.	5-7	7.2
	May	15	7.1
	June	17-18	15.2
1881	Apr.	29	19.5
		29	P 19.7
	June	5	9.7
		17	9.9
	July	18-19	6.5
	Oct.	9	13.0
		18	13.1
	Nov.	5-6	12.9
1882	Apr.	13	13.3
	May	16-17	11.7
	June	30	10.0
	Aug.	26-27	8.2
1883	Apr.	7	† 7.4
		22	12.5
	May	24	8.8
	June	8-10	8.5
1884	Apr.	3	9.8
	May	5-7	10.2
		26-29	7.8
	Oct.	10	6.5
1885	Apr.	5	6.6
		28-29	7.3
	June	18-19	7.4
1886	Mar.	29	8.2
	Apr.	21	6.7
	May	3-5	8.0
	June	20	6.3
1887	Mar.	25-26	7.9
	Apr.	17	9.6
1888	Apr.	14	14.4
	May	11	14.1
		28-29	11.2
	June	15-16	9.0
1889	May	21	** 4.5
1890	June	23	7.0
1891	Apr.	9	6.3
		17	6.4

† First day of record; may not be peak

** Below base

Flood stages and discharges of Mississippi River at St. Paul, Minn.
(Base discharge 14,600 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1892	May	26	12.6		45,700
	June	9	9.8		30,700
		21	9.8		30,700
	July	28	6.7		16,400
	Aug.	3-4	6.6		16,000
1893	Apr.	10	10.9		36,300
	May	5-7	14.7		58,800
1894	Apr.	25	10.6		34,800
	May	21	11.8		41,200
1895	June	16-17	4.6	**	9,640
1896	Apr.	18	10.7		35,300
	May	7	9.3		28,300
		21-22	10.5		34,300
	June	12-13	8.9		26,300
		27	6.8		16,800
1897	Apr.	6	18.0		80,800
	June	23	6.8		15,600
	July	11	13.6		49,600
1898	June	8-9	10.7		35,300
	July	13	6.9		17,200
1899	Apr.	14	10.5		34,300
	May	8	7.6		20,200
	June	22-23	11.0		36,800
	Aug.	26	8.8		25,800
	Oct.	24	8.8		25,800
1900	Oct.	7	6.6		16,000
1901	Apr.	12	7.5		19,800
	May	9-11	7.3		18,900
	June	30	6.2		14,400
	July	11-13	7.2		18,500
1902	May	26-27	7.5		19,800
	June	9-10	6.8		16,800
1903	Mar.	27-28	8.3		24,000
	Apr.	18	8.9		26,800
	May	19	10.9		36,900
	June	3-4	11.9		42,500
	July	13	7.7		21,400
	Aug.	8	6.3		15,800
	Sept.	22-24	11.9		42,500
	Oct.	14	13.5		51,800
1904	Apr.	11-12	9.9		31,600
	June	11	7.8		21,800
	Oct.	27-28	7.8		21,800
1905	Mar.	28	5.9		14,400
	Apr.	10-12	6.7		17,400
	May	18-19	11.7		41,300
	June	11-12	8.4		24,500
	July	11	14.8		59,800
	Aug.	21	8.2		23,600
	Sept.	21	7.4		20,200
	Oct.	26	6.0		14,700
	Nov.	29	5.9		14,400
1906	Apr.	19	12.0		43,000
	June	12	13.3		50,600
	Aug.	17-18	6.9		18,200
	Sept.	1-2	8.4		24,500
		28	8.3		24,000
	Nov.	2-3	7.9		22,300
		30	6.3		15,800
1907	Apr.	4	13.3		50,600
	June	1-2	8.9		26,800
		18-19	11.0		37,400
	July	25	6.7		17,400
	Sept.	25-26	6.3		15,800
1908	Apr.	1	5.9		15,300
		9	5.6		14,200
	May	2-3	7.5		21,400
	June	4	15.3		63,200
	June	14	15.0		61,200
		29	16.8		73,000
1909	Apr.	4-5	13.0		48,900
	June	8	8.8		27,100
		18	8.2		24,400
	Aug.	18-20	6.3		16,700
1910	Mar.	19	10.6		35,800
1911	Oct.	8	4.8	**	11,800
1912	Apr.	4	6.5		17,400
	May	10	11.2		39,000
		27-30	6.2		16,700
1913	May	27-28	6.1		15,800
1914	May	8	6.0		15,500
	July	3-4	12.2		40,500
	Sept.	20-21	5.8		14,900
1915	Mar.	7	5.9		15,200
	Apr.	5	10.5		31,100
	May	10	6.3		16,300
	July	4-5	9.9		28,600
	Nov.	15	6.8		17,800
1916	Apr.	6	16.6		73,500
		28	15.1		61,200
	May	30	13.8		51,100
	July	6-7	12.4		41,600
	Aug.	28	6.2		16,000
	Sept.	19-20	6.1		15,800
1917	Apr.	8	16.0		68,600
		8	16.2	P	70,200
	June	15-17	8.1		22,000
	July	1	6.7		17,500
1918	Mar.	24-25	7.5		20,900
	June	4	6.5		17,600
	Aug.	27	5.5		14,700
1919	Mar.	25-26	12.5		45,300
	Apr.	22	13.8		54,500
	June	27-29	12.4		44,600
1920	Mar.	29	13.6		53,100
	May	1	8.2		24,600
		17	7.6		22,500
	June	19	10.2		32,600
	July	4-7	11.3		37,800
1921	Apr.	12	6.4		18,600
	June	16	6.7		19,500
1922	Mar.	21	7.1		20,800
	Apr.	1	10.2		32,600
		13-14	12.6		46,000
1923	May	7-8	4.3	**	13,200
1924	Aug.	26-28	4.0	**	12,900
1925	June	20-21	6.2		16,500
		20	6.33	P	16,800
1926	Mar.	27	5.2		14,200
		28	5.3	P	14,500
1927	Mar.	19	11.50		34,300
		19	11.60	P	35,000
	Apr.	24-27	11.2		32,400
	May	27-28	8.4		21,000
	June	13	7.30		18,200
1928	Mar.	28-29	11.3		33,000
		30	11.4	P	33,600
	Apr.	26-27	8.2		20,500
	May	7-8	7.0		17,500
1929	Mar.	22-24	12.9		45,000
		24	13.0	P	45,800
1930	May	19	8.78		22,000
1931	June	26		**	9,670
1932	Apr.	12-13			17,600
1933	Apr.	6			14,400
1934	Apr.	12		**	7,460

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Mississippi River at Le Claire, Iowa

<u>Location</u>.- At foot of Dodge Street, Le Claire, Scott County, 15 miles above Davenport and 135 miles above Keokuk.
<u>Drainage area</u>.- 88,600 square miles.
<u>Records available</u>.- June 1873 to September 1934, except August and September 1873.
<u>Sources of data</u>.- Gage-height records from U. S. Signal Service, U. S. Weather Bureau, and Corps of Engineers, U. S. Army. Discharge records determined by Mississippi River Power Co. in collaboration with the Corps of Engineers, U. S. Army.
<u>Gage</u>.- Nonrecording. Zero of gage is 562.19 feet above mean sea level.
<u>Stage-discharge relation</u>.- Affected by ice. Control permanent except for a change in 1915, when a canal was constructed about a third of a mile below gage.
<u>Storage and regulation</u>.- Several navigation dams on main stream and numerous storage reservoirs on headwaters and tributaries. Effect on flood flows of these regulating works is not large.
<u>Historical data</u>.- Flood record prior to June 1873 taken at Davenport, Iowa, and gives flows that are comparable with those at Le Claire. Gage-height records refer to Davenport gage.

Flood stages and discharges
(Base discharge 80,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1861	Apr.	27	15.1	197,000
1862	May	4	16.0	214,000
1866	May	4	16.0	214,000
1867	June	28	14.7	189,000
1870	Mar.	24	16.6	225,000
	Apr.	24	17.0	233,000
1871	May	14	13.1	160,000
.....	.....	.....	....	....
1873	June	16-17	9.5	151,000
	July	11	8.4	130,000
.....	.....	.....	....	....
1874	May	17	6.6	98,400
	July	18-20	5.8	85,600
1875	Apr.	29-30	10.3	167,000
	June	15-16	6.1	90,400
	July	6	6.3	93,600
	Sept.	18-20	5.9	87,200
1876	Mar.	18	7.7	* 113,000
	Apr.	19-21	10.1	163,000
	May	7-10	10.2	165,000
	May 30-June 2		10.2	165,000
	July	7-8	8.0	123,000
1877	Apr.	3	6.9	104,000
1878	June	5	5.5	80,800
1879	June	1	6.5	96,800
	July	13	5.9	87,200
		25-26	5.9	87,200
1880	Apr.	26-27	7.5	114,000
	June	8	7.0	106,000
		25	14.5	250,000
1881	Apr.	16	7.2	109,000
	May	12	10.7	174,000
	June	15	7.0	106,000
	July	14	6.5	96,800
	Oct.	26-27	13.9	237,000
1882	Apr.	22	11.3	186,000
	May	28	8.7	136,000
	July	10-11	7.3	111,000
1883	May	1	10.7	174,000
	July	28-30	7.8	120,000
1884	Mar.	27-28	9.1	144,000
	May	3	7.0	106,000
	June	4	6.2	92,000
		23	5.8	85,600
	Sept.	27-28	9.1	144,000
	Oct.	18	9.2	146,000
1885	Apr.	20	6.9	104,000
	May	9-10	7.8	120,000
	June	6	6.5	96,800
	July	1-4	5.5	80,800
	Aug.	3-4	6.7	100,000
		25	6.4	95,200
1886	Mar. 28-Apr. 1		6.5	96,800
	May	1-2	9.8	157,000
1887	Mar.	13	6.1	90,400
	Apr.	28	9.4	149,000
1888	Apr.	27	13.0	219,000
	May	14-16	14.45	248,000
1889	May 30-June 1		4.4	** 64,300
1890	Apr.	26-27	7.4	113,000
	June	28-29	9.0	142,000
1891	May	2-3	8.4	130,000
1892	Apr.	19-20	6.3	93,600
	May	6-7	6.5	96,800
	June	5	11.8	196,000
		26	13.95	238,000
1893	Mar.	13	8.0	* 100,000
	Apr.	23	9.6	153,000
	May	12-15	10.7	174,000
1894	May	7	8.7	136,000
		30-31	9.8	157,000
1895	Mar.	2	5.4	** * 70,000
1896	May	4-5	8.3	128,000
		28-29	9.3	148,000
1897	Apr.	17-18	11.9	198,000
	July	24-28	6.4	95,200
1898	June	24-27	6.0	88,800
1899	Apr.	29-30	7.5	114,000
	May	17-18	7.1	107,000
		30	7.2	109,000
	June	24-26	9.4	149,000
1900	Apr.	4	5.9	87,200
	May	3-4	6.7	100,000
	Oct.	20	9.0	142,000
	Nov.	15-16	7.1	107,000
1901	Mar.	21	6.5	* 84,000
	Apr.	21-24	7.0	106,000
1902	May	26-27	8.0	123,000
	July	19	6.1	90,400
1903	Apr.	3-4	8.0	123,000
	June	4-8	10.2	165,000
	July	21	8.1	125,000
	Aug.	7	5.6	82,400
	Sept.	29-30	10.8	176,000
	Oct.	23-25	8.4	130,000
1904	Mar.	27	7.1	* 101,000
	Apr.	25-26	7.4	113,000
	June	10-11	6.8	102,000
	Oct.	26-27	6.5	96,800
1905	Mar.	27	6.8	102,000
	Apr.	12-13	7.5	114,000
	May 31-June 1		8.1	125,000
	June	21-22	10.6	172,000
	Sept.	3	5.6	82,400
1906	Apr.	22-25	10.4	169,000
	June	11-12	7.8	120,000
1907	Apr.	11-13	10.5	171,000
	July	13-14	7.1	107,000
	Oct.	5	6.1	90,400
1908	May	13-14	6.5	96,800
	July	20	8.6	134,000
1909	Apr.	22	8.0	123,000

* Estimated
** Below base

Flood stages and discharges of Mississippi River at Le Claire, Iowa.--Continued

Date	Gage height (feet)	Discharge (second-feet)
1909 May 2-3	7.9	121,000
18-21	6.4	95,200
June 10-11	6.2	92,000
26-27	5.8	85,600
1910 Mar. 25	5.0	** 73,100
1911 Feb. 18	5.7	84,000
Oct. 21-22	7.8	120,000
1912 Apr. 7	6.9	104,000
20	6.2	92,000
May 28-29	6.3	93,600
1913 Mar. 27	8.0	123,000
Apr. 17-18	6.7	100,000
1914 May 15	5.6	82,400
June 20-21	6.8	102,000
July 13-15	7.3	111,000
1915 Apr. 23-24	6.2	92,000
June 4-7	6.3	90,400
Aug. 5-7	6.0	82,400
1916 Mar. 29	8.5	123,000
Apr. 17	11.0	172,000
May 5	12.1	195,000
June 8-10	9.7	146,000
July 21	6.5	87,000
1917 Mar. 31-Apr. 1	6.9	93,900
Apr. 21	9.5	142,000
June 15	6.7	90,400
1918 Apr. 2	7.2	99,300
June 13-14	8.5	123,000
1919 Apr. 25	10.7	166,000
July 12	6.8	92,100
1920 Apr. 9	13.4	222,000
June 3	6.7	90,400
July 1	7.4	103,000
1921 May 11-13	6.4	85,300
1922 Feb. 27	6.6	* 80,000
Apr. 23	12.9	212,000
May 27	6.5	87,000
1923 Apr. 7-8	7.6	106,000
May 5-7	7.1	97,500
1924 May 9-11	6.8	92,100
Aug. 23	7.6	106,000
1925 June 19-20	6.9	93,900
1926 Apr. 26-27	5.9	** 77,200
Oct. 7	7.1	97,500
1927 Mar. 30-Apr. 1	9.0	133,000
May 12	7.0	95,700
26	7.4	103,000
1928 Apr. 9-10	8.1	116,000
Sept. 30	6.9	93,900
Nov. 1-3	6.2	82,000
1929 Apr. 2-3	9.7	146,000
1930 June 28	6.3	83,600
1931 July 6-11	3.1	** 40,700
1932 Apr. 22-23	7.1	97,500
1933 Apr. 8-13	6.8	92,100
May 22-23	6.3	83,600
1934 Apr. 19-20	6.4	85,300

* Estimated
** Below base
Note.- All discharge quantities are average daily flows.

Mississippi River at Keokuk, Iowa

Location.- January 1878 to May 1913 at upper lock of canal at Galland (formerly Nashville), Lee County, about 8 miles above Keokuk; thereafter at dam of Mississippi River Power Co. at Keokuk.
Drainage area.- 119,000 square miles.
Records available.- January 1878 to May 1913 at Galland, May 1913 to September 1934 at Keokuk.
Sources of data.- Gage-height records from January 1878 to May 1913 from Corps of Engineers, U. S. Army. Discharge records furnished by Mississippi River Power Co.
Gage.- Nonrecording gage read twice daily January 1878 to May 1913. Gage heights subsequent to May 1913 are for the lower lock at Keokuk. Zero of gage at Galland is 496.93 feet and at Keokuk 477.84 feet above mean Gulf level.
Stage-discharge relation.- Permanent control for period January 1878 to May 1913; thereafter discharge computed from power-house records. Backwater from Des Moines River affects gage readings used subsequent to May 1913.
Storage and regulation.- Several navigation dams on main river and numerous storage reservoirs on headwaters and tributaries. Effect on flood flows of these regulating works is not large.
Historical data.- Flood of June 6, 1851, had a stage estimated as 13.5 feet at Galland (discharge, 360,000 second-feet).

Flood stages and discharges
(Base discharge 100,000 second-feet)

Date	Gage height (feet)	Discharge (second-feet)
1878 May 9-11	5.0	113,000
June 11	6.4	150,000
July 19-20	4.5	101,000
1879 June 2-3	4.85	110,000
July 16	4.8	108,000
1880 Apr. 25	6.2	145,000
29	10.6	271,000
1881 Apr. 23-24	9.6	241,000
May 16	8.3	203,000
June 15-16	6.7	159,000
30	6.4	150,000
July 18-19	8.2	201,000
Oct. 31-Nov. 1	11.3	293,000
1882 Apr. 25	9.2	230,000
June 3-4	8.2	201,000
12	7.3	175,000
30	7.7	186,000
1883 Mar. 20-21	5.0	113,000
May 18	8.2	201,000
June 21	6.6	156,000
July 17	4.6	103,000
Aug. 4	6.0	140,000
1884 Apr. 1	9.45	236,000
May 9-10	5.8	134,000

Flood stages and discharges of Mississippi River at Keokuk, Iowa--Continued

Year	Month	Day	Gage height (feet)	Discharge (second-feet)
1884	Oct.	9-10	7.1	170,000
1885	Mar.	19	5.4	* 102,000
	Apr.	25-26	6.4	150,000
	May	10	6.4	150,000
	June	13	6.4	150,000
	Aug.	8-9	5.3	121,000
		27	6.2	145,000
	Sept.	19	4.7	106,000
1886	Mar.	31	7.9	192,000
	May	6	8.6	212,000
1887	Mar.	15	6.0	140,000
	May	4	6.6	156,000
1888	Mar.	28	6.0	140,000
	May	1	9.55	240,000
		18	12.0	314,000
1889	Apr.	20	3.8	** 84,200
1890	Apr.	29	5.15	118,000
	July	1	7.4	178,000
1891	Mar.	27-28	6.0	140,000
	May	3	6.05	141,000
1892	Apr.	6	4.65	104,000
		22	5.2	119,000
	May	8	8.0	195,000
	June	7	10.3	262,000
		29	11.75	306,000
1893	Mar.	17	7.8	* 150,000
	May	15-17	8.3	203,000
1894	Mar.	9	4.75	107,000
	May	12	6.3	148,000
	June	4	6.65	158,000
1895	Mar.	11	2.65	** 59,200
1896	May	7-9	5.6	129,000
		19	6.0	140,000
	June	3	6.8	161,000
1897	Apr.	28-29	9.2	230,000
	July	26	4.5	101,000
1898	Mar.	20	4.8	108,000
1899	Mar.	20-21	4.9	111,000
	May	5	5.7	132,000
		22	6.1	142,000
	June	3	6.1	142,000
		29	6.7	159,000
1900	Mar.	16-17	5.45	* 102,000
	Apr.	5-6	5.4	124,000
		22-23	5.0	113,000
	May	6	4.75	107,000
	Oct.	24	5.95	138,000
	Nov.	19	5.15	118,000
1901	Mar.	24-26	6.4	150,000
	Apr.	4	6.1	142,000
1902	June	2	6.0	140,000
		13	5.7	132,000
	July	21-22	7.5	181,000
	Aug.	19	4.8	108,000
1903	Mar.	11	5.45	125,000
	Apr.	17	6.45	152,000
	June	6	10.55	270,000
	July	24-26	6.0	140,000
	Oct.	7	7.7	186,000
		26-27	6.1	142,000
1904	Mar.	30	7.15	171,000
	Apr.	29-May 1	6.3	148,000
	June	12-15	5.0	113,000
1905	Mar.	30	6.5	153,000
	Apr.	22	5.9	137,000
	June	3	6.25	146,000
		10	8.6	212,000
		25-27	7.8	189,000
1906	Mar.	7-10	5.75	133,000
	Apr.	26-28	7.9	192,000
	July	2-3	5.55	128,000
1907	Apr.	17-18	7.4	178,000
	May	27	4.8	108,000
	June	14	5.15	118,000
	July	21	6.3	148,000
	Oct.	8	4.75	107,000
1908	Mar.	3	4.8	108,000
		11-12	5.1	116,000
	May	16	6.2	145,000
	June	9	7.4	178,000
	July	2	6.9	164,000
1909	Apr.	29	7.45	180,000
	May	5-7	7.5	181,000
		23	6.0	140,000
	June	12	6.25	146,000
		29-30	5.4	124,000
	July	8	5.5	126,000
	Dec.	8	4.7	* 104,000
1910	Mar.	20-23	5.4	124,000
1911	Feb.	21	6.6	156,000
	Oct.	26	6.0	140,000
1912	Apr.	6-7	8.85	220,000
	May	28	5.15	118,000
1913	Mar.	29	7.45	169,000
	Apr.	19	6.2	130,000
	June	2-3	9.35	110,000
1914	June	24	11.15	122,000
	July	14-17	10.0	112,000
1915	Feb.	28	13.25	142,000
	Apr.	3	9.9	107,000
		24	9.05	102,000
	June	7-8	13.55	140,000
	July	12	10.55	108,000
	Aug.	7	12.3	133,000
	Oct.	2	11.7	120,000
1916	Jan.	27	12.95	149,000
	Mar.	31	16.3	206,000
	May	9	16.4	213,000
	June	11	14.3	176,000
1917	Mar.	17	9.2	102,000
	Mar.	31-Apr. 1	11.7	142,000
	May	2	13.5	158,000
	June	9	13.3	131,000
		17	14.95	169,000
1918	Mar.	6	8.85	100,000
		27-28	9.7	116,000
	May	28	11.75	130,000
	June	12	16.45	192,000
1919	Mar.	21	14.45	173,000
	Apr.	25-27	16.0	196,000
	May	8	17.2	205,000
	June	7	10.95	111,000
	Nov.	14	9.9	111,000
1920	Mar.	17	10.55	117,000
	Apr.	10-11	16.45	230,000
	May	14	11.3	120,000
	June	4-5	9.15	104,000
	July	4	8.55	100,000
1921	Apr.	29	8.95	102,000
	May	12-13	9.5	108,000
	Sept.	24	9.45	103,000
1922	Mar.	2	9.15	104,000
	Apr.	24-25	17.4	240,000
	May	29	9.9	107,000
1923	Apr.	9-10	11.7	148,000
	May	6	8.5	102,000
1924	June	29	13.7	145,000
	Aug.	24-25	12.95	160,000
1925	June	23	10.05	112,000
1926	Apr.	11	8.7	104,000
	Sept.	4	9.9	111,000
		9	11.0	107,000
		16	11.75	117,000
	Oct.	2	13.05	147,000
1927	Feb.	8	9.7	113,000
	Apr.	3	14.1	175,000
		21	14.75	164,000
	May	14	10.8	128,000
		19	12.5	142,000
		28	13.5	165,000
	June	4-5	13.65	158,000
1928	Feb.	17	8.9	100,000
	Mar.	17	9.05	108,000
	Apr.	12	11.8	150,000
	Nov.	21	11.8	132,000
1929	Mar.	23	19.15	247,000
	Apr.	21	18.25	237,000
1930	Feb.	27	8.65	104,000
	June	18	13.7	163,000
1931	July	3	4.85	** 48,500

* Estimated
** Below base

Flood stages and discharges of Mississippi River at Keokuk, Iowa--Continued

Date	Gage height (feet)	Discharge (second-feet)
1931 Dec. 3	9.75	105,000
1932 Apr. 24-25	9.8	106,000
1933 Apr. 9	14.45	160,000
May 13-14	10.65	114,000
26	13.25	154,000
1934 Apr. 22	7.3	** 83,500

** Below base

Note.- All discharge quantities are average daily flows.

Mississippi River at Hannibal, Mo.

Location.- At Wabash Railway bridge at Hannibal, Marion County.

Drainage area.- 137,300 square miles (data of U. S. Weather Bureau).

Records available.- Gage-height records August 1878 to December 1934. Miscellaneous discharge measurements, 1878, 1880, 1881, 1910, and 1930.

Sources of data.- Gage-height records by U. S. Weather Bureau. Discharge measurements by Corps of Engineers, U. S. Army.

Gages.- Nonrecording gage read at least once daily. Recording gage installed June 12, 1914. Zero of gage is 449.07 feet above mean sea level (1929 general adjustment). All gage-height records referred to same datum.

Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river training works involving levees, dredging, etc. Flood stage, about 13 feet.

Remarks.- Only those gage-height crests which were 0.7 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before or since measurements were made.

Historical data.- Flood of 1851 reached stage of 21.6 feet (data of Mississippi River Commission). Fragmentary gage-height records to an unknown datum are available 1870-74; these records indicate that no important floods occurred in that period.

Flood stages
(Base gage height 11.0 feet)

Date	Gage height (feet)
1879 June 2-3	** 10.62
1880 Apr. 27-28	11.25
June 10	11.25
July 3	18.67
1881 Apr. 25-26	19.08
May 20	16.67
June 23	14.83
July 2	13.83
21	16.83
Oct. 27	20.58
1882 Apr. 27-28	18.17
May 9-11	17.58
June 5-6	17.17
14	15.92
July 2	18.42
1883 Feb. 20	15.83
May 20	17.58
June 22-23	15.50
Aug. 4-6	11.08
1884 Apr. 3	18.50
May 10	11.75
Oct. 13	14.75
1885 Jan. 13	12.25
Mar. 10	12.42
16	13.25
Apr. 27	13.08
June 15-16	12.83
Aug. 3	12.58
1886 Feb. 24	12.79
26	13.00
Apr. 3	15.42
May 9	17.08
17	16.25
1887 Feb. 13	12.00
Mar. 17	11.17
May 5-6	11.83
1888 Mar. 28	13.92
Apr. 17	14.25
May 17	23.08
June 24	14.17
July 11	14.42
1889 May 30	** 8.67
1890 July 3	13.5
1891 Mar. 29-30	12.1
Apr. 23	12.2
1892 Apr. 6	12.6
23	12.1
May 9	18.5
25-27	17.3
June 6-7	19.8
July 3	20.8
1893 Mar. 19	13.7
May 1-2	15.9
17-18	16.1
28	16.8
1894 May 12	11.8
June 4-6	12.1
1895 June 27	** 5.2
1896 May 22-23	12.8
June 3-4	13.3
1897 Jan. 4	11.2
Apr. 4	16.6
29	20.8
1898 May 21	11.7
1899 May 8	11.3
23	15.0
June 4	12.7
July 1	13.3
1900 Mar. 15	13.0
1901 Mar. 26	12.7
Apr. 8	12.9
1902 June 3	11.4
July 23	16.6
Aug. 22-23	11.7
1903 Mar. 9	11.5
Apr. 12	14.2
June 8	22.5
July 26	12.2
Oct. 10	15.8
1904 Jan. 26	12.2
Mar. 31	14.1
Apr. 11	11.2
28-29	16.4
June 5	11.0
1905 Mar. 31	12.7
Apr. 23	12.1
June 1-6	12.2
12	P 18.3
13	18.1
27-28	14.8
1906 Feb. 27	12.4
Apr. 25-29	15.2
1907 Jan. 22	11.4
Apr. 17-19	13.6
June 13	11.5
July 23	14.7
1908 May 17	13.8
June 1	17.6
10	15.9
15	16.3
July 1-2	14.8
1909 Apr. 26-29	14.8
May 9	15.3
28	13.3
June 12-13	14.4
July 1-2	11.9

** Below base

Flood stages of Mississippi River at Hannibal, Mo.--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1909 July 9	P	16.6	Mar. 21	P	16.3	Apr. 22		17.9
10		16.5	Apr. 28-29		17.8	22	P	18.0
1910 Mar. 20-21	**	10.9	28	P	17.9	May 15		12.7
1911 Feb. 22		12.7	May 8		20.1	20		13.8
Oct. 26-28		11.1	June 9		13.2	20	P	14.1
1912 Apr. 8		19.0	Nov. 15		11.5	26		15.7
1913 Mar. 31-Apr.1		14.3	1920 Mar. 18-19		12.0	June 6		17.0
Apr. 10		13.1	30		16.6	13		14.1
May 31-June 2		11.2	Apr. 22		19.5	1928 Jan. 8		11.3
1914 June 25-26		11.4	May 14		14.7	Apr. 14		13.5
25	P	11.44	June 5		11.5	Sept. 13		11.0
1915 Feb. 7-8	*	11.8	July 16		12.5	13	P	11.1
Mar. 2		14.3	1921 Apr. 27		11.3	Nov. 19		17.8
June 8		15.4	May 3-4		11.7	19	P	17.9
22		12.7	14		11.3	Dec. 18		11.0
30		11.0	Sept.23-25		11.4	1929 Jan. 31	*	12.3
July 13		12.9	1922 Mar. 15		11.9	Feb. 6-7		11.1
26		13.0	Apr. 25		18.8	Mar. 3		13.8
Aug. 5		16.1	25	P	18.87	25		20.4
Oct. 3-4		13.1	May 30		11.6	Apr. 2		20.2
1916 Jan. 23		12.7	1923 Apr. 11-12		12.9	23		21.7
29		15.3	1924 June 30		15.2	27		22.1
Apr. 1		18.3	Aug. 27		14.3	May 19		12.8
22-23		16.2	1925 June 24		11.7	June 3		12.6
May 16		19.1	1926 June 18		12.7	July 17		11.9
28-29		16.4	Sept. 5		12.5	1930 June 19		15.5
June 10		16.9	6	P	13.2	1931 Nov. 30		12.2
1917 Apr. 2		14.1	10		14.1	1932 Jan. 3		11.0
28		15.0	10	P	14.2	Apr. 25		11.0
May 3-4		16.2	17-18		14.2	1933 Apr. 10	P	15.9
June 9		18.1	17	P	14.4	11		15.7
17-18		17.6	Oct. 3-4		16.7	May 14		14.8
1918 May 31		14.0	3	P	16.8	27		15.8
June 13		17.7	1927 Feb. 9		11.3	July 1		11.9
13	P	17.8	Mar. 22		12.0	1934 Apr. 23	**	8.5
27		12.4	Apr. 4		16.5	Dec. 2	**	9.7
1919 Mar. 21-22		16.2	17		15.3			

* Ice gorge
** Below base
Note.- Unless designated by "P" (momentary peak) gage-height values are single daily readings, usually taken in morning.

Minnesota River near Montevideo, Minn.

Location.- At highway bridge 800 feet below mouth of Chippewa River and 1 mile south of Montevideo prior to Feb. 6, 1932; on bridge 300 feet upstream on U. S. highway 212 thereafter.
Drainage area.- 6,300 square miles.
Records available.- July 1909 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths twice daily during open-water season except in 1919 and 1920, when it was read only once daily; gage was read two or three times a week during periods of ice effect, about Nov. 15 to Mar. 15. Zero of gage is 910.87 feet above mean sea level (1912 adjustment).
Stage-discharge relation.- Permanent except as affected by ice. Bank-full stage, about 14 feet.
Regulation.- Slight fluctuation caused by power plant on Chippewa River in Montevideo; regulation of low flow at Lac Qui Parle Dam.

Flood stages and discharges
(Base discharge 400 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1909 July	22	5.4	805	Apr.	23	8.12	1,780
Aug.	14	4.65	587	May	17	5.66	889
Nov.	21	4.34	500		30	4.91	659
1910 Mar.	9	8.10	1,770	June	13	4.26	478
	13	9.32	2,250	1911 Mar.	15	3.96	400
	17	9.74	2,420	1912 Apr.	6	5.1	715
	17	9.85	P 2,460		20-21	4.9	656

Flood stages and discharges of Minnesota River near Montevideo, Minn.--Continued

Date		Gage height (feet)	Discharge (second-feet)
1912 May	9		* 5,900
	9	* 14	P 6,300
	18	8.0	1,730
June	19	4.8	627
1913 Apr.	2	5.8	934
	11	5.4	807
	18	6.2	1,070
1914 Apr.	6	4.4	516
	8	4.6	571
	10	4.5	543
	20-21	4.0	418
May	1	4.5	543
	5	4.8	627
	12	4.9	656
June	18-19	6.9	1,310
July	4	12.6	3,810
Aug.	22	5.3	776
Sept.	14-15	4.4	516
	22-26	4.7	599
Oct.	19-21	5.6	846
Nov.	3	5.2	731
	9	4.6	568
1915 Apr.	2		* 2,520
May	9	8.7	2,000
July	3-5	8.6	1,960
	22	11.1	3,160
Sept.	18	5.1	703
Oct.	11-13	6.0	967
	20-21	6.2	1,030
Nov.	8	5.5	817
	26-27	4.7	* 594
Dec.	16	5.5	442
1916 Apr.	2-5	14.4	7,540
	3	14.41	P 7,580
	22-26	13.5	5,210
May	30	12.9	4,400
July	3-4	13.2	4,760
Aug.	25-29	8.4	1,870
Oct.	24	5.57	846
Nov.	17	5.53	817
1917 Apr.	4-5	15.1	10,000
	4	15.16	P 10,200
June	29	6.30	1,060
July	16	5.02	675
1918 Mar.	16	5.51	* 817
	23	7.75	* 1,610
	30	8.05	* 1,690
	30	16.90	P
Apr.	6	6.9	* 1,270
	13	6.0	967
	29-30	4.85	619
May	13	4.95	675
	27	4.8	619
June	5-6	5.3	759
	22	4.95	675
1919 Mar.	19	9.65	2,410
	25	10.1	2,660
Apr.	12	8.75	2,050
	17-18	8.9	2,100
May	21-22	6.45	1,100
June	25	18.85	* 22,000
Nov.	16-20	4.10	436
1920 Apr.	3	11.33	3,180
	26-29	7.60	1,450
May	14	7.48	1,410
June	24	14.15	6,310
July	9-10	14.95	8,930
Sept.	6-8	5.35	731
	28-29	5.50	759
Oct.	16-19	4.70	540
	26-27	4.80	566
Nov.	15	5.28	703
Dec.	9-10	4.95	619
	16	4.98	619
1921 Mar.	21	5.15	731
	25-26	5.38	788
Apr.	9	8.08	1,740
	9	8.18	P 1,760
June	15-18	4.45	514
Sept.	25-26	4.50	540
1922 Mar.	25	14.01	6,310
	25	14.08	P 6,530
1923 Apr.	17-18	5.95	967
	17	6.05	P 982
May	20	4.44	514
1924 Apr.	9	5.30	759
	17	4.27	488
	21	4.00	410
	30	4.87	647
May	8-10	4.15	462
	13-14	4.39	514
	20	4.06	436
June	15	4.49	540
1925 Mar.	27	4.96	675
Apr.	29	4.06	436
June	26-29	7.05	1,300
1926 Mar.	1	4.8	619
	23	6.3	1,100
	23	6.50	P 1,130
	27	6.20	1,030
Apr.	14	4.55	566
	24-25	3.95	410
Aug.	23	4.86	647
Sept.	19-20	3.96	410
	22	4.20	462
1927 Mar.	4	6.00	967
	18	8.92	2,100
	18	9.1	P 2,180
Apr.	21-22	8.48	1,920
May	11-12	6.42	1,100
	27-28	7.85	1,610
July	17	4.10	410
1928 Apr.	7	6.27	1,060
	19	5.20	731
May	3	4.45	518
1929 Mar.	19	10.67	2,960
	19	10.91	P 3,080
Apr.	28-29	6.25	1,030
1930 Feb.	21-22	7.32	759
Mar.	12	5.62	675
	20	5.72	876
	24	5.55	846
May	16	6.72	1,200
	19-20	6.39	1,100
Nov.	22	3.62	** 324
1931 Feb.	5	4.20	** * 281
1932 Mar.	1	7.45	765
Apr.	7	4.07	407
	10	4.15	430
1933 May	20	4.19	430
1934 Dec.	6-9	1.60	** * 27

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Minnesota River at Mankato, Minn.

<u>Location</u>.- Prior to Oct. 19, 1921, at Sibley Park, 1,000 feet below mouth of Blue Earth River and 2 miles above center of Mankato, Blue Earth County; thereafter at Main Street highway bridge in Mankato.
<u>Drainage area</u>.- 14,600 square miles (no change owing to new location).
<u>Records available</u>.- May 1903 to October 1921 at Sibley Park; March 1922 to September 1934 at Mankato.
<u>Sources of data</u>.- Discharge records by U. S. Geological Survey; gage-height records by U. S. Weather Bureau through Nov. 30, 1924.
<u>Gages</u>.- Nonrecording gage read to tenths once daily May 20, 1903, to Oct. 19, 1921, at Sibley Park and Mar. 15, 1922, to Mar. 25, 1925, at Mankato; recording gage thereafter. Relation between gages at two locations has not been determined. Zero of present gage is 747.925 feet above mean sea level (1929 adjustment).
<u>Stage-discharge relation</u>.- Considerably affected by ice. Control shifts. Flood stage, Sibley Park, 18 feet; flood stage, Main Street, 22 feet.
<u>Regulation</u>.- Nearest dam on Minnesota River is at Minnesota Falls, 140 miles upstream. A dam on Blue Earth River at Rapidan, a few miles above mouth, controls low flow of that river.
<u>Historical data</u>.- Highest known flood occurred in 1881; stage, about 27 feet at Sibley Park gage and 31.5 feet at present gage (discharge, about 65,000 second-feet).

Flood stages and discharges
(Base discharge 3,500 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1903	May	20	9.2	9,560
		29	19.6	38,700
	July	4	7.85	6,960
		21	7.3	6,060
	Aug.	7	5.9	4,090
		17	6.9	5,460
	Sept.	5-6	5.95	4,160
		17	15.65	27,300
		30	7.35	6,140
	Oct.	9	13.45	20,500
1904	Apr.	12-13	8.3	7,740
		24-25	7.4	6,220
1905	Mar.	6	6.1	4,620
		23-24	6.8	5,620
	May	18	10.1	11,900
	June	28	6.3	4,900
	July	9	12.65	18,600
1906	Apr.	3	8.1	6,830
		11	8.0	6,690
		17	9.3	9,290
	May	4	6.6	5,050
	June	10-11	9.2	9,940
	Aug.	12	7.8	7,260
		20-30	8.0	7,600
	Sept.	27	7.2	6,300
	Nov.	1	6.9	5,840
1907	Mar.	23	9.3	10,200
	Apr.	5	10.8	13,600
	May	30	7.3	6,460
	June	21-22	14.1	22,100
	July	23-24	8.9	9,310
	Aug.	30	5.8	4,340
	Sept.	22	6.0	4,600
1908	Mar.	17	6.0	4,600
		24		3,960
	Apr.	20-21	5.7	4,200
	Apr.	29-May 1	6.9	5,840
	May	31	17.5	32,000
	June	26	21.2	43,800
	July	29	9.0	9,520
1909	Mar.	29-30	17.3	31,400
	May	2	8.3	8,340
		19-21	5.5	3,900
		27	6.7	5,610
	June	6	8.9	9,520
		15	8.4	8,530
		25	7.6	7,070
	July	1-3	10.9	14,000
	Nov.	30	6.9	5,920
1910	Mar.	12	14.85	20,000
1911	Mar.	13-14	2.0	** 847
	Oct.	20	5.3	3,650
1912	Apr.	2	8.4	8,530
	Apr.	25	5.9	4,450
		29		3,770
	May	8	7.6	7,070
1913	Apr.	15	6.6	5,460
		27	5.9	4,450
	May	25	6.3	5,010
		29	5.7	4,170
1914	June	11	7.1	5,880
		17	9.9	11,000
	July	1	8.1	7,550
		13		5,280
		19	5.7	3,890
1915	Mar.	1	7.9	7,890
		28	14.6	23,100
	May	4	5.9	4,670
		7	6.5	5,530
		12	5.7	4,400
		31	8.3	8,650
	June	7	7.5	7,160
		14	7.6	7,340
		24	6.3	5,230
		30	8.7	9,450
	July	10	8.9	9,850
		22	10.1	12,400
	Aug.	8	9.4	10,900
	Sept.	20	5.5	4,140
	Nov.	14	6.1	4,950
1916	Mar.	28	17.0	30,200
	Apr.	22	14.7	23,900
	May	19	9.4	11,200
		28-29	10.6	13,800
	June	16	7.0	6,550
		26-27	6.4	5,620
	July	6	8.5	9,270
		10	8.4	9,070
		15	13.8	21,600
1917	Apr.	15	15.8	26,900
	May	22	6.8	6,230
	June	2	10.2	12,900
		12	11.6	16,200
		28	9.2	10,500
	July	7	7.1	6,470
		26-27	5.2	3,760
1918	Mar.	20	10.7	14,100
	June	4	7.1	6,710
	July	30	5.0	3,790
	Aug.	24	10.9	14,500
	Nov.	2	5.2	4,030
		13	5.6	4,520
		22-23	7.4	7,220
1919	Mar.	19	14.7	23,900
	Apr.	19-20	17.0	30,200
	May	6		6,710

** Below base

Flood stages and discharges of Minnesota River at Mankato, Minn.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1919	May	9-10	8.1	8,490
	June	21	18.9	35,800
	July	1	16.8	29,600
1920	Mar.	27	9.9	14,300
	Apr.	26	6.7	7,570
		30	7.1	8,300
	May	20-21	5.9	6,390
	June	20	8.3	10,900
	July	18	12.0	19,600
1921	May	30	5.9	4,910
	June	14-15	4.8	3,570
....			....	......
1922	Mar.	16	13.5	9,040
		25	10.9	6,440
	Apr.	15	12.8	8,340
	May	4	8.9	4,350
1923	May	4	5.49	** 1,630
1924	July	2	7.8	3,540
1925	June	17		8,240
		17	13.1	P 8,640
	July	12-13		3,810
1926	Mar.	22	8.60	4,650
		22	8.8	P 4,880
	Sept.	23	7.92	4,100
1927	Mar.	14	14.30	11,400
		15	14.50	P 11,700
	Apr.	27	13.55	10,800
	May	12	8.10	4,430
		26	10.60	7,280
		30-31	10.90	7,640
	June	10-12	8.45	4,880
		24	9.40	5,900
1928	Feb.	14	9.0	4,930
	Mar.	20	13.4	9,590
		20	14.0	P 10,700
	Apr.	23	10.1	6,100
	May	6	9.2	5,220
	Aug.	27	7.20	3,960
1929	Mar.	18	18.85	21,100
		18	19.0	21,400
	Apr.	7	10.80	9,120
		16	10.40	8,560
		29	11.05	9,400
1930	Feb.	22	9.95	* 7,440
	May	16	7.45	4,580
1931	June	23	4.30	** 1,160
1932	Mar.	5	11.90	* 6,080
		30	12.27	* 6,920
		30	12.88	P* 8,310
	Apr.	8	9.63	6,560
	May	7-8	7.63	4,560
1933	Mar.	1	9.47	* 4,010
	Apr.	3	15.05	P 13,500
		4	14.80	13,100
1934	Apr.	6-7	5.30	** 1,980

* Estimated
** Below base
<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

St. Croix River at Swiss, Wis.

<u>Location</u>.- In sec. 33, T. 42 N., R. 15 W., at highway bridge near Swiss, Burnett County, 3½ miles below mouth of Namakagon River.
<u>Drainage area</u>.- 1,550 square miles.
<u>Records available</u>.- March 1914 to September 1933.
<u>Source of data</u>.- U. S. Geological Survey.
<u>Gage</u>.- Nonrecording gage read to quarter-tenths every day during open-water season and on alternate days during ice periods.
<u>Stage-discharge relation</u>.- Permanent for open channel; slightly affected by aquatic growth and considerably affected by ice. Bank-full stage, about 8 feet.

Flood stages and discharges
(Base discharge 2,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1914	Apr.	24	4.0	3,870
		29	3.6	3,450
	June	28	4.1	3,870
	July	14	2.9	2,650
1915	Apr.	12	2.7	2,430
	May	18	4.0	3,970
	June	9-10	2.6	2,320
		19-20	4.2	4,230
		19	4.4	P 4,500
	Nov.	12	3.9	3,840
1916	Apr.	21-22	6.6	8,220
		22	6.73	P 8,480
	May	16	2.9	2,660
		30-31	3.1	2,880
	June	15	2.4	2,150
		30	3.6	3,450
1917	Apr.	4	4.52	2,280
		21-23	2.36	2,170
	July	21	2.96	2,780
		21	3.05	P 2,840
1918	May	21	2.8	2,630
	June	1-4	3.1	2,950
		2	3.15	P 3,000
1919	Mar.	29	3.20	3,000
	Apr.	11	3.46	3,330
1920	Mar.	27	5.41	6,050
	Apr.	27-28	2.59	2,430
	May	24	2.95	2,840
	June	2	2.38	2,130
		12	2.67	2,530
		17		2,530
	July	2	5.47	6,220
		2	5.55	P 6,300
		8	3.08	2,950
1921	Apr.	8	2.78	2,630
		30	2.62	2,430
1922	Apr.	11	6.14	7,280
	May	5	2.75	2,630
		9	2.69	2,530
		19-21	2.32	2,130
1923	Apr.	16		2,990
		23-24	3.40	3,280
	June	26		2,730
1924	Apr.	26	2.38	2,230
	May	12	3.18	3,060
1925	Mar.	28	2.59	* 2,430

* Estimated

Flood stages and discharges of St. Croix River at Swiss, Wis.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1926	Apr.	15	2.15	2,030
	Oct.	5	2.59	2,420
	Nov.	16-19	2.19	2,030
1927	Mar.	19	5.65	6,360
	Apr.	6	3.00	2,820
		20	2.26	2,120
	May	26	2.46	2,320
1928	Apr.	5	3.54	3,350
		23-26	2.61	2,420
	May	4-5	3.34	3,240
		7	3.34	3,240
	July	9	2.26	2,120
		20-22		2,120
		24-25		2,120
	Sept.	17	3.80	3,690
	Oct.	21-23	2.98	2,820
1929	Mar.	31		* 3,350
		31	4.35	P* 3,460
1930	May	14	3.22	3,020
		14	3.28	P 3,130
1931	June	24	3.12	2,920
		24	3.22	P 3,020
1932	Apr.	8	3.26	3,130
		8	3.35	P 3,240
		10		2,920
1933	Apr.	3	3.55	* 3,160
		20	2.31	2,340
	May	2	2.62	2,690

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

St. Croix River near St. Croix Falls, Wis.

Location.- In sec. 18, T. 34 N., R. 18 W., at power plant of Northern States Power Co. on Wisconsin side of St. Croix River near St. Croix Falls, Polk County.
Drainage area.- 5,930 square miles.
Records available.- January 1902 to June 1905, January 1910 to September 1934.
Sources of data.- Records from January 1902 to December 1909 from Minnesota State Drainage Commission; thereafter from power-house records furnished by Minneapolis General Electric Co. and Northern States Power Co.
Regulation.- Flow regulated since 1890 for logging and power purposes at Nevers Dam (capacity, 19,000 acre-feet).
Remarks.- During periods of missing record, Sept. 13-20, Oct. 7-11, 1903, no daily discharges were computed but they were all above 20,000 second-feet.

Flood discharges
(Base discharge 8,880 second-feet)

Date			Discharge (second-feet)
1902	May	23	9,600
	June	5	11,900
		10	10,500
	July	10	12,900
1903	Mar.	22-23	11,500
	Apr.	4	12,200
		12	20,200
		25	9,740
		28	10,500
	May	6	15,600
		12	16,200
		25	12,100
		28	12,600
	June	2	10,400
	July	11	11,600
....			......
	Oct.	12	23,600
1904	Apr.	9	18,300
		15	12,600
		23	11,300
	May	10	13,400
	June	7	17,900
	Oct.	5	11,300
		12	15,000
		22	18,700
1905	Apr.	6	12,200
	May	8	10,600
		15	15,000
		29	9,180
	June	9	15,100
		15	12,300
		17	10,900
	June	23	9,060
		28	11,800
....			......
1910	Mar.	18	9,390
		21	9,870
1911	May	23	** 7,500
1912	Apr.	6	9,670
		28	11,300
	May	6	33,500
		15	9,540
1913	May	22	8,980
1914	May	2	12,300
	June	29	15,300
1915	Apr.	29	9,980
	May	6	11,400
		20	12,900
	June	15	9,330
		22	15,100
		27	11,200
	Nov.	14	11,200
1916	Apr.	5	19,000
		23	35,100
	May	20	14,100
		26	20,000
	July	1	21,500
		9	8,940
1917	Apr.	5	17,700
		16	12,600
1918	June	3-4	10,100
1919	Mar.	25	9,930
		27-28	13,200
	Apr.	12	14,900
	Apr.	15	14,300
	June	25	8,930
1920	Mar.	26	35,800
	Apr.	13	13,000
		25	9,390
		28	10,600
	May	1	9,370
		25	11,100
	June	4	10,900
		16-18	11,200
		30	11,500
	July	8	9,600
1921	Apr.	9	11,500
1922	Apr.	1	13,600
		10-11	18,600
	May	7	10,400
		12	9,780
1923	Apr.	28	8,880
1924	May	15	9,800
1925	Apr.	26	** 5,860
1926	Sept.	22	** 6,140
1927	Mar.	18	27,600
	Apr.	3	11,400
		8	17,900
		17	10,400
		22	21,700
	May	25	9,440
1928	Mar.	30	21,800
	Apr.	8	17,200
		22	12,200
		25	11,600
	May	6	13,100

** Below base

Flood discharges of St. Croix River near St. Croix Falls, Wis.--Continued

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1928 Sept. 19	10,300	Apr. 8	15,600	Apr. 26	16,600
Oct. 21	9,420	18	12,700	1932 Apr. 10	18,500
1929 Mar. 18	15,500	21	11,900	May 10	13,400
22	15,800	1930 May 16	17,500	1933 May 4	** 7,060
Apr. 1-2	16,900	1931 June 16	8,890	1934 Apr. 12	12,100

** Below base
Note.- Breaks in record: Sept. 13-20, Oct. 7-11, 1903.

Apple River near Somerset, Wis.

Location.- In sec. 21, T. 31 N., R. 19 W., at power plant of Northern States Power Co., 3½ miles below Somerset, St. Croix County.
Drainage area.- 550 square miles.
Records available.- January 1901 to September 1934. Monthly records only prior to July 1914.
Sources of data.- Discharge determined from power-house records of Northern States Power Co. Tailrace discharge checked by U. S. Geological Survey.
Regulation.- Power dams at and above this station probably have little effect on flood flows.
Remarks.- Monthly records show discharge of 2,280 second-feet in June 1905 and 2,250 second-feet in May 1906.

Flood discharges
(Base discharge 592 second-feet)

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1914 Sept. 16	** 433	Apr. 12	1,120	1926 Mar. 25	932
1915 Apr. 7	824	1920 Mar. 26	1,370	Sept. 5	754
May 23	612	Apr. 12	637	20	715
June 9	660	May 12	647	1927 Mar. 14	913
21	726	June 18	721	18	982
July 16	631	30	1,220	May 25	843
1916 Apr. 5	1,740	July 6	604	June 22	601
23	1,800	1921 Mar. 29	671	Sept. 13	657
May 17	640	1922 Mar. 26	872	1928 Mar. 27	1,160
25	845	28	936	Apr. 16	598
July 5	713	Apr. 11	1,420	21	654
1917 Apr. 6	966	18	748	23	854
16	679	24	636	May 5	630
21	658	28	870	8	695
26	625	June 18	1,220	Oct. 19	686
30	691	27	610	1929 Mar. 20	1,140
1918 Mar. 21	786	1923 Apr. 8	613	1930 Feb. 26	919
May 31	895	14	1,060	1931 Nov. 2	** 381
June 3	1,160	22	677	1932 Apr. 8	1,220
10	686	May 4	612	12	691
1919 Mar. 17	743	1924 Apr. 8	** 537	1933 Apr. 1	1,300
21	959	1925 Mar. 24	598	1934 Apr. 5	1,670
28	689				

** Below base
Note.- All discharge quantities are average daily flows.

Chippewa River at Chippewa Falls, Wis.

Location.- Prior to June 19, 1932, in SE¼ sec. 6, T. 28 N., R. 8 W., at highway bridge at Chippewa Falls, Chippewa County, a quarter of a mile below mouth of Duncan Creek; thereafter in lot 1, sec. 12, T. 28 N., R. 9 W., 1 mile below mouth of Duncan Creek.
Drainage area.- 5,600 square miles.
Records available.- June 1888 to September 1933. Open-water record only from 1888 to 1899.
Sources of data.- Gage-height records furnished by Chippewa Lumber & Boom Co., U. S. Weather Bureau, and Chippewa Valley Railway, Light & Power Co. prior to Jan. 1, 1913, and by U. S. Geological Survey thereafter. All discharge determinations by U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths once daily prior to January 1914; recording gage thereafter.
Stage-discharge relation.- Affected by ice but otherwise practically permanent until 1928, after which discharge determinations were based on power-house records. Flood stage, about 16 feet.
Storage and regulation.- Flow regulated at the following reservoirs for power purposes: Rest Lake, capacity, 23,000 acre-feet; Flambeau (1926), capacity, 132,000 acre-feet; Moose Lake, capacity, 11,000 acre-feet; Chippewa (1923), capacity, 229,570 acre-feet; Wissota (1917), capacity, 50,000 acre-feet.
Historical data.- The greatest known flood since 1838 occurred Sept. 10, 1884, stage, 26.94 feet (discharge not estimated).

Flood stages and discharges of Chippewa River at Chippewa Falls, Wis.
(Base discharge 20,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1888	June	22	7.8	22,800
	July	19	8.2	24,200
1889	May	8	7.4	21,300
		14	7.8	22,800
		21	7.7	22,400
1890	Apr.	13	9.0	27,200
	May	24	7.5	21,600
	Oct.	17	7.1	20,200
1891	Apr.	20	8.5	25,400
		24	9.0	27,200
1892	Apr.	7	7.2	20,500
	May	21	11.2	35,800
	June	28	9.4	28,800
1893	Apr.	14	8.2	24,200
		28	9.1	27,600
	May	3	8.0	23,500
		13	11.8	38,200
		26	8.2	24,200
		31	7.5	21,600
1894	Mar.	22	7.7	22,400
	Apr.	21	10.4	32,700
	May	7	8.3	24,600
		16	14.0	47,300
1895	June	13	6.8	** 19,100
1896	Apr.	19	12.0	39,000
		28	7.5	21,600
	May	4	8.0	23,500
		16	7.8	22,800
		19	7.6	22,000
1897	Mar.	20	8.5	25,400
		24	9.3	28,400
		26	9.0	27,200
	Apr.	2	17.0	60,100
		5	10.6	33,400
	May	22	7.6	22,000
	June	5	8.8	26,500
		19	7.5	21,600
	July	28	7.2	20,500
1898	May	28	6.8	** 19,100
1899	Apr.	29	8.50	26,200
	May	4	7.75	23,300
		6	8.75	27,200
		20	8.38	25,800
	June	15	7.00	20,400
	Oct.	28	7.18	20,800
1900	Apr.	20	12.00	40,400
	July	8	7.25	20,200
		14	12.00	23,300
	Aug.	25	9.33	29,800
	Sept.	1	7.00	20,400
		8	7.83	22,900
		13	13.00	44,800
	Oct.	5	13.08	45,500
		18	7.17	21,200
	Nov.	3	9.67	31,300
1901	Apr.	7	7.25	21,300
		11	7.25	21,300
1902	Apr.	28	7.75	23,300
	June	14	7.75	23,300
	Nov.	1	7.17	21,000
		16	9.08	28,200
1903	Mar.	20	10.08	32,800
	Apr.	30	8.60	26,600
	May	1	10.83	27,200
		13	9.50	30,200
		29	12.42	41,900
	July	5	10.50	34,700
	Aug.	8	7.59	22,600
	Sept.	16	13.25	45,900
	Oct.	5	7.83	24,200
1904	Apr.	26	6.91	20,500
	May	7	8.00	24,200
		27	10.17	33,300
	June	6	7.00	20,400
	July	6	7.00	20,400
	Oct.	3	7.00	20,400
		9		* 28,400
		11	11.83	39,600
		22	7.41	22,100
1905	Mar.	30	9.50	30,200
	Apr.	3	7.8	33,500
	May	17	8.6	26,600
	June	6	17.5	64,400
		18	7.6	22,700
	July	3	7.5	23,300
		6	7.8	23,500
		8	8.7	27,000
	Sept.	21	7.5	22,300
1906	Apr.	5	8.67	26,900
		10	9.75	31,300
		15	11.50	38,500
	May	14	7.42	22,000
		24	7.00	20,400
		28	7.00	20,400
	June	1	7.96	24,100
1907	Mar.	30	11.00	36,400
	Apr.	5	8.00	24,200
	Sept.	21	10.00	32,300
		26	6.9	20,000
1908	Apr.	29	8.9	27,800
	May	27	8.0	24,200
1909	May	8	8.0	24,200
		10	7.1	20,700
		18	8.5	26,200
	June	4	7.4	21,900
	Nov.	15	7.45	21,300
1910	May	20	4.0	** 9,870
1911	May	24-25	4.5	** 11,400
	Oct.	7	10.55	33,400
		19	7.06	20,200
1912	Apr.	8	7.7	22,400
	May	6	9.4	28,800
		24	9.1	27,600
		29	8.0	23,500
1913	Apr.	4	11.0	35,000
		19	7.8	22,800
	July	6	7.7	22,400
1914	Apr.	30	10.7	33,900
	June	5	9.6	29,700
		28	10.0	31,200
1915	Apr.	12	7.1	20,400
		12	P	21,500
	May	23	8.0	23,700
		23	8.12 P	24,100
	Aug.	5-6	7.4	21,500
		5	P	21,800
1916	Apr.	2		39,200
		14	8.6	25,900
		18	9.4	29,000
		23	13.45 P	52,400
		23	13.40	52,100
	May	1	7.2	20,800
1917	Apr.	13	7.0	20,000
		23	8.32 P	24,900
		23	7.86	23,300
1918	May	28		34,000
	June	1		36,300
		1	12.4 P	43,700
1919	Mar.	26		22,200
		29		22,200
	Apr.	13		35,000
		13	P	45,000
1920	Mar.	27	15.41	66,200
		27	17.0 P	78,000
	Apr.	1		38,400
1921	Mar.	29		24,100
	Apr.	29	10.41 P	33,500
		29		30,100
1922	Mar.	28		27,800
		31		27,700
	Apr.	10		60,900
	May	8		20,800
	June	19		20,800
1923	Apr.	22	14.4 P	59,000
		22		54,000
1924	Apr.	19		35,500
		26		46,000
		26	14.4 P	60,000
		28		34,100
	May	10		29,800

* Estimated
** Below base

Flood stages and discharges of Chippewa River at Chippewa Falls, Wis.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1925	June	15		** 18,600	1929	Mar.	21		26,600
1926	Apr.	15		20,200		Apr.	1		30,200
	Aug.	22		28,200			8	10.92	36,200
	Sept.	6		28,200	1930	June	15	10.80	35,600
		20	11.40	39,000			15	11.6 P	40,200
		20	12.55 P	46,400	1931	June	22		** 15,200
	Nov.	17		26,700	1932	Apr.	9		37,100
1927	Mar.	16	12.42	45,400	1933	Apr.	6		21,000
		16	13.4 P	52,100			6	11.8 P	24,300
1928	Mar.	26		30,100		May	2		20,600
	Oct.	22		20,000					

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Flambeau River near Ladysmith, Wis.

Location.- Prior to Sept. 30, 1923, 6 miles above Ladysmith, Rusk County; thereafter in sec. 35, T. 36 N., R. 5 W., at Big Falls power plant of Lake Superior District Power Co., 14 miles above Ladysmith.
Drainage area.- 1,940 square miles prior to Oct. 1, 1923; 1,910 square miles thereafter.
Records available.- January 1914 to September 1934.
Sources of data.- 1914-23, U. S. Geological Survey records; thereafter power-house records furnished by Lake Superior District Power Co.
Gages.- 1914-23, chain gage read to hundredths twice daily except occasionally, when gage was read every other day.
Stage-discharge relation.- 1914-23, not permanent.
Regulation.- Flow regulated at Rest Lake (drainage area, 225 square miles; capacity, 23,000 acre-feet) throughout period of record and at Flambeau Reservoir (total drainage area, including that of Rest Lake, 620 square miles; capacity, 132,000 acre-feet) since Mar. 15, 1926. Storage used principally during winter.
Historical data.- Flood of Apr. 11, 1922, was greatest since June 1880.

Flood stages and discharges
(Base discharge 5,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1914	Apr.	29	7.8	9,640		May	7	6.30	7,140
	June	28	6.0	6,140		June	18	6.04	6,440
1915	Apr.	13	5.4	5,100	1923	Apr.	23	8.17	12,500
	May	17	7.1	9,240		May	1	5.82	6,000
		17	7.2 P	9,520			17	5.37	5,210
		23	6.0	6,140	1924	Apr.	18		9,320
1916	Apr.	12	7.3	9,800			22		5.840
		17	8.2	12,500			25		8,320
		23	9.6	17,400		May	11		7,550
	July	4	5.6	5,600	1925	Apr.	25		** 3,390
1917	Apr.	21		6,000	1926	Aug.	20		6,150
	June	7	6.6	7,880		Sept.	5		8,820
1918	June	2	7.2	9,520			19		8,860
		5	6.8	8,400		Nov.	16		6,460
	Nov.	8	5.50	5,400	1927	Mar.	18		8,350
1919	Mar.	28		* 5,120		May	23		5,040
	Apr.	12	7.30	9,800	1928	Apr.	6		8,120
		21	5.40	5,210		May	5		6,490
	May	2	5.85	6,000		Sept.	15		6,610
		7		6,000		Oct.	22		5,460
	July	7	6.2	6,900	1929	Mar.	31		5,610
	Nov.	11	5.40	5,210		Apr.	7		7,240
1920	Mar.	31		* 12,000	1930	June	15		5,710
1921	Mar.	30	6.40	6,900	1931	June	22		5,440
	Apr.	29	6.30	6,660	1932	Apr.	10		7,460
1922	Apr.	11	10.2	19,500	1933	Apr.	20		5,140
		19	6.80	8,400	1934	Apr.	9		7,080
		26	5.70	5,800		Sept.	26		6,590

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Jump River at Sheldon, Wis.

Location.- In sec. 26, T. 33 N., R. 5 W., at highway bridge in Sheldon, Rusk County, 11 miles above mouth of river.
Drainage area.- 510 square miles.
Records available.- July 1915 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to half tenths twice daily except during ice periods, when it was read on alternate days.
Stage-discharge relation.- Permanent; considerably affected by ice.

Flood stages and discharges
(Base discharge 3,500 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1915	Aug.	5	7.8		5,570	1926	Apr.	14	7.62		5,180
	Nov.	12	6.6		3,560		Aug.	22	7.82		5,610
1916	Apr.	4	8.4		5,050		Sept.	5	7.62		5,180
		13	6.9		4,040			19	8.18		6,510
		22	9.4		8,600			19	8.5	P	7,220
1917	Apr.	22	6.83		3,880		Nov.	16	6.92		3,820
		22	6.89	P	4,020	1927	Mar.	16	9.82		10,600
1918	May	27	8.95		7,800			16	9.94	P	10,900
	June	1	8.7		7,230		July	18	7.10		4,190
1919	Mar.	25	7.00		4,200	1928	Mar.	26	9.25		9,000
	Apr.	11	8.25		6,290			26	9.45	P	9,530
		11	8.38	P	6,620		Apr.	6	7.62		5,180
	Nov.	11			4,710			22	7.02		4,000
1920	Mar.	26	11.48		12,800		May	6	6.78		3,640
	June	17	7.09		4,370	1929	Mar.	18	8.60		7,470
		30	6.57		3,560			20-21	7.28		4,570
1921	Mar.	20	8.70		7,230			31	7.48		4,970
		28	7.48		5,050		Apr.	8	8.28		6,740
	Apr.	29	7.75		5,570		June	29	7.12		4,190
1922	Mar.	27	6.98		4,200	1930	June	14	9.20		9,000
	Apr.	10	9.15		8,200	1931	June	14	6.98		4,000
		10	9.3	P	8,400			21	7.60		5,180
1923	Apr.	21	10.36		12,400	1932	Apr.	11	7.21		4,380
	June	9	7.00		4,200			11	7.3	P	4,570
1924	Apr.	18	8.50		7,180	1933	Apr.	2	6.95		4,000
		25-26	8.50		7,180			6	7.52		4,970
	May	10-11	8.05		6,080		May	2	8.20		6,510
1925	June	14	6.75		3,880			2	8.75	P	7,970

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Red Cedar River at Menomonie, Wis.

Location.- June 17, 1907, to Sept. 3, 1908, at highway bridge 3,000 feet west of Chicago & North Western Railway depot, Menomonie, Dunn County; subsequent to May 9, 1913, in sec. 26, T. 28 N., R. 13 W., 900 feet below power house of Northern States Power Co., 1,000 feet below mouth of Wilson Creek, 1 mile above first location, and 13 miles above mouth of river.
Drainage area.- 1,810 square miles.
Records available.- June 1907 to September 1908, May 1913 to September 1923, March 1925 to September 1934.
Source of data.- U. S. Geological Survey.
Gages—June 17, 1907, to Sept. 3, 1908, nonrecording gage read to tenths twice daily; subsequent to May 9, 1913, recording gage. No relation between gages. Zero of recording gage raised 0.42 foot when gage was reestablished on Mar. 8, 1925.
Stage-discharge relation.- Permanent.
Regulation.- At power plants at Menomonie and Cedar Falls and by following reservoirs: Bear Lake, Hemlock, Long Lake, Big Chetac Lake, Cedar Lake, Birch, and Balsam (aggregate capacity, 39,100 acre-feet). Information regarding initial dates of operation was not obtained.

Flood stages and discharges of Red Cedar River at Menomonie, Wis.
(Base discharge 3,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1907	July	3	4.62		3,110
		17	5.96		5,050
	Sept.	21	6.65		6,120
1908	Mar.	14	4.75		3,290
		24	4.95		3,570
	Apr.	27	5.95		5,040
	May	31	5.17		3,880
	June	16	4.55		3,010
.....	.....	.....	....		.....
1913	May	22	3.82		3,110
	July	6	3.92		3,330
1914	Mar.	31	4.0		3,460
	June	6	5.35		6,700
		28	5.05		5,860
1915	Mar.	26	4.14		3,740
	Apr.	6-7	4.95		5,600
		7	5.13	P	6,140
	May	24	3.95		3,360
	Aug.	6	3.93		3,320
1916	Apr.	1	6.8		11,800
		1	7.0	P	12,000
		24			4,060
	July	2			5,230
1917	Apr.	4			7,640
1918	Mar.	20			6,970
		20	6.05	P	7.570
	May	28			3,420
	June	3			4,000
1919	Mar.	17			6,000
		28			3,630
	Apr.	10			5,690
1920	Mar.	26		*	14,000
	Apr.	15			3,930
	June	19			3,490
		30			5,880
1921	Mar.	29			3,100
1922	Mar.	28			5,820
	Apr.	5			5,530
		10			6,000
		21			3,030
	June	20			3,820
		23			3,120
1923	Apr.	14-15			7,740
		14	5.70	P	8,120
		21			4,290
.....	.....	.....	....		.....
1925	Mar.	26		**	2,660
1926	Mar.	25			10,400
		25	6.25	P	11,000
	Sept.	5			10,100
		20			4,600
	Nov.	17-18	4.12		5,050
1927	Mar.	15	5.80		9,850
		15	6.1	P	10,700
1928	Mar.	24	5.20		8,050
	Apr.	22-24	3.27		3,180
1929	Mar.	21	6.70		12,500
		29	3.63		3,910
	Apr.	2	3.40		3,390
		8			3,390
1930	Feb.	24	4.45		5,800
		24	4.50	P	6,050
1931	Apr.	20		**	1,460
1932	Mar.	31	3.20		3,000
	Apr.	9	4.28		5,460
1933	Mar.	18	3.23		3,220
		25-26	3.16		3,010
	Apr.	1	4.86		7,070
		1	5.20	P	8,160
		7	3.23		3,220
1934	Apr.	4		*	29,000
		4	16.0	P*	40,000
	Sept.	27			5,590

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Black River at Neillsville, Wis.

Location.- In sec. 15, T. 24 N., R. 2 W., at lower highway bridge in Neillsville, Clark County, 1 mile below O'Neill Creek and 1½ miles above Cunningham Creek.
Drainage area.- 774 square miles.
Records available.- April 1905 to March 1909, December 1913 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to quarter-tenths twice daily.
Stage-discharge relation.- Permanent but considerably affected by ice.

Flood stages and discharges
(Base discharge 3,790 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1905	Apr.	6	8.2		3,900
	May	14	10.7		7,900
	June	6	21.1		33,200
		6	22.4	P	37,100
		11	8.6		4,340
		17	11.2		8,800
	July	5	8.4		4,120
	Sept.	19	8.6		4,340
1906	Apr.	3	12.0		10,400
		8	11.4		9,200
	May	27	9.3		5,180
1907	Mar.	26-27	12.4		11,200
		29	11.8		10,000
	July	6	10.15		7,000
1908	Apr.	27	10.8		8,100
	May	22	9.7		6,200
		31	9.9		6,500
	June	8	8.4		4,140
	July	7	9.9		6,500
.....	.....	.....	...		.....
1914	Apr.	25	8.7		4,560
		29	9.1		5,160
	May	22	9.1		5,160
	June	5	17.5		23,000
		5	19.55	P	28,700
		28	8.4		4,160
1915	Apr.	8	9.3		5,480
		8	9.62	P	5,990
	May	22	9.4		5,640
	Nov.	12	9.4		5,640

Flood stages and discharges of Black River at Neillsville, Wis.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1916	Mar.	31	12.5	11,000
		31	12.78	P 12,000
	Apr.	22	11.7	9,490
		22	11.82	P 10,000
	June	3	8.2	3,910
1917	Apr.	4	10.22	6,940
		4	10.35	P 7,200
		21	8.54	4,290
1918	May	26-27	10.6	7,620
		26	11.45	P 9,060
	June	1	9.8	6,280
		1	10.0	P 6,600
1919	Mar.	16	13.22	* 5,000
		21	9.71	6,120
		21	9.8	P 6,300
	Apr.	8	10.44	7,280
		11	10.80	7,960
		11	11.15	P 8,800
	June	24	10.75	7,960
		24	11.4	P 8,980
	Aug.	8	8.2	3,910
	Nov.	11	9.85	6,280
		11	10.45	P 7,400
1920	Mar.	26	14.90	17,500
		26	15.2	P 18,400
	Apr.	24	8.48	4,290
	June	17	11.09	8,470
		17	11.3	P 9,000
1921	Mar.	20	12.08	10,600
		20	12.65	P 11,800
	Apr.	28	11.08	8,480
		28	11.15	P 8,800
	June	11	8.79	4,700
1922	Apr.	4	10.40	7,280
		4	11.45	P 9,400
		9	13.05	12,500
		9	13.5	P 13,600
	June	11	8.15	3,910
		11	9.7	P 6,150
1923	Apr.	13	9.24	5,320
		22	10.01	6,650
		22	10.1	P 6,830
1924	Apr.	8	10.78	8,090
		8	10.9	P 8,300
		17	9.65	P 6,100
		~~18~~	~~9.20~~	~~5,320~~
		26	12.35	11,200
	May	10	8.72	4,560
	Aug.	22	12.45	11,200
1925	June	13-14	8.10	3,790
		14	8.45	P 4,220
1926	Mar.	24	10.65	7,730
	Apr.	11	11.65	9,600
		11	12.0	P 10,400
1927	Mar.	13	12.03	8,680
		13	12.33	P 9,190
1928	Mar.	24	12.07	8,850
	Apr.	19	9.54	4,960
	May	5	9.60	5,090
	Aug.	21	13.35	11,100
	Sept.	14	13.70	11,700
		14	16.4	P 17,500
	Oct.	17	8.70	4,060
1929	Mar.	15	12.75	* 7,100
		20	12.50	9,530
	Apr.	8	11.39	7,700
		15	8.86	4,300
1930	Feb.	26	8.60	3,950
	June	14	14.35	13,100
		14	15.5	P 15,400
		24	9.55	5,150
1931	June	20	7.20	** 2,530
	Nov.	18	9.42	4,900
		24	9.66	5,280
1932	Mar.	30	9.40	4,900
	Apr.	7	13.85	11,900
	May	7	9.83	5,410
1933	Apr.	6	9.34	4,780
		6	9.6	P 5,150
		10	8.96	4,420
1934	Apr.	5	14.80	19,100
		5	15.3	P 20,800
	Sept.	26	13.92	16,100

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

La Crosse River near West Salem, Wis.

Location.- In sec. 32, T. 17 N., R. 6 W., at highway bridge 2 miles west of West Salem and 6 miles below mouth of Dutch Creek.
Drainage area.- 412 square miles.
Records available.- December 1914 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths twice daily.
Stage-discharge relation.- Affected by ice; control shifts. Bank-full stage, about 10 feet.

Flood stages and discharges
(Base discharge 800 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1914	June	9	3.2	889
		28	4.7	1,390
1915	Sept.	15	3.0	862
1916	Jan.	29	5.4	* 1,690
		29	5.6	P* 1,700
	Feb.	20	3.8	* 889
	Mar.	13		* 862
		26	4.3	1,230
	Sept.	29	2.9	807
1917	Mar.	24	6.79	2,480
		24	7.4	P 2,850
	Apr.	19	6.14	2,060
	July	24	4.32	1,230
	Aug.	3	3.11	862
1918	Feb.	27	5.8	* 1,190
	Mar.	4		1,150

* Estimated

Flood stages and discharges of La Crosse River near West Salem, Wis.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1918	Mar.	14	6.4	2,240
		14	6.8	P 2,480
		18	6.5	2,300
	June	11	3.8	1,060
1919	Mar.	17		2,480
1920	Mar.	27	3.08	862
	June	17	6.46	2,300
		17	6.65	P 2,390
		30	4.17	1,190
1921	Jan.	22	3.70	* 835
	June	10	3.48	972
		10	3.95	P 1,100
1922	Feb.	24	8.30	* 2,830
	Mar.	7	7.72	* 2,360
		12	4.95	* 1,060
		14	3.66	862
	Apr.	11	3.54	972
	June	12	5.44	1,700
		12	6.0	P 2,010
1923	Mar.	3	5.55	1,230
	Apr.	4	6.80	2,240
1924	Apr.	7		807
	June	19	4.30	1,230
		24	2.86	807
		30	3.80	1,060
	Aug.	5	6.12	2,060
		20	6.40	2,240
		20	6.9	P 2,540
1925	Feb.	10	6.48	* 1,150
	Mar.	19		835
	June	15		1,900
		15	6.22	P 2,080
	July	10		1,230
		21		862
	Sept.	8		807
	Oct.	1-2	3.04	835
1926	Mar.	23	4.33	1,230
	Apr.	26	2.88	810
	Aug.	22	5.60	1,740
		22	5.85	P 1,840
1927	May	11	3.05	835
	July	21	4.42	1,260
		21	4.55	P 1,330
1928	Feb.	8	10.41	2,420
	Mar.	16	4.49	1,120
	Aug.	23	5.02	1,370
	Sept.	15	9.58	4,620
		15	9.8	P 4,780
1929	June	14-15		830
		20		1,030
		20		P 1,070
1930	Feb.	21	8.36	* 2,990
1931	June	23		** 528
1932	Feb.	28	4.46	1,040
	Apr.	8	4.66	1,220
	May	7-8	1,2	1,270
	June	8		2,010
		8	6.30	P 2,220
		20		866
	Aug.	18		1,040
1933	Mar.	31	8.99	2,500
	Apr.	7	4.23	800
		11		800

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Wisconsin River at Merrill, Wis.

Location.- At site of former highway bridge 300 feet below present bridge at east end of Merrill, Lincoln County, on line between secs. 12 and 13, T. 31 N., R. 6 E., half a mile below mouth of Prairie River.
Drainage area.- 2,630 square miles.
Records available.- November 1902 to September 1933.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths prior to Sept. 10, 1914; recording gage thereafter.
Stage-discharge relation.- Practically permanent; affected by ice.
Regulation.- Flow regulated by 10 power plants upstream and by 19 lakes and reservoirs on Wisconsin and Tomahawk Rivers (total combined usable capacity, 191,000 acre-feet in summer and 226,000 acre-feet in winter). About 50 percent of drainage area is controlled.
Remarks.- Owing to uncertainties in base data no record is given for period Nov. 18, 1902, to June 17, 1903.

Flood stages and discharges
(Base discharge 7,100 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1903	July	5	8.80	12,200
	Aug.	6	7.45	7,900
	Sept.	16	11.50	* 19,800
		26	7.20	7,240
	Oct.	5	8.00	9,560
		7	8.85	12,300
1904	Apr.	9	7.20	7,240
		28	8.50	11,200
	May	5	7.30	7,520
		9	8.40	10,900
		27	10.60	18,100
	June	6	8.30	10,600
		12	7.55	8,200
		24	7.25	7,380
		28	7.25	7,380
	July	11	7.20	7,240

* Estimated

Flood stages and discharges of Wisconsin River at Merrill, Wis.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1904	Aug.	13	7.15		7,120
	Sept.	4	7.80		8,940
		26	7.75		8,800
	Oct.	11	10.40		17,500
		26	7.20		7,240
1905	Apr.	3	9.20		13,000
		9	8.60		11,000
	May	17-18	7.80		8,480
	June	6	10.4		17,200
		18-19	10.6		18,000
		27	7.6		7,910
	July	1	7.4		7,360
		6	8.2		9,680
	Sept.	20	7.35		7,220
1906	Apr.	5	7.65		8,050
		14	10.05		16,000
	May	3	7.8		8,480
	June	7	8.25		9,840
	July	8	7.5		7,630
	Aug.	23	7.55		7,770
		26	8.45		10,500
1907	Apr.	4	8.6		11,000
	May	5	7.35		7,220
		8	8.3		9,990
		17	8.35		10,200
1908	Apr.	16	8.15		9,520
		29	9.25		13,200
	May	25	7.35		7,220
	July	7	7.85		8,620
	Nov.	9	7.35		7,220
1909	Apr.	22	8.35		10,200
		27	7.35		7,220
	May	7	8.65		11,100
		11	8.4		10,300
		19	8.25		9,840
	June	9	8.05		9,220
	Nov.	16	7.85		8,620
1910	Apr.	7	7.1	**	6,540
1911	May	23	7.35		7,180
	Oct.	7	11.1		19,000
		19	9.3		13,000
1912	Apr.	8	8.5		10,800
		16	7.7		8,140
		24	8.3		9,860
		27	7.5		7,860
	May	5	7.6		7,860
		24	8.2		9,570
		29	8.1		9,570
	July	24	13.5		27,200
		24	17.4	P	45,000
	Aug.	11	9.6		14,000
	Sept.	2	12.4		23,500
		4	9.1		12,600
1913	Apr.	3	9.5		12,000
		18	9.1		12,300
	July	28	8.4		10,200
1914	Apr.	29-30	8.8		10,700
		30	8.9	P	11,000
	June	29	8.1	P	8,700
		30	7.8		7,890
1915	Apr.	13			7,150
	Aug.	6			7,520
		7	7.30	P	6,760
1916	Apr.	6-7	8.22		9,040
		14	9.42		12,600
		22	12.35		22,500
		22	12.8	P	24,100
	June	4	8.45		9,680
		9	7.7		7,630
	July	3	8.0		8,430
		3	8.1	P	8,700
1917	Apr.	10			7,480
		13			7,880
		13	8.8	P	10,700
		22			9,920
	May	2			8,950
	June	8			7,510
1918	May	28			12,900
		28	9.7	P	13,400
	June	2			11,600
1919	Mar.	27			8,950
	Apr.	11			12,500
		11		P	12,900
	June	27			8,300
	Nov.	11			8,060
1920	Mar.	29			18,700
		29		P	19,200
	June	16			7,130
1921	Mar.	21			9,840
		28			10,500
	Apr.	27	10.12	P	14,800
		28-29			13,500
1922	Apr.	11			17,700
		11	11.2	P	18,400
1923	Apr.	22			20,300
		22	11.87	P	20,700
	June	9			10,800
		9	9.2	P	11,900
1924	Apr.	17			12,500
		17	9.65	P	13,300
		27			12,200
	May	10			11,300
		14			7,370
1925	June	14		**	5,520
1926	Apr.	16			7,710
		25			7,440
	May	4			7,630
	Aug.	21			14,500
		21	10.86	P	17,400
	Sept.	21			8,430
	Nov.	16	8.01		8,430
1927	Mar.	18	10.40		15,700
		18	10.90	P	17,400
1928	Mar.	26	8.32		9,260
	Apr.	6	8.19		8,980
		24	7.68		7,630
	May	6	8.38		9,540
	Sept.	14-15	10.06		14,700
		14	11.00	P	17,700
	Oct.	5	8.82		10,700
		13	9.20		11,900
		17	9.58		13,100
1929	Mar.	19	7.70		7,630
		30	9.08		11,600
	Apr.	7	11.81		20,500
		7	12.2	P	21,900
	June	13	8.34		9,260
		29	7.65		7,370
1930	June	14	8.05	P	8,430
		16	7.65		7,370
1931	June	21	7.5		7,110
		21	7.95	P	8,430
	Nov.	25	7.65		7,360
1932	Apr.	10	8.70		10,400
		11	8.87	P	11,000
1933	Apr.	17	7.46		7,100
	May	2	7.53		7,100
		2	8.89	P	11,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Wisconsin River at Muscoda, Wis.

Location.- In sec. 1, T. 8 N., R. 1 W., at highway bridge half a mile above Eagle Mill Creek and 1 mile north of Muscoda.
Drainage area.- 10,300 square miles.
Records available.- December 1902 to December 1903, November 1908 to October 1912, and December 1913 to September 1933.
Sources of data.- Gage-height records Nov. 1, 1908, to Oct. 30, 1912, from U. S. Weather Bureau; subsequent gage-height records and entire discharge record from U. S. Geological Survey.
Gages.- Nonrecording gage prior to Nov. 21, 1929, read as follows: to tenths once daily prior to Oct. 30, 1912; to half-tenths twice daily December 1913 to Sept. 30, 1917; to hundredths twice daily Oct. 1, 1917, to Nov. 21, 1929; recording gage thereafter.
Stage-discharge relation.- Affected by shifting control and by ice. Bank-full stage, about 9 feet.
Regulation.- Flow regulated by 37 power plants upstream and 19 lakes and reservoirs (total usable capacity, 191,000 acre-feet in summer and 226,000 acre-feet in winter).
Historical data.- Flood of June 11, 1881, reached a stage of 11.1 feet.

Flood stages and discharges
(Base discharge 19,400 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1903	Mar.	27	7.88		39,300
	May	10	5.78		22,400
		20	5.78		22,400
	June	5	7.16		32,300
	July	11	6.48		26,700
	Sept.	14	5.21		19,400
		23	10.08		60,500
		25	9.88	*	59,200
	Oct.	15	6.38		26,100
....			.....		......
1909	Apr.	20	5.5		20,900
		29	6.4		26,200
	May	16	6.0		23,600
		23	5.3		19,900
1910	May	3		**	15,700
1911	May	30	5.2		19,400
	Oct.	14	9.8	*	58,500
		25	7.9		39,300
1912	Apr.	6	5.6		21,400
		14	6.1		24,200
		30	5.2		19,400
	May	30	5.7		21,900
	June	4	5.9		23,000
	Aug.	2	6.9		30,000
		20	6.2		24,800
	Sept.	10	8.8	*	46,500
....			....		......
1914	May	7-8	6.4		26,200
	June	13	8.5		44,700
	July	8	5.4		20,400
1915	Apr.	17	6.0		23,600
	May	29	5.7		21,900
1916	Mar.	27	5.6		23,100
	Apr.	9	8.7		49,500
		21	6.6		30,000
		29	9.1		53,500
		29	9.18	P	54,300
	June	10	7.0		33,200
		16	6.5		29,200
1917	Apr.	1-2	5.60		23,100
		10-11	6.82		31,600
		11	6.95	P	32,800
		19	5.72		23,800
		27	6.08		26,400
	May	8			26,400
	June	15	6.09		26,400
		25	5.14		20,300
1918	Mar.	15-16	6.1	*	20,300
		27	6.8		29,300
		30	6.9		30,100
	May	17	5.8		22,400
	June	4-5	8.0		39,900
		4	8.04	P	40,300
1919	Mar.	28	6.35		28,500
	Apr.	3	5.50		22,500
		16	7.94		41,500
	Apr.	16	7.98	P	42,300
		18	7.86		40,500
	July	2-3	5.90		24,400
	Nov.	18	6.99		30,800
1920	Apr.	2			62,200
		2	10.10	P	64,400
	June	18	5.64		23,800
		23	5.75		24,400
1921	Mar.	28	7.33		36,800
	Apr.	2	5.67		23,800
	May	6	7.57		37,700
		6	7.74	P	39,000
1922	Feb.	23	7.50	*	22,500
	Mar.	12	4.95		20,800
	Apr.	16	10.60		72,100
1923	Apr.	4	5.45		24,400
		20			30,000
		27	8.65		52,500
1924	Apr.	15	7.66		39,500
		24	7.79		40,500
		24	7.89	P	41,400
	May	2-3	7.35		36,800
		16-17	6.81		31,600
1925	June	22	5.90		24,400
		22	6.00	P	25,100
1926	Apr.	20	6.88		33,100
		26	5.22		21,200
	Aug.	29	8.22		43,000
		29	8.28	P	43,800
	Sept.	22	5.30		21,800
		25	6.20		28,000
	Oct.	4-5	5.15		21,200
		9	5.28		21,800
1927	Mar.	20-21	8.10		42,200
		20	8.20	P	43,000
	Apr.	6	4.92		19,400
		11-12	5.20		21,200
	May	16	5.12		20,600
		30	5.62		23,800
	June	28	5.12		20,600
1928	Mar.	14	6.35	*	21,200
	Mar.	31-Apr. 1	8.58		46,200
	Apr.	13	6.78		32,400
		18-19	5.45		22,500
		26	6.95		33,900
		28	6.48		30,100
	May	12	5.78		25,200
	Aug.	28	5.88		25,900
	Sept.	22	9.38		51,800
		22	9.48	P	52,600
	Oct.	15	5.15		22,500
		19	5.50		23,100
		25-26	6.55		30,900
1929	Mar.	26-27	8.81		47,800
	Apr.	6	7.38		36,900
		14	9.26		51,800

* Estimated
** Below base

Flood stages and discharges of Wisconsin River at Muscoda, Wis.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1929	Apr.	21	7.15		35,400
		30	5.43		22,500
1930	June	22	7.60		38,400
1931	June	29	3.10	**	10,500
	Dec.	1	5.06		20,400
1932	Apr.	7	4.96		19,800
		15	7.86		40,000
	May	14	5.24		21,000
1933	Mar.	31	5.24		21,600
	Apr.	7	6.20		27,900
		7	6.54	P	30,000
		11	6.44		29,300
		17	6.25		27,900
	May	7	5.51		23,400
		21	5.22		21,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kickapoo River at Gays Mills, Wis.

Location.- In sec. 28, T. 10 N., R. 4 W., at highway bridge 300 feet below power plant of Interstate Power Co., in Gays Mills, Crawford County, 2 miles below mouth of Tainter Creek and 25 miles above mouth of river.
Drainage area.- 629 square miles.
Records available.- December 1914 to June 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to half-tenths twice daily prior to 1928 and to hundredths thereafter.
Stage-discharge relation.- Considerably affected by ice. Control shifts. Bank-full stage, about 10 feet.
Regulation.- Operation of several power plants above station does not affect flood flows.

Flood stages and discharges
(Base discharge 1,260 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1914	June	23	5.3		1,260
		23	5.5	P	1,330
1915	July	30	6.6		1,760
		30	6.85	P	1,880
1916	Jan.	28	8.2		1,760
		28	8.6	P	2,760
	Feb.	18	5.5	*	1,300
		18	5.6	P*	1,370
	Mar.	27	7.7		2,010
	June	4	9.8		3,360
		4	10.00	P	3,460
1917	Mar.	24	11.02		3,500
		24	15.05	P	6,300
	Apr.	21	6.52		1,640
		21	6.75	P	1,740
	June	8	6.35		1,600
		25	7.50		1,990
		25	7.7	P	2,060
	July	23	13.15		4,740
		23	13.9	P	5,310
1918	Mar.	14	9.5		2,620
		19-20	9.8		2,740
		19	10.15	P	2,900
	May	10	9.0		2,520
		10	9.8	P	2,900
		20	6.8		1,710
		28	6.6		1,670
1919	Mar.	13	6.35		1,600
		17	11.65		3,800
		17	11.9	P	3,950
	May	8	6.58		1,600
		8	6.75	P	1,740
	Nov.	12	7.25		1,780
		12	7.3	P	1,920
1920	Mar.	27	7.38		1,880
	Apr.	2	5.82		1,360
		2	5.9	P	1.420
	May	24	7.52		1,960
	May	24	8.1	P	2,200
	June	18	10.05		2,950
		18	10.5	P	3,250
		30	9.00		2.560
1921	Sept.	6	9.08		2,360
		6	9.31	P	2,440
		17	7.93		1,920
		17	8.75	P	2,480
		21	8.60		2,160
		21	8.65	P	2,400
1922	Mar.	6-7	8.42		2,300
		6	9.10	P	2,620
		26	6.08		1,450
	Apr.	11	7.55		1,940
	June	11	5.98		1,420
1923	Mar.	3	8.40		2,260
		3	8.55	P	2,340
		12	5.60		1,270
		12	5.75	P	1,330
	Apr.	3	12.38		4,240
		3	12.50		4,300
		12	6.25		1,450
		12	6.35	P	1,510
	June	26	5.82		1,330
		26	6.9	P	1,660
1924	Apr.	8	8.06		2,140
	June	19	6.62		1,560
		24	5.98		1,340
		30	7.51		1,900
	Aug.	4	10.22		3,100
		4	10.7	P	3,370
		10	9.10		2,570
		20	9.35		2,700
1925	Feb.	10	9.00		2,470
	Mar.	10	6.66		1,560
		18	6.80		1,590
	June	15	8.95		2,470
		15	9.02	P	2,480

* Estimated

Flood stages and discharges of Kickapoo River at Gays Mills, Wis.--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1925	July	10	8.59		2,260	1929	Mar.	15	12.45		5,210
		21	8.82		2,380			15	12.80	P	5,840
	Aug.	7	5.97		1,280		Apr.	9	8.54		2,440
	Sept.	7	7.12		1,700			26	5.84		1,300
1926	Mar.	21	7.02		1,620		June	13	6.35		1,520
	Apr.	26	6.05		1,280	1930	Feb.	23-24	9.75	*	2,640
	Aug.	23-24	7.62		1,650		June	14	7.90		2,090
		24	8.9	P	2,100	1931	June	4		**	778
1927	Mar.	13	5.85		1,280	1932	Feb.	12	7.50		1,490
	May	11	9.08		2,520		Mar.	27			1,530
		11	9.25	P	2,620		June	8-9	8.65		2,010
		29	7.38		1,820		July	12	10.78		3,620
	Sept.	12	10.48		2,380			12	11.35	P	4,240
		18	9.30		2,420		Sept.	20	7.32		1,410
	Oct.	5	7.35		1,840	1933	Mar.	31	13.70		6,990
1928	Feb.	9	11.07	*	3,320			31	13.96	P	7,350
	Mar.	13	12.39		4,460		Apr.	7	9.25		2,310
		13	12.65	P	4,580			11	11.12		4,010
	July	3	7.10		1,720		May	19-20	8.33		1,780
		9	6.32		1,410		July	2	10.49		3,400
	Aug.	23	6.80		1,600	1934	Jan.	23	7.90		1,640
	Sept.	17	11.86		4,190		Apr.	5	12.25		5,000

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak)

Maquoketa River below North Fork of Maquoketa River, near Maquoketa, Iowa

Location.- In $SW\frac{1}{4}NE\frac{1}{4}$ sec. 17, T. 84 N., R. 3 E., 2 miles below North Fork of Maquoketa River and 3 miles northeast of Maquoketa, Jackson County.
Drainage area.- 1,550 square miles.
Records available.- September 1913 to September 1934.
Sources of data.- U. S. Geological Survey records except gage-height records after Oct. 1, 1927, which were kept by Iowa Railway & Light Corp., and discharge measurements, 1929 to 1931, made by Corps of Engineers, U. S. Army and furnished through University of Iowa.
Gages.- Nonrecording gage read to hundredths once daily prior to July 14, 1924; recording gage thereafter. Readings discontinued during ice periods.
Stage-discharge relation.- Seriously affected by ice. Control shifts. Bank-full stage, about 12 feet.
Historical data.- A stage of about 23.5 feet, discharge about 24,300 second-feet, was reached probably in 1905.

Flood stages and discharges
(Base discharge 3,500 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1914	June	5	13.1		7,530	1918	June	5	11.8		6,430
	Sept.	6	11.6		6,280		Aug.	18	9.0		4,400
		15	16.4		11,200	1919	Mar.	12	10.3		5,470
1915	June	13	12.8		7,260			17	15.8		10,400
	Sept.	28	18.1		13,800			17	16.57	P	11,400
		28	19.4	P	16,200		Apr.	16	8.6		4,260
	Oct.	18	9.0		4,440		May	4	15.3		9,800
1916	Jan.	22	14.3		8,700			7	11.1		5,990
		27	14.3		8,700		June	3-4	10.4		5,540
	Feb.	23	8.7		4,190			17	7.7		3,680
	Mar.	27	20.7		18,700		July	10	12.6		7,060
		27	22.0	P	21,300		Aug.	21	8.3		4,070
	June	2	11.6		6,280		Sept.	19	8.0		3,880
1917	Mar.	11	13.1		7,530		Oct.	1	8.3		4,070
		14	13.3		7,720			5	12.0		6,600
		22	8.5		4,050		Nov.	11		*	9,690
	June	13	16.4		11,200	1920	Mar.	12-13	14.0		8,400
		13	16.8	P	11,800			26	13.0		7,420
1918	Feb.	26-27	10.2		5,240		Apr.	2	11.0		5,920
	Mar.	14	8.3		3,920			20	10.3		5,470
	May	25	7.7		3,510		May	23	13.6		8,000

* Estimated

Flood stages and discharges of
Maquoketa River below North Fork of Maquoketa River, near Maquoketa, Iowa--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1920	June	3	8.4		4,140	1927	Feb.	2	9.80		4,000
1921	Apr.	21	7.7		3,590			5			7,830
	Sept.	17	12.8	*	7,240		Mar.	12			4,110
		20		*	7,500		May	10			7,880
		25		*	6,500			24			10,400
1922	Jan.	5	7.8		3,660			24	15.9	P	12,900
	Feb.	24	18.3		14,200			28			5,920
		24	18.85	P	15,200		June	21			8,100
	Mar.	20	8.9		4,460		Oct.	6			5,910
	Apr.	11	9.8		5,140	1928	Mar.	11			6,850
	May	26	11.4		6,180			13			11,100
	July	23	14.0		8,500		Aug.	30			4,470
1923	Apr.	4	20.5		18,300		Nov.	18	9.15	*	4,490
		4	20.6	P	18,500	1929	Mar.	7	12.4		7,670
	Sept.	2	12.1		6,670			14	20.2		21,000
		21	8.0		3,880	1930	Feb.	20			6,760
1924	Mar.	6	8.7		3,840			20	12.90	P	8,320
	June	24	8.7		3,840	1931	Sept.	25	8.1		4,080
	July	22	11.0		5,550			25	11.00	P	6,090
		24	9.0		4,020		Oct.	11			7,820
	Aug.	20	19.8	P	19,300		Nov.	12			4,400
		21	18.6		17,000			24	9.85		5,520
1925	Mar.	19	8.3		3,600	1932	Mar.	26			7,040
	June	17	19.1		18,000			26	15.0	P	11,400
		17	19.7	P	19,100		May	26			3,560
1926	Mar.	1	11.80	*	6,930		Dec.	25			5,600
	Sept.	9	8.95	*	4,340	1933	Apr.	1			4,730
		21		*	7,180		May	16			3,710
		21	12.8	P	8,190			20			7,580
		25	9.15		4,490			20	13.5	P	9,130
	Oct.	1			3,550		July	2			6,130
		6			4,600	1934	July	6			6,920
	Nov.	27			3,940			6	13.60	P	7,520

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Rock River at Afton, Wis.

Location.- On line between secs. 22 and 27, T. 2 N., R. 12 E., at highway bridge in Afton, Rock County, three-quarters of a mile above mouth of Bass Creek.
Drainage area.- 3,190 square miles.
Records available.- February 1914 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to hundredths twice daily February 1914 to August 1932; recording gage thereafter. Zero of gage is 743.18 feet above mean sea level.
Stage-discharge relation.- Considerably affected by ice; practically permanent during open-water season.
Regulation.- Some regulation of flood flow at several lakes and reservoirs near headwaters.

Flood stages and discharges
(Base discharge 3,200 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1914	Apr.	6-8	4.8		3,450		Apr.	1-3	9.1		9,200
	Sept.	15	6.2	*	4,530			24	6.7		5,810
1915	Mar.	5	7.7		7,190		May	1			5,810
	May	29	4.6		3,240		June	14-15	6.0		4,900
	Aug.	9-12	5.3		4,040	1917	Mar.	16	4.56		3,240
	Sept.	13	8.9		8,910		Apr.	1-2	8.65		8,470
		13	9.88	P	10,300			1	8.90	P	8,910
		26	8.3		8,040			26	5.60		4,400
	Dec.	3-4	5.3		4,040		May	6	5.60		4,400
1916	Jan.	22	8.0	*	4,900			13	4.65		3,240
		28	7.2	*	6,490		June	13	6.68		5,810
	Mar.	27	8.9		8,910		July	3-6	8.56		8,470

* Estimated

Flood stages and discharges of Rock River at Afton, Wis.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1917	Nov.	2	4.58		3,240
1918	Feb.	28	6.3		4,040
	Mar.	14	9.7		10,900
		24-26	10.5		12,700
	May	23	6.3		5,290
		27	4.6		3,240
1919	May	12	4.55		3,240
	Oct.	5	5.91		4,770
1920	Apr.	1	9.19		9,900
		1	9.25	P	10,000
		4			9,900
		20	6.57		5,550
		26	5.70		4,520
	June	23	5.38		4,160
1921	May	2	8.26		8,200
	Sept.	26	5.26		4,040
	Dec.	7-8	4.86		3,470
		17	4.72		3,260
1922	Feb.	23	8.04		7,550
	Mar.	3	7.66		7,100
		16	8.16		7,870
	Apr.	11	8.40		8,200
		11	8.65	P	8,640
		21	8.09		7,710
	May	26			3,580
1923	Mar.	12	5.78		4,510
		22	4.96		3,680
	Apr.	12-14	9.52		10,300
1924	Apr.	8-9	6.44		5,290
		28	4.98		3,580
	Aug.	20	7.70		7,100
	Sept.	8	5.60		4,270
1925	Feb.	23	5.68		4,300
		23	6.04	P	4,720
1926	Mar.	30-31	6.28		5,060
	Apr.	11-14	5.91		4,540
1927	Feb.	5	5.99		4,670
	Mar.	20	6.72		5,610
		20	6.77	P	5,750
	Apr.	29-30	4.80		3,290
	May	29	6.18		4,930
	June	4	6.68		5,610
	Oct.	7	5.60		4,180
		12	5.28		3,830
1928	Feb.	21-22	6.51		5,330
	Mar.	21	6.28		5,060
		29	6.35		5,190
	Apr.	14	7.30		6,510
		14	7.42	P	6,670
	June	29	4.96		3,500
	July	3-4	4.82		3,290
	Nov.	18	5.64		4,160
		23-25			4,160
		27	5.31		3,830
	Dec.	19-20	5.56		4,160
1929	Mar.	13	5.02		9,110
		23-24	10.81		13,000
	Apr.	8	9.51		10,100
	June	16	5.62		4,160
	Aug.	1	4.88		3,390
1930	Mar.	4	5.76		4,380
		4	5.96	P	4,620
	Apr.	21-23	5.33		3,830
	May	6	4.88		3,390
1931	Mar.	28	2.37		1,320
	Nov.	27	5.58		4,160
1932	Mar.	27	5.21		3,720
		27	5.67	P	4,270
1933	Mar.	31	6.40		5,250
	Apr.	9	7.35		6,640
	May	18-19	9.10		9,140
		18	9.28	P	9,440
1934	Apr.	11	5.25	**	2,710

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Rock River at Lyndon, Ill.

Location.- In NE¼ sec. 21, T. 20 N., R. 5 E., at highway bridge in Lyndon, Whiteside County, 14 miles above mouth of Rock Creek.
Drainage area.- 9,010 square miles.
Records available.- November 1914 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths twice daily throughout period except climatic year 1916, during which it was read once daily. During seasons of fairly constant ice effect gage was read 3 times a week. Zero of gage is 584.37 feet above mean sea level (1929 general adjustment).
Stage-discharge relation.- Affected by ice; control practically permanent. Bank-full stage, about 10 feet.
Diversion.- About 100 second-feet diverted at Sterling Dam to Illinois and Mississippi Canal.

Flood stages and discharges
(Base discharge 15,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1915	Feb.	25	12.9		23,200
	June	14	10.7		15,200
	Aug.	4	10.9		15,800
	Sept.	18	12.0		19,800
		29-30	11.6		18,300
	Oct.	4	10.8		15,100
1916	Mar.	28	17.0		39,500
	June	9	12.5		21,000
1917	Mar.	21		*	18,100
	June	14	12.26		20,200
		14	12.6	P	21,400
1918	Feb.	21-28		*	26,800
	Mar.	7	13.60	*	25,400
		16	14.42	*	28,600
		28	11.26		16,800
1919	Mar.	20	16.50		37,000
	May	5-6	14.00		27,000
	Nov.	1	12.15		20,500

* Estimated

Flood stages and discharges of Rock River at Lyndon, Ill.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1920	Mar.	13	15.96		35,000
		22	12.96		23,400
		27	16.29		36,200
......	......		.....		......
1921	Apr.	28	13.66		25,600
1922	Feb.	24	12.85		22,300
		28	13.07		23,400
	Mar.	21	12.33		20,600
	Mar.	31-Apr. 1	12.63		21,600
	Apr.	12	13.47		25,000
		12	13.8	P	26,200
		17	13.76		26,200
1923	Mar.	26-28	12.50		21,100
	Apr.	2-3	10.86		16,000
		11	14.7		29,800
1924	Aug.	9	10.90		16,000
		23	14.40		28,600
		23	14.7	P	29,800
1925	Feb.	10	13.21		23,800
		24	17.70	P	39,000
		25	16.92		35,800
	Mar.	3	15.94		23,800
1926	Feb.	26	13.66		25,800
	Mar.	2	12.26		20,400
	Apr.	10-11	13.22		23,800
	Dec.	19	12.16	*	16,900
1927	Feb.	7	15.04		31,000
		7	15.07	P	31,400
	Apr.	22	11.14		16,600
	May	2	10.66		15,400
		25	14.98		31,000
	June	4	12.10		19,700
	Oct.	14	10.88		16,000
	Dce.	30		*	20,100
1928	Jan.	1		*	17,800
	Feb.	9	12.27		20,400
	Mar.	14	10.92		16,000
	Apr.	7	10.92		16,200
		16-17	10.80		15,600
	Nov.	20	11.10		16,600
	Dec.	16	10.85		15,700
1929	Mar.	17	15.63		37,200
	Apr.	3	13.45		24,600
		13	12.20		20,400
		22	13.50		25,000
1930	Feb.	26-27	11.15		17,100
1931	Aug.	25-27	6.49	**	4,920
	Oct.	11	13.03		23,200
		11	13.40	P	24,600
1932	Mar.	28	11.20		17,100
1933	Apr.	8	11.26		17,400
	May	11	11.07		16,800
		22	12.79		22,500
		27-28	13.78		26,100
1934	Apr.	7-8	6.50	**	5,280

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Aug. 7 to Oct. 9, 1920.

Pecatonica River at Freeport, Ill.

Location.- In NW¼ sec. 32, T. 27 N., R. 8 E., at Hancock Avenue Bridge, in Freeport, Stephenson County, 2 miles above mouth of Yellow Creek.
Drainage area.- 1,330 square miles.
Records available.- September 1914 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths twice daily. Zero of gage is 739.52 feet above mean sea level.
Stage-discharge relation.- Affected by shifting control and by ice. Bank-full stage, about 16 feet.
Storage and regulation.- Little effect on flood flows from a number of dams upstream.
Historical data.- Floods of March 1916 and 1929 were the greatest known in history of Pecatonica Valley.

Flood stages and discharges
(Base discharge 2,600 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1914	Sept.	16	18.35		13,000
1915	Feb.	16-19	15.6		5,520
		28	17.1		8,520
	June	14	12.2		2,670
	Aug.	4	12.6		2,880
		4	12.72	P	2,940
	Sept.	17-18	16.1		6,310
		17	16.19	P	6,490
		28	15.80		5,810
1916	Jan.	26	16.1	*	6,310
		26	16.20	P	6,490
	Feb.	21	14.02		2,670
		23	14.1		2,770
	Mar.	28	19.4		17,000
	June	9	13.09		3,120
1917	Mar.	16	16.05		6,140
	June	14	14.02		3,830
1918	Feb.	15	16.20		6,490
		15	16.35	P	6,880
	Mar.	2	15.97		6,140
		2	16.07	P	6,310
		15	15.73		5,660
		15	15.79	P	5,810
1919	Mar.	16-17	17.20		8,790
		16	17.6	P	10,000
	May	4	13.25		3,240
		4	13.40	P	3,380
	Sept.	24	13.20		3,240
	Oct.	1-2	13.15		3,240
		6-7	13.83		3,670
		6	13.99	P	3,830
	Oct.	31-Nov. 1	13.63		3,520
	Nov.	11	12.82		3,000
1920	Mar.	16	15.40		5,250

* Estimated

Flood stages and discharges of Pecatonica River at Freeport, Ill.--Continued

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1920 Mar. 16	15.5	P 5,380	Mar. 13	12.68	2,940
27	14.81	4,560	May 12	12.91	3,020
Apr. 22	12.46	2,820	30-31	14.40	3,870
22	12.90	P 3,060	Sept. 14	13.15	3,170
1921 Aug. 20	11.82	2,600	20	12.58	2,900
1922 Feb. 25-26	18.69	14,200	Oct. 8-9	15.50	5,310
25	18.8	P 14,500	Dec. 30	14.47	3,960
Mar. 9	14.51	4,270	1928 Feb. 12	16.23	6,640
22	12.85	3,000	Mar. 16	16.7	7,810
22	12.88	P 3,060	Apr. 8	12.23	2,740
Apr. 11	14.06	3,910	Aug. 5	12.15	2,740
11	14.24	P 4,000	28	14.82	4,280
1923 Mar. 1-3	13.63	3,580	Nov. 19	14.78	4,210
5	15.07	5,080	Dec. 16-17	13.23	3,170
5	15.55	P 5,790	1929 Mar. 16	19.51	17,000
Apr. 6-7	18.23	12,600	16	19.76	P 18,400
6	18.35	P 13,100	Apr. 11	13.86	3,560
July 6	11.98	2,600	21	12.28	2,780
1924 Mar. 7	12.61	2,910	27	11.89	2,620
30	13.70	3,660	1930 Feb. 24	16.21	5,980
June 26	13.80	3,860	24	16.25	P 6,060
July 25	12.06	2,940	June 16	12.13	2,700
Aug. 7	12.48	3,120	1931 Sept. 27	10.90	** 2,240
23	14.80	4,720	Nov. 21	13.55	3,220
1925 Feb. 10	13.28	3,540	25	13.79	3,330
24	14.21	4,090	1932 Mar. 29	16.24	5,650
24	14.28	P 4,180	June 10	14.07	3,500
Mar. 21	12.39	2,880	Dec. 29	14.19	3,690
June 27	12.50	2,930	1933 Apr. 3	17.30	8,260
1926 Mar. 2	12.98	3,150	3	17.37	P 8,600
21-22	13.02	3,150	May 3	13.44	3,270
Apr. 10	14.08	4,000	9	13.15	3,180
June 14	15.08	4,040	17	12.15	2,740
Oct. 3	14.36	3,870	23	15.31	4,560
1927 Feb. 5	14.62	4,060	July 6-7	15.43	4,670
5	14.89	P 4,400	1934 Jan. 15	11.79	** 2,580

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Sugar River near Brodhead, Wis.

Location.- In sec. 26, T. 2 N., R. 9 E., at highway bridge 2 miles southwest of Brodhead, Green County, and 2 miles above Jordan Creek.
Drainage area.- 529 square miles.
Records available.- February 1914 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read twice daily to quarter-tenths.
Stage-discharge relation.- Not permanent; affected by ice. Bank-full stage, about 7 feet.

Flood stages and discharges
(Base discharge 1,000 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1914 June 28	3.8	1,100	Mar. 27	8.9	6,090
Sept. 15	8.1	4,750	May 2	3.7	1,010
15	9.0	P 6,500	June 8	4.7	1,500
1915 Feb. 24	6.9	2,970	1917 Mar. 12	6.4	1,830
Aug. 4	5.4	1,920	22	4.7	1,540
Sept. 14	10.0	8,600	June 6	3.72	1,060
18	6.4	2,550	13	6.58	2,710
27	6.7	2,790	1918 Feb. 19	5.2	* 1,010
27	6.95	P 3,070	27	8.6	* 2,490
Nov. 28	4.4	1,350	Mar. 5	7.12	3,180
1916 Jan. 23	8.2	* 4,500	14	7.87	4,350
28	8.2	* 3,450	19	5.8	2,160
Feb. 21	4.4	* 1,150	May 22	3.6	1,010

* Estimated

Flood stages and discharges of Sugar River near Brodhead, Wis.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1918	May	24	3.8		1,100
1919	Mar.	17	8.55		6,090
		17	8.7	P	6,380
	Sept.	23	4.8		1,580
	Oct.	6	6.18		2,420
	Nov.	1	4.66		1,520
1920	Mar.	13			2,360
		27	6.13		2,360
		27	6.2	P	2,420
	Apr.	22	4.04		1,160
	June	19	4.02		1,160
1921	Apr.	28	3.5		1,020
	Sept.	24	3.60		1,020
1922	Feb.	23	9.71		5,390
	Mar.	7	6.52		2,870
		22	4.11		1,320
	Apr.	11	5.65		2,240
1923	Mar.	4	4.75		1,800
	Apr.	4	8.52		7,000
		4	8.65	P	7,580
1924	Mar.	6	4.25		1,480
		29	4.74		1,780
	June	26	5.61		2,360
	July	24	4.11		1,420
	Aug.	7	4.61		1,720
		22			1,720
1925	Feb.	10	5.39		2,150
	Mar.	20	3.46		1,050
1926	Mar.	20	5.14		2,000
		20	5.3	P	2,140
	Apr.	9	3.38		1,020
	Oct.	2	3.56		1,120
		4	3.70		1,170
1927	Feb.	6	7.42		4,080
		6	7.6	P	4,440
		22	4.12		1,390
	Mar.	14	3.38		1,020
	Mar.	21	4.03		1,330
	May	11	4.20		1,450
		30	5.21		2,050
	Oct.	7			2,050
		12	3.54		1,070
1928	Feb.	9	6.44		2,920
		16	3.55		1,120
	Mar.	13	7.21		3,930
		13	7.42	P	4,250
	Apr.	8	4.12		1,450
	June	30	3.42		1,070
	Aug.	5	3,52		1,120
		25	4.96		1,990
	Nov.	19	5.62		2,320
	Dec.	15	4.39		1,570
1929	Mar.	14	9.82		10,800
		14	9.95	P	11,400
	Apr.	8	6.20		2,600
		13	3.90		1,170
1930	Feb.	21	7.26		3,930
1931	Sept.	28		**	775
	Nov.	20	4.10		1,310
		25	4.38		1,410
1932	Mar.	27	7.24		3,990
		27	7.38	P	4,350
	July	13	4.22		1,310
	Dec.	26-27	5.51		1,030
1933	Feb.	25	3.80		1,120
	Mar.	31	8.48		7,970
		31	8.81	P	9,200
	May	3	3.82		1,180
		8	4.04		1,280
		10	4.00		1,280
		13	3.46		1,030
		17	3.70		1,130
		21	8.18		6,830
	July	3	6.08		2,540

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Iowa River at Iowa City, Iowa

Location.- June 1, 1903, to July 21, 1906, in sec. 10, T. 79 N., R. 6 W., at Iowa Avenue highway bridge, Iowa City, Johnson County; Oct. 30, 1913, to Nov. 18, 1921, in sec. 15, T. 79 N., R. 6 W., at Benton Street Bridge, 500 feet below Chicago, Rock Island & Pacific Railway bridge, three-quarters of a mile below first location, and half a mile below Iowa State University dam; thereafter in sec. 15, T. 79 N., R. 6 W., 200 feet below Burlington Street Bridge and 50 feet below new hydraulic laboratory of Iowa State University.

Drainage area.- 3,230 square miles.

Records available.- June 1903 to July 1906, October 1913 to September 1934. Fragmentary record June-July 1907. Prior to winter 1918-19 no gage-height records kept when river was frozen over.

Sources of data.- U. S. Geological Survey and Iowa State University. Record for June-July 1907 from 71st Cong., 2d sess., H. Doc. 134.

Gages.- Nonrecording gage read to hundredths once daily June 1, 1903, to July 21, 1906; to half-tenths twice daily from Oct. 30, 1913, to Sept. 30, 1916; to hundredths once daily Oct. 1, 1916, to Nov. 19, 1921; recording gage thereafter. Zero of gage, 42.05 feet 1903-6, and about 39.00 feet Oct. 30, 1913, to Nov. 18, 1921; 40.0 feet Nov. 19, 1921, to Sept. 30, 1928; 39.0 feet thereafter. Elevations of zero, and gage-height records for June-July 1907 and October 1931 to September 1933 have been reduced to Iowa City datum.

Stage-discharge relation.- Affected by ice; control shifts.

Remarks.- Discharge records during periods of missing gage-height records December 1907 to October 1913 and winters 1915-18 and adjustments for ice effect and shifting control computed from records at power plant. Dam built between Burlington Street and Benton Street in the summer of 1906 drowned out first gage. Elevation of crest, 49.0 feet, Iowa City datum. Record for June-July 1907 taken at a location about 3,000 feet upstream from dam at Iowa State University.

Historical data.- Fragmentary records 1851-93 taken from 71st Cong., 2d sess., H. Doc. 134; gage heights referred to Iowa City datum but may not have been taken at location of present gage.

Flood stages and discharges of Iowa River at Iowa City, Iowa
(Base discharge 5,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1851	June				50,000
	....		.....		......
1881	July	17	63.28		40,200
	....		.....		......
1893	Mar.	13	51.8		12,000
		13	54.4	P	
	....		.....		......
1903	June	3	14.65		21,800
1904	Mar.	25	7.8		8,410
	Apr.	26	5.28		5,100
1905	Mar.	20	6.30		6,350
		25	6.50		6,600
	May	15	7.10		7,390
		24	8.00		8,710
	June	10	7.60		8,110
1906	Jan.	21	6.00		5,900
	Feb.	28	9.4		11,400
	Mar.	2	9.9		11,900
		26	5.95		5,840
	Apr.	3	7.6		8,110
	....		......		......
1907	June	10	52.6		8,000
	July	11	53.6		9,500
		15	54.2		13,000
		20	53.8		10,000
	....		......		......
1908	June	3			5,850
1909	Apr.	29			6,110
	May	20			6,640
	July	7			12,400
1910	Mar.	9			9,520
1911	Feb.	14			7,140
		17			9,680
		19			9,070
		21			8,360
1912	Mar.	20			5,410
		29			11,400
	Apr.	4			20,000
1913	Mar.	18			6,300
		24			7,030
1914	Sept.	15		*	8,000
		18	7.8		5,310
1915	Feb.	18			20,000
		24-25			20,000
	Apr.	1	7.7		5,580
	May	29	8.6		6,620
	June	4-5	10.8		9,340
	July	28	10.3		8,700
	Aug.	2	10.7		9,210
		7	7.4		5,240
	Sept.	30	12.4		11,500
1916	Jan.	26			6,240
	Feb.	1			5,280
	Mar.	26	11.8		10,500
		26	13.2	P	12,300
1917	Mar.	15			5,700
		18			5,700
		29			17,500
	June	9-22		*	7,300
1918	Feb.	16			6,500
	May	27	12.7		14,200
	June	7	19.45	P	36,200
	June	8	19.2		35,300
	July	7	8.7		7,220
1919	Mar.	12	7.3		5,430
		16	9.7		8,820
		20	9.8		9,000
	Apr.	23	8.7		7,270
		27	8.9		7,510
	May	4	9.4		8,300
		7	11.6		12,800
	June	6-7	8.5		6,940
		13	7.4		5,560
		25	7.2		5,350
	Nov.	13	8.2		6,570
1920	Mar.	17-18	9.3		8,130
		26	9.0		7,660
	Apr.	2	8.4		6,820
		23	8.0		6,330
	May	16	8.1		6,450
1921	Sept.	16	8.4		6,820
		21	12.0		13,800
		23	12.20		14,300
1922	Apr.	11	6.9		5,780
1923	Apr.	3	9.7		8,280
1924	Mar.	10	8.9		7,310
		30	7.2		5,140
	June	8	9.4		7,860
		11	7.8		5,860
		24	7.6		5,620
	July	1	15.0		19,100
		1	15.34	P	19,900
		27	10.1		9,060
	Aug.	23	7.5		5,500
1925	Mar.	21	3.35	**	1,510
1926	Sept.	23	14.94		17,400
		23	15.05	P	17,800
1927	May	12-13	8.66		6,390
		24			9,310
		24	11.8	P	10,900
	June	21			5,100
	Oct.	7	10.38		8,670
1928	Feb.	14	10.53		8,820
	Mar.	13	8.77		6,510
	Nov.	18	7.72		5,600
1929	Mar.	7	8.24	*	5,240
		16	16.47		21,900
	Apr.	25			5,380
	May	1-6	7.70		5,600
	Aug.	3			8,070
		7-8	9.94		8,310
1930	Feb.	22			5,340
		24			6,880
	June	15			11,300
		15	13.3	P	13,600
1931	Sept.	28	4.6	**	2,790
	Nov.	27	48.1		7,400
	Dec.	1	48.4		7,750
1932	Jan.	6	46.0		5,100
		17	46.3		5,400
1933	Apr.	10	48.99		8,700
	May	25-26	47.68		7,130
1934	July	18	42.20	**	1,840

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Iowa River at Wapello, Iowa

<u>Location</u>.- In sec. 27, T. 74 N., R. 3 W., at highway bridge at city limits of Wapello, Louisa County, 15.4 miles above mouth of river.
<u>Drainage area</u>.- 12,480 square miles.
<u>Records available</u>.- February 1915 to September 1934.
<u>Sources of data</u>.- Gage-height records by U. S. Geological Survey in collaboration with Mississippi River Power Co., which furnished record for 1927-33. Discharge data by U. S. Geological Survey
<u>Gage</u>.- Nonrecording gage read to hundredths once daily Feb. 26, 1915, to Sept. 30, 1924; to half-tenths once daily Oct. 1, 1924, to Sept. 30, 1931; to hundredths once daily Oct. 1, 1931, to Apr. 17, 1934; recording gage thereafter. Nonrecording gage read several times daily during high water. Prior to winter of 1920-21 gage was read two or three times a week during periods when river was frozen over.
<u>Stage-discharge relation</u>.- Seriously affected by shifting control and by ice. Levees on left bank subject to overflow at very high stages.
<u>Remarks</u>.- Levee on left bank broke during flood of June 1918.
<u>Historical data</u>.- Flood of June 1892 was probably much higher than that of June 1918.

Flood stages and discharges
(Base discharge 18,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1915	Feb.	26-27	11.5		41,800
	Apr.	1	10.0		33,700
	June	5-6	10.5		36,300
	July	31	7.7		22,600
	Oct.	1	10.5		36,300
1916	Jan.	24	8.6		20,000
		27	8.2		24,800
	Mar.	28	12.6		48,300
		28	12.7	P	48,900
	Apr.	1-2	9.6		31,700
	June	9	7.3		21,300
1917	Mar.	15	6.8		19,200
		18	6.8		19,200
		29	12.6		48,300
		29	13.20	P	52,000
	June	15	11.8		43,500
1918	Feb.	14	7.5		22,100
	May	29	9.8		32,700
	June	8	14.94	P	63,100
		9	14.5		60,300
	July	8	6.8		19,200
1919	Mar.	18	10.5		36,300
		23	10.7		37,400
		23	10.83	P	38,100
	Apr.	18	9.6		31,700
		23	8.9		28,300
	May	7	10.2		34,700
	June	7-8	7.3		21,300
		18	6.7		18,800
		26	7.3		21,300
	Nov.	13	7.8		23,400
1920	Mar.	18	7.2		20,900
		29	9.7		32,200
	Apr.	3	8.9		28,300
		23	7.7		23,000
	May	15	7.2		20,900
1921	June	5	6.4		18,800
	Sept.	24	9.5		31,900
		24	9.6	P	32,400
1922	Mar.	2	8.6		26,500
		12	7.1		20,500
		22	6.6		18,400
	Apr.	12-13	7.5		22,300
1923	Apr.	6-7	9.4		30,700
		7	9.5	P	31,200
1924	Mar.	31-Apr. 3	6.6		18,000
	June	25	7.6		22,400
		28	10.1		34,200
		28	11.23	P	40,300
	July	27	8.3		25,500
	Aug.	22-23	10.2		34,700
1925	June	21	5.10	**	12,500
1926	Sept.	25	11.76		43,500
	Oct.	3	6.7		18,500
		7-8	6.60		18,000
1927	Feb.	5	7.30		21,000
	Apr.	20	9.6		31,700
	May	11	6.95		19,700
		26	9.95		33,700
		26	10.1	P	34,200
	June	4	7.75		23,200
		22	8.1		24,600
	Oct.	9	9.0		28,800
1928	Feb.	16	9.1	*	28,000
	Mar.	15	7.8		23,200
	July	5	6.3		16,900
	Sept.	2	8.8		27,800
	Nov.	19-20	8.8		27,800
	Dec.	18	6.6		18,000
1929	Mar.	20	16.5		63,400
	Apr.	13	8.1		24,600
		20-21	8.6		26,900
		26	8.3		25,500
	May	4	9.3		30,200
1930	Feb.	26	8.4		26,000
	June	17	13.3		51,200
1931	Sept.	27-28	3.1	**	6,740
	Nov.	27	8.3		25,500
	Dec.	2	8.8		27,800
1932	Mar.	27	6.8		18,900
	Apr.	5	8.3		25,600
	June	27	7.8		23,200
1933	Apr.	7	15.24		60,800
		7	15.38	P	62,000
	May	24	9.16		28,600
1934	Apr.	11	3.27	**	7,230

* Estimated
** Below base
<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Cedar River at Cedar Rapids, Iowa

Location.- In sec. 28, T. 83 N., R. 7 W., in central part of Cedar Rapids, Lynn County, 1,000 feet above Eighth Avenue Bridge and half a mile below dam.
Drainage area.- 6,640 square miles.
Records available.- February 1903 to September 1934.
Sources of data.- U. S. Geological Survey records, except gage-height records by U. S. Weather Bureau Apr. 1, 1909, to Aug. 20, 1920, and discharge determinations by Corps of Engineers, U. S. Army, 1929-31.
Gages.- Nonrecording gage read to tenths once daily prior to Aug. 21, 1920; recording gage at same datum thereafter.
Stage-discharge relation.- Seriously affected by ice in severe winters. Control shifts occasionally. Bank-full stage, about 14 feet.
Historical data.- Flood of Mar. 19, 1929, is greatest known, the next highest having occurred in June 1851; stage, about 20 feet; discharge, about 65,000 second-feet. Gage heights for the two floods probably not comparable owing to artificial changes in channel cross-section.

Flood stages and discharges
(Base discharge 10,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1903	Mar.	14	6.25		11,200
	Apr.	18	6.4		11,800
	May	18	6.3		11,400
		31	16.55		52,400
	June	12	5.95		10,100
	July	14	7.15		14,800
		19	6.0		10,200
	Aug.	9	7.3		15,400
	Sept.	21	6.4		11,800
1904	May	29	5.55	**	8,840
1905	Mar.	11	7.0		14,500
		23	9.0		22,800
	May	20	7.9		18,200
1906	Mar.	30	16.27		50,500
	May	20	6.35		11,300
1907	Feb.	23	6.6		12,300
	Mar.	6	6.55		12,100
	July	20	8.4		19,400
	Aug.	17	8.15		18,400
1908	Mar.	11	6.2		10,800
	May	30	8.65		20,400
	June	26	8.0		17,800
1909	Mar.	8	6.5		11,900
		30	8.8		21,000
	Apr.	22	7.4		15,400
		29	6.9		13,500
	May	3	6.8		13,100
		16	6.7		12,700
	Nov.	20	7.9		17,400
	Dec.	2	7.2		15,400
		11-12	8.3		19,000
1910	Mar.	7	6.0		10,100
		14	9.5		23,700
1911	Feb.	16	6.8		13,100
		18	6.6		12,300
1912	Mar.	22	8.7		12,700
	Apr.	1	17.2		54,100
1913	Mar.	18	8.9		21,400
		25	6.9		13,500
	May	26	6.0		10,100
1914	June	19	7.7		16,600
1915	Feb.	17	7.2		14,600
		25	10.2		26,500
	Mar.	29	11.7		32,400
	June	2-3	11.0		29,600
	Aug.	6	6.2		10,800
	Sept.	28	9.3		22,900
1916	Jan.	28	6.1		10,400
	Feb.	25-26	6.5		12,000
	Mar.	19	6.4		11,600
		30	9.9		25,300
	Apr.	26	7.2		14,600
	May	20	6.2		10,800
	June	6	7.9		17,400
1917	Mar.	26	16.8		52,600
		26	17.2	P	54,200
	June	13	8.2		18,600
		29	6.8		13,100
1918	Mar.	23	6.4		10,400
	May	25	7.0		12,500
	June	7-8	10.5		26,200
1919	Mar.	20	11.4		29,700
	Apr.	15	9.4		21,800
	May	5	6.7		11,400
		7	7.0		12,500
	June	15	7.2		13,300
		23	6.4		10,400
1920	Mar.	26	7.0		12,500
		30	7.5		14,400
	Apr.	21	6.4		10,400
	May	23	6.9		12,200
1921	June	1	8.0		16,300
		1	8.4	P	17,900
	Sept.	21	6.6		11,100
1922	Feb.	26-27	10.9		28,300
		26	12.15	P	33,300
	Mar.	11	6.2		10,100
	Apr.	15-16	6.6		11,500
1923	Apr.	4	7.7		15,700
		4	7.80	P	16,000
1924	Mar.	8	6.60		11,400
	Apr.	1	6.2		10,100
	Aug.	22	10.1		24,500
		22	10.54	P	26,300
1925	June	18	6.8		12,200
		18	7.00	P	12,800
1926	Sept.	21	6.12	**	9,450
1927	May	25	6.73		11,500
		25	6.77	P	11,800
	June	1	6.38		10,500
1928	Feb.	12	7.48		14,300
	Aug.	29	10.88		28,500
		29	11.05	P	29,200
1929	Mar.	19	19.1		67,200
		19	20.1		72,000
	Apr.	9	7.62		14,800
		16	6.62		11,200
		30	9.00		20,300
1930	Feb.	24	6.86		12,200
1931	Sept.	26	4.01	**	3,020
	Nov.	28	8.05		16,300
1932	Mar.	4	6.50		10,800
	Apr.	2	8.64		18,600
		2	8.73	P	19,100
	June	23	8.23		17,100
1933	Apr.	4	18.26		63,300
		4	18.60	P	64,800
	May	22	7.03		12,600
1934	Apr.	9	5.49	**	8,440

** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Skunk River at Coppock, Iowa

Location.- In sec. 1, T. 73 N., R. 8 W., at highway bridge one eighth of a mile above Chicago, Burlington & Quincy Railroad bridge at Coppock, Henry County, and a quarter of a mile above mouth of Crooked Creek.
Drainage area.- 2,890 square miles.
Records available.- October 1913 to September 1934.
Sources of data.- U. S. Geological Survey 1913-26, 1932-34; Mississippi River Power Co. 1927-32.
Gage.- Nonrecording gage read to hundredths once daily except winters prior to 1920-21 when gage was read once a week or oftener while the river was frozen over. Subsequent to 1917 several readings daily during rapidly changing high stages.
Stage-discharge relation.- Affected by ice and by drift lodging against railroad bridge below gage at high water. Control shifts.
Historical data.- Greatest known flood on or about May 31, 1903, gage height, about 22 feet; estimated discharge, 25,000 second-feet; determined from high-water marks and flow at comparable stations.

Flood stages and discharges
(Base discharge 5,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1914	Sept.	22	11.4		6,430
1915	Feb.	24	14.4		10,700
	May	27	11.1		6,260
	June	8	11.1		6,260
		13	10.9		6,020
	July	11	13.3		9,090
		25	11.5		6,740
	Aug.	4	16.3		13,700
	Sept.	11	10.9		6,020
		16	11.3		6,500
		29	12.9		8,540
	Oct.	2	14.4		10,700
1916	Jan.	25	11.9		7,230
		27	12.6		8,130
	Feb.	24	10.0		5,040
	Mar.	2	10.2		5,260
		27	17.1		15,000
	May	15	11.6		6,860
		25	10.0		5,040
	June	7	10.0		5,040
	Sept.	6	10.8		5,910
1917	Mar.	14	11.9		7,230
		17	10.1		5,150
	May	1	12.0		7,360
		5	10.2		5,260
		22	11.1		6,260
	June	7	16.6		14,200
		14	17.3		15,400
		14	17.5	P	15,700
1918	May	29-30	11.8		7,100
	June	9	19.7	P	19,600
		10	19.3		18,800
1919	Mar.	17	14.9		11,500
		17	15.02	P	11,700
	May	5	14.0		10,100
	June	9	12.6		8,130
	Nov.	11	11.0		6,140
1920	Mar.	12		*	6,000
		18			5,910
		27	15.4		12,200
		27	15.43	P	12,300
	Apr.	2	11.6		6,860
		20	13.2		8,950
		24	12.3		7,740
		30	10.4		5,470
	May	13	12.4		7,870
1921	May	11	10.4		5,480
	June	18-19	12.8	*	7,480
	Sept.	21	11.6		6,860
		27	14.60		11,000
1922	Feb.	23	10.7		5,800
	Mar.	11	10.8		5,910
		11	10.85	P	5,970
	July	23-24	10.7		5,800
1923	Apr.	1-2	10.2		5,260
		2	10.24	P	5,300
	Oct.	1	10.8		5,580
1924	Mar.	11	12.2		7,610
		30	11.0		6,140
	June	25	11.2		6,370
		29	18.85		18,000
	July	4	11.8		7,100
		25	13.1		8,810
	Aug.	7	11,0		6,260
1925	June	4		**	4,360
1926	June	15	13.82		9,520
	Aug.	1	10.17		4,940
	Sept.	10	14.28		10,100
		16	17.62		15,400
		26	19.10		17,900
		27	19.34	P	18,200
1927	Feb.	6	14.52		10,400
	Apr.	2	10.52		5,260
		16	11.52		6,500
		19	15.27		11,600
		19	15.42	P	11,800
	May	10	10.57		5,360
		25	11.28		6,140
	June	4	11.22		6,020
1928	Feb.	13	10.5		5,580
	June	30	14.0		10,100
	July	4	13.6		9,520
	Aug.	6	14.3		10,600
	Nov.	19	14.1		10,200
	Dec.	14	10.7		5,800
1929	Mar.	19	17.7		16,000
	Apr.	1	11.4		6,620
		20-21	13.5		9,380
		26	14.4		10,700
1930	June	15	20.8		22,200
		15	22.13	P	25,200
1931	Sept.	28	8.2	**	3,360
	Nov.	18	10.6		5,690
		20	10.2		5,260
		29	15.3		12,100
1932	Jan.	1-2	12.9		8,540
		18	10.6		5,690
	June	26	11.8		7,100
		28	11.6		6,860
	July	5	10.7		5,800
		11	10.8		5,910
	Aug.	13	11.0		6,140
1933	Mar.	31	10.50		5,580
	May	13	12.70		8,260
		25-26	13.89		9,960
		26	13.98	P	10,100
1934	Jan.	26	6.17	**	1,640

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Des Moines River at Keosauqua, Iowa

Location.- In sec. 36, T. 69 N., R. 10 W., at county bridge in Keosauqua, Van Buren County, a quarter of a mile above old dam site and Government locks.
Drainage area.- 13,900 square miles.
Records available.- May 1903 to July 1906, April to December 1910, and August 1911 to September 1934.
Sources of data.- U. S. Geological Survey May 1903 to July 1906 and August 1911 to September 1927; Corps of Engineers, U. S. Army April to December 1910; gage-height records by Mississippi River Power Co. October 1927 to December 1933; discharge determinations by U. S. Geological Survey October 1927 to September 1934.
Gages.- Nonrecording gage read to half-tenths once daily prior to Dec. 22, 1933, with these exceptions: prior to 1916 observations discontinued during ice periods; 1916-21 gage read two or three times a week while river was frozen over; subsequent to 1916 Sunday readings were discontinued; subsequent to August 1911 several observations made daily during times of rapid change at high stages. Recording gage installed Dec. 22, 1933.
Stage-discharge relation.- Considerably affected by ice. Control shifts.
Historical data.- Greatest known flood prior to that of June 1, 1903, was that of June 1, 1851, stage, about 24 feet, estimated discharge, about 80,000 second-feet.

Flood stages and discharges
(Base discharge 17,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1903	June	1	27.70		97,100
		24	7.15		21,100
	July	15-16	6.10		17,200
		23	6.30		18,000
	Aug.	31	10.20		32,400
	Sept.	10	7.40		22,000
		24-25	6.20		17,600
1904	Mar.	25	7.35		21,800
	Apr.	9	6.88		20,100
		12-13	6.28		17,900
		26-27	15.15		43,300
	July	22	8.08		24,500
	Sept.	28	6.60		19,100
1905	Mar.	1	9.40		26,200
	May	15	8.60		23,400
	June	10	22.80		75,800
	July	1	9.40		26,200
	Aug.	25	8.2		22,000
	Oct.	19	7.6		19,900
1906	Jan.	21	7.90		21,000
	Feb.	25	10.65		30,800
	Mar.	30	9.88		28,000
	Apr.	16	7.82		20,700
		18	7.75		20,400
......	......		....		......
1910	Apr.	6		**	11,800
......	......		....		......
1911	Sept.	29		**	12,600
1912	Apr.	4	16.6		54,700
1913	May	16	8.1		22,400
		21-22	9.2		26,200
1914	Sept.	18	10.8		31,900
1915	Feb.	16	10.0		29,000
		25	12.2		37,000
	June	3	16.4		52,600
		19	6.6		17,500
	July	11	6.6		17,500
		15	7.2		19,500
		24	17.0		54,800
	Aug.	3	18.2		59,200
	Sept.	18	7.4		20,100
		28	9.9		28,600
	Oct.	2	10.1		29,400
1916	Jan.	22	7.4		20,100
	Feb.	23	10.2		29,700
	Mar.	17-18	6.7		17,800
		27	13.7		42,600
		27	14.2		44,400
	May	1	6.6		17,500
		15	9.7		28,000
		24	10.1		29,400
1917	Mar.	29	9.2		26,200
	May	1	7.6		20,800
	May	5	8.0		22,100
	June	6	14.8		46,700
		14	17.8		57,800
1918	May	29	9.0		25,500
	June	10-11	12.8		39,300
		25	13.0		40,000
1919	Mar.	17	14.0		43,700
	Apr.	13	8.0		22,100
		17	8.3		23,100
		26	10.8		31,900
	May	8	13.5		41,800
	June	8	11.9		35,900
		12	8.8		24,800
		24	7.5		20,400
	Nov.	11	8.1		22,400
1920	Mar.	17	8.7		24,500
		26	14.1		44,100
	Apr.	4	7.1		19,100
		21	11.2		33,300
		28	7.7		21,100
	May	15	10.2		29,700
	July	14	10.9		32,200
1921	Apr.	20	6.5		17,200
	June	3	6.9		18,500
	Sept.	18	8.9		25,200
		21	9.4		26,900
		21	9.45	P	27,100
1922	Apr.	17	8.4		23,500
	May	28	9.4		26,900
	July	19	6.8		18,200
1923	Mar.	28	9.2		26,200
1924	Mar.	5-6	8.8		24,800
		30	8.2		22,800
	June	10	7.2		19,500
		28	13.0		40,000
		28		P	41,800
1925	June	16	7.30		19,800
1926	June	16	9.45		26,900
	Sept.	9	9.50		27,200
		15	11.55		34,800
		25	11.50		34,400
	Oct.	6	7.65		20,800
1927	Feb.	5	7.00		18,800
	Apr.	16	9.05		25,500
		19	13.95		43,700
	May	1	7.4		20,100
		19	6.96		18,800
		25	9.35		26,900
	June	4	8.75		24,800
1928	Aug.	5	7.2		19,500
	Nov.	18	10.6		31,200
	Dec.	16	6.5		17,200
1929	Mar.	17	13.5		41,800

** Below base

Flood stages and discharges of Des Moines River at Keosauqua, Iowa--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1929 Apr.	1	7.0	18,800	Jan.	15	8.2	22,800
	20	10.4	30,400	Mar.	6	9.3	* 25,500
	25	11.3	33,700	June	28	8.5	23,800
	28	9.3	26,600	July	10	8.9	25,200
1930 June	15	9.8	28,300	Aug.	13	8.9	25,200
1931 July	3	6.7	17,800		18	7.6	20,800
Oct.	8	9.2	26,200	1933 Apr.	1	7.40	20,100
Nov.	25	11.6	34,800		8	7.15	33,300
1932 Jan.	4	10.6	31,200	1934 Apr.	4	3.70	** 8,740

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Raccoon River at Van Meter, Iowa

Location.- In SW$\frac{1}{4}$ sec. 22, T. 78 N., R. 27 W., at highway bridge a third of a mile from railraod station at Van Meter, Dallas County, 1 mile below junction of North and South Raccoon Rivers and 30 miles above junction of Raccoon and Des Moines Rivers.
Drainage area.- 3,410 square miles.
Records available.- April 1915 to July 1934.
Sources of data.- U. S. Geological Survey except gage-height records since Nov. 4, 1927 by U. S. Weather Bureau.
Gages.- Nonrecording gage read to hundredths once daily prior to May 31, 1923; to tenths once daily Nov. 5, 1927, to Aug. 8, 1934; recording gage May 31, 1923, to Nov. 4, 1927, and subsequent to Aug. 8, 1934. In general daily gage readings were discontinued during ice periods. Zero of gage is 841.12 feet above mean sea level.
Stage-discharge relation.- Seriously affected by ice. Control shifts. Rating well defined to 15,000 second-feet. Bank-full stage, about 13 feet.

Flood stages and discharges
(Base discharge 4,680 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1915 May	29	15.8	22,900	1922 Feb.	25-26	7.6	* 4,760
July	13	8.0	5,320	Apr.	11	12.0	11,200
	19	13.3	13,900	1923 Mar.	27	11.3	9,780
	29	11.8	11,000		27	11.50	P 10,100
Sept.	30	12.9	18,700	Oct.	4	11.1	9,470
Oct.	20-21	7.5	4,680	1924 Mar.	2	10.7	8,880
1916 May	25-26	6.9	** 3,960		5	8.0	5,390
1917 Mar.	23	10.9	9,540		29	11.2	* 9,100
	27	10.2	8,450	June	8	11.0	9,320
June	7	17.5	31,800		17	8.1	5,520
	10	16.8	28,000		25	14.2	16,300
	13	13.5	14,300		25	15.23	P 20,100
1918 May	27	8.4	5,860	1925 June	17	8.1	5,520
June	8	13.6	14,600		17	8.45	P 6,000
1919 Mar.	16	9.6	7,450	Aug.	8	8.2	5,640
Apr.	24	12.4	12,000	1926 June	14		8,370
	30	7.6	4,880	Sept.	3		4,750
May	4	12.2	11,600		12	10.85	8,450
June	4	11.1	9,670		20		34,800
	6	10.5	8,740		20	18.96	P 40,000
	11	10.8	9,200	1927 Feb.	8	9.6	6,750
	17	9.4	7,180	Apr.	17-18	8.26	5,130
	21	8.1	5,490	May	26-27	8.90	5,850
	28	7.8	5,120	1928 Aug.	27	10.5	8,000
Oct.	1	8.4	5,860	Dec.	14	8.0	* 4,770
	5	8.4	5,860	1929 Mar.	12	15.5	20,200
Nov.	10	9.7	7,590		12	18.5	P 37,700
1920 Mar.	5	11.5	5,500		14	16.0	22,600
	13-14	12.2	* 9,000	1930 May	13-16	8.8	5,870
Apr.	21	9.0	6,640	1931 June	21	8.1	5,030
May	13	10.0	8,010	Nov.	24	13.0	12,300
1921 Feb.	17	9.2	6,910		24	14.2	P 15,400
June	1	7.8	5,120	1932 Jan.	1	12.3	10,900
Sept.	20	11.0	9,510		5-6	10.0	7,420

* Estimated
** Below base

Flood stages and discharges of Raccoon River at Van Meter, Iowa--Continued

Date	Gage height (feet)	Discharge (second-feet)
1932 Jan. 13	8.0	4,910
Mar. 4	14.0	14,800
4	14.2	P 15,400
June 20	8.3	5,270
1933 Jan. 25	8.0	4,910
Apr. 5	10.0	7,420
1934 Apr. 7	5.0	** 2,020

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kankakee River at Momence, Ill.

Location.- In NE¼ sec. 24, T. 31 N., R. 13 E., at highway bridge in Momence, Kankakee County, 1½ miles above mouth of Tower Creek.

Drainage area.- 2,340 square miles.

Records available.-February to December 1905, February to July 1906, December 1914 to September 1934.

Source of data.- U. S. Geological Survey.

Gage.- Nonrecording gage read probably to tenths twice daily, 1905-6; to hundredths twice daily Dec. 3, 1914, to Apr. 30, 1917; to hundredths once daily May 1, 1917 to Feb. 15, 1931, and to hundredths twice daily thereafter. Zero of gage is 5.38 feet above Momence City datum and 610.32 feet above mean sea level.

Stage-discharge relation.- Affected by shifting control, by aquatic growth during spring and summer, and by ice in winter. Banks not overflowed at high stages.

Remarks.- A maximum stage of 7.5 feet on Jan. 21, 1916, resulted from combined effect of ice and high discharges.

Flood stages and discharges
(Base discharge 2,970 second-feet)

Date	Gage height (feet)	Discharge (second-feet)
1905 Feb. 28	3.8	5,030
Mar. 2	3.9	5,300
7	4.5	6,960
19-20	3.05	3,090
25-26	3.2	3,460
Apr. 22	3.2	3,460
May 12	4.5	6,960
17-18	3.95	5,700
27	3.75	4,900
June 11	3.3	3,710
18-19	3.0	2,970
Sept. 3	3.05	3,090
....	....	.....
1906 Feb. 25	3.10	3,210
Mar. 4	3.42	4,020
8	3.30	3,840
28	3.25	3,580
Apr. 10	3.50	4,230
....	....	.....
1915 Feb. 26	3.8	5,180
July 11	3.8	4,640
15	3.8	4,640
1916 Jan. 22	5.7	* 11,400
22	6.4	P* 14,000
31	4.2	6,300
Apr. 3-8	3.5	4,370
May 30-June 1	3.3	3,850
June 16-17	2.95	2,980
22	3.3	3,850
1917 Mar. 15	2.95	2,980
23	3.10	3,350
Apr. 6-7	3.48	4,370
29	3.08	3,350
1918 Feb. 25	4.15	6,300
Dec. 24-27	3.60	4,370
1919 Mar. 18-21	4.60	7,060
20	4.65	P 7,200
May 5-10	3.80	4,930
1920 Mar. 12	4.00	5,480
Mar. 26	3.62	4,370
Apr. 22	4.20	5,940
May 1	4.17	5,940
13-14	3.40	3,830
18-20	3.36	3,830
1921 Mar. 25	3.29	2,970
Dec. 3-5	3.28	2,970
20	3.27	* 2,970
1922 Jan. 6	3.33	* 2,970
Mar. 16-17	3.28	3,230
20-23	3.90	4,820
Apr. 1-4	4.60	6,850
11-12	5.48	9,650
May 27	3.25	2,980
1923 Mar. 16	3.80	4,430
May 18-19	3.79	4,150
Dec. 7-8	3.60	3,870
15	4.24	5,600
1924 Feb. 7	4.33	6,200
15	3.36	3,340
Mar. 14-15	3.28	3,090
30	4.56	6,800
June 10-12	3.75	4,150
29	4.49	6,500
1925 Mar. 20	3.74	4,430
1926 Feb.27-Mar.1	4.00	4,720
Mar. 26	3.46	3,420
Apr. 10-11	5.05	7,870
25-27	3.38	3,190
June 15	3.57	3,660
Oct. 4	3.82	4,170
Nov. 17	3.47	3,420
1927 Feb. 1	5.77	5,620
6-8	4.70	6,890
Mar. 14-15	3.72	3,910
21-23	3.78	4,170
Apr. 20	4.80	7,210
30	4.64	6,570
May 25	4.27	5,620

*Estimated

Flood stages and discharges of Kankakee River at Momence, Ill.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1927	June	4	4.35		5,930
	Oct.	3	3.38		3,150
	Nov.	30-Dec. 2	4.39		5,930
	Dec.	15	5.30		8,890
1928	Jan.	11	5.00	*	6,570
		21	4.70	*	5,930
	Feb.	19-20	3.78		4,140
	Mar.	25-27	3.38		3,150
	Apr.	9	4.00		4,700
1929	Jan.	9	5.64		3,490
		24-25	7.06		9,650
	Feb.	16	5.80		3,270
		28	3.94		4,210
	Mar.	18-19	4.63		6,240
		22	4.70		6,560
	Apr.	1-2	4.22		5,020
		13	4.66		6,560
		21	4.28		5,310
		26-27	4.50		5,920
	May	3-5	4.82		6,890
		15	4.38		5,610
	June	17	3.60		3,490
1930	Jan.	1-2	4.75	*	3,600
		7	4.09	*	4,740
		15	4.49		5,920
	Feb.	13	3.41		3,150
		25-26	4.26		5,580
	Apr.	1	3.78		4,170
		16	3.80		4,170
		21	4.06		5,000
1931	May	12-13	3.10	*	2,500
	Nov.	25-26	3.69		3,290
1932	Jan.	22-25	3.72		3,290
	Feb.	12-14	3.72		3,290
	Mar.	28-Apr. 1	4.04		4,000
	Dec.	27	4.04		4,120
		29	3.86		3,880
1933	Feb.	1	3.49		2,970
	Mar.	21	4.01		4,120
		27	4.06		4,370
	Apr.	1	4.78		6,260
		17-19	4.42		5,150
	May	12-14	4.86		6,550
1934	Apr.	6-10	3.30	**	2,570

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Fox River at Algonquin, Ill.

Location.- In NW¼ sec. 34, T. 43 N., R. 8 E., at Chicago Street Bridge, Algonquin, McHenry County, 100 feet above Public Service Co.'s dam and 300 feet above Crystal Lake outlet.
Drainage area.- 1,340 square miles.
Records available.- October 1915 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths twice daily, except during the period Oct. 1, 1926, to Feb. 15, 1931, when it was read to hundredths once daily. Zero of gage is 729.31 feet above mean sea level (1929 general adjustment).
Stage-discharge relation.- Permanent for high stages.
Regulation.- Undetermined amount infrequently from Fox chain of lakes and Lake Geneva.

Flood stages and discharges
(Base discharge 1,800 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1915	Oct.	3	2.86		2,430
1916	Jan.	28-29	3.49		3,480
	Mar.	31	4.85		6,070
		31	5.3	P	8,000
	June	12-15	2.78		2,260
1917	Mar.	28-29	2.80		2,260
1918	Mar.	6	4.34		5,400
		14	4.43		5,600
1919	Mar.	21-22	4.00		4,800
	May	6-7	2.89		2,730
1920	Mar.	19-20	3.93		4,450
		30	4.16		5,050
1921	May	1	4.12		4,850
		1	4.15	P	4,950
	Dec.	7	2.56		2,100
		23-24	2.60		2,100
1922	Mar.	4-5	3.00		2,750
	Apr.	4	2.95		2,750
1923	Mar.	28	2.38		1,800
	Apr.	12-14	3.3		3,280
1924	Apr.	4	3.50		3,660
	July	1-2	2.49		1,950
	Aug.	13-14	3.47		3,660
1925	Feb.	25-26	2.44		1,880
1926	Sept.	25-30	2.21	**	1,500
	Oct.	4-8	2.67		2,220
	Nov.	19-21	2.77		2,380
	Nov.	30-Dec. 1	2.67		2,220
1927	Feb.	11	2.93		2,550
		16	3.01		2,720
		21	2.77		2,380
		24	2.77		2,380
	Mar.	20-21	2.67		2,220
	Apr.	9-10	2.67		2,220
		21-24	2.67		2,220
		30	2.75		2,380
	May	13-14	2.45		1,840
	June	1-15	2.55		2,060
1928	Mar.	16-18	2.45		1,840
	Apr.	10-11	3.15		3,080
	June	30	2.47		1,840
	July	6-9	3.07		2,900
	Nov.	21-25	2.87		2,550
	Dec.	18-19			2,380
1929	Mar.	16	4.37		5,450
	Apr.	22-23	3.37		3,450
	May	13-14	2.47		1,840
1930	Feb.	27-Mar. 1	2.68		2,260
	Apr.	25-26	2.58		2,100
	May	6	2.56		2,100

** Below base

Flood stages and discharges of Fox River at Algonquin, Ill.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1931	Mar.	28-Apr. 1	1.66	** 755		May	13-16	3.37	3,470
1932	Apr.	1-3	2.46	1,880			27-31	3.16	3,100
1933	Apr.	11-12	2.86	2,580		Nov.	5	1.88	** 1,040

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Vermillion River at Streator, Ill.

Location.- Prior to Sept. 24, 1925, in SE¼ sec. 2, T. 30 N., R. 3 E., at former highway bridge 300 feet upstream from present South Bloomington Street Bridge, Streator, La Salle County; thereafter at South Bloomington Street Bridge.

Drainage area.- 1,080 square miles.

Records available.- July 1914 to June 1931 except October and November 1920 and February to June 1921.

Source of data.- U. S. Geological Survey.

Gage.- Nonrecording gage read to hundredths twice daily prior to Aug. 22, 1916; to hundredths once daily thereafter. Relation between gage datums at two sites not determined.

Stage-discharge relation.- Affected by shifting control and by ice.

Diversions.- Subsequent to 1926 water supply for city of Streator, diverted from river 1 mile above station and returned as sewage through Prairie Creek, 2 miles below gage.

Flood stages and discharges
(Base discharge 2,500 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1915	Feb.	2	7.6	2,510		Aug.	22	8.50	2,990
		5	9.3	3,720	1925	Feb.	9	8.10	2,710
	Aug.	1	8.9	3,410		Mar.	20-21	8.00	2,640
		3	15.7	9,340	1926	Feb.	26	8.68	2,820
		3	18.35	P 12,000		Apr.	8-9	12.20	5,700
	Sept.	19	8.8	3,340			24	9.08	3,120
1916	Jan.	21	19.5	13,100		Sept.	5	13.50	6,870
		21	22.4	P 16,000			15	11.80	5,340
		27	8.3	2,990			24	16.12	9,400
		31	11.4	5,400		Oct.	2	19.40	12,400
	Mar.	28	8.2	2,920		Nov.	15	17.10	10,000
	May	16	9.5	3,880			26	10.80	4,350
	June	9	7.8	2,640	1927	Feb.	3	13.90	7,010
		23	8.7	3,270			5	19.33	12,200
1917	Mar.	13	11.43	5,400		Mar.	14	8.47	2,630
	June	6	11.80	5,750			21	11.56	4,990
		13	10.32	4,520		Apr.	4	9.62	3,400
1918	Feb.	15	11.00	5,080			19	18.76	11,800
1919	Mar.	17	12.95	6,830			29	9.59	3,400
	May	5	9.39	3,800		May	19	17.53	10,400
1920	Mar.	12	14.08	7,820			23	18.10	11,000
	Apr.	30	22.88	16,500		June	2	10.00	3,710
....			.....	......			4	16.70	9,650
1921	Nov.	20	8.65	3,200		Oct.	1	9.40	3,260
	Dec.	2	7.90	2,710		Nov.	30	9.84	3,550
1922	Mar.	15	9.50	3,880		Dec.	11	8.90	2,910
		20	10.90	5,000			14	13.00	6,200
		26	9.80	4,120	1928	Jan.	12	9.80	3,550
	Apr.	1-3		* 6,500	1929	Jan.	26	8.71	2,770
		11	18.80	12,400		Feb.	27	12.94	6,110
1923	May	18	7.70	2,570		Mar.	5	9.32	3,190
1924	Mar.	1	7.90	2,580			16	14.50	7,550
		30-31	8.90	3,270		Apr.	1	8.52	2,630
	June	9	8.00	2,640			11	9.15	3,120
		25	10.00	4,140	1930	Feb.	24	10.67	4,270
		28	12.60	6,410		Apr.	19	11.81	5,150
	Aug.	9	10.70	4,700			21	11.61	4,990

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Sangamon River at Monticello, Ill.

Location.- In $SW\frac{1}{4}$ sec. 12, T. 18 N., R. 5 E., at Illinois Central Railroad bridge half a mile west of Monticello, Piatt County.
Drainage area.- 550 square miles.
Records available.- February 1908 to December 1912, June 1914 to September 1921, and December 1921 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths once daily prior to Feb. 15, 1931, and to hundredths twice daily thereafter.

Stage-discharge relation.- Affected by shifting control and by ice.
Remarks.- Gage heights from various periods in record are not comparable because many and extensive channel changes have been made.

Flood stages and discharges
(Base discharge 1,500 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1908	Feb.	17	12.0		4,250
		27	10.6		2,540
	Mar.	8	10.8		2,760
	Apr.	27	11.1		3,120
	May	8	13.5		6,560
		14	15.2		9,280
		18	12.0		4,250
1909	Feb.	25-26	11.1		3,120
	Apr.	8	9.8		1,740
		14-15	10.9		2,880
		22	10.5		2,430
	June	14	9.7		1,660
	July	12	14.85		8,720
1910	Jan.	21-22	10.2		2,120
1911	Apr.	16	10.10		2,020
	Sept.	29	9.56		1,550
	Nov.	20	10.20		2,120
1912	Feb.	27	10.8		2,760
	Mar.	20	13.9		7,200
		29	11.7		3,860
	Apr.	20	10.3		2,220
		30	11.9		4,120
	May	13	9.8		1,740
....			....		.....
1913	Mar.	25	17.7	*	13,600
....			.....		......
1915	Aug.	1	13.6		4,860
		1	13.65	P	4,940
		17	11.7		2,640
		21	12.3		3,200
	Sept.	20-21	10.4		1,810
1916	Jan.	24	11.0		2,140
		31	13.7		5,020
1917	Mar.	16	10.20		1,540
	June	9	12.0		2,530
1918	Feb.	14	14.40		6,180
	Apr.	23	9.98		1,610
		29	9.92		1,560
	June	26	11.2		2,270
	Dec.	25	10.9		2,060
1919	Mar.	18	13.0		4,650
	June	25	15.15		7,370
1920	Mar.	15	11.0		2,500
		27-29	10.65		2,080
	Apr.	22	14.85		7,960
	May	12-13	10.55		2,080
		18	12.95		5,150
1921	Mar.	28-29	10.4		1,880
	May	27	10.4		1,880
	Sept.	4	10.5		1,980
1922	Mar.	17	12.00		3,750
		31	12.80		4,870
	Apr.	9	11.70		3,360
		13	13.45		5,750
		17	11.90		3,620
	May	30	10.30		1,800
1923	Mar.	16	13.40		5,250
	May	14	13.20		4,950
	May	18	13.25		4,950
	Aug.	11	12.20		3,560
	Oct.	22	11.40		2,570
	Dec.	8	11.3		2,460
		14	11.7		2,930
1924	Feb.	7	11.2		2,350
	Mar.	31	11.2		2,350
	June	9	10.7		1,890
		30	13.3		5,100
	Aug.	21	13.2		4,950
		21	13.4	P	5,250
		25	11.8		3,050
	Sept.	3	10.5		1,750
1925	Feb.	9	10.80		1,970
	Mar.	19	10.90		2,060
1926	Feb.	27	10.95		2,330
	Apr.	8	13.20		5,420
		8	13.3	P	5,580
	Sept.	7	13.30		5,580
		13	12.30		4,030
		28	12.70		4,630
	Oct.	4	18.40		15,400
	Nov.	18	11.80		3,320
1927	Feb.	3	12.00		3,600
	Mar.	22	13.60		6,060
	Apr.	4	11.80		3,320
		11	10.50		1,850
		21	13.80		6,400
	May	21	12.20		3,880
		27	11.30		2,670
	June	6	10.90		2,220
	Oct.	3	10.4		1,770
	Dec.	1	12.7		4,630
		10	12.5		4,330
		16	11.5		2,920
1928	Feb.	8-9	10.4		1,770
		15	10.7		2,020
1929	Jan.	23	12.9		4,940
	Mar.	1	10.2		1,530
		18	11.2		2,350
	Apr.	3	11.2		2,350
		11	12.6		4,090
	May	6	10.9		2,060
		20	11.3		2,460
	July	8	14.7		7,270
1930	Jan.	4	11.6		2,810
		15	11.6		2,810
	Feb.	26	11.3		2,460
	Apr.	18	10.7		1,890
		23	10.9		2,060
1931	Sept.	19	10.48		1,740
1932	Jan.	19	10.18		1,530
1933	Mar.	20	12.77		4,390
		27	10.56		1,690
	Apr.	3	11.39		2,370
	May	12	14.41		7,920
		23	11.66		2,740

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Sangamon River at Riverton, Ill.

Location.- In SW¼ sec. 9, T. 16 N., R. 4 W., at Wabash Railway bridge in Riverton, Sangamon County, 5 miles below mouth of South Fork.
Drainage area.- 2,560 square miles.
Records available.- February 1908 to December 1912, and August 1914 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths once daily prior to August 1916; to hundredths once daily August 1916 to Feb. 15, 1931; and to hundredths twice daily thereafter. Zero of gage is 503.15 feet above mean sea level.
Stage-discharge relation.- Affected by shifting control and by ice.
Historical data.- Flood of 1883 reached a gage height of approximately 32 feet on present gage; that of 1875 said to have been 0.5 foot lower, (discharge not estimated).

Flood stages and discharges
(Base discharge 7,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1908	Feb.	27	22.1	8,010		Nov.	24-26	21.22	8,080
	Mar.	10	22.3	8,230	1922	Mar.	16-17	27.22	20,300
	May	9	26.4	13,100		Apr.	2-3	24.73	14,500
1909	Apr.	23	22.6	8,580			11	28.22	22,700
	July	15	24.3	10,600			19	26.77	19,300
1910	Jan.	21	21.2	7,020	1923	Mar.	20	23.62	11,000
1911	Jan.	16	21.6	8,010		Oct.	21-22	21.00	7,800
	Apr.	16	20.9	7,060	1924	Apr.	1-4		8,500
	Oct.	1	27.1	19,200		June	27-28	22.90	9,500
1912	Feb.	29	21.8	8,300		Dec.	25-26	22.34	* 8,200
	Mar.	23-24	25.2	14,900	1925	Mar.	20-21	23.31	10,200
		30	23.9	12,100	1926	Apr.	8-9	25.40	13,400
	Apr.	20	23.4	7,580		Sept.	11	30.15	25,200
	May	1	24.5	13,300		Oct.	4	32.04	30,200
		13-14	21.0	7,180		Nov.	29	22.32	7,780
.....	.....	.....	....	.....	1927	Feb.	6	23.72	9,980
1915	Feb.	6	21.0	7,180		Mar.	21	25.50	13,500
	May	30	23.2	10,700		Apr.	6	24.95	12,500
	July	14	21.2	7,450			17	25.45	13,300
	Aug.	24	26.8	18,500		May	11	22.13	7,500
1916	Jan.	22	22.1	8,780			29	26.10	14,900
	Feb.	3	27.8	20,800		June	14	22.80	8,510
1917	Mar.	15	23.43	11,100		Oct.	4	25.67	14,000
	June	7	27.40	19,900	1928	Apr.	8	22.26	7,640
1918	Feb.	13	22.70	9,800	1929	Jan.	25	24.05	10,400
		19	21.65	8,010		Apr.	14	23.65	11,400
	May	11	22.33	9,080			23	22.41	9,240
1919	Mar.	22-23	21.60	8,010		May	5	23.50	11,200
	June	29	23.37	11,100			20	24.8	14,000
1920	Mar.	20	21.55	8,010		June	14	21.00	7,100
		28	22.58	9,620		July	11-13	22.82	9,930
	Apr.	21	22.09	8,450	1930	Feb.	28	22.52	9,800
	May	14	25.07	14,200	1931	July	5	11.51	** 1,040
		18	23.79	11,400	1932	Jan.	23	16.15	** 3,030
	June	3	22.77	9,560	1933	Apr.	3	24.07	12,700
1921	Mar.	30	22.50	10,100		May	16	26.05	18,700
	Apr.	28	22.10	9,460			24	24.58	14,200

* Estimated
** Below base
Note.- All discharge quantities are average daily flows.

Kaskaskia River at Vandalia, Ill.

Location.- In SE¼ sec. 16, T. 6 N., R. 1 E., at Gallatin Street Bridge, Vandalia, Fayette County, 3½ miles above Hickory Creek.
Drainage area.- 1,980 square miles.
Records available.- February 1908 to December 1912, August 1914 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to half-tenths once daily prior to Dec. 31, 1912; to hundredths once daily Aug. 11, 1914, to Jan. 28, 1931; and to hundredths twice daily thereafter. Datum lowered 2 feet on Oct. 1, 1932, making zero of gage 453.30 feet above mean sea level.
Stage-discharge relation.- Affected by shifting control and by ice. Gage heights for different portions of the record not comparable because influence of levees varied.
Remarks.- Levees above station failed on days indicated as estimated, and an undetermined discharge passed around gaging station.
Historical data.- Flood of 1875 is said to have reached a stage of 22.8 feet.

Flood stages and discharges
(Base discharge 5,500 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1908	Feb.	28	19.8	7,020
	Mar.	11	18.9	6,570
	May	6	21.2	* 7,720
		24	16.8	5,520
1909	Feb.	25	17.2	5,720
	Mar.	11	17.1	5,670
	Apr.	8	20.3	7,270
		14	20.9	7,570
	July	14	18.4	6,320
1910	Jan.	20	17.5	5,870
	Mar.	1	19.7	6,970
	May	25	18.55	6,400
	July	18	16.9	5,570
1911	May	2	6.5	** 5,370
	Oct.	4-5	20.0	* 13,000
1912	Feb.	29	19.6	6,970
	Mar.	20,22-23	19.8	7,060
		30	20.1	7,210
	Apr.	29	18.7	6,540
....			....	.....
1915	Feb.	4	17.3	6,990
	May	27	22.2	14,800
	June	22	16.1	5,850
	July	13	17.6	7,320
	Aug.	21	22.1	14,600
1916	Jan.	31	22.0	14,400
	June	23	17.4	7,100
1917	June	2	18.59	8,600
		6	20.21	11,100
		6	23.0	P 16,400
1918	Feb.	14	18.25	8,060
	Apr.	27	17.70	7,440
	May	11-12	18.51	8,460
	Dec.	23-24	17.49	7,210
1919	Mar.	19	20.10	11,000
	June	27	18.6	8,600
	Nov.	2	18.96	9,180
	Dec.	1	16.41	6,090
1920	Feb.	23	18.07	7,930
	Mar.	14	18.34	8,190
		27	19.0	9,180
	May	19	20.78	12,200
		19	21.0	P 12,600
		26	16.35	6,090
	June	2	16.26	6,010
....			.....	.....
1921	Dec.	26	16.75	6,460
1922	Mar.	16	19.02	* 16,500
	Apr.	1	18.15	* 14,500
		9	19.20	* 17,000
		15	19.74	* 18,200
		18	19.87	* 18,800
1923	Mar.	17	21.58	13,700
	Apr.	15	16.00	5,770
	Dec.	15	19.82	10,500
1924	Jan.	31	17.48	7,210
	Mar.	31	18.72	8,740
	Dec.	22	18.25	8,060
1925	Mar.	15	19.25	9,500
		20	18.31	8,190
1926	Feb.	27	17.67	7,440
	Apr.	13	16.32	6,010
	Sept.	17	18.47	8,460
	Oct.	4	20.38	* 20,000
1927	Feb.	2	18.06	7,930
	Mar.	20	20.26	* 19,800
	Apr.	2	18.54	* 15,200
		16	18.57	* 15,500
	May	20	17.65	7,320
		24	18.46	8,460
		30	19.63	10,100
	June	14	15.99	5,770
	Oct.	4	19.40	9,820
		9	18.83	8,880
		14	18.35	8,320
	Dec.	1	20.55	11,800
		15	18.24	8,060
1928	Jan.	21	16.16	5,930
	Feb.	7	17.69	7,440
	Apr.	7	18.48	8,460
	May	18	17.42	7,100
	June	22	16.68	6,360
1929	Jan.	21	17.05	6,660
	Mar.	15-17	16.77	6,460
		28	18.73	8,740
	Apr.	2	16.13	5,850
		19	20.14	11,000
		16	16.62	6,270
		23	18.02	7,800
	May	5	19.49	9,980
		14	20.58	11,800
		19	19.23	9,500
	June	15	16.89	6,560
	July	18	16.26	6,010
1930	Jan.	13-14	19.91	10,600
1931	Sept.	18	5.42	** 1,010
1932	Jan.	24	15.39	5,550
1933	Jan.	24-25	17.84	5,910
	Feb.	26	17.73	5,840
	Mar.	26-27	17.38	5,660
	Apr.	2	20.08	8,060
		18	18.17	6,200
	May	15	22.37	16,900
		15	22.65	P 17,500
		21	21.39	14,300
1934	Aug.	19	14.76	** 4,250

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Mar. 13 to June 24, 1921.

Big Muddy River at Plumfield, Ill.

Location.- In $W\frac{1}{2}$ sec. 20, T. 7 S., R. 2 E., at highway bridge at Plumfield, Franklin County, $1\frac{1}{2}$ miles below mouth of Middle Fork, prior to July 13, 1932; in $SW\frac{1}{4}$ sec. 20, at highway bridge on Illinois State route 149, half a mile below former site, thereafter.
Drainage area.- 753 square miles.
Records available.- August 1914 to September 1933.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to hundredths once daily at former station; to hundredths twice daily at present site. Relation between gages not determined.
Stage-discharge relation.- Affected by vegetation at high stages and by ice. Control shifts occasionally.

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1915	Feb.	4	23.8	8,830
	May	31	18.5	4,250
	Aug.	25	23.4	8,430
	Dec.	20	17.1	3,370
1916	Jan.	4	17.4	3,550
	Feb.	1	30.0	16,000
		1	30.2	P 16,300
1917	Jan.	8	24.66	9,770
	Apr.	6	19.52	4,960
1918	Feb.	14	20.81	6,020
	Apr.	30	22.98	8,030
	May	15	24.30	9,330
	Dec.	17	20.84	6,020
		25	18.30	4,110
1919	Mar.	20	20.56	5,840
	June	28-29	16.67	3,170
	Oct.	31-Nov. 4	24.20	9,230
		31	24.24	P 9,270
	Dec.	4	18.25	4,040
1920	Mar.	15	20.18	5,520
		28	16.98	3,320
	May	23	22.84	7,830
	June	5	18.91	4,530
1921	Mar.	31	19.2	4,740
	Nov.	22	20.15	5,520
	Dec.	27	20.22	5,520
1922	Mar.	18	21.21	6,380
	Apr.	2	25.1	10,200
		19	17.62	3,670
1923	Feb.	5	18.80	5,140
	Mar.	19	22.96	9,000
	May	19	20.82	5,590
	Dec.	15	19.41	4,880
		25	17.06	3,370
1924	June	21	18.95	4,600
1925	Mar.	21	12.55	** 1,670
1926	Feb.	19	17.5	3,330
	Mar.	1	17.00	3,080
	Apr.	12	16.93	3,030
1927	Jan.	24-25	22.44	7,200
	Mar.	23	20.86	5,760
	Apr.	4	22.42	7,200
		17	26.02	10,900
	May	12	21.03	5,500
	June	4	21.93	6,310
	Dec.	16	24.29	8,680
1928	Feb.	10	18.24	3,370
	June	10	17.82	3,130
		25	20.40	4,970
	Dec.	21	18.89	4,430
1929	Jan.	27	23.06	8,100
	Mar.	1	18.92	4,430
	Apr.	14	17.93	3,730
	May	10	18.46	4,150
		17	23.01	8,000
	June	17	21.33	6,420
	Dec.	21	16.94	3,030
1930	Jan.	16	26.49	11,800
	Mar.	1	17.79	3,660
1931	Sept.	6	17.74	3,590
		6	17.78	P 3,660
1932	Jan.	4	21.15	6,330
		20	22.41	7,410
		26	21.19	6,330
	Dec.	27	20.63	5,570
1933	Jan.	3	23.05	7,690
		25	22.70	6,770
	Apr.	4	21.81	5,880
		20	18.94	3,540
	May	9	21.07	5,250
		17	27.86	12,700

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Beaverhead River at Barratts, Mont.

Location.- At highway bridge a few feet below railroad bridge in SW¼SE¼ sec. 19, T. 8 S., R. 9 W., 1 mile southwest of Barratts, 2 miles below Grasshopper Creek, and 10 miles southwest of Dillon, Mont.
Drainage area.- 2,850 square miles.
Records available.- August 1907 to August 1933 except winters of 1911-15, 1923-25, 1926-29, 1931-32.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths or half-tenths twice daily prior to Jan. 1, 1923, and to hundredths thereafter.
Stage-discharge relation.- Rock control shifts occasionally.
Regulation and diversions.- Slight effect from storage in Lima Reservoir on Red Rock Creek completed in 1909 (capacity, 57,000 acre-feet; enlarged to 80,000 acre-feet in 1934). Many large diversions above station; among other tracts are about 49,000 acres irrigated in Red Rock River Basin and about 25,000 acres in Dillon Valley. During period of record little increase occurred in diversion, which began about 1870.

Flood stages and discharges
(Base discharge 800 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1908	Apr.	20	2.36	909
	May	12	2.25	834
		20	2.20	800
		27	3.75	1,880
		31	5.10	2,920
	June	4	4.95	2,800
		11	5.15	2,960
		19	6.00	3,640
	Oct.	26	2.08	809
	Dec.	23	2.12	831
1909	Apr.	17	2.3	885
		28	2.45	970
	May	6	2.8	1,190
		11	2.65	1,090
		29	3.2	1,480
	June	10	3.25	1,510
		17	2.05	805
		21	2.5	1,000
1910	Mar.	5	3.70	2,010
		22	3.00	1,490
	Apr.	13	2.78	1,330
		22	2.82	1,360
	May	6-7	2.90	1,420
		12	3.02	1,500
		28	2.05	860
1911	June	3	2.00	835
		8-10	2.20	965
		15-16	2.20	965
		21	2.70	1,310
1912	Apr.	4	2.1	835
		4	2.2	P 900
		9	2.2	900
	May	11-12	2.6	1,160
		22	3.9	2,100
		28	3.2	1,580
	May 31-June 1		3.2	1,580
	June	10-11	4.9	2,900
		15	4.4	2,500
	Aug.	3	2.8	1,300
		3	3.3	P 1,660
		19	2.1	835
		19	8.2	P 900
	Oct.	30-Nov. 1	2.2	900
1913	Apr.	1-2	3.7	1,860
		6	2.8	1,240
		14-15	3.4	1,650
		20	3.3	1,580
		28-29	3.2	1,510
	May	1	3.2	1,510
		9	3.4	1,650
		19-20	3.2	1,510
		31	4.0	2,070
	June	13-14	4.3	2,280
		28	3.2	1,510
	July	29	2.2	880
	Aug.	6	2.2	880
1914	Apr	23	2.8	1,220
	May	4	3.0	1,350
		11	3.15	1,410
	June	6	3.1	1,410
	Nov.	12	2.25	898
1915	Apr.	26-May 5	2.8	1,220
	May	11	2.5	1,040
		21	2.8	1,220
	June	2-6	2.4	986
		12	3.5	1,660
	July	9	2.4	986
1916	Mar.	10	2.32	900
		10	2.5	P 1,020
		20	2.15	840
	May	7	3.3	1,540
		20	2.48	1,020
		27	2.68	1,150
	June	11-12	2.75	1,210
		22	4.0	2,010
		22	4.2	P 2,150
	July	4	2.98	1,340
	Oct.	27-29	2.4	961
1917	Apr.	12	2.25	840
		25-27	3.0	1,340
	May	16	5.65	3,130
		16	5.70	P 3,200
		21	4.6	2,430
		31	4.3	2,220
	June	5	4.2	2,150
		5	4.3	P 2,220
		11	4.45	2,290
		20	4.8	2,570
1918	May	7	2.1	818
1919	Apr.	28	2.3	938
1920	May	17	2.69	1,130
	June	18	2.28	836
1921	Apr.	16	2.73	1,230
	May	9		* 980
		22		* 1,230
	June	11		* 2,050
		18	4.2	2,070
1922	Apr.	25	2.82	1,160
		25	2.87	1,180
	May	22	4.12	1,940
		22	4.17	P 1,970
		28	4.72	2,320
		28	4.77	P 2,360
	June	10	3.92	1,820
		10	3.97	P 1,850
		17	3.62	1,630
		17	3.67	P 1,660
1923	May	23-24	2.70	1,090
	June	1	2.76	1,120
		8	2.40	918
		24	2.90	1,200
1924	Apr.	15	2.36	896
		15	2.39	P 912
	May	4	2.33	879

* Estimated

Flood stages and discharges of Beaverhead River at Barratts, Mont.--Continued

Date		Gage height (feet)		Discharge (second-feet)	Date		Gage height (feet)		Discharge (second-feet)
1925 Apr.	14	2.61		1,140	June	14-15	3.2		1,490
	23	2.37		993	1928 Mar.	23	2.90		1,310
May	23	2.16		871		23	2.97	P	1,350
June	5	3.50		1,670	May	13-15	2.40		1,010
	11	2.77		1,230	1929 May	8-10	2.20		894
	11	2.80	P	1,250	June	18	2.30		952
	17	3.35		1,580	1930 Apr.	9-10	1.84	†	702
	17	3.50	P	1,670	1931 Apr.	8	1.50	†	535
	23	2.65		1,160	1932 June	7	2.89		1,300
	23	2.70	P	1,190		17	2.15		895
1926 Apr.	19-20	2.40		1,010	1933 May	18	2.85		1,240
1927 May	29	2.2		894		18	2.87	P	1,300
June	12	3.30		1,550					

† Below base

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Missouri River at Fort Benton, Mont.

Location.- In NE$\frac{1}{4}$ sec. 26, T. 24 N., R. 8 E., at highway bridge at Fort Benton, Chouteau County.

Drainage area.- 24,600 square miles.

Records available.- July 1881 to September 1934.

Sources of data.- U. S. Geological Survey records except gage-height records prior to 1910, which were furnished by U. S. Army Engineers, and U. S. Weather Bureau.

Gage.- Nonrecording gage read to tenths once daily 1881-1915; to hundredths twice daily 1916-18, and to hundredths once daily (twice daily during periods of rapid fluctuation) 1919-20; recording gage thereafter.

Stage-discharge relation.- Control practically permanent for high stages.

Regulation and diversions.- Numerous small diversions 1881-91. Gradual increase in diversions 1891-1921. Large increase in diversions, principally on Madison and Sun Rivers 1921. Total diversions 1934 estimated at about 2,000 to 3,000 second-feet. Little regulation prior to 1915, when Hebgen Reservoir on Madison River was completed, capacity, 350,000 acre-feet. Regulation due to storage on Sun River since 1929.

Flood stages and discharges
(Base discharge 15,000 second-feet)

Date		Gage height (feet)		Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1881 June	24	5.35		25,600	June	25-26	8.9	48,200
1882 May	18-19	4.50		20,800	July	3-4	8.5	45,400
June	19	7.90		41,400	1893 Apr.	1	3.6	15,900
1883 May	26	5.20		24,700	May	20-21	6.4	31,900
June	12	6.35		31,600	June	16-18	7.1	36,200
1884 June	14	6.65		33,400	1894 Apr.	2	3.6	15,900
1885 May	11	4.00		18,000		29-30	5.5	26,500
	17-18	4.25		19,400	June	8	9.8	55,200
June	14	9.65		54,000	1895 May	3-7	4.0	18,000
1886 May	30-31	5.65		27,400		26	4.6	21,300
June	16	4.35		19,900	June	15	4.8	22,400
1887 May	15	4.00		18,000		29	4.1	18,600
June	8	7.65		39,700	1896 June	20-23	7.8	40,700
	18	10.10		57,600	1897 Mar.	30	4.0	18,000
1888 May	10	4.60		21,300	Apr.	23	4.1	18,600
	19	4.35		19,900	May	1	4.7	21,800
June	10	6.70		33,700		8-9	5.3	25,300
1889 June	3		**	11,700		22-23	5.8	28,300
1890 May	1-31		*	18,300	June	17	4.2	19,100
June	1-30		*	17,600		28	4.0.	18,000
1891 Apr.	28	3.40		15,400	July	8	3.7	16,400
May	12	4.65		21,600	1898 Apr.	30-May 1	3.9	17,400
	20-21	4.60		21,300	May	20	6.7	33,700
	30	4.80		22,400		30	7.2	36,800
June	17	6.70		33,700	June	20-21	7.4	38,100
July	14	7.70		40,000	July	3	5.3	25,300
Aug.	6-7	3.50		15,400	1899 Apr.	12-14	4.0	18,000
1892 May	31	6.0		29,500	May	14	5.0	23,500
June	14	11.0		65,500	June	5-7	7.0	35,500

* Estimated
** Below base

Flood stages and discharges of Missouri River at Fort Benton, Mont.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1899	June	27	8.6		46,100
	July	29	3.9		17,400
1900	May	1-31		*	27,400
	June	1-30		*	19,100
1901	May	5	6.0		29,500
		23-24	6.3		31,300
1902	May	22	6.5		32,500
	June	3	6.3		31,300
	July	3	3.8		16,900
		5	3.8		16,900
1903	May	19	3.8		16,900
	June	9-10	6.3		31,300
	July	5	4.2		19,100
1904	May	8-9	4.0		18,000
		25	5.4		25,900
	June	6	5.4		25,900
1905	June	11	3.8		16,900
1906	May 31-June 1		4.1		18,600
	June	17-18	4.3		19,600
1907	June	25-26	9.6		53,600
	July	22	6.3		31,300
1908	Apr.	16	6.4		31,900
	May	14-15	4.4		20,200
	June	6	15.2		120,000
		6	18.0	P	140,000
		23	9.4		52,800
1909	June	12	9.7		54,400
		22	8.6		46,100
		30	6.3		31,300
	July	7	6.8		34,300
		18	3.7		16,400
		29	4.5		20,800
1910	May	4	3.5	*	23,500
		15-16	3.5	*	23,500
1911	May	18	3.8	*	15,400
	June	20	6.7	*	31,900
1912	May	24-27	6.1		30,000
	June	15-20	6.4		31,900
1913	Apr.	21-24	4.0		18,000
	May	15	4.9		22,900
	June	1-6		*	45,000
		30	5.2		24,700
1914	May	27	5.8		28,300
	June	15-16	5.9		28,900
1915	Apr.	23	3.5		15,400
	May	26	5.9	*	23,500
	June	1-2	5.5	*	23,500
		8-10	6.0	*	26,500
		15-16	5.8	*	25,300
1916	Mar.	13	4.35		20,100
	May	11	4.59		21,200
	June	23	9.25	P	50,600
		23	8.95		48,900
1917	Mar.	31	3.99		18,000
	Apr.	8-9	4.28		19,600
		25	4.35		20,100
	May	27	9.86		55,200
	June	14-15	9.27		51,000
1918	May	9			15,300
	June	19			28,000
		20	6.30	P	31,200
1919	May	30		**	13,900
1920	May	16-17	5.37		25,700
	June	18-20	6.20		30,700
	July	8	3.47		15,200
1921	May	13	3.85		17,200
		29-30	5.32		25,400
	June	16-17	6.33		31,500
		16	6.45	P	32,200
1922	May	12	4.01		19,300
		28-29	6.20		32,500
	June	12-13	6.45		34,100
		12	6.48	P	34,300
1923	Apr.	25	3.24		15,000
	May	11			18,000
		17	3.45		16,600
		30	4.70		23,300
	June	8			16,100
		26	5.05	P	25,400
		27-28	4.77		23,700
1924	May	18	6.05		23,800
		21	6.13	P	24,300
1925	May	16	5.15		18,800
		20	5.70		21,800
		25	7.00		29,500
		25	7.05	P	29,800
		31	6.90		28,900
	June	5-6	6.10		24,100
		16	5.50		20,800
		22	5.60		21,300
1926	Apr.	21	5.35		19,900
		21	5.45	P	20,400
	May	1	5.10		18,600
		7	5.10		18,600
		25	5.00		18,000
1927	May	3	5.15		18,800
	June	2	9.95		50,100
		13	10.30		52,900
1928	Apr.	30	6.00		23,500
	May	14	7.50		32,800
		28	7.60		33,400
	June	12-13	5.20		19,100
		21-23	5.20		19,100
		27	5.40		20,200
1929	May	25	5.43		20,200
		29-30	5.5		20,800
	June	2	5.5		20,800
		19	5.41		20,200
		19	5.5	P	20,800
1930	Apr.	13	4.8		16,900
		16	4.7		16,400
		20	4.80		16,900
1931	Apr.	20		**	9,090
1932	May	24	4.90		17,400
	June	12	5.73		21,800
		13	5.95	P	23,500
		21	5.75		22,400
1933	May	29	4.78		18,400
	June	6-7	6.15		24,400
		10	6.49	P	26,200
		11	6.18		24,400
		16	6.08		23,800
1934	Jan.	3	12.2	P#	
	June	9			16,200
		9	5.4	P	19,600

\# Ice gorge
* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Missouri River at Bismark, N. Dak.

Location.- Prior to Oct. 17, 1928, on Northern Pacific Railway bridge about 2 miles west of Bismarck, Burleigh County; thereafter in sec. 31, T. 139 N., R. 80 W., at city water plant 1 mile west of Bismarck and 0.4 of a mile below first location.
Drainage area.- 186,400 square miles.
Records available.- Gage-height records February 1881 to October 1882, May 1886 to September 1934; daily discharge records September 1904 to December 1905 and October 1927 to September 1934.
Sources of data.- Gage-height records February 1881 to November 1898 by Missouri River Commission and November 1898 to October 1928 by U. S. Weather Bureau; subsequent gage-height records and all discharge records by U. S. Geological Survey. Northern Pacific Railway kept continuous gage-height records 1881-91, which were not available for this report.
Gages.- Nonrecording gage read to tenths once daily Feb. 19, 1881, to Jan. 1, 1888, and Nov. 16, 1898, to Oct. 16, 1928; to tenths twice daily Jan. 2, 1888, to Nov. 15, 1898; recording gage subsequent to Oct. 16, 1928. Zero of recording gage is 1,622.62 feet above mean sea level which is same as zero of nonrecording gage, but former gage reads several tenths of a foot lower than latter owing to slope of river between locations.
Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, and natural instability of channel. Bank-full stage, about 14 feet.
Storage and diversions.- Several storage reservoirs on tributaries. Numerous diversions above station.
Remarks.- Only those gage-height crests which were 1.0 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before measurements were made.

Flood stages
(Base gage height 9.0 feet)

Date				Gage height (feet)
1881	Feb.	20		11.2
	Mar.	20-22		17.4
		31	#	26.1
		31	P#	27.6
	Apr.	20		10.7
	May	29		9.9
	June	5		13.0
		10		14.0
		25		12.0
	July	9		10.8
1882	Apr.	5		12.9
	June	20-23		13.0
....				....
1886	June	4-5		10.5
....				....
1887	Mar.	16		11.2
		18		27.4
		21		26.9
	June	8		12.6
		22		14.5
	Sept.	6		9.7
1888	Mar.	8		10.4
	Mar.	31-Apr. 1		16.8
	Apr.	14		15.3
	June	25		14.3
	July	6		12.3
1889	Mar.	24		11.0
1890	June	8		10.2
	July	2		9.3
1891	Apr.	3		12.0
	June	8		9.5
		14		10.3
		24		11.2
		30		12.3
	July	14		10.4
		20-21		10.1
1892	Mar.	20		9.7
	June	3		9.1
	July	7		14.5
1893	Apr.	3		11.5
		6-7		15.0
	June	19		11.5
1894	Mar.	15		10.1
		27		15.0
	Apr.	8		17.8
	May	21		11.5
	June	13		13.7
		25		11.6
1895	Mar.	10-11		11.1
		30		10.8
1896	Mar.	31		12.7
	June	10		11.5
		23-24		11.7
1897	Apr.	6		21.7
		8		23.5
		11	#	17.1
	May	27-28		9.1
1898	Apr.	15		10.6
	June	3		10.5
		26		12.6
1899	Mar.	22		10.9
	Apr.	14		21.2
	May	26		9.1
	June	4		9.6
		10		10.7
	July	7-8		11.9
1900	Apr.	3		12.8
1901	May	28		9.8
	June	5		10.2
		28		9.0
1902	Mar.	19-20		9.6
	June	4		9.3
1903	Apr.	6		12.4
1904	Apr.	7		14.2
1905	Mar.	23		9.1
		23	P	10.5
1906	Apr.	3		10.3
	June	11-12		12.6
		18-19		9.5
1907	Mar.	4-5		9.4
	Apr.	11		9.5
	May	30		9.6
	June	14-15		9.5
		29		12.2
1908	June	8		11.4
		19		15.1
1909	Apr.	4		9.5
	June	3		11.1
		15		13.9
		26		13.9
	July	4		12.4
1910	Mar.	14	#	23.5
		14	P#	26.4
1911	Mar.	25		10.4
1912	Apr.	6		16.4
	July	7		9.2
1913	Apr.	7		18.0
		7	P	18.6
1914	Apr.	7		10.2
	July	1		9.1
1915	Apr.	7		9.6
	June	16		9.2
1916	Mar.	1		12.4
		20-21		15.2
		20	P	15.3
	Apr.	3		10.2
		7		10.4
		11		10.2
	June	27		10.6
	July	5		11.8
1917	Apr.	8		22.2
		8	P	23.6
	June	6		9.0
		29		10.8
1918	Mar.	23		13.6
	June	25		11.5
1919	Apr.	5	P	15.6
		6		14.6
1920	Mar.	29	P	18.5
		30		17.8
	June	22		9.8
1921	June	24		12.0
		24	P	12.7
1922	Apr.	3		9.8
		7		9.3
1923	Apr.	9		11.0
	June	30		10.5
1924	Apr.	8		9.5
1925	Mar.	29		10.6
		31		12.6
1926	Mar.	23	**	7.7
1927	June	21-23		11.2
1928	Mar.	22	#	11.5
		22	P#	12.0
		24		13.2

\# Ice gorge
** Below base
P Momentary peak

Flood stages of Missouri River at Bismark, N. Dak.--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1928 Mar.	24	P 13.8	Mar.	27	P# 17.8	1932 June	13	** 8.26
	26	10.6	1930 Mar.	6	# 11.36	1933 Mar.	21	# 9.31
June	5	9.6		6	P# 11.38		21	P# 9.53
July	11	9.3	1931 June	9	** 5.26	1934 Mar.	20	**# 5.36
1929 Mar.	27	# 16.39						

\# Ice gorge
** Below base
P Momentary peak
<u>Note</u>.- Break in record: July 25 to Sept. 25, 1886.

Missouri River at Pierre, S. Dak.

<u>Location</u>.- Prior to 1917 on right bank at Fort Pierre, Stanley County, about 300 feet below mouth of Bad River; thereafter in SW¼ sec. 32, T. 111 N., R. 79 W., on Chicago & North Western Railway bridge at Pierre, Hughes County, 1½ miles above mouth of Bad River.
<u>Drainage area</u>.- 246,700 square miles prior to 1917; 243,500 square miles thereafter.
<u>Records available</u>.- Daily gage-height records intermittently August 1891 to September 1934; daily discharge records October 1929 to September 1934.
<u>Sources of data</u>.- Gage-height records by U. S. Weather Bureau prior to Oct. 1, 1929; subsequent gage-height records and all discharge records by U. S. Geological Survey.
<u>Gages</u>.- U. S. Weather Bureau nonrecording gage read to tenths once daily (oftener during high water) prior to Oct. 1, 1929; to hundredths twice daily Oct. 1, 1929, to Mar. 10, 1932; U. S. Geological Survey recording gage thereafter. Gages at two locations used prior to and subsequent to 1917 were set to read same. Zero of present Weather Bureau gage is 1,416.41 feet above mean sea level; zero of Geological Survey recording gage is 1,414.41 feet above mean sea level. All gage-height records in this compilation refer to datum of Weather Bureau gage.
<u>Stage-discharge relation</u>.- Continually subject to change; affected by ice, irregularity of slope, and natural instability of channel. Flood stage, about 14 feet prior to 1917 and about 13 feet thereafter.
<u>Remarks</u>.- Only those gage-height crests which were 1.0 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before measurements were made.
<u>Historical data</u>.- Flood of March 1881 reached a stage of 21 feet at first location. Gage destroyed July 1905 and March 1916 by floods of unreported magnitudes.

Flood stages
(Base gage height 8.0 feet)

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1892 July	9	9.3	1901 Apr.	4	8.3	June	29	11.4
....		....	May	28-30	9.2	July	5	11.4
1893 Apr.	9	10.0	June	7	9.6		5	P 12.0
....		....		18	9.8	1910 Mar.	18	14.5
1894 Apr.	11	9.8		30	9.5		18	P 15.0
June	12-13	8.0	July	10	8.7	1911 June	28	9.4
....		....	1902 Mar.	29	8.0	1912 Apr.	10	14.0
1895 July	9	** 6.6	June	10	9.2	May	12	8.3
....		....		18	8.8	June	17	9.8
1896 Apr.	2	9.5	July	15	8.3	July	8	10.9
June	11-12	9.8	1903 Apr.	9	9.0	1913 Mar.	26	10.0
	26	10.0	June	25	9.2	Apr.	10	15.0
1897 Apr.	13	12.1	July	8	9.0	June	20	10.3
May	30	8.7	1904 Apr.	10	12.7	....		....
1898 Apr.	17	8.7	June	9	10.6	1914 June	13	9.4
May	30	8.3	1905 June	21	8.7		30	# 9.5
June	5	9.4	....		....	....		....
	28	11.2	1906 May 31-June 1		8.1	1915 Apr.	10	10.9
1899 Apr.	19	15.9	June	13	10.7	June	19-20	10.7
May	28	9.3		21	8.8		28	8.9
June	5	10.9	1907 May	28-29	8.8	....		....
	11-12	10.5	June	15	9.1	1916 Feb.	26	9.6
	28	11.5	July	1	10.0	Mar.	4	# 10.1
1900 Apr.	6	8.5	1908 June	22	11.4	....		....
June	5	8.8	1909 June	4	9.0	1918 Mar.	22	10.2
	14	8.5		13	11.1		29	10.8

** Below base
\# Last reading before or first reading after break in record; may not be peak.

Flood stages of Missouri River at Pierre, S. Dak.--Continued

Date			Gage height (feet)
1918	June	26	10.4
......			....
1919	Apr.	8	11.0
......			....
1920	Mar.	22 #	8.6
	Apr.	1	12.9
		1 P	13.1
	May	14	11.7
	June	8	8.7
		24	10.8
......			....
1921	June	26	11.9
		26 P	12.1
1922	Apr.	6	8.5
		12-13	8.7
	June	2	8.0
		23	9.8
		23 P	10.1
1923	Apr.	15-16	8.2
	June	7	8.7
	June	24	8.6
	July	4	10.0
		4 P	10.2
	Oct.	7	8.9
1924	Mar.	6	10.7
		14	12.1
	Apr.	11	9.4
	June	15	9.1
		21	9.0
1925	Apr.	2	9.9
	June	9	9.5
		24	8.6
		30	8.6
1926	June	1 **	7.7
1927	May	10	13.9
		10 P	14.4
	June	5-6	10.3
		27	11.6
1928	Jan.	30	10.4
	Mar.	26	9.7
	June	4-6	9.4
	July	13	9.8
		22	8.7
1929	Mar.	16 *	9.2
		22	8.3
		30	10.1
		30 P	10.4
	June	4	9.7
		12	9.5
1930	June	7 **	6.51
1931	June	12 **	6.53
1932	June	15	8.94
		15 P	8.96
	July	3	8.48
1933	May	28	8.14
		28 P	8.29
	June	25	8.37
1934	June	20 **	6.40

* Estimated
** Below base
\# First reading after break in record; may not be peak.
P Momentary peak

Note.- Breaks in record: Oct 1, 1891, to Mar. 31, 1892; Nov. 21, 1892, to Apr. 4, 1893; Nov. 20, 1893, to Mar. 17, 1894; Nov. 18, 1894, to Mar. 20, 1895; Nov. 22 to Dec. 31, 1895; July 3 to Nov. 29, 1905; July 1 to Dec. 31, 1913; July 1, 1914, to Mar. 31, 1915; July 1, 1915, to Feb. 23, 1916; Mar. 5, 1916, to Mar. 19, 1918; July 1, 1918, to Mar. 24, 1919; July 1, 1919, to Mar. 21, 1920; July 1, 1920, to Feb. 25, 1921.

Missouri River at Sioux City, Iowa

Location.- At highway bridge at Sioux City, Woodbury County, about half a mile below Big Sioux River.

Drainage area.- 311,650 square miles (U. S. Weather Bureau).

Records available.- Daily gage-height records September 1878 to December 1934; discharge measurements 1878-79, 1895, 1928-31; daily discharge records September 1928 to September 1931.

Sources of data.- Gage-height records by Missouri River Commission 1878-88 by U. S. Weather Bureau 1888-1928, 1931-34 and by U. S. Geological Survey 1928-31; discharge measurements by Corps of Engineers, U. S. Army, 1878-79, 1895; by U. S. Geological Survey 1928-31; daily discharge records by U. S. Geological Survey.

Gage.- Nonrecording gage usually read to tenths twice daily 1878-88, 1929-31; to tenths once daily 1888-1928, 1931-34. Zero of gage is 1,078.64 feet above mean sea level.

Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, and natural instability of channel.

Remarks.- Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before or since measurements were made. Only those gage-height crests which were 0.8 foot or more above preceding and following low points were used in this compilation.

Flood stages
(Base gage height 12.0 feet)

Date			Gage height (feet)
1879	Apr.	7	15.2
	June	16	14.2
		26	14.8
1880	Apr.	4	12.9
	June	19	12.5
	July	7-8	13.7
		19-20	13.7
1881	Mar.	27	16.3
	Apr.	1	17.3
		7	20.0
		23	22.2
		23 P	22.5
	June	14	14.1
		29	12.3
1882	June	27	13.1
1883	Apr.	17	12.1
	May	24	12.4
	June	25	12.9
	July	9	13.2
1884	Mar.	22	14.0
	Apr.	4	15.6
	June	21	15.0
1885	Mar.	13	12.65
	June	15	14.87
1886	Mar.	20	14.4
	June	21-22	12.4
1887	Mar.	13	12.3
		17	12.1
		26-27	17.4
	June	11	14.8
	June	25-26	15.8
	Sept.	11	12.5
1888	Mar.	21	16.4
		21 P	16.6
	Apr.	4	15.9
		8	14.8
		18	15.9
	May	29	13.5
	June	13	14.2
		28-29	16.3
	July	4	15.0
		10	15.3
1889	July	1 **	9.6
1890	June	7	13.5
		12	12.8

** Below base

Flood stages of Missouri River at Sioux City, Iowa--Continued

Date				Gage height (feet)
1890	June	21		12.0
1891	June	13		12.0
		19		13.3
		29		13.1
	July	4		14.6
		20		13.4
		26		13.6
1892	June	10		13.9
	July	12		15.9
1893	Mar.	12	#	14.0
	Apr.	11		15.4
	June	22		14.1
		29		13.7
1894	Apr.	13		16.0
	May	25		14.2
	June	17-18		15.7
		29		14.8
1895	May	2-3		17.9
	June	6-7		12.7
1896	Mar.	21		12.4
	Apr.	5		13.6
	June	14		14.2
		28		13.9
1897	Mar.	21		14.3
	Apr.	4		14.1
		15		16.4
	May31-June 1			12.1
1898	Apr.	20		12.7
	June	1		13.1
		5-6		13.8
	June30-July 2			14.7
1899	Apr.	23		18.4
	May	31		12.4
	June	8		14.0
		14		13.2
	July	1		14.0
		11-12		13.9
1900	Apr.	8		12.4
	June	17		12.0
1901	June	9		12.7
		18		13.4
		21		13.5
	July	3		12.5
		13		12.1
1902	June	12		12.4
		21		12.0
1903	May	30		12.3
	June	28		12.5
	July	10-11		13.2
1904	Apr.	12	P	15.7
	Apr.	13		15.4
	June	10-11		13.3
1905	July	7		17.5
		7	P	18.0
1906	Apr.	8		12.6
	June	3		13.4
		16		15.2
		23-24		12.8
1907	Feb.	17		12.2
		19		12.4
	Mar.	14		13.7
	Apr.	15		12.2
	May	30		15.2
	June	18		14.5
	July	1		14.2
		14		13.7
1908	June	1		12.4
		23		15.2
	July	13-16		12.0
1909	June	6		13.4
		15-16		14.5
		15	P	14.7
	July	1		14.5
		10		13.8
1910	Mar.	20		16.6
1911	June	30		12.0
1912	Mar.	29		13.1
	Apr.	2		12.6
		10-11		16.1
	June	20		12.1
	July	10		14.3
1913	Apr.	12		16.4
	June	7		13.2
1914	May	29-30		12.2
	June	13		13.5
		29		13.0
1915	Feb.	23-24	#	12.2
	Apr.	8		14.9
		12		14.9
	May	27		12.2
	June	16		14.4
	July	18		14.9
	Aug.	5		13.0
1916	Feb.	21		12.1
	Mar.	12		13.3
		15		13.9
		25		13.7
	Apr.	10-11		13.7
		15		13.0
	July	10		14.9
	July	24		13.8
1917	Mar.	28		13.2
	Apr.	13		16.5
	May	27		13.6
	June	6		13.2
		21		12.3
		29		13.4
1918	Mar.	10		12.8
		25		13.0
		29		14.7
	June	6		12.2
		27		13.8
1919	Apr.	10		13.6
		17		12.1
1920	Mar.	16		12.0
		30		12.7
	Apr.	3		15.4
	May	16		16.1
	June	18		12.0
		27		15.1
1921	June	27	P	14.2
		28		14.0
1922	Apr.	8		12.2
	June	17		12.5
		24		13.1
1923	Mar.	10	#	14.5
	Apr.	23	P#	16.8
		24		16.5
	June	10		13.2
		26		12.7
		30		13.0
	July	4		13.3
1924	Apr.	13		12.6
	June	21		12.1
1925	Apr.	4		13.1
	June	11		13.6
		26		12.1
1926	June	21	**	10.2
1927	May	13		16.5
		13	P	16.6
	June	7		12.2
		21		12.7
1928	Feb.	5	P	12.6
		6		12.5
	Mar.	28		12.0
1929	Apr.	1	**	11.93
1930	Apr.	10	**	9.60
1931	June	16	**	9.71
1932	June	16	**	11.7
1933	June	27	**	10.2
1934	Mar.	3	P	13.4
	May	4		12.3

\# Ice gorge
** Below base
P Momentary peak

Missouri River at Omaha, Nebr.

Location.- Prior to Oct. 19, 1931, at Douglas Street Bridge between Omaha, Nebr., and Council Bluffs, Iowa; thereafter at Nebraska Power Co.'s intake, 200 feet upstream from power plant and half a mile below Douglas Street Bridge.
Drainage area.- 322,800 square miles.
Records available.- Daily gage-height records April 1872 to September 1934; discharge measurements 1877-80, 1882, 1895, 1928-34; daily discharge records September 1928 to September 1934.
Sources of data.- Gage-height records by Missouri River Commission 1872-74, by U. S. Weather Bureau 1875 to November 1929, and by U. S. Geological Survey thereafter. Discharge measurements by Corps of Engineers, U. S. Army, 1872-95, and by U. S. Geological Survey 1928-34. Daily discharge records by U. S. Geological Survey 1928-34.
Gages.- Nonrecording gage read to tenths once daily prior to Dec. 1, 1929; to hundredths twice daily Dec. 1, 1929, to Oct. 19, 1931; recording gage thereafter. Zero of all gages is 958.24 feet above mean sea level, but recording gage reads several tenths of a foot less than nonrecording gage because of slope of river between locations.
Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river traning works involving dikes, etc.
Remarks.- U. S. Geological Survey gage on Illinois Central Railroad bridge used to determine daily discharge records Sept. 7, 1928, to Nov. 30, 1929, but these readings were discarded as not being comparable with those at Douglas Street Bridge. Only those gage-height crests 1.0 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before measurements were made.
Historical data.- Flood of June 1844 said to have reached stage 10 feet higher than flood of 1881.

Flood stages
(Base gage height 12.5 feet)

Date			Gage height (feet)
1872	June	29	13.4
	July	11-12	14.5
		25	12.8
....			.....
1873	Apr.	12	15.0
....			....
	June	9	13.1
	July	4	16.0
....			....
1874	June	15-18	12.6
....			....
1875	Apr.	27-28	17.8
	June	27-28	15.2
....			....
1876	Apr.	15	13.7
	June	20-21	14.8
	July	4	14.6
....			.....
1877	Apr.	7	16.1
	May	29	14.2
	June	13	17.4
	June	30-July 1	15.2
	July	8	14.6
		21	13.8
1878	Apr.	27	14.5
	May	28-29	16.8
	June	7-8	17.5
		25-26	17.8
	July	26	14.4
1879	Apr.	9	17.0
	June	7	13.2
		18	15.6
		28	17.0
	Aug.	1	13.0
1880	Apr.	6	15.8
	June	21	15.6
	July	9	17.1
		22	16.9
1881	Mar.	27	16.0
	Apr.	9	22.0
		24-25	23.8
	June	16	14.2
		30	13.2
1882	June	28	14.5
1883	Apr.	18-19	13.3
	May	25	14.2
	June	28	14.2
	July	8	15.2
1884	Mar.	24	15.5
	Apr.	6	17.0
	June	22	14.6
	July	4	13.2
1885	June	11	14.7
		17	16.6
1886	June	11-12	12.9
1887	Mar.	18	12.5
		28	17.9
	June	12-13	13.5
		26	14.0
		29	14.9
1888	Apr.	5	15.8
		9	15.2
		19	15.9
	May	30	13.1
	June	30	16.3
1889	July	1	** 9.7
1890	June	9	12.9
1891	June	20	13.4
		29-30	14.4
1892	May	23	13.1
	June	11-12	13.2
	July	3	15.3
1893	Apr.	12	15.1
	June	23-24	12.9
1894	Apr.	14	15.1
	May	26	13.4
	June	19	14.9
1895	June	8-9	** 12.0
1896	Apr.	6	13.4
	June	16	14.3
		30	13.7
1897	Mar.	23	15.0
	Apr.	15-17	17.1
	June	3	12.6
1898	June	9	13.6
	July	3	14.7
1899	Apr.	25	18.5
	June	1	12.8
	June	9	13.6
		15-16	13.7
	July	2-3	14.2
1900	Apr.	9	** 11.7
1901	June	23	13.8
1902	June	14	** 12.4
1903	June	1	14.4
	July	12	12.6
1904	Apr.	15	16.5
	June	12-14	13.8
....			....
1905	July	9	15.5
1906	Apr.	10	13.1
	June	4	15.8
		18	16.8
....			....
1907	Mar.	16	14.5
	Apr.	8	13.5
		16	14.8
	May 31-June 1		17.6
	June	19-20	17.0
	July	4	17.3
		18	17.3
....			....
1908	June	25-26	19.1
1909	Mar.	8	15.8
		23	14.2
	June	7-8	17.5
		17	18.5
	July	3	18.5
	Aug.	14	12.5
1910	Mar.	9	14.5
		12	14.6
		22	19.5
	June	14	12.6
1911	Apr.	1	13.1
	June	8	12.5
	July	2	14.7
1912	Apr.	4	15.1
		14	18.5
	June	22	13.3
	July	13	15.3
1913	Apr.	14	18.7
	June	10	13.9

** Below base

Flood stage of Missouri River at Omaha, Nebr.--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1914 June	14	14.0	May	18	19.5	July	2	13.6
July	3-4	13.8	June	10	14.4	1926 Mar.	28	12.6
1915 Apr.	13	16.7		29	18.1	1927 May	15	19.7
May	28	12.5	1921 June	30	17.8		15 P	19.9
June	18	15.5	1922 Mar.	19	13.5	June	8	16.6
July	20-21	16.5	Apr.	10	14.8		23	17.1
Aug.	6	14.8		16	14.9	1928 Mar.	11	12.6
1916 Feb.	25	13.1	May	21	12.9		29	15.2
Mar.	11	15.2	June	6-7	13.2	May	23	13.1
	26	14.8		26	16.0	June	8-9	14.3
Apr.	13	15.1	1923 Mar.	12	13.1	July	15	15.0
May	27	12.5		24	12.8	1929 Mar.	16	13.1
July	11-12	16.2	Apr.	19	14.0		20	12.9
1917 Mar.	29	15.1	June	11	15.8		26	13.6
Apr.	18	18.7		19	14.2	Apr.	2	15.0
May	29	15.3	July	6	17.0	June	7-8	15.3
June	10	15.4	Aug.	8	13.3		15	14.7
July	1	15.5	Oct.	5	12.5	1930 Apr.	11 **	11.99
1918 Mar.	26	14.2		11	14.4	1931 June	18 **	10.78
	31	17.3	1924 Mar.	9	15.4	1932 June	19	14.98
June	7	14.0	Apr.	15	16.0		19 P	15.12
July	1	15.8	May	29-30	12.6	July	7	13.2
1919 Mar.	18	13.2	June	22	14.7	1933 May	29	12.66
Apr.	12	15.9		27	15.0		29 P	13.03
	19	14.8	1925 Mar.	8	15.4	June	1	12.80
1920 Mar.	17	14.8	Apr.	5	16.1		29	12.78
	26	13.8	June	12	17.2	1934 Mar.	5	12.82
Apr.	5	18.9		27	14.8		5 P	15.00
	27-28	13.0						

* Below base
P Momentary peak

Note.- Breaks in record: Aug. 25, 1872, to Mar. 13, 1873; May 11-31, 1873; Dec. 4, 1873, to Mar. 16, 1874; Nov. 24, 1874, to Mar. 29, 1875; Nov. 24, 1875, to Mar. 30, 1876; Jan. 5 to Feb. 20, 1877; Oct. 1, 1904, to Feb. 28, 1905; Jan. 1 to Feb. 28, 1907; Dec. 1, 1907, to Jan. 31, 1908.

Missouri River at Kansas City, Mo.

Location.- Prior to Aug. 30, 1878, on levee at foot of Delaware Street, Kansas City, Clay County; thereafter in sec. 31, T. 50 N., R. 33 W., at Chicago, Burlington & Quincy Railroad bridge 1 mile below Kansas River.
Drainage area.- 489,200 square miles.
Records available.- Daily gage-height records April 1873 to September 1934; discharge measurements 1883, 1895, 1905, 1909, 1928-34; daily discharge records August 1928 to September 1934.
Sources of data.- Gage-height records by U. S. Signal Service, U. S. Weather Bureau, and U. S. Geological Survey; discharge measurements by Corps of Engineers, U. S. Army, and U. S. Geological Survey; daily discharge records by U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily (sometimes oftener during high water) prior to Jan. 1, 1931; twice daily Jan. 1 to May 12, 1931; recording gage thereafter. Prior to 1896 no readings when river was frozen over. Elevation of zero of U. S. Weather Bureau gage is 715.79 feet above mean sea level. U. S. Geological Survey recording gage moved 300 feet upstream and elevation of zero changed to 715.89 feet Aug. 24, 1934.
Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river training works involving levees, dredging, etc. Flood stage, about 22 feet.
Remarks.- Only those gage-height crests which were 1.0 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before measurements were made.
Historical data.- Flood of June 16, 1844, reached stage of 38.0 feet (U. S. Weather Bureau).

Flood stages of Missouri River at Kansas City, Mo.
(Base gage height 16.0 feet)

Date			Gage height (feet)
1873	May	28	16.1
	June	6	18.3
		25	19.2
	July	5	† 19.3
....			....
1874	June	17-19	16.2
1875	Apr.	30	17.8
	June	29	17.5
	July	14	16.5
1876	Apr.	17	17.4
	June	16	18.0
	July	5	16.8
1877	May	22	18.1
	June	3-4	18.8
		10	22.2
	July	1-2	19.5
		18	16.5
1878	May	31	18.0
	June	10	19.5
	July	2-3	19.8
		29	18.5
1879	Apr.	11	16.7
	June	20	16.8
		30	19.2
....			....
1880	July	10-12	16.7
....			....
1881	Feb.	7	16.0
	Mar.	30	18.6
	Apr.	2	18.0
		13-14	21.2
		30	26.3
	June	3	16.4
		18	17.0
	July	2-3	17.0
1882	July	3	19.2
1883	May	27	17.1
	June	26-27	23.8
	July	12	19.1
1884	Mar.	26	16.7
	Apr.	9	18.1
	June	24	18.3
	July	5-6	17.2
		13	16.6
1885	June	19	19.1
1886	Apr.	17	**15.8
1887	Apr.	1	20.2
	June	15	19.0
		29	18.8
	July	2-3	18.9
1888	Apr.	7	18.1
		11	18.7
		20-22	18.3
	May	15	16.4
	June	1	18.8
		16	17.7
	July	2-3	20.4
1889	Aug.	14	**13.9
1890	June	11	17.2
1891	June	3	16.8
		7	17.5
		17	18.1
		22	20.2
	July	1	23.1
		8	20.7
		24	16.4
		29	17.0
1892	May	15	23.2
		21	24.9
	June	3	18.1
		14	17.9
	July	5	19.8
1893	Apr.	14	18.1
	June	6	17.0
		26	17.2
	July	5	17.7
1894	Apr.	16	18.5
	May	28	16.7
	June	20-21	20.1
1895	June	12	16.9
		21	16.4
1896	Apr.	10	16.0
	May	22	19.2
	June	3	16.0
		10	16.0
		17	18.8
	July	6	19.1
		21	17.1
1897	Mar.	25	18.2
	Apr.	19	P 22.8
		20	22.6
		27	22.6
	June	6	17.6
	July	2	18.0
		6-7	17.6
1898	June	12	21.5
	July	5	19.7
1899	Apr.	28-29	23.2
		28	P 23.3
	May	23	18.0
	June	2	18.6
		11	21.4
		18	20.6
	July	9	22.2
1900	June	11	16.3
		20	17.8
1901	Apr.	15	16.5
	June	12-13	17.7
		24-25	19.4
	July	6	16.7
1902	June	11	19.0
		24	17.5
	July	4	19.4
		14-15	23.1
		14	P 23.2
		20	20.2
	Sept.	2	17.0
1903	Mar.	15	16.7
	June	1-2	35.0
		28	17.7
	July	14	16.6
	Aug.	17	17.3
	Sept.	1	18.0
1904	Apr.	17	19.4
		26	19.9
	May	6	16.1
		31	19.4
	June	4-5	20.7
		14	20.2
		27	20.7
	July	8	25.2
1905	Mar.	2	16.6
	May	17	17.0
	July	4	20.0
		12	23.0
	Sept.	19	18.6
1906	Apr.	11	17.0
	June	7	17.3
		21	19.7
1907	Feb.	23	16.2
	June	4	18.9
		24	19.8
	July	8	20.3
		20-21	23.5
1908	June	15	30.2
		15	P 30.3
	July	10	21.9
		18	19.0
1909	Mar.	10	17.6
	June	11	20.0
		25	21.6
	July	13	27.0
	Nov.	17	17.5
1910	Jan.	16	16.5
	Mar.	24	20.2
1911	July	5	**14.1
1912	Apr.	2	23.1
		6	22.6
		17	23.2
	July	14	16.7
1913	Apr.	16	21.9
		16	P 22.1
	June	11	16.5
		26	16.7
1914	June	17	21.2
		17	P 21.3
	July	1	18.2
1915	Apr.	15	21.3
	May	30	25.2
	June	12	23.7
		21-22	26.9
		21	P 27.0
	July	2	23.9
		21	29.0
	Aug.	1	26.4
		8	24.5
		20	19.0
	Sept.	29-30	16.7
1916	Mar.	15	17.4
		27	18.9
	Apr.	15	18.5
	May	16	16.4
		25	17.6
	June	21	16.7
	July	5	19.6
		15	19.8
1917	Mar.	30	17.1
	Apr.	20-21	21.6
	May	1	16.9
	June	3	22.7
		9	26.5
		9	P 26.7
		28-29	20.8
1918	Apr.	2	19.2
	May	30	17.1
	June	8	17.3
	July	1	18.4
1919	Mar.	18	20.8
	Apr.	13	20.7
	May	5	16.5
	June	14	18.0
1920	Apr.	7	21.0
		7	P 21.1
		29	17.1
	May	21	22.6
	June	5	17.4
		12	17.1
	July	1	21.6
		14	19.6
		14	P 19.8
1921	July	2	21.5
1922	Mar.	20	16.4
	Apr.	11	21.5
	June	19	17.5
		28	18.1
	July	12-13	18.8
1923	June	13	21.7
		21	19.6
	July	6	20.7
		6	P 20.9
		15	17.2
	Oct.	12-13	16.3
		12	P 16.9
1924	Apr.	17	18.7
	June	10	16.3
		14	18.4
		21	19.6
		24	18.7
		28	P 22.3
		29	22.1
	July	22	16.1

† Last reading before break in record; may not be peak.
** Below base.

Flood stages of Missouri River at Kansas City, Mo.--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1925 Apr.	7	17.6	June	13	20.4	1930 May	9	16.5
	7	P 17.7		19	20.9		9	P 16.7
June	3	P 16.6	1928 June	9	17.2		15	16.1
	4	16.2		9	P 17.3	June	17	16.2
	6	17.9		20	16.3	1931 June	24	**11.9
	16	19.5		29	16.2	Nov.	25	18.2
	16	P 19.7	July	14	17.1		25	P 18.5
	18-19	20.0	1929 Mar.	15	17.5	1932 June	4	17.4
	18	P 20.7		15	P 18.1		12	16.5
	28	18.8	Apr.	4	16.7		21	20.6
July	4	16.6		22	21.2		21	P 20.9
1926 Sept.	17	16.0		22	P 21.4		28	17.7
	24	16.1	June	5	23.4	July	6	18.5
1927 Apr.	21	24.8		17	19.6	1933 May	31	**14.5
	30	16.7		23	P 22.3	1934 June	12	**12.2
May	18	21.8		24	21.9			
	31	19.0	July	8	19.1			

** Below base
P Momentary peak

Note.- Breaks in record: July 6 to Sept. 30, 1873; Dec. 15, 1879, to Jan. 4, 1880; Dec. 30, 1880, to Feb. 5, 1881.

Missouri River at Herman, Mo.

Location.- In SW¼ sec. 25, T. 46 N., R. 5 W., at bridge on State highway 19 at Herman, Gasconade County, 7 miles below Gasconade River.

Drainage area.- 528,200 square miles.

Records available.- Daily gage-height records April 1873 to September 1934; daily discharge records August 1928 to September 1934.

Sources of data.- Gage-height records prior to Sept. 25, 1930, by U. S. Weather Bureau with occasional peak readings by Mississippi River Commission; subsequent gage-height records and all discharge records by U. S. Geological Survey.

Gages.- U. S. Weather Bureau nonrecording gage read to tenths once daily prior to Sept. 26, 1930; U. S. Geological Survey nonrecording gage read to tenths once daily Sept. 26, 1930, to Jan. 25, 1931; to tenths twice daily Jan. 26, 1931, to Mar. 27, 1932; recording gage thereafter. Zero of U. S. Weather Bureau gage is 481.88 feet and zero of U. S. Geological Survey gage is 481.49 feet above mean sea level. Latter gage is 400 feet upstream from former gage but both read same at stage of 4.0 feet.

Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river training works involving levees, dredging, etc. Right bank does not overflow; left bank overflows at about stage of 21 feet.

Storage and regulation.- Osage River, entering 34 miles above station, controlled for power since February 1931 by Lake of Ozarks (available capacity, 1,200,000 acre-feet; drainage area, 14,000 square miles).

Remarks.- Only those gage-height crests 1.0 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before measurements were made.

Historical data.- Flood of June 1844 reached stage of 35.7 feet.

Flood stages
(Base gage height 16.0 feet)

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1873 June	10	**15.9	June	17-18	19.4	June	13	18.2
....		....		25	20.9	July	8	18.5
1874 June	19	16.5	July	6	22.9		30-31	17.0
....		....		17	19.2	....		....
1875 May	1	18.3	....		....	1879 June	29	19.4
July	8	19.6	1877 Apr.	11	16.3	1880 July	15	16.7
	19	19.4		26-27	16.6	1881 Mar.	18	17.5
	29	19.2	May	24	19.0	Apr.	1	18.4
Aug.	1	21.9	June	13-14	22.4		15-16	18.6
1876 Apr.	5	16.8	July	3	18.9	May	4	23.7
	18-19	18.6	1878 Mar.	11	17.6		25	16.3
May	2	16.6	Apr.	24	16.1	June	5	16.6
	8	22.1	May	29-30	18.4		13	16.8

**Below base

Flood stages of Missouri River at Herman, Mo.--Continued

Date			Gage height (feet)
1881	June	20	17.8
	July	3	17.7
	Nov.	19	17.2
1882	Feb.	21	20.4
	May 30-June 1		17.9
	July	3	22.2
		19	16.6
1883	Feb.	17	20.5
		25	16.1
....			....
	June	23-24	24.4
		24 P	24.5
....			....
1884	Mar.	28	17.4
	Apr.	9-10	17.4
		25	16.5
	May	6	18.1
	June	11	16.5
		25	17.1
	July	16	17.6
	Oct.	1	16.6
1885	Mar.	7	16.5
		15	19.8
	Apr.	5	17.7
		26	20.0
	May	29	17.7
	June	16	22.2
	July	9	19.5
	Aug.	14	17.8
	Sept.	14	19.5
....			....
1886	Mar.	22	16.7
		27	16.4
	Apr.	19	16.3
	May	12	18.2
	June	27	18.0
....			....
1887	Apr.	2	16.9
	June	16	17.4
	July	4-5	16.3
....			....
1888	Mar.	27	19.3
	Apr.	14	16.9
		23	16.9
	May	18	16.8
	June	3	18.2
	July	1	19.8
		10	18.2
	Aug.	14	17.5
....			....
1889	Mar.	6	16.8
	May	21	16.6
		30	19.4
1890	Jan.	13	**15.2
1891	Apr.	24	16.2
	June	9	19.0
		24	19.4
	July	3	20.2
	Aug.	21	17.9
....			....
1892	Apr.	6	19.2
		21	17.7
	May	15	24.5
	June	4	22.3
		27-28	16.1
	July	4	16.9
		14	16.6
		18	16.5
....			....
1893	Apr.	21	16.8
	May	1	19.0
	June	3	16.7
		8	16.6
	July	7	17.1
....			....
1894	May	10	16.0
	June	28	16.3
....			....
1895	July	7-8	**15.6
	Dec.	20	18.1
1896	May	25	20.8
	June	5	17.0
1897	Jan.	4	16.7
	Apr.	2	16.4
		10	17.8
		22	16.5
	Apr. 30-May 1		18.0
	July	3	16.0
1898	May	22	18.0
	June	5	16.0
		17	18.8
	June 30-Jul. 1		17.2
1899	Apr.	26-27	18.9
	June	2	16.7
		13	18.3
	July	11	17.8
1900	Mar.	12-13	16.2
1901	Apr.	17-18	** 15.5
1902	July	3	18.0
		16	17.6
	Sept.	4	16.0
	Oct.	8	16.3
1903	Mar.	8	18.0
	June	6-7	29.1
		7 P	29.5
	Sept.	16	16.3
1904	Apr.	27	23.7
	June	1	18.5
		6	21.1
		30	19.5
	July	12	22.7
1905	Mar.	4	16.0
....			....
	May	19	16.1
	July	6	17.6
		14	19.6
	Aug.	2	16.8
		23	16.3
	Sept.	19-20	25.4
		19 P	25.7
1906	Mar.	29	16.6
	Apr.	14	16.3
	June	23-24	16.3
1907	Jan.	20	18.3
	May	17	16.2
	June	15	17.2
		26	19.0
	July	23-24	19.5
1908	June	20	25.0
	July	5	21.4
1909	Mar.	12	16.6
	June	13	17.9
	July	14	26.1
	Nov.	19	16.2
1910	Jan.	13	17.3
	Mar.	26	16.4
	May	9	19.4
	June	11	20.2
1911	Feb.	21	** 14.1
1912	Apr.	4	22.5
		19	18.9
		29	20.8
	June	19	17.3
1913	Mar.	26	16.9
		26 P	17.3
	Apr.	16-17	18.7
1914	June	20	16.8
1915	Feb.	26	17.5
	Apr.	14	17.7
	June	2	25.9
		15	21.2
		22-25	23.5
	July	4	20.0
		21	24.3
	Aug.	4	21.1
		11	20.2
		21	19.6
	Sept.	12	16.8
		21-22	17.7
1916	Jan.	24	16.5
	Jan.	28	19.6
	Mar.	29	20.1
	Apr.	20	17.7
	May	30	20.7
	June	9	21.1
		24	17.2
1917	Apr.	22-23	17.8
	May	2	18.6
	June	12 P	24.8
		13	24.7
	July	1	17.5
1918	July	2-3	16.0
1919	Mar.	20	17.8
	Apr.	15	17.5
	May	9	17.7
		22	16.8
	June	5 P	18.6
		6	18.5
		15	18.2
	Oct.	28	17.0
1920	Mar.	30	20.5
	Apr.	9	19.2
		22-23	16.8
	May	2	16.2
		21	19.0
	July	3-4	17.4
1921	May	13	18.6
	June	30	20.2
1922	Mar.	17	17.9
		22	17.8
		27	19.0
	Apr.	1	19.7
		9	23.5
		12-13	24.6
		18	24.7
		30	16.2
	July	19	16.9
1923	June	16	20.4
		23	17.9
	July	5 P	19.3
		6	18.9
1924	June	1-2	16.0
		13	18.6
		19	19.5
		19 P	19.6
		30	21.5
	July	24	16.7
1925	June	20-21	17.9
		20 P	18.0
		30 P	16.3
	July	1	16.1
1926	Sept.	19	16.3
		26	16.7
	Oct.	11	20.0
1927	Mar.	21	18.6
	Apr.	4	21.0
		24	26.8
	May	10	21.3
		17	18.8
		25	18.0
	June	6-7	21.5
		6 P	21.8
		14	19.6
		24	21.0
	Aug.	14	17.4
	Oct.	4	18.6
1928	Apr.	10	18.0
	June	13	18.6
		21	23.7
		29	19.5
	July	14	16.3
	Nov.	21	20.7
1929	Mar.	16 P	20.2
		17	19.8
	Apr.	5	17.6
		11	19.8
		26	22.8
	May	3	18.8
		15	22.2
		19	24.2

** Below base

Flood stages of Missouri River at Herman, Mo.--Continued

Date		Gage height (feet)	Date		Gage height (feet)	Date		Gage height (feet)
1929 June	8	24.6	1931 May	20	**13.4	July	9	17.4
	8	P 24.8	Nov	29	20.8	1933 May	14	19.1
	26	20.9		29	P 20.9		14	P 19.4
July	10	17.8	1932 June	25	17.2		28	17.6
1930 Feb.	7	**15.3	July	1	16.0	1934 Mar.	10	**10.9

** Below base
P Momentary peak

Note.- Breaks in record: July 1 to Sept. 30, 1873; Jan. 10 to Feb. 20, 1875; Dec. 16, 1876, to Jan. 31, 1877; Dec. 23, 1878, to Jan. 9, 1879; May 1 to June 15, 1883; July 2 to Nov. 20, 1883; Jan. 6-31, 1884; Jan. 10 to Feb. 13, 1886; Dec. 30, 1886, to Jan. 25, 1887; Oct. 1 to Dec. 31, 1888; Jan. 11-29, 1892; Dec. 27, 1892, to Feb. 16, 1893; Dec. 29, 1894, to Feb. 25, 1895. Fragmentary record: Dec. 29, 1887, to Feb. 18, 1888; Dec. 3, 1893, to Feb. 17, 1894.

North Fork of Sun River near Augusta, Mont.

Location.- Prior to Jan. 1, 1916, in sec. 33, T. 22 N., R. 7 W., below Kilraven Ditch, 14 miles northwest of Augusta, and 21 miles southwest of Chouteau, Mont.; thereafter 8 miles upstream just above Sun River Diversion Dam in sec. 36, T. 22 N., R. 9 W.
Drainage area.- 596 square miles at upper location.
Records available.- August 1889 to December 1890, monthly summaries only; July 1904 to September 1928 except winters of 1904-9, 1912, 1922-25.
Sources of data.- U. S. Geological Survey records except those for 1918-28, which were furnished by U. S. Reclamation Service.
Gages.- Nonrecording gage read to tenths once daily 1904-11, 1913-16; to tenths 3 times a week 1912; to hundredths twice daily 1917-18; to hundredths once daily 1919-20; to half-tenths twice daily 1921, and to half-tenths or hundredths once or twice daily 1922-28. Relation between zeros of gages at two locations not determined.
Stage-discharge relation.- Controls permanent at both locations.
Diversions.- About 10 second-feet diverted just above first location prior to 1921. Diversions at Sun River Diversion Dam began in summer 1921 and are included in record 1924-28; annual diversions, about 55,000 acre-feet 1921; from 50,000 to 70,000 acre-feet 1922 and 1923. Maximum mean daily diversions, about 600 second-feet 1921-23.
Remarks.- Record includes all flood peaks except possibly two not recorded, May 21 and 27, 1922.

Flood stages and discharges
(Base discharge 3,500 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1905 June	6	4.1	4,070	1912 May	21	4.8	5,670
1906 June	13	3.1	** 2,320		27	4.3	4,580
1907 May	20	5.0	5,360	June	2	3.9	3,740
June	2	5.6	6,530		10	4.3	4,580
	8	5.2	5,740	1913 May	29	6.6	9,830
	13	4.3	4,090	1914 May	17	4.3	4,440
	23	5.3	5,940		17	4.35	P 4,540
	28-29	5.4	6,130		24	4.0	3,850
July	4	4.7	4,800	June	2	4.2	4,240
1908 June	2	5.5	6,330	1915 May	1	4.0	3,850
	6	9.5	* 15,000	1916 May	7	3.9	5,820
	26	4.0	4,020	June	10	3.8	5,580
1909 May	27	4.6	4,720		21	11.4	P 32,300
June	3	6.0	7,030		21	9.70	25,000
	16	6.0	7,030		29	6.42	12,900
July	1	3.9	3,650	July	2	5.55	10,200
	28	3.8	3,500		8	4.45	7,180
1910 Apr.	28	4.6	4,340	1917 May	16	5.0	8,650
May	8	5.1	5,040		20-21	3.4	4,670
	26	4.2	3,780		25	8.2	P 18,700
1911 May	5	3.9	3,710		26	7.2	15,500
	16	4.2	4,340	June	9	5.2	9,210
June	2-3	4.5	5,000		17	5.40	9,790
	8	4.4	4,780		29	3.55	5,000
	15	4.8	5,690	July	3	3.20	4,230

* Estimated
** Below base

Flood stages and discharges of North Fork of Sun River near Augusta, Mont.--Continued

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1918 May 5	4.02	6,110	June 11-12	3.60	5,120
16	3.03	3,880	1924 May 15	4.40	7,150
June 10	5.81	11,000	June 15	2.80	3,640
10,11	6.02	P 11.600	1925 May 6		3,600
1919 May 22-23	3.10	4,020	20		7,920
28	3.40	4,670	June 20		4,430
1920 May 17	3.02	3,860	1926 Apr. 30	2.8	3,540
June 7-10	3.40	4,670	1927 May 17		6,160
15	3.90	5,820	26		3,710
1921 May 19	4.30	6,800	June 9	5.95	11,400
26	4.40	7,050	11		9,800
June 3-4	3.80	5,580	15		8,100
6		5,820	22-23		5,600
1922 June 5-6	4.40	7,050	1928 May 12	4.70	7,970
1923 May 23	3.20	4,230	23	5.60	10,700
25	3.60	5,120	26	5.30	9,920

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Two Medicine River at Family, Mont.

Location.- In NW¼ sec. 2, T. 31 N., R. 9 W., at Holy Family Mission, 6 miles above Badger Creek and 16 miles southeast of Browning.
Drainage area.- 368 square miles.
Records available.- April 1907 to October 1924 except winters.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read to tenths once daily 1907-14; to tenths twice daily 1915; to quarter-tenths twice daily 1916, and to hundredths twice daily 1917-24. Owing to rapidly scouring stream bed gage lowered as follows: July 1, 1908, 0.95 foot; June 7, 1913, 2.85 feet; July 2, 1916, 2.4 feet. Temporary gage at unknown datum used May 16-July 1, 1916. Gage washed out and discharge estimated June 5-14, 1908, June 3-9, 1913, May 4-26, 1918.
Stage-discharge relation.- Control not well defined; channel deepening throughout record.
Storage and diversions.- Storage at Two Medicine Lake Reservoir subsequent to 1914, capacity, 16,000 acre-feet. Total annual diversions, in acre-feet, for Blackfeet project for 1912-19 were as follows: 1912, 3,650; 1913, 700; 1914, 15,300; 1915, 8,259; 1916, 7,036; 1917, 21,284; 1918, 22,324; 1919, 38,319. Only a few small diversions are not included in this project, which has operated since 1912.

Flood stages and discharges
(Base discharge 1,100 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1907 May 8	4.50	1,730	May 26	3.7	1,240
11	5.00	2,300	1911 Apr. 22	3.8	1,320
16-17	5.50	2,930	26-27	4.2	1,680
June 2	5.60	3,060	May 6	4.6	2,040
8	5.60	3,240	9	4.2	1,680
23	8.40	7,550	16	6.8	4,140
28	5.20	2,760	June 3-4	4.5	1,950
July 4	4.40	1,890	12	4.0	1,490
1908 Apr. 21	4.50	1,990	25	3.8	1,320
May 15-16	5.10	2,640	Sept. 5	3.6	1,150
June 5 or 6		* 15,000	1912 Apr. 11-12	3.6	1,150
25	3.75	1,280	29-30	3.6	1,150
1909 May 5	4.55	1,980	May 9-10	4.2	1,680
10	4.05	1,460	21	5.4	2,800
27	6.25	4,240	27	4.2	1,680
29	5.95	3,790	June 2	3.7	1,230
June 3	6.95	5,380	11	3.55	1,110
9	8.15	7,600	1913 Apr. 20-21	4.0	1,490
19	5.85	3,640	26-27	4.0	1,490
July 28	8.0	7,310	May 12	3.9	1,400
1910 Mar. 23	3.7	1,240	June 3		* 7,180
Apr. 13	3.7	1,240	30	1.85	1,270
20	3.8	1,320	1914 Apr. 15	4.3	1,120
27	4.3	1,790	20	4.6	1,280
May 10	4.0	1,500	25	4.3	1,120

* Estimated

Flood stages and discharges of Two Medicine River at Family, Mont.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1914	Apr.	29-30	4.3	1,120
	May	3-4	4.7	1,460
		10-11	4.5	1,280
		17	4.9	1,640
		25-26	4.4	1,200
	June	3-6	4.2	1,040
1915	May	2	4.9	1,640
		2	5.05	P 1,790
1916	Feb.	19	4.30	1,140
	Mar.	12	4.60	1,390
	Apr.	11	4.30	1,140
		28	4.55	1,340
	May	6	5.60	2,280
		21	4.40	1,220
		29	4.70	1,510
	June	2	4.55	1,440
		5	5.20	2,040
		10	5.20	2,100
		16	5.55	2,240
		21	7.45	4,300
		21	7.5	P 4,500
1917	May	11	5.85	2,600
		16	7.45	4,740
		21	5.65	2,350
		29	6.35	3,240
	June	2	6.05	2,860
		8	7.65	5,020
		16	6.25	3,120
		30	4.8	1,380
1918	Jan.	1	5.80	2,530
	Apr.	14	4.55	1,110
		21	4.73	1,300
	May	* 4	* 7.6	P* 4,950
		4	* 7.3	* 4,530
		14	5.8	2,530
	June	1	4.58	1,140
		11	5.75	2,470
1919	Apr.	30	4.67	1,260
	May	24	5.13	1,730
	May	29	5.38	P 2,030
		29	5.33	1,970
1920	May	9	5.04	1,640
		14	5.31	1,940
		19	5.38	2,030
		21	5.40	2,050
		21	5.48	P 2,150
	June	10	5.30	1,930
		16	5.08	1,680
1921	Apr.	2	5.08	1,950
		16	4.53	1,140
		22	5.07	1,940
	May	7	5.42	2,600
		21	5.48	2,720
		21	5.58	P 2,920
		26	5.25	2,280
	June	2	4.67	1,300
		8	5.34	2,450
1922	Apr.	29	4.68	1,410
	May	5	4.44	1,180
		20	5.94	3,900
		26	5.34	2,560
	June	7	6.24	4,120
		7	6.26	P 4,160
1923	Apr.	19	4.62	1,240
		28	4.75	1,410
	May	5	4.50	1,110
		11	5.25	2,280
		26	5.08	1,930
	June	2	4.90	1,640
		12	5.55	2,860
		12	5.60	P 2,960
		22	4.50	1,110
1924	May	4	4.98	1,780
		11	5.00	1,810
		16	5.38	2,520
	June	6	5.38	2,520
		11	5.95	3,660
		11	6.05	P 3,860

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Marias River near Shelby, Mont.

Location.- In sec. 20, T. 31 N., R. 2 W., at highway bridge 7 miles southwest of Shelby.
Drainage area.- 2,610 square miles.
Records available.- April 1902 to January 1908, April 1911 to September 1934 except winters.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily 1902-6, 1914-19, to half-tenths 1907-13, 1922, to hundredths 1920-22 except for short periods during 1912, 1913; recording gage 1923-34 and parts of 1912, 1913. Zeros of all gages at same elevation.
Stage-discharge relation.- Control slightly shifting. Gas pipe line below gage caused slight backwater beginning Oct. 14, 1930.
Storage and diversions.- Storage at Lake Francis subsequent to 1910 (capacity, 112,000 acre-feet), at Swift Dam subsequent to June 1, 1913 (capacity, 4,000 acre-feet), at Two Medicine Lake Reservoir subsequent to spring of 1914 (capacity, 16,000 acre-feet), and at Four Horns Reservoir subsequent to August 1915 (capacity, 4,000 acre-feet). Total annual diversions above station 1902-11, about 20,000 acre-feet; 1912-19, about 60,000 acre-feet; and 1920-33, about 80,000 acre-feet.
Remarks.- Probably some peaks above base not recorded in spring of 1904, 1907, 1914, and 1925, and during periods of fragmentary records, May 23 to June 6, 1914; May 22-31, July 19 to Aug. 9, 1923; May 13 to June 21, July 12 to Aug. 5, 1927, and Apr. 28, to May 3, 1933. An unrecorded flood occurred on Jan. 1 or 2, 1917 (see record for Two Medicine Creek at Family, Mont.).

Flood stages and discharges of Marias River near Shelby, Mont.
(Base discharge 2,160 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1902	May	16	5.7		5,230
		22	14.5	*	25,000
		30	7.0		7,510
	June	11	5.1		4,160
		27	4.40		2,930
	July	4	11.5		15,400
1903	Mar.	24	3.9		2,400
		31	6.4		7,400
	Apr.	27	3.8		2,200
	May	8	4.0		2,600
		16	4.5		3,600
	June	3	6.5		7,600
		7	6.6		7,800
		30	4.7		4,000
	Nov.	26	3.9		2,400
	Dec.	4	3.8		2,200
		19	3.8		2,200
1904	Apr.	8	7.2		8,560
		22	4.0		2,300
		29	4.6		3,360
	May	23	5.4		4,960
	June	2	4.8		3,760
		7	4.6		3,360
		18	4.40		2,970
1905	May	3	4.1		2,450
		26	4.9		3,940
	June	10	4.0		2,290
1906	June	9	4.9		4,090
1907	May	21	5.4		4,840
		31	5.15		4,170
	June	3	6.3		6,800
		9	6.65		7,580
		14	5.45		4,700
		24	14.9		29,500
		28	7.4		8,970
	July	4	6.2		6,520
		8	5.6		4,700
		22	4.5		2,470
.....	.....	.....	.....		.....
1911	Apr.	27	5.2		2,570
	May	6	5.8		3,380
		17	7.75		6,110
	June	4	6.7		4,640
		13	5.95		3,590
		25	6.7		4,640
	Sept.	6	6.5		4,360
1912	Apr.	12	5.0		2,450
	May	9	5.5		3,130
		22	8.0		6,630
		26	7.0		5,230
	June	10	5.0		2,450
		14	4.9		2,320
1913	Apr.	15	4.8		2,220
		23	5.4		3,210
	May	14	5.2		2,940
		29	7.6		6,480
	June	20	5.2		2,560
		28	5.3		2,690
1914	May	17	5.4		2,790
		20	6.5		4,430
1915	May	3	5.3		2,660
1916	Apr.	29	5.0		2,270
	May	6	5.9		3,500
	June	5	6.7		4,750
		12	6.3		4,110
		22	13.5		15,600
1917	Apr.	8	5.9		3,830
	May	14	7.6		7,080
		20	7.0		6,350
		31	8.4		10,000
	June	5	7.4		7,580
		12	7.9		8,830
		18	7.3		7,340
		26	7.1		6,860
		28	5.9		4,220
	July	8	5.4		3,330
1918	Mar.	23	4.9		2,560
	May	6	6.2		4,810
		8	6.0		4,410
		10	5.7		3,850
	May	15	5.3		3,160
	June	2	4.9		2,560
		10	6.3		5,020
		24	5.3		3,160
1919	May	4	4.58		2,320
		24	5.48		3,720
		31	5.58		3,890
1920	Apr.	14	7.0		6,620
		16	5.7		4,100
		21	4.7		2,480
	May	10	7.4		7,580
		17	7.4		7,580
	June	10	6.4		5,310
		17	6.4		5,310
		25	6.3		5,100
	July	5	4.8		2,260
		13	4.9		2,420
1921	Mar.	27	4.76		2,350
	May	8	5.55		3,710
		12	5.45		3,530
		20	6.34		5,230
		27	6.04		4,640
	June	7	5.93		4,430
1922	May	4	4.85		2,490
		18	5.75		4,080
		21	5.99		4,540
		22	6.02	P	4,690
		28	5.85		4,280
	June	4	5.55		3,900
		9	5.65		3,900
1923	May	11	5.53		3,670
	June	3	5.45		3,530
		12	5.72	P	4,030
		13	5.60		3,800
		22	5.47		3,570
	July	18			2,440
1924	May	5	5.55		3,320
		17	6.15		4,450
	June	17	6.94		6,110
		17	7.00	P	6,240
1925	Apr.	13	6.35		4,860
		18	5.70		3,580
		24	5.75		3,670
	May	3	6.05		4,600
		7	5.97		4,440
		21	7.18		7,200
		21	7.35	P	7,680
		30	6.24		5,020
	June	5	5.55		3,600
		23	5.60		3,690
1926	June	24	4.75		2,180
		24	4.8	P	2,240
1927	Apr.	28	6.80		5,820
	May	18	7.0		6,240
		22	8.3		9,130
	June	9	8.7		10,000
		9	9.50	P	12,000
	July	4	6.05		4,300
	Aug.	17	4.75		2,180
	Sept.	15	5.70		3,660
1928	Mar.	23	5.65		3,570
	Apr.	29	5.7		3,660
	May	2	5.25		2,880
		9	6.8		5,820
		14	6.8		5,820
		24	7.0		6,240
		24	7.1	P	6,450
	June	30	6.15		4,480
	July	8	5.05		2,580
		20	4.85		2,300
1929	May	15	5.33		3,150
		25	6.12		4,200
	June	3	6.12		4,380
		3	6.16	P	4,460
		12	5.12		3,080
1930	Apr.	16	5.06		2,780
		17	5.09	P	2,850
		27	4.77		2,290
	May	5	4.93		2,490
	June	6	5.05		2,490

* Estimated

Flood stages and discharges of Marias River near Shelby, Mont.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1931 May	18	4.51	2,160	June	10	6.30	P 5,500
	18	4.60	P 2,290		17	5.93	4,760
1932 May	14	5.42	4,070		22	5.18	3,260
	23	5.42	4,070	Oct.	30	4.87	2,640
June	3	4.66	2,800	1934 Apr.	9	5.23	3,360
	11	5.07	3,480		14	5.26	3,360
	15	6.98	P 7,000		24-26	6.16	5,070
	16		3,990	May	8-9	5.82	4,240
1933 Apr.	27	4.55	2,180		18	5.43	3,580
May	6	4.69	2,400		28-30	4.75	2,460
	17	5.18	3,260	June	8		14,000
	27	5.52	3,840		8	11.05	P 16,200
June	2	6.12	5,070		27	4.88	2,700
	10	6.12	5,070				

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

South Fork of Milk River at and near international boundary

Location.- Prior to Oct. 1, 1930, in NW¼ sec. 29, T. 37 N., R. 9 W., just above Kennedy Coulee, 5 miles south of international boundary, and 30 miles northeast of Browning, Mont.; thereafter about 10 miles downstream in NW¼ sec. 6, T. 1, R. 19 W. 4th meridian, 1 mile north of international boundary and 20 miles west of Milk River, Alberta.
Drainage area.- 288 square miles prior to Oct. 1, 1930, and 433 square miles thereafter.
Records available.- April 1905 to September 1934. No record during most winters and springs.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths or hundredths once or twice daily for intermittent periods prior to Apr. 13, 1913; recording gage thereafter.
Stage-discharge relation.- Controls shifts at both locations; influenced by aquatic growth at upper station. Bank-full stage at upper station, about 12 feet.
Diversions.- Few small diversions above station.
Remarks.- Discharge records at two locations not comparable owing to inflow from tributaries. Probably some peaks not recorded during spring of 1907, 1908, 1909, 1913, and May 1-16, 1920.

Flood stages and discharges
(Base discharge 230 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1905 June	26	4.20	** 144	May	6	3.90	273
1906 May	29	5.2	350		16	6.3	1,040
	31	5.50	427		26-28	3.90	273
1907 Apr.	9	5.05	# 370	June	25	5.95	918
May	9	5.88	623	July	1	3.90	273
	17	5.38	467	Sept.	5-6	4.35	400
June	8	5.6	534	1912 Apr.	3-5	4.5	445
	23	8.45	1,690		9-10	4.15	342
Sept.	17	4.75	286	May	22	5.4	731
1908 Apr.	4	6.10	695	1913 Apr.	13	5.55	# 864
	15	5.95	646		19	4.8	588
	23	5.22	419		27	4.13	351
May	15	5.65	550	May	3	3.80	248
	27	5.7	565		8	3.74	232
June	1	7.55	1,240		13	4.01	311
	6	15.4	P* 15,000		19	4.54	494
....		.....	......		28	4.32	417
1909 May	29	4.55	# 460	June	28	4.23	386
June	9	5.65	815	1914 Apr.	6	4.35	429
	18	4.3	385		12	4.52	488
	21	4.55	460		12	4.8	P 588
July	7	4.05	312	1915 Mar.	18	3.73	237
	28	5.9	900	Apr.	3	4.07	335
1910 June	9	3.8	246	May	2	3.71	232
1911 Apr.	26	4.15	342		15	3.83	263

First record in spring; may not be peak
* Estimated
** Below base

Flood stages and discharges of
South Fork of Milk River at and near international boundary--Continued

Date			Gage height (feet)		Discharge (second-feet)
1915	June	4	5.50	P	845
		5	5.45		826
		10		*	300
		26	4.94		624
	July	18	4.21		339
		28-29		*	235
	Sept.	4	4.35		388
1916	Feb.	16	8.6		2,840
		20	5.9		1,230
	Mar.	10	6.6		1,640
		21	4.14		355
	Apr.	12	3.79		242
		16	3.82		251
	May	2	3.87		266
		28	4.77		626
	June	2	4.52		509
		11	4.36		381
		23	4.75		616
		30	4.82		670
	Sept.	4			279
1917	Apr.	8			1,170
		8	6.42	P	1,520
		16	3.92		238
		21	4.3		377
	May	2			372
		9	5.2		841
		22	4.8		681
		30			801
	June	12			826
1918	Jan.	2	3.40		370
	Apr.	9	3.22		347
1919	Apr.	1	2.87		249
		1	3.14	P	326
1920	Apr.	23	3.11		349
		27	4.20		851
		27	4.22	P	886
....			....		...
	May	18	3.75		632
1921	Apr.	13	3.17		396
		13	3.48	P	533
	May	8-9	2.75		246
		20	3.17		396
	June	5	2.70		231
1922	May	5	3.17	P	346
		6	3.14		337
		18	3.04		309
		30	3.13		334
	June	10	2.81		247
1923	Apr.	18	3.00		295
		30	2.79		234
	May	11			369
	June	1	3.00		295
		22	3.58		466
		22	3.62	P	487
1924	Apr.	7		*	350
	June	8			804
		8	4.96	P	903
1925	Apr.	2		*	600
		13	4.17		658
		18	3.30		388
		23	3.65		496
	May	6			280
		14			357
1926	Apr.	13		*	250
1927	Apr.		7.60	P*	[illegible],290
	May	11	3.14		321
		22		*	1,000
		25	5.12		1,340
		29	6.10	P	
		30	5.58		1,680
	June	1	5.57		1,670
		1	6.35	P	
		12	4.28		799
	July	5	3.20		340
	Aug.	1	2.89		251
		18	2.82		233
	Sept.	14	5.04		1,290
		14	5.6	P	
1928	Mar.	26	2.91	#	245
	Apr.	1	3.01		288
		17	2.79		274
		28	3.56		506
	May	9	3.13		349
		14	3.39		458
	June	19	3.76		639
		26	3.10		345
	July	1	3.97		729
		1	4.07	P	771
		19	3.09		333
1929	Apr.	18	3.12		302
		27	3.34		409
	May	11-12	2.86		243
	June	3	3.66		548
		3	3.77	P	597
		11	2.88		234
1930	Feb.	20	3.53	#	420
	Mar.	28	5.90	P	1,570
		29	4.93		1,100
	Apr.	3		*	1,020
		30	3.50		436
	May	4	3.58		469
		12	3.52		444
	June	4	3.54		452
1931	Apr.	7	2.25	P	275
		7	2.10		230
1932	Apr.	1	2.63	#	250
	May	5	2.78	P	435
		5			341
1933	Apr.	29	2.60		447
		29	2.69	P	495
	May	6	2.32		315
		10	2.43		364
		16	2.39		346
1934	Mar.	15-21		*	280
	Apr.	7	2.90		635
		19	2.12		270
	May	7	2.28		354
		13	2.07		262
	June	9	3.24		809
		9	3.56	P	983
		28	2.11		266

* Estimated
# First record in spring; may not be peak.
Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak). Break in record: June 1 to Aug. 7, 1908; May 1-16, 1920.

Lodge Creek at international boundary

<u>Location</u>.- In SE¼ sec. 12, T. 1, R. 29 W. third meridian, in Saskatchewan, at Willow Creek barracks of Royal Northwest Mounted Police, 1 mile north of international boundary, and 30 miles northwest of Havre, Mont.
<u>Drainage area</u>.- 797 square miles.
<u>Records available</u>.- April to May 1910; March 1911 to September 1934 except winters.
<u>Sources of data</u>.- Record furnished by Reclamation Service, Department of Interior, Canada, prior to Mar. 31, 1917; U. S. Geological Survey thereafter.
<u>Gages</u>.- Nonrecording gage read twice daily to hundredths prior to May 6, 1919; recording gage thereafter. Elevation of zero of gages is 2,721.06 feet above mean sea level.
<u>Stage-discharge relation</u>.- Affected by ice. Control shifts slightly.
<u>Diversions</u>.- Several small irrigation diversions above station.
<u>Remarks</u>.- Record begun each spring before high water except possibly 1912 and 1916.

Flood stages and discharges
(Base discharge 300 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1911	Mar.	29		* 684
	July	4		321
	Sept.	7		1,830
1912	Apr.	5		# 5,700
1913	Apr.	7		920
		12		1,010
1914	Mar.	16		554
	Apr.	3		347
		7		360
1915	Mar.	25		588
		29		502
	Apr.	4		1,400
	July	15		405
		18		393
	Aug.	22		456
1916	Mar.	13		2,030
		24		1,140
		27		1,030
	May	31		437
	June	13		855
	July	4		1,180
1917	Apr.	10	10.13	2,100
		16	8.00	1,560
		23	7.75	1,540
	May	5	4.25	331
		19	5.55	654
1918	Mar.	31	12.90	* 2,700
	Apr.	6	6.10	* 891
		9	6.94	* 1,260
		12	8.00	* 1,810
1919	Apr.	20	4.19	338
1920	Apr.	14	4.86	498
		21	4.70	469
		21	5.26	P
	June	18	4.36	520
		18	6.50	P 1,030
1921	Apr.	4		562
		16		1,070
	May	10		870
1922	Apr.	8	10.66	1,670
		11	6.26	819
		15	7.08	1,060
		15	8.10	P 1,350
		23	8.72	1,530
		23	9.05	P 1,630
	May	1	5.31	555
		1	5.52	P 611
1923	Apr.	15	4.32	368
		20		307
	Apr.	20	4.30	P 363
	June	22		1,240
		22	8.51	P 1,520
	July	9		373
		9	6.40	P 933
1924	June	9		482
		9	5.67	P 729
1925	Mar.	27	7.61	1,280
		30		1,400
	Apr.	3	6.78	981
		7	6.06	756
		24		1,480
		24	8.77	P 1,690
	June	14		686
		14	7.45	P 1,220
1926	Mar.	2	6.78	* 448
		2	7.61	P* 650
1927	Mar.	29		1,260
		31		1,300
	Apr.	6	5.87	703
		6	6.90	P 1,010
		8	6.06	749
		17	6.07	752
		17	6.46	P 860
		27	8.32	1,640
	May	23	10.99	2,970
		23	12.41	P 3,680
		29	8.20	1,580
		29	9.02	P 1,990
1928	Mar.	23	12.60	P* 3,500
		24	10.63	* 2,800
	Apr.	2	7.60	1,290
		2	8.33	P 1,600
1929	Apr.	24	4.23	334
	May	1	6.56	889
		1	7.10	P 1,080
1930	Feb.	23	5.58	581
	Mar.	12	6.30	797
		25	4.60	361
	Apr.	5		491
		5	5.22	P 529
1931	July	1	2.57	** 84.0
1932	Feb.	29	5.29	544
	Apr.	3	5.30	546
		3	5.66	P 628
1933	Mar.	20	4.50	* 388
		20	4.88	P* 459
1934	Mar.	3	## 8.00	
		11-20		** * 194

* Estimated
** Below base
\# First day of record in spring; may not be peak.
\## Ice gorge
<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Battle Creek at international boundary

Location.- In SE¼ sec. 4, T. 1, R. 26 W. third meridian, in Saskatchewan, a quarter of a mile above international boundary and 35 miles north of Chinook, Mont.
Drainage area.- 726 square miles.
Records available.- April 1917 to September 1934 except winters.
Source of data.- U. S. Geological Survey.
Gage.- Recording.
Stage-discharge relation.- Slightly shifting.
Diversions.- Several small diversions above station, total probably less than 20 second-feet. Little change during period of record.
Remarks.- Record started each spring before high water except 1926.

Flood stages and discharges
(Base discharge 200 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1917	Apr.	13		2,830	1926	Mar.	24	3.89	* 274
		13	8.50	P 3,200		Apr.	14	3.89	274
		23	5.48	942			14	4.05	P 326
	May	13	6.08	1,280	1927	Mar.	31	4.19	411
1918	Mar.	31	8.22	* 2,500		Apr.	4	6.47	1,700
	Apr.	6	5.00	810			4	7.02	P 2,010
		9	5.83	1,310			17	5.41	1,090
		13	5.23	838			30	6.28	1,620
		16	5.11	816		May	10	3.64	241
1919	Apr.	17	3.28	** 125			22	6.17	968
1920	Apr.	1	4.40	* 227			24	6.42	1,690
		13	4.35	558			29	5.48	1,160
		23	3.80	293		June	16	4.02	365
	May	1	3.78	284			16	5.29	P 1,030
		11	4.92	843		July	4	4.40	523
		11	5.08	P 923	1928	Mar.	29	7.58	* 1,140
1921	Apr.	6	3.78	265		Apr.	3	8.93	* 2,000
		17	4.55	610			3	9.50	P* 2,320
		17	4.71	P 690			10	4.21	407
		21	4.08	396			10	4.42	P 516
1922	Apr.	4	6.04	* 920		June	23	3.70	260
		7	6.14	* 980	1929	Apr.	25	4.85	656
		15	4.41	* 534			26	4.07	P 763
		25	5.61	1,060			30	3.72	258
	May	4	5.44	996	1930	Mar.	12	5.52	* 432
		19	3.97	352			27	5.64	* 250
1923	Apr.	21		283		Apr.	2	5.18	* 796
	June	25		227			2	5.80	P* 1,070
		25	3.94	P 341			8	4.51	576
1924	Apr.	11	3.81	269	1931	Apr.	7	2.82	** 53
		11	3.81	P 269	1932	Mar.	3	4.67	* 236
1925	Mar.	29		* 1,160		Apr.	6	3.92	369
	Apr.	2	6.38	P 1,430			6	4.10	P 418
		3	6.15	1,310	1933	Apr.	22	3.70	260
		9	5.22	858			22	3.89	P 310
		25	4.18	392	1934	Apr.	9	3.96	324

* Estimated.
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Yellowstone River at Glendive and Intake, Mont.

Location.- At highway bridge at Glendive 1897-1910, 1931-34. About 18 miles downstream at Lower Yellowstone Diversion Dam, at Intake, in NW$\frac{1}{4}$ sec. 36, T. 18 N., R. 56 E., Jan. 1, 1911, to Sept. 30, 1931.

Drainage area.- 66,100 square miles at Glendive, 66,800 square miles at Intake.

Records available.- July 1897 to November 1934 except some winters.

Sources of data.- U. S. Geological Survey records except gage-height records, which were furnished by Corps of Engineers, U. S. Army 1897-1901 and by U. S. Weather Bureau 1902.

Gages.- Nonrecording gage read to tenths once daily 1897-1903; to tenths or half-tenths twice daily 1903-31, and to hundredths twice daily thereafter. Relation between zeros of gages at two locations not determined.

Stage-discharge relation.- At Glendive, shifting control; bank-full stage, about 16 feet. At Intake, control permanent, rock-full dam.

Diversions and regulation.- Just above Intake station Lower Yellowstone Canal diverts water for irrigation of 66,000 acres; maximum flow, about 400 second-feet and not included in record at Intake. Many diversions from tributaries above Glendive. Natural regulation at Yellowstone Lake and artificial regulation at Shoshone Dam affects flow slightly.

Flood stages and discharges
(Base discharge 35,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1898	Apr.	10	8.0		
	May	31	9.2		
	June	24	10.4		
1899	Apr.	8	13.4		
	June	7	7.1		
		24	10.9		
	July	3	11.6		
1900	May	15	7.5		
	June	1	8.8		
		9	10.0		
		24	7.6		
1901	May	24	8.8		
	June	1-2	9.6		
		25	6.5		
1902	June	19	7.0		
1903	Apr.	3	7.2		39,200
	June	12	8.0		49,300
		20	9.0		62,300
	July	3	8.9		61,000
1904	Apr.	1	11.90	*	100,000
	May	27	9.30		66,200
	June	4	9.60		70,100
		14	8.60		57,100
		23	10.20		77,900
	July	4-6	8.20		51,900
1905	June	8	9.4		67,800
		11-12	9.3		66,400
		16	8.6		57,200
		26	8.0		49,500
	July	1	8.3		53,300
		4	8.3		53,300
1906	Mar.	30	6.7		36,400
	May	17	6.9		38,100
		27	8.35		55,400
	June	8	10.1		79,400
		16	9.3		68,200
1907	May	26	9.1		65,400
	June	11	9.2		66,800
		16	8.75		60,600
		24	10.9		90,600
	July	8	10.7		87,800
		21	8.4		56,100
1908	May	24	6.95		38,600
		30	7.9		49,700
	June	5	10.0		78,000
		18	10.6		86,400
		30	8.85		62,000
	July	8	9.3		68,200
1909	May	31	7.65		46,700
	June	9	12.0		107,000
		22	11.15		94,200
	July	7	11.3		96,500
		21	6.85		37,600
1910	Mar.	8	7.85		47,600
	May	17	7.0		38,000
	May	31	7.1		39,100
	June	5	7.85		47,600
		9	7.85		47,600
1911	June	5	5.6		42,200
		11	6.8		59,800
		18-19	7.7		73,800
		22	8.0		78,400
1912	Mar.	29	10.2		114,000
	Apr.	2	7.1		64,400
	May	24	5.4		39,400
	June	13	8.2		81,600
	July	4	10.1		112,000
		23	5.2		36,800
	Aug.	6	5.2		36,800
1913	June	4	7.7		73,800
		21	6.9		61,400
	Aug.	17-18	5.1		35,600
1914	May	27			62,900
	June	7	8.0		78,400
		22	7.4		69,100
		28	7.2		66,000
1915	June	6-7	5.7		43,600
		13	9.2	P	97,400
		13	9.0		94,200
		21-22	6.3		52,200
		28	6.0		47,900
	July	10	5.9		46,400
		16	7.6		72,200
		27	5.2		36,800
	Aug.	3	5.3		38,100
1916	Mar.	11	9.0	#	94,200
	June	13-14	5.4		39,400
		23	9.4		101,000
		28	6.8		59,800
	July	1	8.3		83,000
		8	7.1		64,400
		16	7.8		75,300
1917	Apr.	4	6.2	#	50,800
	June	1	6.55		56,800
		6	5.95		47,900
		14	6.8		59,800
		23	9.0		94,600
	July	11-12	7.8		75,300
1918	Mar.	20	7.8	#	75,300
	June	20	10.8		126,000
	July	18	5.9		46,400
1919	May	29-30	4.25	**	25,900
1920	May	13	6.0		47,900
		31	5.6		42,200
	June	20	8.7		89,700
	July	2	7.1		64,400
		6	7.25		66,800
		15	5.6		42,200
1921	June	2-3	5.85		45,700
		21	12.6	P	159,000

* Estimated
** Below base
\# First record in spring; may not be peak.

Flood stages and discharges of
Yellowstone River at Glendive and Intake, Mont.--Continued

Date		Gage height (feet)		Discharge (second-feet)
1921 June	21	11.65		142,000
	27	5.9		46,400
1922 May	29	5.7		43,600
June	10	7.6		72,200
	17	8.5	P	86,400
	17	8.3		83,200
1923 May	30	6.1		49,400
June	16	6.6		56,800
	20	7.1	P	64,400
	20	6.75		57,500
	27	6.5		55,200
July	5-6	5.3		38,100
	28-29	5.65		42,900
Oct.	3	10.4		119,000
	3	11.2	P	134,000
1924 Apr.	3	7.35		58,300
	10	9.3		99,800
May	22-23	6.9		61,400
June	8	6.45		54,500
	20	7.8		75,300
	30	6.15		50,100
July	10	5.4		39,600
1925 Mar.	10	5.1		36,000
May	25	6.5		55,200
June	2	7.5	P	70,000
	3	7.40		59,100
	18	6.55		57,500
	22	7.3		67,600
	24	7.25		66,800
July	4	6.9		61,400
1926 May	27	6.35	P	53,000
	27-28	6.0		47,900
1927 May	22	5.7		43,600
	30	5.8		45,000
June	23	8.5		86,400
July	1	9.4		101,000
1928 May	15	5.6		42,200
June	1	8.6		88,000
July	5	7.2		66,000
	8	8.2		81,600
	19-20	5.8		45,000
1929 Mar.	13	6.98		50,800
May	30	7.60		72,200
June	7	9.00	P	94,600
	7	8.35		84,800
	11	6.75		59,800
	19	5.90		61,400
	22	6.65		56,800
July	2-3	5.48		40,800
1930 June	2	5.35		40,800
1931 June	11	5.30	P	46,100
	11-12	5.2		44,900
1932 May	17-18	8.7		39,300
	25	10.14		51,600
June	11	11.11		61,200
	19	10.11		51,600
	28-29	11.3		63,100
	29	11.50	P	55,100
1933 May	25	8.15		35,200
June	6-7	10.0		53,800
	20	10.89		63,700
	20	10.97	P	64,800
1934 May	12	6.44	**	20,600

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Big Horn River at Thermopolis, Wyo.

Location.- At highway bridge in sec. 36, T. 43 N., R. 95 W., at east edge of Thermopolis.
Drainage area.- 8,080 square miles.
Records available.- May 1900 to December 1905; June 1910 to September 1934.
Sources of data.- U. S. Geological Survey records and 1913 and 1914 reports of Wyoming State engineer.
Gage.- Nonrecording gage read twice daily to tenths 1900-1915; to half-tenths 1916; to quarter-tenths 1917-18, and to hundredths thereafter. Zero of gage is 4,304.80 feet above mean sea level.
Stage-discharge relation.- Control shifts slightly at high stages. Hot springs near gage prevent ice formation except during most severe winters.
Diversions.- Practically no diversions between Thermopolis and junction of Wind and Popo Agie Rivers. Increasingly large diversions from headwaters about 60 miles above. Estimated total annual diversions above station in acre-feet were as follows: 1900, 120,000; 1905, 121,000; 1910, 202,000; 1920, 345,000; 1930, 386,000; 1933, 403,000.

Flood stages and discharges
(Base discharge 7,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1900 June	8	6.6	14,100
	27	5.25	11,100
1901 May	21	7.95	17,000
	30	7.30	15,600
June	24	4.15	8,700
1902 June	5	5.00	9,890
1903 June	11	5.90	8,730
	19	6.55	9,840
	30	5.05	7,280
1904 May	23	7.25	12,800
June	3	6.00	10,100
	10	6.3	10,700
June	23	7.85	14,200
July	2	5.35	8,700
	6	5.65	9,350
1905 June	2	4.65	7,010
	5	6.2	10,400
	10	5.5	8,880
	15	4.8	7,340
	28	5.05	7,890
....		....	.....
1911 June	10	7.0	10,000
	19	11.5	18,000
1912 June	11	10.3	19,500

Flood stages and discharges of Big Horn River at Thermopolis, Wyo.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1912 June	26	7.4	12,900	May	21	7.8	11,200
1913 May	31	9.6	14,700		31	9.4	14,300
June	7	7.55	11,400	June	8	8.6	12,800
	18	5.3	7,640		18	10.7	16,700
	21	5.6	8,140		26	6.8	9,380
	30	5.55	8,060	1925 June	1	6.30	8,230
1914 May	26	6.55	9,710		25	6.70	8,940
June	5	8.4	12,800	July	5	7.15	9,730
	22	5.85	8,550		5	7.30	P 10,000
1915 June	3	7.25	10,900	1926 July	11	7.25	P 10,200
	3	7.80	P 11,800		11	7.00	9,750
1916 June	12	6.6	8,140	1927 May	19	5.60	7,160
	21	9.2	12,400	June	10	6.40	8,640
	21	9.25	P 13,000		16	8.38	12,400
	30	6.8	8,470		30	9.65	14,700
1917 June	24	13.4	19,400		30	9.70	P 14,800
	24	13.40	P 19,400	1928 May	30	9.66	14,800
July	8	10.2	14,100		30	9.90	P 15,200
1918 June	17		19,000	June	30	6.65	9,010
	17	13.3	P 19,200	July	9	5.67	7,290
	24	12.9	18,500		15	5.60	7,160
1919 June	1	4.6	** 4,840	1929 Mar.	11	9.04	13,600
1920 Mar.	15	6.20	7,660		11	9.25	P 14,000
June	1	6.94	9,130	June	18	5.95	7,900
	12	9.7	13,800	1930 June	1	6.68	9,430
	25	6.45	8,600		13	6.30	8,720
1921 June	3	8.0	11,000	July	14	5.48	7,210
	10	13.4	20,700	Aug.	16	9.36	14,300
	10	13.43	P 20,700		16	9.41	P 14,500
	26	6.4	8,840	1931 June	4	6.51	8,660
1922 June	11	8.2	12,100		9		8,640
	22	8.0	11,700		9	6.51	P 8,700
1923 May	26	6.4	8,660	1932 May	23	7.58	10,800
June	14	15	* 15,300		25	6.58	8,820
July	5	6.1	8,090	June	18	6.41	8,460
	16	6.3	8,470		26	8.08	11,600
	24	16.2	P 29,800		26	8.16	P 11,800
	25	15.4	27,000	1933 June	4	7.17	10,000
Sept.	29	12.6	20,400		15	9.66	15,000
1924 Apr.	6	11.00	P 17,300		15	9.88	P 15,500
	7	10.4	16,200	1934 May	8	4.55	** 3,790

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Nowood Creek at Bonanza, Wyo.

Location.- In sec. 13, T. 49, N., R. 91 W., below Paint Rock Creek, at Bonanza.
Drainage area.- 1,790 square miles.
Records available.- July 1910 to September 1928 except winters.
Sources of data.- U. S. Geological Survey and 1913, 1914 reports of State engineer of Wyoming.
Gage.- Nonrecording gage read to half-tenths once daily (twice daily during high stages) prior to 1919 and to hundredths thereafter.
Stage-discharge relation.- Control shifts.
Diversions.- About 30 second-feet diverted above station during irrigation seasons throughout period of record.

Flood stages and discharges
(Base discharge 1,300 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1911 May	16	4.90	1,330	May	27	6.30	2,700
June	2	5.20	1,480	June	7	4.85	1,610
	9	4.50	1,130	July	24	4.45	1,320
	16	5.70	1,730	1914 Apr.	26	5.20	1,890
1912 June	23	5.8	1,960	May	11	5.30	1,970
July	2	8.3	3,460		17	5.00	1,730
1913 Apr.	15	5.00	1,720		21	6.60	3,060
	18	5.10	1,800		24	7.40	3,760
	28	5.25	1,910		28	7.60	3,940
May	11	5.85	2,370	June	3	7.00	3,400

Flood stages and discharges of Nowood Creek at Bonanza, Wyo.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1914	June	19	4.75		1,540
		21	5.00		1,730
1915	May	1	5.4		1,820
		15	5.5		1,900
		30	5.75		2,090
	June	6	6.6		2,770
		13	6.8		2,930
		18	6.7		2,850
		25	5.75		2,090
	July	7	4.75		1,340
		14	5.65		2,010
1916	May	7	5.1		1,590
		31	5.4		1,820
	June	6	5.8		2,140
		11	6.2		2,500
		15	5.8		2,140
		19	7.5		3,780
		22	6.3		2,590
		28	5.3		1,740
1917	May	21	6.6		2,880
	June	11	6.2		2,500
		18	7.2		3,480
		25	6.6		2,880
	July	5	5.3		1,740
1918	Apr.	16	4.7		1,310
	May	10	5.4		1,820
		17	4.8		1,380
		25	5.4		1,820
		31	5.3		1,740
	June	7	7.1		3,380
		12	7.8	P	4,080
		23	6.4		2,680
1919	May	20	5.30		1,660
		20	5.42	P	1,760
		30	5.10		1,520
1920	Mar.	23	6.9		3,180
	May	13	6.0		2,320
		30			2,980
	June	10	7.6		3,880
		11	7.7	P	3,980
		18	5.8		2,140
		24	5.6		1,980
		30	5.6		1,980
1921	May	25	5.1		1,690
		29	6.3		2,750
	June	3	5.0		1,610
		8	6.0		2,460
		19	6.3		2,750
		19	6.5	P	2,950
1922	May	29	6.6		3,050
	June	7	6.3		2,750
		15	5.3		1,850
1923	Mar.	25	5.6		2,100
		29	6.6		3,050
	May	21	6.5		2,950
	May	27	6.8		3,250
	June	1	5.8		2,280
1923	June	5	6.4		2,850
		13	6.3		2,750
		16	5.9		2,370
		21	5.0		1,600
	July	25	6.6		3,050
	Sept.	29	7.2		3,650
		29	7.35	P	3,800
1924	Mar.	28	5.5		1,930
	Apr.	4	6.9		3,500
		16	4.9		1,430
	May	6	6.3		2,760
		19	7.3		4,040
	June	5	6.4		2,870
		15	7.9		4,880
		15	8.09	P	5,160
		23	6.0		2,430
		27	6.4		2,870
	July	8	5.3		1,760
1925	May	22	6.99		3,590
		22	7.0	P	3,600
		26	5.21		1,650
		31	6.31		2,730
	June	22	5.46		1,840
		30	5.06		1,530
	July	2	5.16		1,620
		6	4.73		1,300
1926	May	6	5.2		1,680
		17	5.0		1,520
		25	6.2		2,690
		25	6.3	P	2,800
		28	6.0		2,470
	June	7	5.5		1,950
	July	7	5.6		2,050
		9	5.5		1,950
1927	May	2	5.56		2,010
		18	6.96		3,580
		28	5.29		1,760
	June	9	6.44		2,950
		12	6.92		3,530
		20	6.21		2,700
		25	6.29		2,790
		28	7.18		3,870
		28	7.46	P	4,260
	July	4	4.96		1,490
1928	May	13	5.29		1,770
		19	5.17		1,680
		27	6.90		3,500
	June	28	5.78		2,360
		30	5.72		2,250
	July	7	6.66		3,260
		7	7.03	P	3,760
		11	4.94		1,520

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

North Platte River near Northgate (Pinkhampton), Colo.

Location.- In sec. 11, T. 11 N., R. 80 W., at highway bridge 6 miles south of Colorado-Wyoming line and 6 miles northwest of Northgate.
Drainage area.- 1,440 square miles.
Records available.- May to November 1904; May 1915 to September 1934 except winters. Records for 1918 fragmentary.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to quarter-tenths twice daily prior to Apr. 8, 1918, and recording gage thereafter.
Stage-discharge relation.- Slightly shifting.
Diversions.- Decrees for diversion of 3,000 second-feet above station; probably not over 1,500 second-feet diverted. Little increase in diversion during period of records.

Flood stages and discharges of
North Platte River near Northgate (Pinkhampton), Colo.
(Base discharge 1,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1904	May	27	6.80		2,540
....			....		.....
1915	June	4	2.80		1,020
		13	2.80		1,020
		20	3.1		1,260
1916	Apr.	12	2.8		1,040
		19	2.8		1,090
		28	3.4		1,740
	May	3	2.8		1,040
		11	3.6		1,980
		23	3.2		1,500
	June	7	3.05		1,320
		12	3.5		1,860
		19	3.6		1,980
		19	3.7	P	2,100
1917	Apr.	19	3.6	*	1,890
		24	4.8		3,350
	May	18	6.0		4,840
	June	1	4.0		2,220
		5	3.8		2,000
		11	4.8		3,200
		20	5.8		4,500
1918	Apr.	14	3.05		1,240
	June	9	4.2		2,610
		21	5.1		3,810
1919	Apr.	25	3.15		1,400
	May	31	3.30		1,570
		31	3.4	P	1,690
1920	May	16	4.35		3,210
		21	4.75		3,890
		27	4.8		3,980
	June	2	4.5		3,450
		11	4.65		3,710
		15	4.6		3,620
		26	3.6		2,060
		29	3.8		2,350
	July	6	3.18		1,500
1921	May	7	3.6		2,060
		19	3.5		1,920
	June	1	4.05		2,730
		8	5.0		4,360
		17	6.0		6,260
		17	6.2	P	6,640
	July	5	2.91		1,180
		19	2.86		1,130
		24	2.91		1,180
1922	Apr.	22	3.54		1,860
	May	8	3.30		1,530
		30	3.23		1,450
	June	11	3.50		1,800
		15	3.55		1,870
		15	3.6	P	1,940
1923	May	1	3.60		2,060
		7	3.90		2,500
		12	3.90		2,500
		22	3.75		2,280
		29	3.90		2,500
	June	6	4.00		2,650
		10	6.10		6,450
		11	6.24	P	6,720
		27	3.80		2,350
	July	11	3.55		1,990
		16	3.35		1,720
		21	3.55		1,990
1924	Apr.	11		*	3,500
		15	4.35		3,270
		24		*	1,450
	May	5	3.20		1,590
		13	2.86		1,200
		20	2.97		1,320
		23	3.11		1,480
		29	4.40		3,350
	June	8	3.85		2,500
	June	16	4.70		3,840
		16	4.87	P	4,130
	July	10	2.67		1,000
1925	Mar.	29	2.91	*	1,250
	May	23	2.81		1,120
	June	1	3.35		1,780
		7	3.85		2,500
		7	3.90	P	2,570
		23	3.40		1,850
1926	Apr.	18	4.1		2,930
		28	3.28		1,680
	May	2	3.45		1,900
		28	5.30		5,300
		28	5.52	P	5,760
	June	9	4.35		3,380
	July	1	2.94		1,290
		9	3.70		2,250
1927	Apr.	29	3.83		2,270
	May	3	3.93		2,430
		8	3.72		2,100
		13	3.68		2,040
		19	4.10		2,710
		19	4.13	P	2,760
		23	3.93		2,430
	June	12	3.90		2,380
		20	4.06		2,640
		30	3.82		2,250
	July	5	2.98		1,230
1928	Apr.	29	3.81		2,120
	May	3	3.95		2,330
		11	4.25		2,840
	June	3	5.13		4,900
		3	5.20	P	5,050
		10	3.86		2,460
		18	3.84		2,430
		26	3.07		1,410
1929	Apr.	26	2.74	*	1,040
		30	3.65		2,040
	May	10	3.88		2,390
		16	4.10		2,720
		29	4.43		3,360
	June	12	4.52		3,450
		12	4.55	P	3,550
		18	4.39		3,260
	July	1	3.94		2,470
1930	Apr.	11		*	3,900
		26	3.38		1,790
	May	4	2.74		1,110
	June	2	3.64		2,020
		13	3.00		1,300
		19	2.82		1,120
		22	2.80		1,100
	Aug.	15	3.07		1,330
1931	Apr.	15	3.46	*	1,730
		15		P*	2,600
	June	9	2.97		1,180
1932	Apr.	17	4.64		3,720
		17	4.86	P	4,190
		22	4.15		2,820
		26	2.92		1,210
	May	15	4.17		2,850
		21	4.14		2,800
		31	3.02		1,310
	June	7	3.21		1,530
		18	3.65		2,080
		29	3.86		2,380
1933	May	23	2.90		1,180
	June	8	3.98		2,530
		13	4.24	P	2,930
		14	4.18		2,830
		16	4.20		2,860
		20	4.19		2,850
1934	May	31	2.15	**	549

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

North Platte River at Saratoga, Wyo.

Location.- In sec. 14, T. 17 N., R. 84 W., at highway bridge in Saratoga.
Drainage area.- 2,880 square miles.
Records available.- June 1903 to October 1906; April to December 1909; April 1911 to September 1934.
Sources of data.- U. S. Geological Survey records, except 1913-14, when reports of State engineer of Wyoming were used.
Gages.- Nonrecording gage read to hundredths twice daily prior to Nov. 1, 1930; recording gage thereafter. Zero of gages is 6,773.8 feet above mean sea level.
Stage-discharge relation.- Slightly shifting owing to aquatic growth.
Diversions.- Decrees for diversions of about 4,000 second-feet above station; probably not over 1,800 second-feet diverted. Little increase in diversions during period of records.

Flood stages and discharges
(Base discharge 4,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1903 June	18	5.25	8,200	1920 May	3	8.00	7,970
1904 May	26	5.48	8,600		10	7.2	5,780
June	14	5.00	7,040		26	9.0	10,800
1905 May	24	4.82	6,330		31	9.2	11,300
June	5	6.0	10,400	June	9	9.4	P 11,900
	9	6.1	11,100		10	9.2	11,300
1906 May	12	4.22	4,510		19	8.7	9,930
	25	5.25	7,760	1921 May	7	6.6	4,240
	29	5.65	9,140		19	7.2	5,780
June	6	5.22	7,660		31	9.0	11,900
	14	5.60	8,960	June	12	9.8	14,900
....		....	.....		12	10.0	P 15,700
1909 Apr.	29	4.30	4,740	1922 May	29	7.60	7,380
May	6	4.65	5,760		29	7.7	P 7,720
	13	4.90	6,570	June	10	7.60	7,380
	24	5.50	8,500	1923 May	12	6.6	4,270
	29	5.35	8,010		27	7.7	7,720
June	8	7.70	16,200	June	2	7.8	8,060
	20	7.30	14,700		11	9.2	12,800
....		....	......		11	9.3	P 13,200
1911 May	9	6.8	4,830	1924 Apr.	11	7.2	6,070
	17	6.9	5,040		15	6.5	4,010
	26	6.8	4,830	May	29	7.2	6,070
June	2	7.6	6,570	June	7	7.7	7,720
	9	7.8	7,030		15	7.8	8,060
	17	8.0	7,490		15	8.0	P 8,740
1912 May	26	8.0	7,900	1925 June	2	6.95	5,280
	31	8.5	9,500		8	7.41	6,750
June	9	9.4	12,600		8	7.49	P 7,020
	30	7.9	7,600		23	6.76	4,710
July	5	7.0	5,160	1926 Apr.	10	6.85	5,160
1913 Apr.	7		4,600		12	6.90	5,310
May	10		4,450		18	6.60	4,440
	13		5,000		21	6.60	4,440
	28		6,500	May	5	7.00	5,600
	30		7,550		28	9.20	12,800
June	7		6,000		28	9.5	P 13,900
1914 Apr.	7		4,550	June	8	8.20	9,370
May	11		5,680	1927 May	21	7.90	7,970
	25		10,300	June	11	7.74	7,450
June	3		12,500		15	8.05	8,460
	7		12,200		20	7.58	6,950
	14		7,300		30	6.78	4,760
	16		7,200	1928 May	2	6.91	4,940
	21		6,800		11	8.12	8,370
1915 June	2	6.7	4,640		13	8.00	7,970
	12	6.7	4,640		30	9.57	13,400
1916 May	10	7.2	5,790		30	9.74	P 14,000
June	1	6.7	4,490	June	13	7.13	5,400
	5	6.8	4,740		18	7.05	5,240
	11	7.2	5,790		28	6.52	4,020
	20	7.2	5,790	1929 Apr.	18	7.73	6,370
1917 Apr.	25	6.8	4,680	May	26	8.43	8,330
May	19	8.8	9,650	June	11	9.01	10,200
	23	8.8	9,650		11	9.10	P 10,600
	31	7.4	6,150		16	8.86	9,880
June	20	10.4	13,800		23	6.96	7,180
1918 May	9	6.9	4,920	1930 Apr.	10	7.2	P 5,220
	30	7.3	5,900		11	6.92	4,540
June	14	9.4	11,200	May	31	6.93	4,540
	14	9.5	P 11,400	1931 June	11		** 3,660
July	1	7.0	5,160	1932 Apr.	17	6.70	4,930
1919 May	30	7.4	6,150		22	6.52	4,260

** Below base

Flood stages and discharges of North Platte River at Saratoga, Wyo.--Continued

Date		Gage height (feet)	Discharges (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1932 May	15	7.69	6,780	1933 June	7	7.82	7,530
	23	8.43	9,290		12	8.35	8,110
	23	8.64	P 10,100		12	8.58	P 8,660
June	7	7.14	5,230		17	8.00	7,270
	16	7.44	6,050	1934 May	13	5.44	** 1,620

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

North Fork of South Platte River at South Platte, Colo.

Location.- In sec. 25, T. 7 S., R. 70 W., a third of a mile above railroad station at South Platte and below all tributaries and diversions. No change during period of records.

Drainage area.- 484 square miles.

Records available.- June 1909 to September 1910, April 1913 to September 4, 1934 except winters.

Sources of data.- U. S. Geological Survey. Records for 1929 furnished by State engineer of Colorado.

Gages.- Nonrecording gage read once or twice daily to half-tenths prior to May 1925 and water stage recorder thereafter. No change in datum. Zero of gage is 6,090.55 feet above mean sea level.

Stage-discharge relation.- Control shifting throughout period of records.

Storage, regulation, and diversions.- Numerous small fish ponds and ice reservoirs above do not affect flow. Adjudicated diversion of 80 second-feet in 1913 and 100 second-feet in 1933.

Flood stages and discharges
(Base discharge 400 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1909 June	9	3.95	1,040	May	11	3.05	442
	20	4.10	980	June	1	3.05	403
	25	3.80	920		13	3.05	403
July	4	4.20	1,120	1917 May	20	3.35	552
	9	3.85	890	June	5	3.55	645
	23	3.15	490		18	4.50	1,140
Aug.	19	3.90	930		18	4.8	P 1,300
	25	3.10	520	July	10	3.55	645
Sept.	7	4.35	1,090		25	3.00	400
	13	4.20	970		27	3.0	400
1910 May	30	3.20	430	1918 May	24	3.35	575
July	29	3.95	790		31	3.30	552
....	....	....	...	June	14	4.10	920
1913 May	13	3.60	675		22	4.40	P 1,080
	27	3.30	517		22	4.30	1,030
	30	3.30	517	July	16	3.60	670
June	11	3.50	620		23	3.40	575
	15	3.10	424	1919 May	4	3.50	620
	18	3.10	424		15	3.5	620
July	17	3.10	424		21	3.70	720
1914 Apr.	6	3.20	410		21	3.75	P 745
	17	3.40	490	June	9	3.05	420
	21	3.55	552		19	3.10	440
May	11	4.60	1,150		21	3.00	400
	23	5.50	1,860	July	3	3.05	420
June	2	5.40	1,780		19	3.45	598
	15	4.40	1,010	Aug.	1	3.40	530
July	5	3.55	552		3	3.25	485
	18	3.35	470	1920 May	3	3.60	598
	23	3.60	575		8	3.80	575
	31	4.30	1,000		25	4.40	1,000
Aug.	3	4.50	1,120		25	4.45	P 1,030
1915 Apr.	29	3.00	400		30	4.00	795
May	13	3.30	520	June	8	4.00	820
	16	3.35	542		27	3.40	552
	25	3.50	610	July	26	3.20	485
June	1	4.20	955	Aug.	21	3.05	420
	12	4.25	980	1921 Apr.	24	3.60	670
	18	4.00	855	May	6	4.00	870
1916 May	11	3.07	P 448		30	4.00	870

Flood stages and discharges of
North Fork of South Platte River at South Platte, Colo.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1921	June	8	5.80	1,860		May	6	3.82	665
		8	5.90	P 1,910			25	4.58	1,160
	July	5	3.60	620		June	2	4.63	1,200
		18	3.80	770			7	4.70	1,260
		23	3.60	670			7	5.02	P 1,520
	Aug.	1	3.50	598			13	4.12	844
		15	3.50	485		July	4	3.20	424
		24	3.75	620			6	3.27	452
1922	May	27	3.62	596			10	3.27	452
		27	3.75	P 674	1927	May	18	2.98	404
		30	3.55	540			18	3.14	P 459
	June	8	3.62	546	1928	May	17	3.28	512
		16	3.40	450			23	3.43	572
	July	28	3.50	480			30	3.87	802
	Aug.	2	3.55	455			30	4.14	P 964
1923	May	27	4.10	695		June	8	3.37	528
	June	1	4.00	668	1929	Aug.	3	3.50	612
		13	4.32	971			6	3.83	760
		16	4.45	1,060			7	4.04	P 857
		17	4.55	P 1,130	1930	May	31	3.42	560
		21	4.22	906		June	12	3.02	416
	July	4	3.55	500			19	3.10	443
		16	3.78	629		Aug.	14	3.66	660
		19	3.60	530			14	3.74	P 670
		21	3.55	515	1931	May	18	3.51	565
		28	3.60	558			27	3.69	630
	Aug.	1	3.40	470			27	3.90	P 740
		8	3.40	455		June	2	3.47	522
		12	4.95	568		July	1	3.08	443
		19	4.00	731	1932	May	23	3.11	443
		22	3.90	662			23	3.35	P 518
	Sept.	1	3.50	480	1933	May	3	3.23	480
1924	May	6	3.58	450			8	3.39	525
		18	3.80	558			23		1,240
		27	3.80	585		June	2	5.38	1,130
	June	7	4.72	1,300			5	4.90	930
		7	4.8	P 1,380			11	4.50	768
		14	4.52	1,230			13	4.52	776
	July	8	3.20	470		July	8	3.62	433
1925	June	21	2.43	** 212		Sept.	10	3.54	412
1926	Apr.	25	3.74.	630	1934	May	10	3.28	** 308

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Clear Creek near Golden, Colo.

Location.- In sec. 6, T. 4 S., R. 70 W., 2 miles above Golden prior to May 3, 1919, and in sec. 32, T. 3 S., R. 70 W., a quarter of a mile downstream thereafter; no tributaries or diversions between.

Drainage area.- 380 square miles prior to 1919 and 392 square miles thereafter.

Records available.- December 1908 to December 1909; June 1911 to September 1933, except winters.

Sources of data.- U. S. Geological Survey records 1911-29. Reports of State engineer of Colorado 1930-33.

Gage.- Recording gage. Change in location only change in datum; relation between two datums not determined.

Stage-discharge relation.- Control shifted slightly nearly every year.

Storage, regulation, and diversions.- Reservoirs on tributaries have an aggregate capacity of 2,100 acre-feet. Decree for diversion of 53 second-feet of Fraser River water into West Fork of Clear Creek. Diversion of about 25 second-feet from Clear Creek above station.

Historical data.- Flood of Aug. 1, 1888, maintained crest flow of 8,700 second-feet for 2 hours (estimated by State engineer). A cloudburst July 26, 1923, on small stream tributary to Clear Creek just below gage caused backwater stage of 10.2 feet at gage (from high-water mark); estimated crest discharge of Clear Creek below tributary, 3,000 second-feet.

Flood stages and discharges of Clear Creek near Golden, Colo.
(Base discharge 600 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1909	June	3	2.92	692
		9	3.65	1,250
		12	3.80	1,480
		19	4.58	1,970
		27	4.80	2,150
		30	4.65	1,530
	July	4	4.90	2,290
		18	3.12	792
		22	3.10	782
	Aug.	18	3.11	800
		21	2.98	685
	Sept.	6	3.00	700
....			....	...
1911	June	9	3.34	898
		13	3.31	877
		19	3.01	686
		23	3.10	740
	July	6	3.75	1,220
1912	May	31	3.30	950
	June	6	4.0	1,570
		25	4.4	1,970
		30	5.0	2,580
	July	9	3.7	1,290
		12	3.8	1,380
		15	3.8	1,380
	Aug.	1	3.2	880
1913	May	27	3.35	960
		30	3.30	920
	June	11	3.05	742
		18	3.20	845
		28	3.05	742
	July	24	2.95	680
1914	May	11	3.55	985
		18	3.65	1,060
		23	4.60	1,950
		28	4.60	1,950
	June	1	5.40	2,900
		15	4.65	2,050
		18	4.45	1,850
		28	3.65	1,140
	July	5	3.50	1,020
		18	3.20	820
		22	3.15	790
		31	3.30	885
	Aug.	2	3.25	852
1915	June	2	3.40	928
		13	4.20	1,400
		19	4.30	1,460
		23	4.40	1,520
	July	12	3.30	872
1916	June	13	3.08	764
		18	3.22	829
		18	3.30	P 872
		29	2.96	702
1917	June	18	4.50	1,450
		18	4.80	P 1,670
		21	4.50	1,440
	July	10	3.75	976
		20	3.10	720
		26	3.05	685
1918	May	28	3.15	780
	June	14	5.40	2,090
		23	4.80	1,730
	July	14	3.25	808
1919	May	29	2.47	910
	June	21	2.21	650
	July	3	2.22	660
		4	2.65	P 1,090
1920	May	26	2.65	1,090
	June	1	2.75	1,190
		8	2.85	1,290
		8	2.90	P 1,340
		25	2.55	990
	July	26	2.20	640
1921	May	7		* 690
		17	2.40	820
		22	2.60	1,060
		31	2.85	1,370
	June	13	4.35	3,020
	July	6	3.00	1,180
		20	2.70	935
		31	2.40	768
		31	5.10	P 4,420
1922	May	30	2.40	665
	June	9		* 800
		13	2.90	P 1,170
		14	2.80	1,060
1923	June	1	2.70	835
		5	2.75	878
		9	2.95	1,070
		16	3.60	1,940
	July	4		* 870
		16		* 1,020
		19		* 820
		27		* 1,120
	Aug.	1		* 660
		16	2.85	655
		22	2.80	620
1924	May	19	3.54	1,260
		27	3.26	889
	June	7		* 1,500
		13	4.70	2,180
		13	4.90	P 2,450
1925	June	21	3.21	648
		21	3.30	P 720
1926	May	6	3.44	872
		26	4.05	1,440
	June	7	4.58	1,950
		7	4.70	P 2,100
		26	4.05	1,010
	July	10	3.94	856
	Aug.	7	3.55	628
1927	May	21	3.64	865
		28	3.62	650
	June	12	3.86	841
		19	3.86	841
		29	3.98	943
		29	4.13	P 1,080
	July	10	3.62	650
1928	May	10	3.56	607
		30	4.66	P 1,560
		31	4.54	1,450
	June	9	4.08	1,030
		17	3.90	875
		29	4.04	996
	July	17	3.59	628
1929	June	10	3.87	769
		15	3.88	776
		24	3.70	646
	July	24	3.70	653
	Aug.	5	4.42	P 1,280
		6	3.78	722
1930	May	31	4.03	960
		31	4.10	P
	June	13	4.20	1,130
		13	4.35	P 1,280
1931	May	27	3.94	641
		27	4.11	P
	June	7	4.49	1,060
		7	4.61	1,170
		17	4.00	704
		17	4.19	P
	July	1	3.94	662
		1	4.02	P
1932	May	23	3.86	615
		23	3.95	P
	June	16	4.03	698
		16	4.12	P
		26	4.15	770
		26	4.29	P 854
1933	May	22	4.13	742
		22	4.19	P
	June	7	5.46	1,410
		7	5.54	P
		14	5.72	1,560
		14	5.92	P
	July	7	5.08	1,190
		7	5.20	P

* Estimated

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Flood stages and discharges of Clear Creek near Golden, Colo.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1933 July	10		1,380	Sept.	9		757
	10	11.12	P* 7,200		9	8.84	P* 5,700

* Estimated

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

St. Vrain Creek at Lyons, Colo.

Location.- 1888-91, 1895-1934 in sec. 17, T. 3 N., R. 70 W., below junction of North and South Forks at Lyons; 1892, gages on both forks above all diversions.
Drainage area.- 1895-1934, 226 square miles; 1888-92, not measured.
Records available.- August 1887 to October 1892, June 1895 to September 1934. Open-water records only prior to 1917.
Source of data.- Reports of State engineer of Colorado.
Gages.- Nonrecording gage read once to three times daily prior to 1923; recording gage thereafter. Datum of gage used 1887-91 not related to that used 1895-1934.
Stage-discharge relation.- Control permanent; not affected by ice during flood periods.
Storage and diversions.- Total capacity of reservoirs on tributaries of South St. Vrain Creek, about 6,000 acre-feet. Decrees for diversion of 726 second-feet from South St. Vrain Creek at point about 4 miles northeast of Ward and 12 miles southwest of Lyons; total flow during irrigation season diverted each year prior to 1934. Supply Ditch diverted from 0 to 110 second-feet during irrigation seasons beginning 1878, and South Ledge Ditch diverted from 0 to 22 second-feet during irrigation seasons beginning 1870; both ditches head just above station.
Remarks.- Except for 1892, flood peaks shown do not include water diverted in Supply and South Ledge Ditches, which if added would increase some peaks not shown here and eliminate others.

Flood discharges
(Base discharge 490 second-feet)

Date		Discharge (second-feet)	Date		Discharge (second-feet)	Date		Discharge (second-feet)
1888 June	19	491	1897 July	3	548	June	1	730
1889 May	28	548		9	860		4	1,380
	31	493		15	535		9	1,440
June	15	500		19	497		22	530
1890 May	23	517	Aug.	5	548		26	600
	25	510	1898 June	17	551	1906 May	23	780
	30	590	1899 Apr.	24	508		28	565
June	2	675		27	508	June	13	1,020
	21	570	June	14	889	July	14	685
	27	555		20	1,140	1907 May	22	570
1891 May	9	598	July	1	985		24	700
	27	1,400		29	539		30	710
June	13	1,280	Aug.	4	761	June	3	635
	19	1,250	1900 Apr.	22	701		6	635
	25	1,300		29	918		16	832
July	7	988	May	5	683	July	2	976
1892 May	29	707		9	738		14	784
June	4	798		24	610		18	536
	10	993		30	882		26	904
	15	781	June	9	774	Aug.	3	512
	24	1,480		14	610	1908 July	30	566
July	1	1,130		20	629	1909 June	19	955
	8	928	1901 May	21	667	July	4	1,000
	16	621		29	604	1910 June	3	** 406
....	..	...	June	9	667	1911 June	9	576
1895 June	14	1,030		15	510		16	632
	16	1,040		23	730		22	576
	25	786	1902 June	9	** 441	1912 May	16	642
July	3	680	1903 June	9	660		21	564
	22	653		13	706	June	6	616
	31	680		17	1,180		9	883
1896 May	30	573		23	1,180		12	668
Aug.	18	529		29	706		25	998
1897 May	18	786	July	17	549		28	998
	27	824	1904 July	2	575	July	1	998
June	1	860	1905 May	2	600		8	616
	11	980		24	565		16	778
	26	688		28	685		26	516

** Below base

Flood discharges of St. Vrain Creek at Lyons, Colo.--Continued

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1913 June 11	** 426	June 9	659	May 28	580
1914 May 1	600	15	664	June 2	822
10	540	25	570	8	1,010
28	870	1921 Apr 24	622	13	867
June 2	1,340	May 5	596	July 7	605
14	1,040	29	518	1927 July 12	498
20	910	31	674	18	508
July 30	670	June 7	2,020	28	550
1915 Apr. 26	670	July 13	518	1928 May 15	610
June 12	750	15	570	29	941
20	830	1922 June 9	507	June 29	665
July 28	750	13	574	1929 June 28	514
1916 May 21	513	1923 May 19	499	July 14	509
June 19	540	27	526	1930 June 12	522
1917 May 16	650	June 2	531	Aug. 14	661
22	810	10	1,360	1931 June 2	502
June 1	490	16	1,240	7	597
11	615	20	950	16	507
18	990	27	890	1932 May 22	507
23	1,090	July 9	669	June 16	543
30	990	14	717	28	672
July 11	688	21	717	1933 May 19	709
1918 June 13	1,255	27	648	June 2	768
22	1,485	1924 May 30	777	6	850
July 14	590	June 7	960	12	790
16	590	14	1,730	18	892
1919 July 29	500	25	594	20	988
31	575	July 7	511	1934 May 8	544
Aug. 3	950	1925 June 23	** 328	10	P 628
1920 May 10	561	1926 Apr. 22	839	21	514
27	691	30	537	30-31	502
30	548	May 6	600		

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Republican River at Junction City and Wakefield, Kans.

Location.- Apr. 26, 1895, to Oct. 31, 1905, at highway bridge at north end of Washington Street, Junction City, Geary County, 3 miles above junction with Smoky Hill River. June 21, 1917, to Feb. 14, 1934, in NE¼ sec. 5, T. 10 S., R. 4 E., at highway bridge about 1,000 feet north of Union Pacific Railroad station, Wakefield, Clay County.
Drainage area.- 25,800 square miles at Junction City; 24,700 square miles at Wakefield.
Records available.- April 1895 to October 1905; June 1917 to February 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gages at both locations; Wakefield gage read to hundredths twice daily. No relation between gages has been established.
Stage-discharge relation.- No well defined control at either station. Bank-full stage at Wakefield, about 11 feet on the left bank, above which the river spreads out to a width of about 1 mile.
Regulation.- Low-water flow affected slightly by regulation at a dam at Clay Center.
Remarks.- No important tributaries enter between stations, so records are comparable.
Historical data.- Flood of June 22, 1915, rose to a point within a few feet of bridge floor at Wakefield, which is at gage height 22.5 feet. Discharge has been estimated as 70,000 second-feet by Corps of Engineers, U. S. Army.

Flood stages and discharges
(Base discharge 4,800 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1895 June 7	9.5	35,000	1897 Apr. 25	7.95	8,250
18	6.15	10,400	June 30	7.4	6,050
July 21	5.7	6,000	July 11	7.5	6,360
Aug. 12	5.6	5,320	1898 May 15	7.9	7,180
17	7.25	* 25,000	21	6.95	5,100
19	5.85	7,200	June 12	7.45	6,160
30	6.05	* 9,100	1899 May 27	8.2	7,750
1896 July 18	10.97	37,500	June 4	10.0	12,000

* Estimated

Flood stages and discharges of
Republican River at Junction City and Wakefield, Kans.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1899	June	9		
1900	Mar.	9	6.8	4,880
1901	Apr.	13	6.8	5,010
1902	May	26	7.6	7,800
	June	8	7.5	7,500
		13	7.4	7,200
	July	1	9.67	14,000
		4	9.3	12,900
		12	12.7	23,100
		30	8.4	10,200
	Aug.	21	7.6	7,800
		31	8.9	11,700
	Sept.	27	8.5	10,500
	Oct.	4	6.6	4,900
		14	6.7	5,150
1903	Mar.	10	8.7	11,100
		15	9.5	13,500
	May	1	7.17	6,450
		14	12.27	26,100
		19	7.87	8,550
		23	8.9	11,700
		30	18.2	* 47,500
	July	16	8.27	9,750
	Aug.	4	8.45	10,400
		14	6.87	5,550
		17	8.22	9,600
1904	Apr.	26	9.1	12,300
	May	9	6.78	5,350
		29	8.6	9,490
	June	1	7.6	7,080
		5	8.58	9,440
		12	7.3	6,440
		16	10.55	15,200
		26	12.85	23,300
	July	6	10.65	15,500
		8	10.45	14,900
		13	6.7	5,260
1905	Mar.	1	7.42	6,690
	May	14	7.15	6,130
		19	7.35	6,540
		25	9.0	10,600
		31	9.0	10,600
	June	5	6.5	4,900
		21	7.55	6,970
		24	8.55	9,360
		26	8.7	9,750
		29	11.15	17,200
	July	8	15.3	35,400
		28	9.0	10,600
	Aug.	1	8.28	8,680
		7	8.58	9,440
....	.....	...	....	.....
1918	May	24	6.45	** 4,650
1919	Apr.	10	7.25	6,230
	May	4	8.2	8,620
	June	4-5	7.1	5,910
		10	11.05	P 18,200
		10	10.7	16,800
	Sept.	21	9.7	13,100
1920	May	15	6.6	4,920
	Sept.	2	6.6	4,920
1921	June	5	6.4	** 4,580
1922	July	12	8.00	8,260
		27-28	7.65	7,380
1923	May	28	10.26	13,400

Date			Gage height (feet)	Discharge (second-feet)
	June	4	12.86	P 20,100
		5	11.72	17,000
		9	11.81	17,300
		12	11.77	17,300
		23	6.93	5,910
		28	8.58	9,280
	July	3	6.65	5,280
		13	8.18	8,360
		20	6.85	5,700
		23	6.63	5,280
	Aug.	13	7.11	5,910
1924	July	23	7.01	5,700
1925	Feb.	13	7.02	4,900
1926	Aug.	15	7.20	5,270
	Sept.	6	8.05	6,880
		12	8.70	8,500
		15	10.45	12,800
		15	11.15	P 14,800
		17	10.28	12,500
1927	Apr.	15	10.34	12,500
		19	10.91	14,100
		19	11.62	P 16,100
		23	8.18	7,690
	June	4	9.50	10,800
		13	7.13	5,410
		17	9.22	10,000
		20	7.54	6,170
	July	21	8.97	9,550
	Aug.	3	8.56	8,610
		13	10.36	13,100
		24	7.26	5,410
		28	7.58	5,970
1928	June	21	8.59	8,560
		25	9.17	9,840
	July	8	7.94	7,100
		11	7.03	5,400
		14	8.16	7,720
		16	8.65	8,560
		19	7.71	6,700
		23	6.85	5,060
		30	8.57	8,560
	Aug.	4	10.21	12,000
		4	10.24	P 12,000
		8	8.50	8,350
1929	Apr.	20	7.83	6,900
	May	12	7.79	6,890
	June	2	6.85	4,890
		11	8.52	8,350
		11	8.60	P 8,560
		20	6.95	5,290
		24	8.05	7,300
	July	29	6.91	5,090
1930	May	8	8.97	8,450
		8	9.64	P 9,720
		12	7.57	5,820
	June	5	8.08	5,650
		8	8.33	5,990
	Oct.	16	7.97	6,500
1931	May	6	7.27	4,880
		6	8.60	P 7,430
1932	Feb.	26	8.67	7,820
	Sept.	1	8.41	7,860
		1	8.85	P 8,760
1933	Apr.	24	8.04	6,200
		24	8.46	P 7,220

** Below base * Value probably too small.

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kansas River at Ogden, Kans.

Location.- In SW¼ sec. 12, T. 11 S., R. 6 E., at highway bridge a quarter of a mile below Sevenmile Creek, three-quarters of a mile south of Ogden, Riley County, 2 miles below Clark Creek, and 10 miles below point where Smoky Hill and Republican Rivers unite to form Kansas River.
Drainage area.- 45,200 square miles.
Records available.- June 1917 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read twice daily prior to June 15, 1934; recording gage thereafter.
Stage-discharge relation.- Control shifts. Bank-full stage, about 18 feet.
Regulation.- Low-water flow affected by operation of power plants at Junction City, Kans.

Flood stages and discharges
(Base discharge 7,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1917	Aug.	17	9.7	6,930
1918	June	8	11.4	11,400
1919	Mar.	16	15.25	23,400
	Apr.	10	12.15	13,800
	May	4	11.7	12,500
		16	10.1	8,250
		19	10.4	9,010
		22	10.1	8,250
	June	5	11.6	12,200
		12	15.15	23,100
	Sept.	22	10.8	10,000
		28	12.9	16,000
1920	Aug.	20	10.7	9,210
	Sept.	3	10.4	8,430
1921	May	12	10.36	8,310
	June	9	9.93	7,070
1922	Apr.	9	10.01	7,310
	July	12	11.59	11,600
		12	11.70	P 11,900
		28	10.36	8,310
	Nov.	12	11.75	11,500
1923	May	29	14.73	20,300
	June	5	15.91	24,400
		10	17.81	31,200
		10	18.15	P 32,600
		29	11.66	11,200
	July	4	13.27	15,700
		14	11.83	11,500
1924	Aug.	22	11.69	11,200
		22	14.22	P 18,700
1925	June	28	9.36	** 5,610
1926	Sept.	12	12.54	11,700
		15	14.40	16,400
		18	14.33	16,100
.....	.....	...	.....	......
1927	Apr.	15	15.36	20,800
		19	16.87	25,700
		19	17.31	P 27,100
		23	14.50	18,100
	June	4	11.90	11,300
		13	13.53	15,400
		17	16.11	23,000
		21	16.11	23,000
	July	1	10.09	7,010
		21	12.64	13,000
	Aug.	4	10.43	7,660
		13	16.14	23,000
		16	14.26	17,500
	Aug.	25	15.46	21,100
		29	13.50	15,400
	Sept.	7	12.46	12,800
		10	12.42	12,500
1928	June	18	12.48	12,800
		21	12.26	12,300
		25	13.59	15,600
	July	9	13.95	16,700
		12	15.20	20,200
		14	15.02	19,600
		19	14.35	17,800
		24	11.87	11,300
		26	12.45	12,500
		31	14.35	17,800
	Aug.	4	16.59	24,700
		4	16.93	P 25,700
		9	15.58	21,400
		14	15.56	21,400
	Nov.	18	11.42	8,960
1929	Mar.	5	10.41	8,240
	Apr.	21	14.84	18,500
	May	12	16.04	22,400
		12	16.23	P 23,100
	June	2	12.97	13,000
		12	13.54	14,400
		25	11.91	10,200
	July	13	13.12	13,300
1930	May	7-8	15.82	22,600
		8	16.14	P 23,700
	June	6	13.89	15,700
		8	14.19	16,600
		15	13.08	13,500
	Sept.	12	10.15	7,200
	Oct.	17	10.27	7,050
1931	May	7	11.21	8,050
		7	11.60	P 9,750
1932	Feb.	26	10.94	8,250
	June	20	11.49	9,170
	July	6	13.51	14,200
		10	12.38	11,300
	Sept.	18	11.04	8,100
1933	Apr.	24	11.85	10,200
	Aug.	25	10.59	7,280
	Sept.	2	11.53	9,170
		13	14.10	15,900
		13	14.70	P 17,800
1934	June	22-24	12.45	10,900
		22	12.53	P 11,100

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kansas River at Topeka, Kans.

Location.- Aug. 1, 1904, to June 11, 1917, on Melan arch highway bridge at Kansas Avenue, Topeka, Shawnee County; June 12, 1917, to Apr. 3, 1918, on Chicago, Rock Island & Pacific Railway bridge, 1,800 feet above Melan bridge; Apr. 4, 1918, to November 1927, 300 feet below railway bridge; and on Melan bridge thereafter.
Drainage area.- 56,400 square miles.
Records available.- August 1904 to October 1916; April 1917 to September 1934.
Sources of data.- Gage-height record obtained in cooperation with U. S. Weather Bureau. Discharge records from U. S. Geological Survey.
Gage.- Nonrecording gage read once daily Aug. 1, 1904, to June 11, 1917, November 1927 to September 1934, and read twice daily during open-water season June 12, 1917, to Apr. 3, 1918. Recording gage Apr. 4, 1918, to November 1927. Recording gage record was not reliable and was supplemented by readings from nonrecording gages. Zero of gage on Melan bridge is 854.62 feet above mean sea level and for other gages was 855.37 feet above mean sea level. All gages read practically the same at high stages.
Stage-discharge relation.- High-water control formed by bridges and levees and probably did not change from 1904-21, but changes have occurred since. Ratings are defined up to about 70,000 second-feet. Flood stage, about 21 feet.
Historical data.- Gages were established simultaneously by the U. S. Geological Survey on Apr. 14, 1904, on the Atchison, Topeka & Santa Fe Railway bridge and on the Chicago, Rock Island & Pacific Railway bridge with zero of gages set at 857.37 and 860.187 feet respectively above mean sea level. A flood record was kept at the latter gage from Apr. 24 to Aug. 31, 1904. Flood of May 1903 reached elevation of 888.00 feet at former location, 890.06 feet at latter location, and 32.7 feet at Melan bridge (discharge, about 220,000 second-feet). Flood of July 7, 1904 reached stage of 26.85 feet at Melan bridge (discharge, about 130,000 second-feet). Flood of June 10, 1844, was 8.5 feet higher than that of 1903 at a point 6 miles upstream and was estimated by U. S. Weather Bureau to have been 42.2 feet on present gage at Topeka.

Flood stages and discharges
(Base discharge 17,800 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1905 Mar.	2	12.5	23,200
May	15	11.7	19,800
	26	15.7	39,700
June	2	14.4	32,500
	6	11.3	18,200
	27	12.4	22,800
July	5	15.4	38,000
	10	17.6	50,900
Aug.	1	11.3	18,200
	20	11.7	19,800
Sept.	17	14.2	31,500
1906 Aug.	5	12.3	22,300
	9	11.2	17,800
1907 July	20	12.2	21,900
1908 May	6	12.6	23,600
	12	12.0	21,000
	24	14.1	30,900
	31	16.3	43,100
June	9	27.9	141,000
	13	24.1	102,000
	21	20.4	69,900
July	1	17.0	47,200
	11	11.8	20,200
	17	15.1	36,300
	26	13.4	27,400
Aug.	8	11.2	17,800
	23	13.7	28,900
	28	13.3	26,900
1909 May	21	12.2	21,900
June	9	11.4	18,600
	23	11.8	20,200
	28	11.6	19,400
July	8	16.6	44,900
	12	18.3	55,300
Sept.	10	12.8	24,500
Nov.	15	20.3	69,200
Dec.	4	15.0	35,700
1910 Jan.	13	18.0	* 53,400
	21	11.2	* 17,800
	28	13.3	* 26,900
	31	11.3	* 18,200
May	23	11.3	18,200
	28	11.8	20,200
May	31	15.0	35,700
June	10	15.9	40,800
Aug.	10	11.2	17,800
	18	17.2	48,400
1911 Feb.	18	15.3	57,400
July	27	11.9	20,600
Aug.	15	13.4	27,400
Oct.	4	14.0	30,400
1912 Feb.	21	13.4	27,400
Mar.	21	17.9	52,800
	29	16.0	41,400
Oct.	12	12.9	25,000
1913 May	13	13.6	28,400
	23	13.2	26,400
1914 June	18	13.2	26,400
1915 May	29	18.1	54,000
June	5	12.0	21,000
	12	21.6	79,200
	20	23.7	98,200
	24	21.0	74,300
July	1	18.3	55,300
	6	12.7	24,100
	8	12.2	21,900
	10	12.0	21,000
	15	18.4	56,000
	17	21.6	79,200
	20	20.6	71,400
	31	18.2	54,700
Aug.	2	18.1	54,000
	7	17.3	49,100
	15	12.4	22,800
	18	12.7	24,100
	20	14.0	30,400
	31	11.7	19,800
Sept.	2	11.8	20,200
	28	13.0	25,400
Oct.	17	14.8	34,600
1916 Feb.	19	16.1	42,000
May	15	15.7	39,700
	25	12.1	21,400
June	12	11.4	18,600
	14	13.2	26,400
	22	12.1	21,400
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* Estimated

Flood stages and discharges of Kansas River at Topeka, Kans.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1917	June	3	17.3		49,100
		7	18.3		55,300
1918	May	30	11.5		20,600
1919	Mar.	17	18.1		54,100
	Apr.	11	14.45		32,700
	May	5	12.75		24,600
		16	12.0		21,400
	June	5	12.7		24,300
		12	17.3		49,000
	Sept.	23	12.35		22,900
		30	11.85		20,800
1920	Apr.	13	10.9		18,100
1921	May	10	14.6		33,000
	June	18	14.15		31,200
	July	3	13.2		26,500
		6	11.7		20,200
1922	Apr.	9	13.72		28,700
	July	12	14.27		31,900
	Nov.	13	11.52		20,400
1923	May	30	11.88		21,400
	June	6	14.60		32,600
		10	20.90		69,800
	July	5	14.20		30,700
		14	12.15		22,100
	Oct.	4	10.43	**	16,100
1924	Aug.	23	10.09	**	15,700
1925	June	5	11.4		18,500
		18	13.25		24,000
1926	Sept.	16	15.47		35,900
	Oct.	4	13.00		24,400
		12	11.50		19,100
1927	Apr.	16	15.97		38,600
		19	19.50		59,300
	June	14	12.20		21,300
		18	16.60		41,900
	June	22	12.75		23,600
	Aug.	9	11.08		18,000
		14	16.80		43,000
		26	12.68		23,200
	Sept.	9	13.60		26,800
	Oct.	3	10.8		18,700
1928	June	20	11.0		19,400
		26	11.5		21,200
	July	10	11.6		21,500
		12	15.1		34,600
		16	11.8		22,300
		20	11.2		20,100
	Aug.	1	10.6		18,000
		6	13.3		27,800
		8	13.7		29,300
		15	11.9		22,600
	Nov.	18	15.1		34,600
1929	Mar.	8	11.8		22,300
	Apr.	20	21.6		66,900
	May	13	14.4		31,900
	June	2	15.5		36,200
		23	13.0		26,700
1930	May	3	11.0		19,400
		8	21.9		69,000
		14	11.5		21,200
	June	6	16.0		38,200
		16	14.6		32,600
1931	Sept.	2	13.7		26,700
	Nov.	17	10.6		19,200
		24	12.7		25,600
1932	June	21	9.5	**	14,500
1933	Aug.	26	10.1	**	16,400
1934	July	25	7.8	**	10,600

** Below base

Note.- All discharge quantities are average daily flows.

Kansas River at Bonner Springs, Kans.

Location.- In NW$\frac{1}{4}$ sec. 32, T. 11 S., R. 23 E., at highway bridge at Bonner Springs, half a mile below Wolf Creek and 18 miles above mouth of river.
Drainage area.- 59,600 square miles.
Records available.- July 1917 to September 1934.
Source of data.- U. S. Geological Survey.
Gage.- Nonrecording gage read twice daily.
Stage-discharge relation.- Not permanent; seriously affected by ice.
Regulation.- No effect on flood discharges.
Historical data.- Discharge for flood of May 1903 estimated as 260,000 second-feet at mouth of river by Corps of Engineers, U. S. Army.

Flood stages and discharges
(Base discharge 20,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1918	May	30	14.9		45,700
1919	Mar.	17	21.75		104,000
		17	22.2	P	109,000
	Apr.	11	14.3		41,900
		30	10.75		21,900
	May	6	12.9		33,400
		17	10.6		21,200
	June	6	11.0		23,100
		13	15.35		48,600
	Sept.	24	10.45		20,500
1920	Apr.	14	10.35		20,000
	July	14	11.4		25,100
1921	May	11	18.4		71,400
		11	19.0	P	76,500
	June	19	12.7		31,700
	July	4	12.1		28,300
		7	10.8		21,500
1922	Mar.	15	11.9		27,800
	Apr.	10	17.4		63,200
	July	13	15.6		50,300
	Nov.	14	11.84		27,200
1923	June	1	10.55		21,200
		7	12.93		33,400
		11	20.34		88,600
	July	6	12.80		32,800
		15	10.76		22,100
1924	Oct.	4	9.40	**	16,000
1925	June	5-6	13.14		34,100
		20	17.78		67,800
1926	Sept.	17	13.49		37,300

** Below base

Flood stages and discharges of Kansas River at Bonner Springs, Kans.--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1926 Oct.	5	13.91	39,000	1929 Feb.	26	12.68	32,300
	13	11.80	26,600	Mar.	7	10.48	21,000
1927 Apr.	2	14.99	47,200	Apr.	21	21.90	106,000
	10	10.89	23,600		21	22.20	P 110,000
	16	17.18	63,000	May	14	13.72	38,100
	20	20.66	91,500	June	3	18.25	69,600
	20	20.85	P 92,700		8	10.79	22,500
May	7	10.69	22,700		24	14.42	42,400
June	6	10.76	23,100	1930 Apr.	17	10.14	22,300
	14	12.18	30,300	May	9	18.38	72,200
	18	15.95	54,200	June	7	13.10	35,900
Aug.	11	10.17	20,400		17	13.14	38,200
	15	15.41	49,900	Sept.	16	11.36	28,600
	26	11.50	26,600	Oct.	17	10.33	23,200
Sept.	9	13.06	35,400	1931 Sept.	3	11.94	31,300
Oct.	3	12.35	32,000	Nov.	15	12.64	35,300
	8	12.02	29,700		18	14.79	48,200
1928 June	25	10.22	20,200		24	16.68	60,200
July	13	12.45	32,000	1932 June	21	10.82	25,600
Aug.	5	12.22	30,800	July	5-6	12.44	30,600
	9	12.99	35,600	1933 Aug.	27	8.70	** 15,900
Nov.	18	17.05	60,200	1934 June	26	7.08	** 9,940

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Smoky Hill River near Abilene and at Solomon, Kans.

Location.- Aug. 1, 1904, to Sept. 30, 1921, in $SE\frac{1}{4}$ sec. 23, T. 13 S., R. 1 E., at highway bridge at Sand Springs, 3 miles above Holland Creek, 4 miles west of Abilene, Dickinson County, and about 9 miles below mouth of Solomon River. Subsequent to Oct. 10, 1922, in $SE\frac{1}{4}$ sec. 19, T. 13 S., R. 1 E., at highway bridge 500 feet below mouth of Solomon River and 1 mile south of Solomon, Dickinson County.

Drainage area.- 18,700 square miles.

Records available.- November 1904 to September 1921 near Abilene, October 1922 to September 1934 at Solomon.

Sources of data.- Gage-height records furnished by U. S. Weather Bureau. Discharge records by U. S. Geological Survey.

Gages.- Nonrecording gage near Abilene read to tenths once daily except for period from June 19, 1918, to Sept. 30, 1921, when it was read to quarter-tenths twice daily. Nonrecording gage at Solomon read to tenths once daily.

Stage-discharge relation.- Not permanent at either station; affected by ice. Bank-full stage, about 22 feet near Abilene and 24 feet at Solomon. Backwater effect from power plant about 10 miles below Abilene station began about 1919 and was cause for discontinuance of station.

Regulation.- Some regulation from mills upstream and on tributaries.

Remarks.- No important tributaries enter between the two stations, so discharge records are comparable.

Historical data.- A flood gage set to undetermined datum was maintained at Solomon location from Apr. 11 to July 15, 1904. Maximum stage recorded was 27.9 feet on July 10 and 11. Levels run to high-water marks indicate that elevation was about 26.4 feet on present gage. High-water marks for flood of May 1903 were 35.0 and 28.4 feet for Solomon and Abilene stations respectively.

Flood stages and discharges
(Base discharge 3,800 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1905 May	26	10.6	4,420	June	26	21.7	13,200
	29	10.1	4,100	July	1	11.4	4,980
June	4	16.5	8,850		19	9.8	3,910
	21	13.4	6,420		23	9.9	3,970
	25	16.3	8,690	1909 May	22	14.5	7,250
July	8	21.2	12,800	June	21	15.3	7,890
Aug.	3	10.5	4,360		27-28	17.8	9,890
1906 May	26	9.0	** 3,440	July	14-15	15.5	8,050
1907 July	1	8.7	** 3,280		25	11.9	5,330
1908 June	11	24.0	15,600	Nov.	17	11.0	4,700
	10	23.4	14,800	Dec.	4	10.2	4,160

** Below base

Flood stages and discharges of
Smoky Hill River near Abilene and at Solomon, Kans.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1910	Jan.	15	11.5	5,050
		21	11.2	4,840
		29	12.1	5,470
1911	Aug.	13	16.7	9,010
1912	Apr.	1	10.7	4,490
	May	9	14.4	7,170
		15	16.2	8,610
	July	7	11.7	5,190
	Aug.	22	16.4	8,770
	Oct.	13	11.5	5,050
1913	May	9	12.4	5,680
1914	July	11	7.8	** 2,790
1915	May	29	17.4	9,570
	June	12	20.6	12,200
		25-26	23.3	14,700
	July	1	17.5	9,650
		5	15.9	8,370
		10	18.8	10,700
		17	13.8	6,720
		22	21.8	13,300
		27	14.5	7,250
	Aug.	5	22.2	13,600
		12	11.3	4,910
		18	15.1	7,730
		21	12.6	5,820
		31	14.4	7,170
	Sept.	27	16.0	8,450
	Oct.	18	17.8	9,890
1916	June	16	18.6	10,500
		23	13.4	6,420
1917	May	30	10.5	4,360
	June	3	10.1	4,100
		9	11.1	4,770
	Aug.	17	12.8	5,970
1918	May	31	10.2	4,230
	June	7	17.0	9,250
	Oct.	11	10.4	4,360
1919	Mar.	17	15.55	8,110
	Apr.	11	14.9	7,610
	May	2	13.8	6,780
		5	11.6	5,190
		8	11.6	5,190
		15	11.3	4,980
		18	13.9	6,860
		21	13.5	6,560
	June	5	12.8	6,050
		14-15	21.3	12,800
		22	11.95	5,440
	Sept.	27	18.5	10,500
1920	Aug.	27	13.55	6,600
	Sept.	2	9.7	3,900
1921	May	11-12	12.2	5,610
	....		....	.....
1923	May	30	17.85	7,500
	June	13	25.96	14,200
		17	22.2	11,000
	July	3	14.95	5,450
	Sept.	23	12.95	4,220
1924	May	1	13.45	4,450
1925	June	27	12.4	3,850
1926	July	18	13.94	3,860
	Sept.	18	19.74	6,800
1927	Apr.	21	22.1	10,100
	May	6	13.3	4,180
	June	10	21.2	9,440
		21	26.5	13,400
	Aug.	5	13.4	4,240
		21	26.8	13,700
		29	23.2	10,900
	Sept.	8	20.1	8,670
1928	June	23	17.4	6,900
		29	18.5	7,700
	July	12	24.1	13,500
		21	21.8	10,900
		25	17.9	7,250
	Aug.	10	28.0	18,400
		22	13.7	4,460
1929	Apr.	23	18.8	7,940
	May	13	23.4	10,800
	June	2	19.5	7,620
		13	21.2	8,550
	July	13	24.5	12,000
1930	May	9	21.7	10,800
	June	6	18.5	7,700
		16	20.6	9,600
	Sept.	10-11	13.4	4,260
1931	May	9	13.4	4,700
	July	10-11	11.9	3,860
1932	June	21	13.4	4,260
	July	7	18.9	8,210
		9	22.2	11,300
	Sept.	3	17.2	7,010
		17	18.7	8,060
1933	Apr.	22	13.1	4,060
	Aug.	25	16.8	6,750
	Sept.	5	12.6	4,260
		18	12.1	3,980
1934	June	22	22.1	11,200

** Below base

<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Oct. 1, 1921, to Oct. 24, 1922.

Solomon River at Niles, Kans.

<u>Location</u>.- In NW¼ sec. 31, T. 12 S., R. 1 W., 6th Principal meridian, at highway bridge three-quarters of a mile west of Niles, Ottawa County, and about 15 miles upstream (by river) from confluence of Smoky Hill and Solomon Rivers.
<u>Drainage area</u>.- 6,710 square miles.
<u>Records available</u>.- May 1897 to November 1903, October 1917 to September 1934.
<u>Source of data</u>.- U. S. Geological Survey.
<u>Gages</u>.- Nonrecording gage read probably to tenths once daily 1897-1903; to quarter-tenths twice daily 1917-20; to hundredths twice daily 1921 to Apr. 25, 1934; recording gage thereafter. No relation between gage datums of 1897-1903 and 1917-34; latter datum lowered 2 feet on Sept. 30, 1922.
<u>Stage-discharge relation</u>.- Affected by ice. Control shifts. Bank-full stage, about 30 feet (1897-1903 datum) and about 24 feet (present datum).
<u>Remarks</u>.- Discharge record from Oct. 1, 1917, to May 14, 1919, obtained from station formerly operated near Bennington, Kans. No important tributaries enter between this station and the one at Niles.

Flood stages and discharges of Solomon River at Niles, Kans.
(Base discharge 1,800 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1897	June	15	13.5		2,000
		19	20.0		4,500
		26	13.5		2,000
	July	2	21.17		5,380
1898	June	10	10.3	**	1,180
1899	May	28	14.45		2,360
	June	5	23.6		6,240
		9	21.5		5,200
		16	13.25		1,940
		26	12.9		1,890
	July	1	18.75		3,900
1900	Mar.	10	12.9		1,870
	Apr.	19	20.2		4,630
	Sept.	16	13.4		2,020
1901	Apr.	13	13.4		2,020
1902	June	3	16.0		2,900
		22	14.6		2,410
	July	2	27.6		7,040
		11	22.1		5,040
		31	20.2		4,370
	Aug.	10	14.5		2,380
	Oct.	1	29.1		7,780
		8	18.1		3,640
		14	17.3		3,360
		19	14.4		2,340
1903	Mar.	15	22.7		5,000
		22	13.5		1,860
	May	1-2	15.6		2,490
		17	32.1		9,860
		22	21.5		4,560
		27	25.0		6,760
	June	3	33.8	*	10,600
		30	17.2		3,010
	July	4	14.4		2,120
		16	20.2		4,070
	Aug.	5	25.9		6,220
		8	25.7		6,140
		19	28.2		7,090
		23	16.7		2,840
		31	16.9		2,910
	Sept.	11	13.6		1,880
....	....	..	....		.....
1918	May	24			4,070
	June	6			7,450
	Sept.	4			4,340
		28			2,270
	Oct.	10	14.35		4,210
1919	Apr.	10			2,080
	May	1			3,390
		4			3,520
		14			4,210
		20	9.5		1,850
	June	5	14.75		4,000
		16	22.6		8,360
		22	9.8		1,960
	July	24	10.1		2,070
	Sept.	26	25.0		10,000
		26	25.25	P	10,200
	Oct.	1	15.65		4,430
1920	Apr.	13	11.4		2,560
	Aug.	21	10.8		2,320
	Sept.	1	15.1		4,170
1921	May	10	16.2		4,700
		10	17.1	P	5,150
	June	8	11.0		2,400
	July	7	10.0		2,030
1922	June	3	6.10	**	916
1923	May	29	23.40		7,180
	June	6	24.06		7,600
		11	26.58		9,230
		11	26.66	P	9,300
	June	16	23.13		7,000
	July	3	14.62		2,860
		5	14.32		2,740
	Sept.	28	14.36		2,780
1924	Aug.	19	13.86		2,410
		19	14.0	P	2,490
1925	Aug.	3	12.91		1,840
		3	13.22	P	1,950
1926	July	17	19.37		4,130
	Sept.	8	16.60		3,030
		20	22.19		5,270
		21	22.40	P	5,350
	Oct.	13	17.30		4,180
	Nov.	17	13.89		2,670
1927	Mar.	15	11.69		1,840
	Apr.	20	25.01		8,480
		24	18.05		4,530
	May	5	16.08		3,640
	June	10	20.39		5,760
		13	13.59		2,550
		20	26.87		9,760
		20	27.05	P	9,860
	Aug.	5	15.85		3,500
		14	21.68		6,480
		17	20.44		5,760
		20	18.30		4,680
		28	21.66		6,480
	Sept.	7	17.50		4,280
		10	19.97		5,540
		19	12.56		2,150
		30	13.10		2,350
	Oct.	2	12.40		2,080
1928	May	23	12.52		2,120
	June	23	19.54		5,280
		28	19.72		5,380
	July	10	26.26		9,340
		17	21.28		6,260
		23	22.02		6,640
	Aug.	9	27.48		10,200
		9	27.53	P	10,200
1929	Apr.	23	24.08		7,450
	June	12	26.48		8,750
		12	26.67	P	8,860
		23	13.46		2,220
	July	12	17.23		3,900
		29	14.74		2,740
1930	May	8			3,810
		13			2,420
	June	5			4,420
		5	18.20	P	4,710
		15			2,510
	Aug.	21			2,300
	Sept.	13			2,460
	Oct.	17	12.29		2,100
1931	May	6	12.20		2,060
		8	16.07		3,720
		8	16.80	P	4,040
		31	12.65		2,220
	July	9	15.80		3,580
	Aug.	13	11.93		1,940
1932	June	20	11.83		1,870
	July	9	18.70		4,950
	Aug.	17	13.35		2,550
	Sept.	2	21.58		6,400
		2	22.32	P	6,800
		16	15.68		3,540
1933	Apr.	25	14.82		3,140
		25	16.08	P	3,720
	Aug.	24	12.19		2,060
1934	June	21	19.57		4,820
		22	19.70	P	4,860

** Below base * Value probably too small.

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Big Blue River at Randolph, Kans.

Location.- In SW¼ sec. 12, T. 7 S., R. 6 E., at highway bridge half a mile above Fancy Creek and three-quarters of a mile east of Randolph, Riley County.
Drainage area.- 8,880 square miles.
Records available.- April 1918 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to quarter tenths or hundredths twice daily prior to May 15, 1934; recording gage thereafter.
Stage-discharge relation.- Affected by ice. Control fairly permanent between high-water periods. Bank-full stage, about 20 feet.
Regulation.- Flow affected by power plant at Blue Rapids.
Historical data.- High-water marks for important floods from 1897 to 1912 have been indicated by Mr. John Nord, of Randolph, and have been reduced to U. S. Geological Survey gage datum.

Flood stages and discharges
(Base discharge 8,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1897	Apr.	25	21.45	
1899	May	21	21.6	
	June	3	21.0	
1902	July	10	27.25	
	Aug.	31	21.95	
1903	May	31	31.7	
	Aug.	26	27.85	
1904	July	6	20.5	
1905	Sept.	17	19.85	
1907	July	18	18.6	
1908	May	22	18.75	
		29	24.2	
	June	7	30.95	
		12	25.0	
		30	20.7	
	July	16	20.0	
	Aug.	20	18.6	
1909	July	8	23.25	
	Nov.	15	24.85	
	Dec.	3	22.1	
1910	June	9	23.45	
1911	Oct.	2	21.6	
1912	Feb.	19	20.6	
	Mar.	21	25.1	
		28	20.9	
1918	May	23	13.15	12,100
		28	15.3	15,200
1919	Mar.	16	13.1	12,000
	Apr.	10	17.0	17,800
	May	4	13.65	11,000
		15	11.55	8,140
	June	4	14.35	12,000
		11	20.30	21,300
	Sept.	22	15.3	13,400
1920	Apr.	12	12.7	9,690
	June	26	11.65	8,260
1921	June	17	18.2	17,900
	July	2	19.1	19,400
		5	17.6	17,000
		19	11.7	8,370
1922	July	12	14.7	12,600
1923	Apr.	24	13.65	11,100
	June	4	15.00	13,200
		9	19.69	20,500
	June	12	19.17	19,500
	July	14	11.86	8,630
	Oct.	2	14.89	12,800
1924	June	27	11.78	8,370
	July	23	12.04	8,630
1925	June	3	17.98	17,500
		19	19.66	20,000
	Aug.	8	11.53	8,250
		13	11.63	8,380
		18	12.05	8,900
1926	Sept.	15	17.13	15,100
	Oct.	10	14.19	11,400
	Nov.	15	13.03	9,800
1927	Apr.	15	16.74	14,600
		19	20.63	19,900
		30	13.79	10,800
	June	4	12.25	8,840
	Aug.	9	19.25	17,900
		15	18.64	17,100
		18	14.17	11,400
		24	12.00	8,600
	Sept.	8	17.09	15,100
	Oct.	2	12.83	9,560
		6	14.54	11,800
1928	Aug.	7	12.81	9,560
1929	Mar.	7	16.75	14,700
	Apr.	22	12.75	9,440
	May	12	15.45	12,900
	June	1	22.18	22,300
		23	16.26	13,600
1930	May	2	12.11	8,740
		8	22.42	28,700
		16	14.79	12,300
	June	5	16.58	15,000
	Aug.	17	12.78	9,640
1931	Sept.	1	16.05	9,200
		26	17.74	16,900
	Oct.	12	11.91	8,500
	Nov.	25	17.20	16,000
1932	June	5	12.40	9,120
	Sept.	1	13.58	10,000
1933	Aug.	24	14.27	11,600
1934	May	15	5.60	** 1,940

** Below base
Note.- All discharge quantities are average daily flows.

Osage River at and near Ottawa, Kans.

Location.- Aug. 26, 1902, to May 31, 1914, in NE¼ sec. 35, T. 16 S., R. 19 E., at Main Street Bridge, Ottawa, Franklin County, 1 mile upstream from Skunk Creek, about 1 mile downstream from Eightmile Creek, and about 1½ miles downstream from waterworks dam of city of Ottawa; Oct. 27, 1918, to Sept. 30, 1934, in NW¼ sec. 6, T. 17 S., R. 20 W., 100 feet upstream from highway bridge on East Seventh Street, 1½ miles southeast of Ottawa, and about 2 miles below first location.
Drainage area.- 1,240 square miles, 1902-14; 1,260 square miles, 1918-34.
Records available.- August 1902 to October 1905; November 1918 to September 1934; gage-height record and estimated discharges for periods April to July 1911-13 and April to May 1914.
Sources of data.- U. S. Geological Survey records except gage-height records 1911-14, which were furnished by U. S. Weather Bureau.
Gages.- Nonrecording gage read to tenths 1902-5, 1911-14; recording gage thereafter. Zero of gage from 1911-14 estimated to be about 0.6 foot higher than that from 1902-5. Elevation of zero of gage at East Seventh Street 852.6 feet above mean sea level. No relation has been determined between datums at Main Street and East Seventh Street.
Stage-discharge relation.- Affected by ice. Controls permanent. Bank-full stage, about 24 feet at Main Street and about 27 feet at East Seventh Street.
Regulation.- Extreme low-water flow regulated at city waterworks upstream.
Remarks.- Flood of Nov. 18, 1928, had a stage of 37.6 feet at Main Street. Discharge records prior to 1928 revised above 13,000 second-feet for this report.
Historical data.- Flood occurred on July 8, 1909, during period when no continuous records were kept; stage, 35.9 feet at Main Street and 37 feet at East Seventh Street (discharge, estimated, 47,000 second-feet). This flood was probably the second largest since 1844 and has been exceeded only by the flood of Nov. 18, 1928.

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1902	Sept.	1	13.5	6,450
		7	15.9	7,170
		24	12.75	6,240
	Oct.	6	22.3	11,400
	Dec.	21	11.6	4,600
1903	Feb.	28	8.6	3,480
	Apr.	4	8.9	3,570
	May	13	9.9	3,960
		25	24.0	13,200
	June	1	23.5	12,600
	Aug.	8	10.8	4,320
		16	15.9	6,750
	Sept.	10	7.0	4,200
	Oct.	8	21.5	10,600
		15	17.1	7,650
	Nov.	2	12.8	6,240
1904	Mar.	26	16.6	7,440
	Apr.	25	24.15	13,400
	May	7	13.75	5,700
		9	9.55	3,840
		17	24.25	13,400
		27	9.4	3,760
		30	31.8	29,300
		30	34.3	P 40,300
	June	12	7.85	3,240
		16	7.5	3,150
		20	15.05	6,300
		27	26.25	16,100
		27	26.6	P 16,800
	July	4	7.35	3,120
		8	30.15	24,300
		8	30.7	P 25,800
	Sept.	3	13.3	5,450
1905	Mar.	29	17.0	7,400
	May	26	16.08	6,860
	July	4	25.45	14,900
		28	9.7	3,880
	Aug.	19	10.8	4,320
	Sept.	10	12.35	5,000
		16	23.45	12,500
		19	26.28	16,300
....			.....	......
1911	Apr.	5	3.7	** 1,920
....			.....	......
1912	Apr.	2	13.8	6,000
	May	13	13.2	5,700
		26	6.5	3,030
	July	5	8.6	3,680
....			...	.....
1913	Apr.	9	17.5	8,070
	May	7	6.5	3,030
		14	6.4	3,000
		22	9.8	4,160
....			...	.....
1914	Apr.	2	8.6	3,680
....			...	.....
1918	Oct.	9	10.3	3,250
		9	12.5	P 4,280
1919	Mar.	18	21.7	9,180
		18	22.35	P 9,530
	Apr.	10	13.9	5,070
		10	16.3	P 6,210
	June	10	11.4	3,810
		10	16.55	P 6,340
1920	June	3	12.15	4,140
	Sept.	9	11.6	3,840
		14	24.85	11,000
		14	25.9	P 11,600
1921	Mar.	9	11.6	3,840
	May	10	24.7	10,900
	June	10	21.2	8,870
		28	10.2	3,170
	Aug.	11	22.9	9,840
		11	26.6	P 12,000
		18	20.3	8,370
1922	Mar.	16	20.5	8,580
	Apr.	4	16.10	6,250
		10	32.49	22,300
		10	32.9	P 23,700
		28	19.40	7,970
	May	9	9.61	3,000
	July	13	12.10	4,250
1923	May	25	18.6	7,530
	June	1	12.77	4,600
		11	31.0	P 17,800
		12	30.63	16,900
	Oct.	16	7.71	** 2,050
1924	May	1	7.01	** 1,720
1925	June	4	12.80	4,570
		4	14.2	P 5,320
1926	Apr.	12	10.10	3,180
		12	11.16	P 3,710
	Oct.	5	22.70	9,600
1927	Apr.	2	22.6	9,540
		9	17.54	6,740

** Below base

Flood stages and discharges of Osage River at and near Ottawa, Kans.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1927	Apr.	16	27.3		12,300
		21	30.85		17,300
		21	31.38	P	18,800
	May	8	25.65		11,300
	June	3	17.32		6,600
		21	24.00		10,300
	Aug.	1	10.48		3,130
		16	20.77		8,500
	Oct.	2	24.37		10,600
		2	24.92	P	10,900
1928	Feb.	7	13.85		4,770
	Apr.	7	11.60		3,670
	June	3	22.98		9,770
		19	18.40		7,210
	July	1	10.45		3,090
	Nov.	17	38.65	P	58,400
		18	36.96		46,300
	Dec.	14	13.27		4,250
		17	15.50		5,390
1929	Jan.	11	19.90	*	5,600
	Feb.	26	15.15		5,230
	Apr.	1	17.40		6,440
		21	22.40		9,410
	May	14	26.85		12,200
	June	5	13.50		4,250
		23	13.00		4,100
	July	12	15.86		5,610
	Nov.	1	10.57		3,000
1930	May	8	11.57		3,440
		8	11.97	P	3,610
1931	June	12	7.02	**	1,550
	Nov.	19	16.00		5,660
		25	29.30		14,000
		25	29.67	P	14,800
1932	June	21	21.31		8,320
		28	11.03		3,170
	July	8	29.16		13,900
1933	May	19	16.20		6,150
		19	17.70	P	7,030
1934	May	15	16.22		6,270
		15	17.78	P	7,140

** Below base
* Estimated
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Part 7. Lower Mississippi River Basin

Mississippi River at St. Louis, Mo.

Location.- Foot of Market Street, St. Louis.
Drainage area.- 701,000 square miles.
Records available.- Fragmentary gage-height estimates 1785-1858; daily gage-height records January 1861 to December 1934; discharge measurements 1866, 1872, 1880-81, 1892, 1895-1919, 1922, 1927-34; daily discharge records 1928-34.
Sources of data.- Gage-height records by Mississippi River Commission and U. S. Weather Bureau; discharge measurements and daily discharge records by Mississippi River Commission 1866-1933 and U. S. Geological Survey 1933-34.
Gage.- Nonrecording gage. Readings reported to hundredths prior to Jan. 1, 1890, and to tenths thereafter except for occasional annual maximum readings, which are reported to hundredths. Zero of gage is 379.796 feet above mean Gulf level and 379.95 feet above mean sea level (1929 general adjustment, U. S. Coast and Geodetic Survey). All gage-height records referred to same datum.
Stage-discharge relation.- Continually subject to change; affected by ice, irregularity of slope, natural instability of channel, and river stabilization works involving levees, dredging, etc. Flood stage, about 30 feet.
Remarks.- Only those gage-height crests which were 0.7 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of discharge measurements to determination of daily discharge for any extended periods before or since measurements were made.

Flood stages
(Base gage height 20.0 feet)

Date			Gage height (feet)
1785	Apr.		* 42.0
1826			33.81
1828			36.4
1838	May	28	27.0
1843	May	2	27.2
1844	June	28	41.39
1845	June	27	32.4
1846	May	10	25.0
1849	Mar.	10	27.4
1851	June	10	36.61
1852	May	20	28.0
1853	May	7	30.0
1855			37.1
1856	May	9	27.4
1858	June	15	37.21
1861	Apr.	12	22.04
	May	15	25.47
	July	3	23.89
1862	Apr.	26	31.45
	June	13-14	20.91
		30	20.77
	July	12-14	20.58
1863	Mar.	4	** 18.02
1864	May	14	20.33
1865	Apr.	1	25.11
	May	8	20.03
	July	28	26.81
	Aug.	9	23.70
		17	22.96
1866	Mar.	15	20.44
	Apr.	7	20.77
		25	26.77
	June	22	20.46
	Sept.	22	21.06
1867	Feb.	21	24.46
	May	1	28.21
	June	4	26.73
		15	24.06
		24-26	24.23
	July	9	26.81
		18	26.66
1868	Apr.	17	20.37
	May	14-15	24.19
1869	Apr.	22	20.78
	June	4	22.51
		11	21.28
	July	5	27.95
		24	29.31
	Sept.	1	20.31
1870	Apr.	5	23.16
		16	26.21
1871	Mar.	4	20.57
	Mar.	17	21.82
1872	May	22	21.80
	June	12-14	23.00
	July	26	21.60
1873	Apr.	11	25.45
	May	13	22.33
		31	24.42
	June	10	25.25
	July	10-11	25.00
1874	June	19-20	**18.40
1875	May	3	24.60
	June	7-8	20.10
		25	23.80
	July	11-12	28.75
		30	24.00
	Aug.	3	29.80
1876	Apr.	6	24.20
		20	29.30
	May	10	32.00
	June	19	26.25
		26-27	27.20
	July	7	30.10
		19	28.35
	Sept.	16	22.25
1877	Apr.	12	22.85
		24	23.55
	May	20	25.55
	June	14	26.60
	July	4	26.55
1878	Mar.	12	22.85
	Apr.	25	22.00
	May	8	21.25
		22	22.75
	June	15	25.75
	Aug.	1	20.20
1879	July	3	21.15
1880	June	12	20.15
	July	12	25.50
1881	Mar.	20	22.30
	Apr.	2	24.95
		17	27.80
	May	6	33.65
	June	5-6	21.85
		21	24.70
	July	4	24.80
		22	22.40
	Oct.	12-13	21.00
		26	25.15
	Nov.	20	29.50
1882	Feb.	22	28.20
	Mar.	12	20.10
	Apr.	16	23.50
	May	1	24.85
		12	24.40
	June	3	28.10
		24	27.70
	July	5-6	32.20
1883	Feb.	18	25.80
		26	26.25
	Apr.	23	20.50
	May	23	26.50
		29-30	26.00
	June	26	34.80
	July	17	24.50
	Aug.	3	21.45
1884	Mar.	28	25.45
	Apr.	9-10	28.10
		25	23.95
	May	7	25.20
	June	12-13	21.70
		27	21.60
	July	18	20.90
	Oct.	2	22.20
		14	20.40
1885	Mar.	16	24.10
	Apr.	6	20.75
		19	20.45
	May	3	26.10
		31	20.15
	June	17	27.10
		23	26.75
	July	10	21.10
	Sept.	9	20.30
		15	22.25
1886	Feb.	13	23.20
	Mar.	30	23.15
	Apr.	21	23.70
	May	13	27.00
	June	28	20.45
1887	Mar.	19	20.10
	Apr.	3	20.65
1888	Mar.	28	25.60
	Apr.	15	23.15
		24	23.32
	May	24	28.05
	June	4	29.38
		19	26.10
	July	1	27.20
		11-12	25.48
1889	June	1	24.82
1890	July	1	20.6
1891	Apr.	25	23.6
	May	4-5	20.8
	June	10	22.9

* Estimated
** Below base

Flood stages of Mississippi River at St. Louis, Mo.--Continued

Date			Gage height (feet)
1891	June	25	23.2
	July	4	23.7
	Aug.	22	20.0
1892	Apr.	8	27.0
		22	26.5
	May	19	36.0
	June	5	34.8
	July	9	31.1
1893	Mar.	13	20.2
		19	22.4
	Apr.	13-14	24.2
		22	26.8
	May	3	31.6
		29-30	28.2
	June	3-4	28.2
		27	21.8
	July	8	21.6
1894	Mar.	10	20.2
	May	11	23.4
1895	July	9 **	16.8
	Dec.	22	23.4
1896	May	26	27.7
	June	6	25.0
	July	23	21.8
1897	Jan.	7	24.8
	Mar.	7	21.9
	Apr.	3	28.0
		11	28.9
	May	2	30.9
	July	4	22.7
1898	Mar.	24	25.2
	May	6-7	21.2
		23	27.2
	June	6	21.0
		18	25.4
	July	1-2	23.2
		9	22.2
1899	Apr.	27	25.68
	May	1	25.2
		14	21.2
		26	24.7
	June	5-6	24.1
		14	24.8
	July	11-12	23.8
1900	Mar.	16	23.53
1901	Apr.	18	22.5
		18 P	22.58
1902	June	15	21.1
	July	4	24.5
		26	26.89
	Aug.	30-31	20.6
	Oct.	9	20.9
1903	Mar.	11	25.2
		22	24.3
	Apr.	8	22.1
		18	24.4
	May	20	21.2
	June	10-11	38.0
	July	19	20.1
		27	20.8
	Sept.	3-4	20.3
		17	21.7
	Oct.	11	22.4
1904	Mar.	30	25.3
	Apr.	19	24.7
		29	33.5
		29 P	33.6
	May	20	22.3
	June	2	24.6
		8	28.9
		22	25.5
	July	1	24.2
		12-13	28.3
1905	May	20	20.6
	June	6	20.1
		16	20.5
	July	7	24.9
		15	25.8
	Aug.	4	21.3
	Sept.	21	30.20
1906	Mar.	3	23.5
		31	25.8
	Apr.	15	26.20
	May	8	22.3
	June	10-11	20.1
		25	22.0
1907	Jan.	23	26.3
	Apr.	22	20.3
	May	18	21.4
	June	6	21.4
		16	23.7
		28	24.5
	July	25-26	28.0
1908	Mar.	11-12	21.0
	Apr.	13	20.1
	May	11	20.5
		19-20	24.2
	June	20	34.9
		20 P	34.95
	July	4-6	31.5
1909	Mar.	13	22.3
	Apr.	23	25.2
	May	14	25.0
		20	21.1
	June	2	21.8
		14	26.2
		21	26.1
	July	3	26.0
		15 P	35.5
		16	35.25
	Nov.	20	20.6
	Dec.	8-9	22.5
1910	Jan.	5	21.3
		13 #	25.2
		14 P#	31.9
	Mar.	27	22.5
	May	10	24.90
	June	12	23.9
1911	Feb.	23 **	19.90
1912	Apr.	5	30.7
		5 P	30.8
		30	30.3
	May	21	21.4
	June	19	23.1
1913	Mar.	27	25.7
		27 P	25.8
	Apr.	16-17	27.20
1914	June	21	20.40
1915	Feb.	27	23.4
		27 P	23.5
	Apr.	15-16	20.8
		16 P	20.9
	June	4	31.3
		15-16	28.6
		24	31.6
	July	23	31.3
	Aug.	5-6	30.1
		21 P	30.6
		22	30.4
	Sept.	14	22.6
		18	24.3
		22	24.2
	Oct.	3	22.2
1916	Jan.	31 - Feb. 1	31.40
	Feb.	24	21.2
	Mar.	31 - Apr. 2	26.2
	Apr.	22	26.0
	May	5-6	24.0
		20	26.8
		31	30.0
	June	10	29.0
		25	24.9
1917	Apr.	3	20.3
		24-25	22.9
	May	4	25.8
	June	14	32.90
	July	2	22.3
1918	June	12	20.8
1919	Mar.	24	23.1
	Apr.	16	23.1
		23	21.4
	May	1	22.5
		11	26.90
		22	23.3
	June	7	24.4
		7 P	24.5
		16	22.5
	Oct.	30	20.6
		30 P	20.7
1920	Mar.	30 P	27.8
		31	27.6
	Apr.	10	27.4
		24	28.0
	May	4	27.0
		22	28.0
	July	5	21.9
		18	21.0
1921	Apr.	29	21.5
	May	14	23.0
	July	1	21.1
1922	Mar.	17-18	23.9
		17 P	24.0
		28	24.2
	Apr.	2	26.5
		19	33.7
		19 P	33.95
	May	1	28.7
1923	June	17	20.7
1924	June	14	21.5
		20	22.0
	July	2-3	26.3
1925	June	25 **	19.9
1926	Apr.	9	20.9
	Sept.	12	23.0
		20	24.2
	Oct.	8	29.4
		8 P	29.5
1927	Mar.	22	27.3
	Apr.	5	31.0
		26	36.1
	May	11	30.3
		18	27.3
		29	29.8
	June	8	33.0
		15	30.0
		25	27.7
	Oct.	6-8	23.3
		7 P	23.4
		13	21.7
1928	Jan.	7	21.6
		10	21.8
	Apr.	10	24.2
		10 P	24.4
	June	14	20.3
		22	27.6
		22 P	27.75
		30	21.8
	Nov.	23	28.45
1929	Mar.	18	28.4
	Apr.	6	29.1
		12	30.5
		28	34.6
	May	4	32.1
		16	31.8
		21	33.2
	June	9	30.8
		27	23.8
	July	11	20.6
		20	21.7
1930	June	21 **	19.6
1931	June	15 **	13.3
	Dec.	1	22.11
1932	Jan.	8	17.87
1933	Apr.	12	21.0
	May	17	27.0
		30	26.4
1934	Apr.	28 **	9.5
	Dec.	3 **	14.8

Ice gorge   ** Below base

Note.- Unless designated by "P" (momentary peak) gage-height values are the usually published daily readings.

Mississippi River at Memphis, Tenn.

Location.- U. S. Engineer gage at foot of Beale Street, Memphis, Shelby County.

Drainage area.- 924,200 square miles (data of U. S. Weather Bureau).

Records available.- Fragmentary records of flood stages 1828-67; daily gage-height records November 1871 to December 1934. Miscellaneous discharge measurements 1892-1904.

Sources of data.- Mississippi River Commission except for occasional supplementary gage readings by U. S. Weather Bureau.

Gage.- Nonrecording gage. Readings reported to hundredths prior to Jan. 1, 1890, and to tenths thereafter except for occasional annual maximum readings, which are reported to hundredths. Zero of gage is 184.21 feet above mean sea level.

Stage-discharge relation.- Continually subject to change; affected by irregularity of slope, natural instability of channel, and river stabilization works involving levees, dredging, etc. Bank-full stage, about 33 feet.

Remarks.- Only those gage-height crests which were 2.0 feet or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of measurements to determination of daily discharge for any extended periods before and since measurements were made.

Flood stages
(Base gage height 29.0 feet)

Date	Gage height (feet)
1828	32.86
1844 July	33.16
1849 Feb. 8, 16	30.86
1850 May 14-21	33.56
1851 Mar. 11	33.16
1852 Apr. 21-23	32.96
1858 June 23	34.16
1859 May 12-13	34.06
1862	34.78
1865	33.68
1867 Mar. 26	34.80
....	.....
1872 Apr. 24	31.50
1873 Mar. 3	32.50
Apr. 17	31.85
May 19	30.40
1874 Mar. 15	33.40
May 2	34.00
1875 Apr. 1	32.90
Aug. 15-17	33.05
1876 Jan. 12	29.80
Feb. 11	33.00
Apr. 8-9	34.08
May 19	32.85
1877 Apr. 29	32.05
1878 May 2	29.10
1879 Jan. 29 **	28.10
1880 Jan. 20	31.60
Mar. 24-29	33.40
1881 Mar. 2-3	31.70
31	29.40
Apr. 27-28	33.30
1882 Mar. 6	35.15
May 22-25	32.20
July 12	30.00
1883 Mar. 6-8	34.75
Apr. 22-23	32.50
July 1	30.25
1884 Mar. 1-3	34.15
Apr. 1-2	33.05
1885 Jan. 28	29.25
1886 Apr. 28	34.80
May 22	30.60
1887 Mar. 10	35.30
May 7	30.32
1888 Apr. 11-12	34.20
1889 June 27 **	26.55
1890 Jan. 27-31	33.3
Feb. 20	32.6
Mar. 16-17	35.60
1891 Mar. 10	34.90
1892 May 2-3	34.6
June 1-2	34.4
1893 Mar. 3	33.0
May 15-17	35.2
June 10-14	33.5
1894 Feb. 19-20	29.00
1895 Jan. 23-25 **	24.04
1896 Apr. 15-16	29.4
1897 Mar. 20-21	37.66
1898 Feb. 4-6	33.6
Apr. 10-11	37.22
1899 Jan. 22-24	29.0
Apr. 1-11	35.20
1900 Mar. 19	29.47
1901 May 6	32.12
1902 Mar. 20-22	30.8
21 P	30.9
Apr. 10-11	29.4
Dec. 29-30	30.0
1903 Mar. 20	40.10
Apr. 29	34.4
June 18-20	33.0
1904 Apr. 11	39.20
May 10	32.3
1905 Mar. 21 **	28.93
1906 Apr. 15	37.07
Nov. 30	29.2
1907 Feb. 3	40.30
Mar. 30 - Apr. 3	35.4
May 15	31.4
June 21	29.4
1908 Mar. 3-4	35.0
24-25	35.55
Apr. 19-21	35.0
May 25-26	35.2
1909 Mar. 22	38.60
May 18	33.4
June 21-22	29.4
July 23-24	33.6
1910 Jan. 31 - Feb. 2	30.4
Mar. 19	33.12
1911 Feb. 16-17	29.1
Apr. 25-26	36.42
1912 Jan. 7-8	31.1
Mar. 9	33.1
Apr. 6	45.23
May 11	38.9
1913 Feb. 4-5	40.4
Apr. 9-10	46.1
9 P	46.55
1914 Apr. 15	32.63
1915 Feb. 17-18	36.08
June 10-11	31.1
June 29 - July 1	29.1
July 22-24	29.3
Aug. 29	30.9
1916 Feb. 9	43.4
Apr. 14-15	34.3
1917 Jan. 16-17	29.1
Apr. 10	40.38
June 20-23	34.1
1918 Mar. 1-2	30.00
1919 Jan. 17	31.1
Mar. 29	37.3
May 19-21	31.5
Nov. 13	29.8
Dec. 22-23	31.9
1920 Feb. 6	30.3
Apr. 5	40.3
May 7	38.7
27	32.5
1921 Apr. 8	29.9
1922 Jan. 6-7	29.1
Apr. 1-2	42.5
Apr. 29 - May 1	42.3
1923 Feb. 16-17	34.1
Mar. 27	36.3
1924 Jan. 18-20	34.1
Apr. 14	30.8
June 6-7	29.5
1925 Mar. 3	29.0
1926 Apr. 19-20	31.0
Oct. 15-18	31.3
1927 Jan. 12	37.7
Feb. 13	37.8
Apr. 23-25	45.8
June 14-15	39.0
Dec. 25-27	29.3
1928 Apr. 13-14	30.8
May 2-3	33.0
July 10	35.8
1929 Feb. 5-6	32.8
Apr. 11	41.1
May 22-28	41.5
1930 Jan. 22-23	34.7
Feb. 19	29.0
Mar. 14-17	29.5
1931 Apr. 15 **	24.4
Dec. 24-25	29.3
1932 Feb. 19-20	38.7
Apr. 13	32.0
1933 Jan. 11-13	32.3
Feb. 5	31.2
Mar. 4-5	31.6
Apr. 11	40.4
May 28-30	39.9
1934 Mar. 19	30.2

** Below base
P Momentary peak

Mississippi River at Vicksburg, Miss.

__Location.__- On left bank of Yazoo Canal, about 1,600 feet above junction with Mississippi River, Vicksburg.
__Drainage area.__- 1,144,500 square miles (data of Mississippi River Commission).
__Records available.__- Fragmentary records of flood stages 1828-67. Daily gage-height records December 1871 to December 1934. Discharge records 1858 and intermittent records 1903-34.
__Source of data.__- Mississippi River Commission.
__Gage.__- Nonrecording gage. Readings reported to hundredths prior to Jan. 1, 1890; to tenths thereafter except for occasional peak stages, which are reported to hundredths. Zero of gage is 46.16 feet above mean Gulf level
__Stage-discharge relation.__- Continually subject to change; affected by irregularity of slope, natural instability of channel, and river stabilization works involving levees, dredging, etc.
__Remarks.__- Only those gage-height crests which were 1.0 foot or more above preceding and following low points were used in this compilation. Irregularity of conditions affecting stage-discharge relation made it inadvisable to apply results of measurements to determination of daily discharge for any extended periods before and since measurements were made.

Flood stages
(Base gage height 31.70 feet)

Date	Gage height (feet)
1828	46.38
1844 June 28	46.18
1849 Apr. 26	46.38
1850 June 4	47.08
1858 June 26	46.98
1859 Apr. 21	48.28
1862 Apr. 27	51.10
1865	46.43
1867	49.02
....	.....
1872 May 2-3	39.50
June 1	32.80
1873 Mar. 11-13	39.70
May 29-30	40.60
Dec. 28-30	35.50
1874 Feb. 10-11	35.80
May 2-5	45.70
1875 Apr. 21	43.00
Aug. 16-29	40.80
1876 Jan. 17	38.50
Feb. 24	42.20
May 10	44.90
July 21-22	40.10
1877 Feb. 6	36.30
May 8-13	41.60
June 25-26	40.15
....	.....
1878 Jan. 10-11	33.00
Mar. 24-27	40.95
May 10	40.75
June 5-6	39.60
....	.....
1879 Feb. 17	39.45
Apr. 14-15	35.30
....	.....
1880 Jan. 29-31	39.90
Apr. 8-9	43.15
July 19	34.30
....	.....
1881 Feb. 5	33.05
Mar. 10-12	41.85
May 10	41.62
Dec. 5-6	34.90
1882 Mar. 20-21	48.75
1883 Apr. 7	43.80
June 26	39.70
1884 Jan. 11-12	36.20
30	32.20
Mar. 25	49.00
1885 Feb. 3	42.40
Mar. 27-28	34.60
May 10-12	40.90
July 4-5	33.70
1886 Mar. 6	38.95
May 7-9	44.15
1887 Mar. 26-31	44.70
May 15	38.20
1888 Apr. 26	44.17
June 13	34.95
1889 Jan. 29	33.78
Mar. 11	33.55
July 3	34.43
1890 Mar. 15	48.0
Apr. 23-27	49.00
1891 Jan. 20-21	33.6
Apr. 2-4	48.1
1892 Mar. 3	33.6
May 10	48.4
1893 Mar. 13-15	42.4
May 22-23	48.3
1894 Feb. 27	40.3
Apr. 2	40.9
28	36.6
May 20-21	32.1
1895 Apr. 3	31.7
1896 Feb. 25	32.6
Apr. 21	39.0
June 9-10	33.4
1897 Apr. 16	52.3
1898 Feb. 13-14	43.1
Apr. 24-25	49.4
May 22	43.0
1899 Feb. 1-2	39.6
22-23	32.9
Apr. 17-23	47.30
1900 Mar. 27	38.00
May 3-4	34.0
July 8-9	32.6
1901 May 16	41.50
1902 Apr. 17-18	41.2
17 P	41.22
1903 Jan. 5-7	39.6
Mar. 28	51.80
June 26-28	43.2
1904 Apr. 25	46.85
June 21-24	38.8
July 25	34.3
1905 Mar. 27-29	37.6
Apr. 12	37.3
June 6	40.75
July 16	33.4
1906 Jan. 17-18	32.0
Feb. 7-9	38.0
Mar. 20	33.9
Apr. 26	47.15
Dec. 7	37.0
1907 Feb. 12-13	49.65
Apr. 9-10	45.4
May 28-29	45.5
June 27 - July 2	40.0
Aug. 6	31.8
1908 May 1-2	47.5
June 5-8	47.80
1909 Apr. 1-2	48.00
May 27	44.0
Aug. 1-2	40.6
1910 Feb. 7-8	37.1
Mar. 25-26	40.60
June 7	33.4
25	34.7
1911 Mar. 6	34.5
May 6	45.13
1912 Jan. 14	39.0
Apr. 12	51.65
May 7-8	48.4
1913 Feb. 16-17	48.8
Mar. 14	38.2
Apr. 27-28	52.20
1914 Apr. 26	41.16
1915 Feb. 28 - Mar. 1	43.90
June 20-21	41.7
July 9-11	41.4
Sept. 7	40.2
1916 Feb. 15	53.85
Apr. 24-26	45.2
July 6	39.4
26-27	32.2
1917 Jan. 22-24	35.3
Feb. 9-10	34.4
Apr. 23	49.98
June 30 - July 1	43.8
1918 Mar. 8	37.66
May 9	35.3
29-30	35.0
1919 Jan. 22-23	40.1
Apr. 10-11	46.37
June 3	42.6
Nov. 21-22	39.4
Dec. 29-31 - 1920 Jan. 1	43.6
Feb. 13	42.5
Apr. 27	50.90
1921 Feb. 26-27	36.4
Apr. 18-19	44.2
May 8	44.55
Dec. 17	34.1
1922 Jan. 12	35.1
Apr. 28	54.85
1923 Feb. 27-28	44.9

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Flood stages of Mississippi River at Vicksburg, Miss.--Continued

Date	Gage height (feet)	Date	Gage height (feet)	Date	Gage height (feet)
1923 Apr. 9-10	47.90	Dec. 9	33.3	1930 Feb. 3	45.7
June 7-9	42.2	1927 Jan. 21	46.5	Mar. 23-25	40.2
27-29	42.0	Feb. 22-24	49.3	May 30-31	35.0
1924 Jan. 29	44.0	Apr. 22	55.1	1931 Apr. 20	** 31.4
Mar. 9-10	36.0	May 4	58.40	1932 Feb. 28-29	51.9
22	34.6	June 26-27	48.5	Apr. 22	40.4
Apr. 20	40.4	1928 Jan. 2-4	38.9	May 11-12	31.7
May 14	38.1	Feb. 27-28	36.7	July 20	32.2
June 13-15	39.4	Apr. 2	35.9	1933 Jan. 19-20	38.3
1925 Mar. 8	35.20	May 10	47.0	Feb. 12-14	39.0
Apr. 4	32.6	July 12-16	49.30	Mar. 11-12	38.1
Nov. 26-27	33.5	Dec. 4-5	34.0	Apr. 22-28	48.0
1926 Feb. 8	34.6	1929 Feb. 13	40.9	June 10	48.9
Mar. 12-13	36.2	Apr. 25-26	52.7	1934 Mar. 24	32.3
Apr. 27-29	39.9	June 6-7	55.2	Apr. 13-14	35.3
Oct. 25	40.80	Dec. 3	32.0		

** Below base
P Momentary peak

Note.- Break in record: Sept. 1 to Oct. 31, 1877. Fragmentary records: Aug. 25, 1878, to Jan. 19, 1879; May 22 to Dec. 15, 1879; Aug. 7, 1880, to Jan. 22, 1881.

Mississippi River at Baton Rouge, La.

Location.- U. S. Engineer gage at Yazoo & Mississippi Railroad station, Baton Rouge, Baton Rouge Parish.
Drainage area.- 1,235,000 square miles (data of U. S. Weather Bureau).
Records available.- Daily gage-height records January 1872 to December 1934.
Source of data.- Mississippi River Commission.
Gage.- Nonrecording gage. One value per day reported to hundredths prior to Jan. 1, 1890; to tenths once daily Jan. 1, 1890, to Dec. 31, 1895; two daily values reported to tenths thereafter, except for annual maximum stages generally reported to hundredths. Subsequent to Dec. 31, 1895, morning readings have been used in this report unless designated by "P" (momentary peak). Zero of gage is 0.42 foot below mean Gulf level.
Stage-discharge relation.- Continually subject to change; affected by irregularity of slope, natural instability of channel, and river stabilization works involving levees, dredging, etc. Bank-full stage, about 25 feet.
Remarks.- Only those gage-height crests which were 1.0 foot or more above preceding and following low points were used in this compilation.
Historical data.- Dates and stages of early floods are Apr. 1, 1851, 34.53 feet; 1862, 36.07 feet; 1869, 34.49 feet; 1871, 34.52 feet.

Flood stages
(Base gage height 26.0 feet)

Date	Gage height (feet)	Date	Gage height (feet)	Date	Gage height (feet)
1872 May 7	29.65	Apr. 22-24	33.20	June 15-18	26.30
June 3-5	26.10	1881 Apr. 8	30.05	1889 Feb. 12	26.20
1873 Mar. 16	28.32	1882 Mar. 26	35.95	Mar. 14	26.75
June 17	29.85	1883 Apr. 9	35.08	1890 Apr. 21	36.6
1874 Feb. 13-14	26.10	1884 Jan. 15	26.83	1891 Apr. 26 -	
Apr. 16	36.15	Mar. 24	36.20	May 7	35.5
1875 May 13	29.75	1885 Jan. 30-31	31.90	May 3, 5	P 35.55
Sept. 1-4	27.25	Mar. 29	27.50	1892 June 26-28	38.4
1876 May 8	33.40	May 11-16	30.15	28	P 38.45
1877 June 1	29.65	1886 Mar. 9-11	28.55	1893 Mar. 16-18	30.2
1878 Apr. 1	28.15	May 31 -		June 23	38.4
May 19	29.35	June 2	32.10	1894 Mar. 2	29.4
1879 Feb. 15-17	26.10	1887 Apr. 10	33.55	Apr. 5-6	30.9
1880 Jan. 31 -		May 16	27.90	1895 Apr. 6	** 23.6
Feb. 6	26.30	1888 Apr. 29 -		1896 Apr. 23-25	28.8
		May 3	32.50		

** Below base

Flood stages of Mississippi River at Baton Rouge, La.--Continued

Year	Date	Gage height (feet)
1897	May 12-17	40.6
1898	Feb. 17	30.6
	Apr. 28 -	
	May 2	34.6
1899	Feb. 3-4	28.6
	Apr. 22-28	33.70
1900	Mar. 28-30	27.25
1901	May 16-19	28.21
1902	Apr. 18-20	29.4
1903	Jan. 11	28.6
	Apr. 6-10	40.0
	7, 8, 10 P	40.05
	July 2	30.5
1904	Apr. 29-30	33.70
	June 27 -	
	July 1	28.2
1905	Apr. 12-16	28.5
	June 9-11	30.80
	July 19	26.6
1906	Feb. 12	28.4
	May 1-4	34.40
	Dec. 10	26.2
1907	Feb. 18-19	37.40
	Apr. 14-15	33.5
	May 31	35.1
1908	June 16-17	39.60
1909	Apr. 7-8	36.17
	June 4-5	34.1
	Aug. 3-5	29.2
1910	Feb. 10-11	27.1
	Mar. 28	29.50
1911	May 13-16	32.43
1912	Jan. 15-17	29.4
	May 11	43.77
	11 P	43.82
1913	Feb. 22	37.2
	May 9	41.30
1914	Apr. 29	32.42
1915	Mar. 5	33.60
	July 12-16	31.2
	Sept. 10	29.6
1916	Mar. 2	42.57
	May 3 P	34.5
	4-5	34.4
	July 8	28.8
1917	Apr. 26 -	
	May 2	37.8
	Apr. 29 -	
	May 1,2 P	37.87
	July 4-5	30.8
1918	Mar. 12	26.7
	May 9-12	26.7
	10 P	26.79
1919	Jan. 25-26	29.6
	Apr. 16	34.45
	June 13-14	31.6
	Nov. 26	29.5
1920	Jan. 2	32.5
	Feb. 15-18	32.4
	May 22	41.50
1921	Mar. 2-4	27.4
	May 14-15	34.90
1922	May 16	45.70
1923	Feb. 28 -	
	Mar. 3	33.6
	Apr. 14-15	38.70
	June 12-15	32.4
1924	Jan. 30	33.7
	Mar. 10	27.5
	Apr. 25	29.9
	June 14-17	28.5
1925	Mar. 11 **	24.00
1926	Mar. 22	27.7
	Apr. 28 -	
	May 4	30.0
	Apr. 28 P	30.10
	Oct. 29-30	28.5
1927	Jan. 26	34.8
	Feb. 28 -	
	Mar. 1	39.0
	May 15	47.80
1928	Jan. 4-8	28.1
	Mar. 2-3	26.1
	May 16	35.0
	July 19-21	36.4
1929	Feb. 15-16	29.9
	15 P	30.2
	June 10-13	43.5
1930	Feb. 4	33.3
	June 2-3	26.2
1931	Apr. 21-23 **	20.1
1932	Mar. 5-6	42.78
	Apr. 22-26	30.2
1933	Jan. 23	29.0
	Feb. 15-17	30.4
	Mar. 13-16	30.0
	May 4-5	38.0
	June 15	38.5
1934	Apr. 15	28.5

** Below base
P Momentary peak

Arkansas River at Granite, Colo.

Location.-In sec. 31, T. 11 S., R. 79 W., 250 feet above railroad station in Granite 1897-99; 500 feet above railroad station 1910 to October 1917; 500 feet below railroad station 1917-34. All locations below Lake Creek and above Cache Creek.
Drainage area.-431 square miles.
Records available.-May to October 1897. August and September 1898, April 1910 to September 1934. Gage-height records only March to September 1899.
Sources of data.-U. S. Geological Survey records 1897-1927, 1933-34. Reports of State engineer of Colorado 1927-33.
Gage.-Nonrecording gage read to tenths twice daily 1897-99, Apr. 27, 1916, to Oct. 18, 1917; recording gage 1910 to Apr. 26, 1916, Oct. 19, 1917, to September 1934. Elevations of zeros of gages at the three locations not determined.
Stage-discharge relation.-Shifting control.
Storage, regulation, and diversions.-Storage in Twin Lakes Reservoir (capacity 54,704 acre-feet) and Sugar Loaf Reservoir (capacity 17,416 acre-feet). Considerable effect from regulation at these reservoirs. Decrees for diversion of about 100 second-feet above station. Small amount of water by-passed around station in flume. Water diverted into Arkansas River in amounts given by the following decrees: 18.5 second-feet June 1, 1906; 35 second-feet June 27, 1921; 125 second-feet June 10, 1927.

Flood stages and discharges
(Base discharge 1,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1897	May	21	5.10	1,440
	May 31-June 3		6.00	2,060
	June	16	6.15	2,160
		22	5.10	1,440
		27	4.90	1,300
	July	10	4.60	1,100
....			....	.....
1910	May	6	3.05	1,040
		13	3.5	1,550
		22	3.25	1,260
		28	3.1	1,090
		31	3.65	1,740
	June	16	3.2	1,200
		27	3.2	1,200
1911	May	9	3.2	1,040
	June	9	3.85	1,730
		15	3.8	1,670
		28	3.4	1,240
	July	5	3.5	1,340
		9	3.25	1,090
1912	May	26	3.6	1,450
		31	3.8	1,670
	June	6-7	4.1	2,030
		11	3.9	1,790
		14	4.0	1,910
		24	3.4	1,240
		30	3.4	1,240
	July	10	3.4	1,240
		14	3.35	1,190
		23	3.6	1,450
1913	May	12	3.45	1,340
		19	3.15	1,040
		27	3.35	1,240
	June	1	3.7	1,600
		7	3.1	1,000
		19	3.3	1,180
1914	May	23	3.45	1,340
		27	3.5	1,380
	June	1-2	3.8	1,700
		15	3.7	1,600
		25-26	3.6	1,490
	July	5	3.45	1,340
		11	3.25	1,140
		22	3.15	1,040
		28	3.3	1,180
	Aug.	1	3.2	1,090
1915	June	2	3.3	1,190
		12	3.55	1,410
		25	3.45	1,300
1916	May	14-15	3.5	1,360
	June	11-12	3.8	1,660
	June 30-July 6		3.6	1,460
	July	9-11	3.7	1,560
	Aug.	1	3.7	1,560
1917	June	19	4.3	2,540
	July	9	4.05	1,950
		19	3.75	1,290
		25	3.9	1,440
1918	May	25	3.47	1,350
	June	11	4.67	2,630
	July	11	3.37	1,040
1919	May	30	3.35	1,160
	June	4-5	3.25	1,100
		21	3.35	1,160
	July	3	3.35	1,160
1920	May	26		1,180
	June	9		1,690
		13		1,690
	July	4		1,650
		26		1,040
1921	June	1-2	3.55	1,190
		14	3.65	1,250
	July	1	3.75	1,310
		1	3.8	P 1,340
1922	May	27	3.37	1,330
	June	9	3.65	1,580
		14	3.77	P 1,680
		21	3.48	1,420
1923	June	4	3.70	1,500
		5	3.74	P 1,530
		16	3.22	1,110
		21	3.33	1,180
	July	10	3.23	1,110
1924	May	18		1,160
		22		1,320
		26		1,320
	June	8		1,930
		16		2,790
		16	4.57	P 2,900
		28-29		1,290
	July	8		1,050
	Aug.	4		1,010
1925	May	30-31	5.22	1,080
	June	21-22	3.27	1,120
		21	3.32	P 1,160
1926	May	25	3.15	1,110
	June	2	3.42	1,360
		7	3.49	1,430
		13	3.57	1,510
		13	3.75	P 1,690
	July	7	3.16	1,110
		27	3.06	1,030
	Aug.	11	3.17	1,120
1927	May	22	3.20	1,170
	June	15	3.54	1,480
		18	3.43	1,380
		25	3.43	1,380
		29	3.92	1,820
		29	3.99	P 1,880
	July	10	3.35	1,300
		13	3.58	1,510
1928	May	31		1,440
	June	7-8		1,060
		29		1,330
	July	15		1,130
1929	May	26		1,380
	June	10		1,600
1930	May	31		1,400
	June	14		1,430
1931	June	8		† 833

† Below base

Flood stages and discharges of Arkansas River at Granite, Colo.-Continued

Date		Gage height (feet)	Discharge (second-feet)
1932 May	25		1,120
June	4-5		1,080
	26		1,560
	29		1,270
1933 June	2		1,860
	5		2,000
June	11		1,800
	17		1,670
	20		1,540
July	4		1,320
	7		1,330
1934 May	31		† 922

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Arkansas River at Salida, Colo.

Location.- In sec. 32, T. 50 N., R. 9 E., at footbridge at railroad yards in Salida, Chaffee County, 1895-1903; 1,000 feet upstream in Salida City Park 400 feet below highway bridge 1909-34. Both locations above South Fork of Arkansas River.

Drainage area.- 1,210 square miles.

Records available.- April to December 1895, May to October 1897, August to November 1898, March 1899 to October 1903 (gage-height records only 1901), November 1909 to September 1934.

Sources of data.- U. S. Geological Survey records 1895-1927, 1933-34. Reports of State engineer of Colorado 1927-33.

Gage.- Nonrecording gage 1895-1903; recording gage 1909-34. Zeros of gages not related. Datum lowered 1.0 foot Jan. 1, 1922.

Stage-discharge relation.- Shifting control.

Storage, regulation and diversions.- Storage in Twin Lakes Reservoir (capacity 54,704 acre-feet), Sugar Loaf Reservoir (capacity 17,416 acre-feet) and Clear Creek Reservoir (capacity 11,444 acre-feet). Some effect from regulation at reservoirs. Decrees for diversions of about 650 second-feet above station. Decrees for diversion of 178.5 second-feet into Arkansas River above Granite.

Flood stages and discharges
(Base discharge 1,800 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1895 Apr.	29	2.91	1,850
May	10	3.08	2,020
	14-15	3.62	2,460
	21	2.83	1,800
June	13	3.00	1,930
	15	3.33	2,240
	29	2.87	1,800
....		....	.....
1897 May	18	3.10	1,980
	31	4.15	2,900
June	13	3.50	2,330
	16	3.65	2,460
	21-24	3.00	1,900
....		....	.....
1899 May	19-20	3.00	1,900
June	2	3.35	2,240
	20	5.10	3,900
1900 May 31-June 1		5.00	3,630
June	9	4.65	3,330
	24	3.10	2,000
1901 May	21	3.75	
June	9	2.55	
	25-26	2.60	
1902 May	15-16	2.1	† 1,620
1903 June	17	4.45	2,330
July	3	3.80	1,900
	5	3.95	2,000
	10-11	3.65	1,800
Aug.	13-14	3.80	1,900
....		....	.....
1910 May	13	3.85	2,280
	30	3.95	2,610
June	6	4.1	2,760
	16	3.35	2,000
	20	3.15	1,810
1911 June	9	4.45	2,660
	15	4.5	2,710
	22	4.6	2,810
July	5	4.9	3,110
July	9	3.8	2,040
1912 May	26	4.0	2,270
	31	4.3	2,470
June	7-8	5.1	3,340
	7	5.3	P 3,550
	24	4.0	2,170
	30	4.4	2,580
July	10	3.9	2,080
	14	4.05	2,220
	23	4.1	2,270
	30	4.1	2,290
1913 June	1	3.4	† 1,700
1914 May	22	3.6	1,930
	28	3.6	1,930
June	2	5.0	3,350
	15	5.2	3,570
	24	4.5	2,820
July	4-5	4.0	2,340
	22	4.2	2,520
	28	4.4	2,720
1915 June	12	4.15	2,400
	23	4.35	2,580
1916 May	13	3.5	1,990
June	14	4.55	2,900
July	2	4.25	2,590
	10	4.3	2,590
Aug.	1	4.2	2,500
1917 June	19	5.90	4,510
	19	6.1	P 4,730
July	10	4.80	3,300
	26	3.95	2,430
1918 May	26	3.4	1,890
June	13	6.2	4,840
	22	6.2	4,840
July	9	3.5	1,980
1919 May	29-30	3.9	2,460
June	18	3.35	1,980
July	3	2.7	2,280

† Below base

Flood stages and discharges of Arkansas River at Salida, Colo.-Continued

Date		Gage height (feet)	Discharge (second-feet)
1920 June	1		2,610
	9		3,210
	9	4.7	P 3,430
	16		2,940
	28		3,040
1921 June	3	4.0	2,730
	12	4.8	3,640
	15	4.9	3,760
	16	5.0	P 3,880
	27	3.98	2,710
July	1	4.18	2,690
	13	3.85	2,340
	24	3.4	1,910
1922 May	28	4.74	2,320
June	14	5.16	2,660
	14	5.42	P 2,870
1923 June	4	4.65	2,230
	16	5.03	2,600
	21	5.06	2,550
	27	5.10	2,510
July	8	4.98	2,310
	18	7.1	P 4,900
	21	4.49	1,830
1924 May	18		1,800
	22		1,890
	26		1,920
June	8		3,260
	16		4,780
	16	7.2	P 5,100
	28-29		1,990
1925 June	22	4.26	1,820
June	22	4.4	P 1,920
1926 June	7	5.06	2,500
	13	4.64	2,170
July	4	5.6	P 3,060
	7-8	4.32	1,930
1927 May	22	4.19	1,810
June	15	5.06	2,510
	18	4.84	2,320
	25	4.77	2,270
	29	6.18	3,480
	29	6.51	P 3,780
July	10	4.47	2,030
	13	4.64	2,160
1928 May	31		2,970
June	8-9		2,070
	29		2,100
1929 May	26		2,250
June	10		2,600
1930 May	31		2,280
June	14		2,170
1931 June	8		† 1,250
1932 June	26		2,380
	29		2,040
July	2		2,110
1933 June	2		2,640
	5		2,670
	11		2,640
	17		2,470
July	8		1,870
1934 May	11		† 1,560

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Arkansas River at Canon City, Colo.

Location.- At footbridge at Hot Springs Hotel at mouth of canyon, an eighth of a mile below Grape Creek and 1½ miles above railroad station in Canon City prior to Mar. 27, 1922, and 200 yards downstream thereafter. Gage was moved a few feet in 1896, 1902, 1907, 1908, and 1909.

Drainage area.- 3,090 square miles.

Records available.- May 1888 to September 1933 except some winters.

Sources of data.- U. S. Geological Survey records 1888-1927, 1933-34. Reports of State engineer of Colorado 1927-33.

Gage.- Nonrecording gage prior to Sept. 9, 1910; recording gage thereafter. Zero of recording gage 2.0 feet lower than that of previous gages.

Stage-discharge relation.- Shifting control.

Storage, regulation, and diversions.- Storage in Twin Lakes, Sugar Loaf and Clear Creek reservoirs (total capacity, 83,564 acre-feet). Slight effect from regulation at reservoirs. Decrees for diversion of about 3,000 second-feet above station. Decrees for diversions into Arkansas River above Granite of 178.5 second-feet.

Flood stages and discharges
(Base discharge 2,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1888 June	8		2,520
	19		2,760
1889 June	1		2,010
....			.....
Aug.	9		2,620
1890 May	28		3,270
June	3		3,260
	13		2,750
	21		2,720
July	11		2,020
1891 May	8		3,370
	14		2,580
	21		2,020
June	1		2,190
	13		4,230
	23		3,720
July	30		2,810
1892 May	28		2,250
June	11		2,740
	15		2,520
	25		4,750
	29		3,900
July	9		2,740
1893 May	20	5.10	3,210
	29	4.90	2,890
June	9	4.90	2,890
	18	6.00	4,750
	25	5.35	3,640
July	2	4.35	2,810
1894 May	14	4.30	2,050
	22	4.90	2,990
	31	5.80	4,400
June	6	5.80	4,400
	15	4.90	2,990
July	7	4.50	2,320
1895 May	17	4.30	2,220

Flood stages and discharges of Arkansas River at Canon City, Colo.-Continued

Date			Gage height (feet)	Discharge (second-feet)
1895	May	31	4.40	2,400
	June	11	4.50	2,590
	July	12	4.30	2,220
	Aug.	1	4.25	2,140
1896	May	31	4.60	2,780
	Aug.	30	4.60	2,880
1897	May	17	4.50	2,200
	June	4	5.55	3,400
		13	5.35	3,170
1898	June	4-5	4.50	2,430
		19-20	5.15	3,240
	July	8	4.20	2,060
		14	4.75	2,740
		16	4.75	2,740
1899	May	17	4.85	2,870
	June	2	5.05	3,120
		19-20	6.10	4,430
	July	2	5.30	3,430
		13	4.45	2,370
		19	4.50	2,430
	Aug.	5	4.45	2,370
1900	May	29	6.65	4,520
	June	8	6.50	4,350
		25	5.65	3,410
1901	May	21	6.00	3,800
		29	5.10	2,800
	June	10	4.80	2,470
		15	4.70	2,360
		26	4.85	2,520
1902	May	12-16	3.75	† 1,290
1903	June	19	6.70	4,920
		29	5.80	2,590
1904	May	25	5.85	2,070
1905	May	24-28	5.50	2,000
	June	5	7.40	5,990
		10	7.65	6,690
		22	5.80	3,060
1906	May	23	5.62	2,770
	June	7	5.35	2,360
		13	6.65	4,630
		22-23	5.45	2,460
	July	15	5.40	2,380
1907	May	23-24	5.45	2,330
	June	6-7	5.45	2,330
		19	6.30	3,790
	July	1	6.95	5,120
		14	6.25	3,700
		27	5.95	3,140
1908	June	18	5.35	† 1,900
1909	June	13	6.55	3,390
		20	7.25	4,320
		24	6.85	3,790
	July	5	7.0	3,990
	Aug.	18	7.95	5,400
	Sept.	6	6.4	3,260
1910	Apr.	29	5.85	2,180
	May	13	6.3	2,810
		22	5.8	2,120
		31	6.65	3,300
1911	June	9	6.55	2,790
		16	6.9	3,190
	July	6	7.15	3,490
		20	6.0	2,200
	Oct.	7	7.55	3,870
1912	May	27	8.4	2,930
		31	8.1	2,980
	June	6	8.55	4,000
		15	7.2	2,570
		25	7.2	2,930
		30		3,270
	July	10	6.7	2,380
		15	6.9	2,640
		23	6.85	2,580
		30	6.8	2,510
1913	June	19	6.7	2,060
1914	May	24		2,150
	June	2		3,320
		16		4,410
	July	5		2,700
		19		3,050
		22		3,210
		29		3,260
	Aug.	2		4,800
1915	June	3		2,000
	June	12		2,530
		24		2,980
1916	June	14		3,050
	July	1		2,480
		10		2,540
	Aug.	2		2,540
1917	June	19-20		4,760
	July	10		3,590
		26		2,150
		28		2,090
1918	June	14-15		4,950
		23		4,760
	Aug.	12		2,020
1919	May	22		2,710
		29		3,030
	June	19		2,120
1920	May	27		2,240
	June	1		3,080
		10		3,930
		14		3,260
		28		3,440
	Aug.	27		2,290
1921	June	5-7	3.85	3,500
		16	4.85	4,980
		27	3.4	2,850
	July	1-2	3.4	2,850
		17	3.37	2,810
		19	3.36	2,790
		22	3.4	2,850
		26	3.2	2,570
	Aug.	2		4,100
		2	10.7	P 19,000
		12	2.40	2,100
1922	May	29-30	2.85	2,480
	June	14	3.20	2,940
		14	3.35	P 3,180
1923	June	4	2.82	2,620
		17	2.96	2,860
		21-22	2.91	2,780
		27	2.92	2,800
	July	12	3.00	3,130
		13	5.1	P 7,200
		21	2.50	2,410
	Aug.	19	2.59	2,460
1924	May	22-23		2,400
		26		2,500
	June	8		3,950
		16		5,260
		16	4.55	P 5,580
		29		2,190
1925	June	22	2.28	† 1,780
	July	21	5.7	P 7,800
1926	May	27	2.62	2,220
	June	7	3.35	3,520
		13	3.10	3,040
	July	8	2.65	2,270
		21	4.8	P 6,460
1927	June	16	3.07	2,700
		19	2.91	2,460
		25		2,450
		25	6.0	P 7,940
		29	3.50	3,380
	July	14	2.68	2,110
1928	June	1		3,930
		9		2,490
		30		2,050
1929	May	26		2,220
	June	10		2,800
	Aug.	3		2,040
		7		2,710
1930	June	1		2,470
		14		2,300
	July	22		2,240
1931	June	8		† 1,390
1932	May	23		2,090
	June	26		3,040
	July	2		2,300
		5		2,360
1933	June	2		2,800
		7		2,860
		12		3,110
		18		2,880
	Aug.	3		2,290
1934	May	12		† 1,460

† Below base

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak). Break in record.- June 2-9, 1889.

Arkansas River at and near Pueblo, Colo.

Location.- Prior to July 10, 1898, at Santa Fe Avenue Bridge, in Pueblo, Pueblo County, 2 miles above Fountain Creek. July 10, 1898, to Mar. 2, 1900, and July 7, 1905, to Mar. 21, 1911, at Main Street Bridge, a quarter of a mile upstream. Mar. 3, 1900, to July 13, 1902, 60 feet below Union Avenue Bridge and 250 feet above Main Street Bridge. July 14, 1902, to July 6, 1905, 30 feet above Union Avenue Bridge. Mar. 22, 1911, to May 24, 1925, 150 feet below Main Street Bridge. May 1925 to September 1934 in sec. 34, T. 20 S., R. 65 W., at south side waterworks dam, 1 mile above Dry Creek and 4 miles above Pueblo.

Drainage area.- 4,820 square miles prior to May 1925 and 4,730 square miles thereafter.

Records available.- May and June 1885, June to September 1886, September 1894 to September 1934.

Sources of data.- U. S. Geological Survey records 1884 to 1910, 1933-34. Station maintained by State engineer of Colorado 1911-33.

Gage.- Nonrecording gage used prior to Mar. 22, 1911; read twice daily 1904-11. Recording gage subsequent to Mar. 22, 1911. Zero of Santa Fe Avenue gage was 4,656.31 feet above mean sea level, and that of gage used 1898-1900, 1905-11 was 4,657.04 feet above mean sea level. Zero of gage used 1902-5 was 0.2 foot lower than that used 1900-1902; sea level elevation not determined.

Stage-discharge relation.- Prior to 1925 stream bed shifting but confined between vertical masonry walls; thereafter control permanent for high stages.

Storage and diversions.- Several small irrigation reservoirs on tributaries entering below Canon City. Storage capacity above Canon City, 83,564 acre-feet. Decrees for diversions of 3,400 second-feet from river and tributaries above station.

Historical data.- Maximum discharge 1887, 6,520 second-feet July 18; 1894, 39,100 second-feet May 31.

Flood stages and discharges
(Base discharge 2,600 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1885	June	5	4.71	4,530
		7	4.15	3,570
		13	4.17	3,600
		22	4.70	4,510
.....	.....	.....	....	.....
1886	May	29	6.27	7,660
	June	2	5.96	6,960
		14	5.72	6,430
	July	21	3.82	3,080
	Aug.	13	4.36	3,920
.....	.....	.....	....	.....
1895	June	10	3.40	3,560
		14	2.90	2,900
		28	2.95	2,970
	July	12	2.95	2,970
		31	4.60	5,000
1896	July	24	2.83	2,840
	Aug.	18	5.05	5,440
1897	May	28	3.05	3,120
	June	2	3.50	3,750
		14	3.20	3,330
1898	June	20	2.8	2,770
	July	13	4.45	5,380
1899	May	20	2.45	2,700
		28	2.55	2,860
	June	20	3.80	4,890
	July	3	2.40	3,120
		7	2.20	2,870
		13	2.00	2,620
		19	2.00	2,620
1900	Apr.	5	4.55	2,910
	May	12	4.50	2,820
		20	5.90	5,410
		30	6.60	6,700
	June	2	6.75	6,980
		9	6.00	5,590
		25	5.05	3,840
1901	May	21	7.30	* 8,000
		21		P* 10,700
		25	4.75	3,320
		31	6.90	* 7,200
	June	16	4.40	2,740
	July	2	4.35	2,660
1902	Aug.	5	8.10	8,320
1903	June	9	6.80	6,100
		19	5.20	3,670
		23	4.80	3,110
	Aug.	6	4.50	2,720
1904	May	3	4.25	2,610
	June	15	4.75	3,310
	July	24	4.25	2,610
1905	May	24	4.60	3,250
	June	6	6.60	6,460
		10	6.60	6,460
1906	May	24	4.45	2,830
	June	14	5.88	4,880
	July	15	4.50	2,900
1907	June	20	5.05	3,540
	July	2	5.70	4,560
		15	4.95	3,380
		28	5.75	4,640
1908	June	15	3.9	† 1,930
1909	June	14	5.05	3,420
		20	5.55	4,160
		25	5.3	3,650
	July	6	5.45	4,000
		24	4.7	2,990
	Aug.	18	6.05	4,920
		22	4.55	2,710
	Sept.	6	4.8	3,060
		8	5.1	3,500
1910	June	1	5.05	3,250
1911	June	10	4.75	2,670
		16	5.2	3,120
		22	4.8	2,660
	July	6	5.25	3,140
	Oct.	7	5.10	2,980
1912	May	27	4.8	2,930
	June	1	4.9	3,100
		9	5.8	4,040
		16	4.5	2,660
		25	4.85	3,040
		30	4.9	3,100
	July	15	5.05	2,980
		31	5.8	3,780
1913	July	23	4.3	† 1,990
	Nov.	9	4.55	2,660
1914	June	3		4,200
		16		6,060
		25		3,040
	July	7		3,220
		14		4,700
		19		3,830
		23		4,610
		28		5,130
		31		6,470
	Aug.	3		6,720

* Estimated
† Below base

Flood stages and discharges of Arkansas River at and near Pueblo, Colo.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1915	June	13		3,020		July	12	12.55	P 25,600
		24		3,370			17		4,570
	July	28		2,950			17		P 12,500
1916	June	13		2,640			20		3,460
1917	June	19		4,690			26		3,200
	July	10		4,080			26		P 11,400
1918	June	14		4,500		Aug.	2		2,800
		17		4,320			19		3,810
		23		6,380			22	5.96	3,120
1919	May	30		2,820			28		2,780
1920	June	2		2,690	1924	June	8		4,160
		4		2,670			15		5,780
		10		3,240			15	7.86	P 6,510
		18		2,950	1925	July	22		† 2,370
		29		2,820	1926	June	8	3.24	3,190
	July	18		2,640			14	3.06	2,960
	Aug.	2		3,080			14	3.86	P 4,520
		20		2,690	1927	June	26		3,980
1921	June	4		* 34,600			30	3.18	3,280
		4	24.66	P* 100,000		Aug.	4		3,880
		13	6.00	6,470	1928	May	31		3,440
		28		2,870	1929	July	28		3,960
	July	2	4.90	3,070		Aug.	3		4,730
		15	5.43	3,830			7		6,520
		19	6.67	6,240			29		3,070
		23	5.60	3,980	1930	Aug.	14		3,320
		25	5.20	3,230			28		3,160
		27	5.25	3,260	1931	May	21		† 1,280
	Aug.	3	6.23	4,800	1932	June	27		3,350
1922	June	10	5.40	2,710		July	30		2,680
1923	June	17		2,640	1933	June	12		3,800
	July	12		6,120	1934	May	14		† 1,370

* Estimated
† Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Purgatoire River at Trinidad, Colo.

Location.- In Trinidad, at Animas Street Bridge 1896-1912; at Commercial Street Bridge, about 1,000 feet downstream 1916-21; about a quarter of a mile above Animas Street 1922-34.
Drainage area.- 742 square miles.
Records available.- May 1896 to July 1899, August to December 1905, November 1906 to March 1907, October to December 1907, March 1908 to November 1912, April 1916 to July 1918, May 1919 to September 1934.
Sources of data.- U. S. Geological Survey Records 1896-1912, 1933-34. Reports of State engineer of Colorado 1916-33.
Gage.-Nonrecording gage read to tenths twice daily prior to 1922; recording gage thereafter. Zero of gage used 1905-12 was 1.70 feet lower than zero of previous gage. Relation between zeros of gages used 1912, 1916, 1917-21 and 1922-34 not determined.
Stage-discharge relation.- Shifting control.
Diversions.- Decrees for diversion of 222 second-feet above station.

Flood stages and discharges
(Base discharge 500 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1896	June	1	3.90	780	1898	May	8	4.35	882
	July	16	3.80	600		June	14	4.30	752
		25	5.45	3,490			19	4.50	1,280
	Aug.	18	4.65	1,660		July	4	4.35	882
	Sept.	22	4.20	554			13	4.45	1,140
1897	May	6	4.35	922			24	4.35	882
		9	4.40	1,040		Aug.	7-8	4.30	752
		13-15	4.30	799		Sept.	11-13	4.50	1,280
		20	4.55	1,420	1899	July	29	4.90	2,360
		27	4.35	922		....	....	....	.....
		30-31	4.30	799	1908	July	24	6.5	1,500
	June	3	4.30	799			30	6.3	1,350
		26	4.60	1,530		Aug.	16	5.4	600
		31	4.20	554			20	5.65	730
	July	9	4.65	656			22	7.15	2,600
	Aug.	8	4.80	2,020			27	5.7	780
						....	....	....	.....

Flood stages and discharges of Purgatoire River at Trinidad Colo.--Continued

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1909	July	3	6.4			Aug.	3		1,070
		9	6.0				11		602
		24	6.4			Sept.	19		775
	Aug.	19	8.0		1922	June	12		719
	Sept.	6	8.0	* 4,800	1923	June	8		1,600
		6	12.5	* 14,000			20		1,480
		9	6.3			July	11		1,100
1910	July	30-31	5.0	515			17		895
1911	July	6	6.33	1,850		Aug.	7		894
		16	6.8	2,400			12		1,550
		18	7.3	3,100			17		580
		21	4.9	630			23		850
	Aug.	25	4.75	540		Sept.	18		1,400
	Oct.	5	6.0	1,120		Oct.	1		1,140
1912	June	7	5.5	584			5		516
		9	5.4	538			9		560
		11	5.5	584	1924	May	14		** 460
		19	5.5	584	1925	July	22		3,620
	July	15	5.6	632	1926	June	3		576
	Aug.	21	5.85	585			7		512
....			....	.....			12		503
1916	May	10		560		July	26		533
	June	4		1,900	1927	July	29		2,950
	Aug.	7		910		Aug.	17		505
1917	Aug.	17		555			23		1,990
1918	July	7		1,220	1928	May	11		977
		10		1,440			29		770
		15		1,240		June	1		792
....			...	.....		Aug.	17		622
1919	May	24		640	1929	May	30		1,680
		28		500		Aug.	7		933
	July	3		1,540			25		643
		15		1,030		Sept.	5		638
		27		2,870	1930	July	22		647
		29		2,550			30		1,620
	Aug.	1		712		Aug.	13		760
		10		974	1931	July	3		660
1920	June	4		605	1932	June	29		644
	Aug.	26		1,280		July	23		536
	Sept.	2		810	1933	Aug.	1		719
1921	June	4		2,530			17		1,630
		16-17		639	1934	July	27		** 350

* Estimated
** Below base
Note.- All discharge quantities are average daily flows.

Neosho River at and near Iola, Kans.

Location.- 1895-1903 at head gates of flume above dam of Iola City waterworks and power plant and about 90 feet above highway bridge 1 mile west of Iola and 2 miles above Elm Creek; 1906-17 about 200 feet above dam; 1917-34 in NE¼ sec. 9, T. 25 S., R. 18 E., 3 miles downstream, 2½ miles south and 1¼ miles west of Iola, half a mile below Elm Creek, and 8 miles above Owl Creek.
Drainage area.- 3,670 square miles prior to 1917, and 3,800 square miles thereafter.
Records available.- August 1895 to November 1903, October 1906 to September 1934.
Sources of data.- Discharge data by U. S. Geological Survey. Gage-height records 1906-17 by U. S. Weather Bureau.
Gages.- Nonrecording gage read to half-tenths 1895-1903 and to tenths 1906-17; recording gage thereafter. Elevation of zeros of gages used 1895-1903 and 1917-34 not determined; that of gage used 1906-17 is 937.4 feet above mean sea level.
Stage-discharge relation.- 1895-1917 control was rock dam, permanent except when small openings in crest were made artificially. Control shifts at location used subsequent to 1917. Bank-full stage, about 27 feet at last location.
Remarks.- Discharge 1906-17 computed from relation curve of U. S. Geological Survey gage near Iola and U. S. Weather Bureau gage above dam at Iola, using period of overlapping record 1917-22. Flood discharges 1895-99, 1918-21 revised for this report. Discharge records prior to and subsequent to October 1917 are not strictly comparable owing to inflow largely from Elm Creek between gage locations.
Historical data.- At point 800 feet below original site reliable flood marks show 1926 flood 0.5 foot higher than 1904 flood and 1.7 feet higher than 1885 flood. Flood of July 10, 1904, reached a stage of 24 feet, referred to gage used 1895-1903 (discharge probably less than that of Sept. 13, 1926). Maximum stages for gage used 1906-17: 15.6 feet, July 10, 1904, and 16.6 feet on an unknown date prior to 1904.

Flood stages and discharges of Neosho River at and near Iola, Kans.
(Base discharge 8,500 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1896	Apr.	9	10.25		11,300
		25	9.5		10,000
		27	9.4		9,800
	May	16	11.55		13,500
		24	20.1		33,800
1897	Mar.	5	6.35	†	4,720
1898	May	3	19.5		32,200
		16	17.5		27,000
		21	12.35		15,300
	June	1	9.4		9,800
		12	9.35		9,600
		27	20.5		34,900
	Dec.	20	13.35		17,400
1899	Mar.	12	11.05		12,800
	June	9	17.03		25,800
	July	4	12.6		15,600
		8	16.5		24,600
1900	Mar.	11	9.15		10,400
	Apr.	24	8.8		9,800
	May	19	15.8		23,700
	Sept.	29	11.7		15,400
	Nov.	2	18.95		30,400
1901	Apr.	8	12.0		16,100
		17	13.3		19,000
1902	May	26	13.5		18,500
	June	11	21.25		35,600
		21	15.5		22,900
	Aug.	24-25	16.25		24,600
	Sept.	1	13.6		18,500
		25	12.25		15,800
	Oct.	5	14.25		20,200
1903	Mar.	8	9.5		9,390
	Apr.	4	10.7		11,700
	May	15	11.9		14,000
		22	12.25		14,700
	June	3	22.0		39,100
	Aug.	6	11.5		13,200
		9	11.5		13,200
		16	14.3		19,200
	Sept.	11	11.9		14,000
	Oct.	8	12.0		14,200
	Nov.	2	14.3		19,200
......	......	......	.....		......
1907	Jan.	20	13.1		28,400
	Mar.	12	5.3		8,500
1908	May	15	6.8		12,200
		27	10.0		20,500
	June	3	6.3		10,900
		5	9.8		20,000
		14	8.6		16,900
		19	12.3		26,400
		19	12.5	P	27,000
		30	5.6		9,200
	July	4	6.9		12,400
	Oct.	24	8.9		17,700
	Nov.	30	9.5		19,200
1909	Mar.	21	6.1		10,400
	May	17	5.5		8,900
		17	5.9	P	9,900
	July	16	13.2		28,700
	Nov.	18	7.8		14,700
1910	Jan.	18	11.4		24,100
	May	8	9.4		19,000
	June	1	5.4		8,700
	Sept.	6	6.2		10,600
1911	Feb.	22	7.6		14,200
1912	Mar.	20	6.3		10,900
		30	10.4		21,500
	Apr.	2	7.8		14,700
		29	7.1		12,900
	May	12	11.0		23,000
	Oct.	15	6.4		11,200
1913	May	22	4.8	*	10,700
	Dec.	9	6.7		11,900
1914	Mar.	27	5.5		8,900
	Apr.	2	7.0		12,600
	Oct.	10	5.7		9,400
		13	7.0		12,600
1915	Feb.	24	5.8		9,700
	Apr.	27	9.1		18,300
	May	23	12.3		26,400
		27	13.0		28,200
		27	13.2	P	28,700
	June	12	11.0		23,000
		20	11.6		24,600
		27	5.7		9,400
	July	2	6.3		10,900
		16	7.0		12,600
		20	6.3		10,900
		23	6.6		11,600
	Aug.	10	7.2		13,200
		19	5.8		9,700
	Sept.	7	14.4		32,200
		7	14.7	P	33,400
		10	8.9		17,700
		16	14.2		31,500
1916	Jan.	22	10.8		22,500
		22	11.4	P	24,100
	Mar.	28	6.0		10,200
	May	17	5.7		9,400
		31	9.2		18,500
	June	7	7.1		12,900
		12	13.8		30,300
		21	13.0		28,200
		26	11.0		23,000
	Sept.	12	5.4		8,700
1917	Apr.	20	6.5		11,400
	May	28	6.2		10,600
		31	6.5		11,400
	June	6	7.9		15,000
	Aug.	18	6.3		10,900
1918	June	11	14.5		12,600
	Nov.	10	13.8		11,600
1919	Mar.	20	19.0		18,900
	Apr.	11	12.15		9,310
	May	3	16.0		14,700
		20	14.9		13,200
1920	Sept.	9	12.75		10,200
		9	13.1	P	10,600
1921	May	9	12.2		9,380
	June	10	12.9		10,400
1922	Mar.	14	14.3		12,300
		18	14.9		13,200
		26	24.9		27,800
	Apr.	4	16.6		15,500
		10	26.9		30,800
		10	27.32	P	31,400
	July	13	14.7		12,900
	Nov.	15	12.33		9,520
1923	May	26	15.70		14,300
	June	15	27.19		31,200
		15	27.2	P	31,400
	July	8	16.62		15,500
1924	May	3	11.78		8,840
1925	June	5	14.25		11,300
		5	14.4	P	11,600
	Nov.	7	14.0		10,400
1926	Sept.	5	17.50		15,000
		13	32.75		43,800
		13	33.2	P	46,000
	Oct.	5	25.70		27,000
1927	Mar.	20	16.95		14,600
	Apr.	1	19.52		18,000
		9	20.10		18,800
		15	19.55		18,200
		19	28.65		31,700
		19	29.8	P	34,000
	May	7	18.15		16,300
		11	17.42		15,200
	June	21	23.4		23,500
		25	18.0		16,000
	Aug.	17	18.44		16,500
	Oct.	3	28.2		31,200
		3	30.0	P	34,400
1928	June	4	22.6		22,300
		9	16.30		13,700
		18	21.42		20,700
	July	14	12.68		9,060

* Estimated
† Below base

Flood stages and discharges of Neosho River at and near Iola, Kans.-Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1928 Nov.	20	30.0	34,400	May	11	18.90	P 17,200
	20	30.42	P 35,200	1931 May	19	9.44	† 5,290
Dec.	14	13.01	9,450	Nov.	18	16.80	14,400
	17	14.89	11,900		24	21.10	20,200
1929 Jan.	12	13.04	9,450		24	21.54	P 20,800
Apr.	21	15.53	12,700	1932 June	23	14.72	11,700
	24	15.30	12,400	July	11	21.06	20,200
May	12	18.10	16,100	1933 Apr.	23	12.87	9,320
	16	19.50	18,000	May	29	12.62	8,930
	18	15.87	13,200		29	13.80	P 10,500
July	18	20.45	19.300	1934 May	15	17.53	15,300
1930 May	11	18.64	16,800		15	18.27	P 16,400

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Brazos River at Waco, Tex.

Location.- Sept. 14, 1898, to Sept. 24, 1914; Mar. 24, 1915, to Dec. 5, 1917; and May 6, 1922, to Feb. 12, 1925, at suspension bridge on Bridge Street, at Waco, McLennan County; high-water records 1902 to 1908 and all records Sept. 25, 1914, to Mar. 23, 1915, from Washington Street Bridge, about 300 feet upstream; Dec. 6, 1917, to May 5, 1922, and Feb. 13, 1925, to Sept. 30, 1933, at bridge of Texas Electric Co. (formerly called Southern Traction Co.), about 100 feet above suspension bridge and 2½ miles below mouth of Bosque River.
Drainage area.- 28,500 square miles (about 9,240 square miles probably noncontributing).
Records available.- September 1898 to September 1933.
Sources of data.- U. S. Geological Survey records except gage-height records, which were from U. S. Weather Bureau March 1908 to Oct. 23, 1915, and May 6, 1922, to Feb. 12, 1925.
Gage.- Nonrecording gage read to tenths once daily prior to Oct. 24, 1915, and May 6, 1922, to Feb. 12, 1925; to quarter-tenths once daily Oct. 24, 1915, to Sept. 30, 1917; to half-tenths once daily Oct. 1, 1917, to Mar. 28, 1918; recording gage Mar. 29, 1918, to May 5, 1922, and Feb. 13, 1925, to Sept. 30, 1933. Zero of all gages is 356.99 feet above mean sea level.
Stage-discharge relation.- Not permanent. Shifting control method used to determine discharge. Bank-full stage, about 27 feet.
Regulation and diversion.- Slightly regulated by Lake Waco. Diversions small.
Remarks.- Discharge records for 1902-3 contain revisions not previously published. No discharge records for 1912-14 have been previously published. Flood of Dec. 3, 1913, broke through levees and overflowed East Waco.
Historical data.- Fragmentary flood-height records 1884 to 1897 obtained from proprietors of Crow Bros. Laundry. Discharge based on measurements made 1898-1905.

Flood stages and discharges
(Base discharge 20,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1884	May	27	31.7		104,000
....			....		....
1885	May	28	34.2		119,000
....			....		....
1887	Aug.	31	31.8		104,000
....			....		....
1890	Apr.	22	31.0		99,500
....			....		....
1895	Mar.	28	30.1		94,300
....			....		....
1897	Mar.	29	32.6		109,000
....			....		....
1899	June	20	20.70		44,800
	July	2	17.00		29,700
		5	14.85		22,900
	Nov.	22	21.85		50,100
1900	Apr.	8	22.90		55,200
	May	31	16.30		27,400
	June	2	14.30		21,100
	Sept.	28	25.70		69,800
1901	May	19	14.75		22,600
1902	July	26	32.10		106,000
	Nov.	25	14.75		22,600
1903	Feb.	27	20.45		43,600
	Oct.	1	14.70		22,400
1904	June	30	12.75	†	17,600
1905	Apr.	24	14.2		20,800
	May	1	25.0		65,500
		9	15.0		23,200
		14	28.6		85,500
		24	16.15		26,900
	July	28	17.1		30,200
1906	June	6	19.8		40,900
1907	July	15	11.4	†	13,500
	Dec.	22	14.8		22,600
1908	Apr.	18	25.6		68,700
		20	32.0		105,000
	May	14	16.8		29,200
		18	19.9		41,000
		25	36.3		132,000
		25	36.7	P	134,000
1909	June	16	15.0		23,200
		18	15.1		23,500
	Dec.	2	16.8		29,200
1910	May	18	14.2		20,800
		22	15.8		25,700
1911	July	18	18.5		35,400
	Sept.	6	15.5		24,800
1912	Aug.	7	16.2		27,100
1913	May	7	14.5		19,000
	Sept.	28	12.8		14,000
	Oct.	8	12.8		14,000
		12	15.8		23,500
	Nov.	26	15.8		23,500
		28	13.8		16,900
		30	18.8		35,700
	Dec.	3	39.7	P	
		4	37.0		126,000
1914	Mar.	31	12.8		14,000
	Apr.	28	28.0		81,100
	May	5	26.8		75,100
		21	15.6		22,800
		28	24.3		62,600
		31	27.8		80,100
	June	6	15.3		21,800
	Aug.	17	24.4		63,100
		29	16.4		25,700
1915	Apr.	24	21.2		57,900
		26	26.0	P	104,000
		27	24.8		91,400
	May	5	12.9		27,200
		10	13.2		28,600
		26	18.8		63,000
		26	19.2	P	66,500
	June	9	25.7	P	101,000
		10	25.0		93,500
	July	5	15.8		23,900
		5	16.2	P	25,700
1916	Apr.	2	31.08		97,800
		2	33.8	P	113,000
		7	21.05		46,500
	May	2	20.30		45,600
		2	21.6	P	51,800
	Oct.	19	13.26	†	13,900
1917	June	9	9.78	†	4,590
1918	Apr.	15	13.74	†	16,300
	Oct.	30	16.78		27,100
		30	18.6	P	34,700
	Nov.	9	31.60		99,800
		9	36.4	P	125,000
	Dec.	24	20.44		42,400
		24	21.5	P	48,000
1919	Jan.	23	16.18		25,300
		23	18.3	P	34,300

† Below base

Flood stages and discharges of Brazos River at Waco, Tex.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1919	Mar.	31	18.18		33,800
		31	22.4	P	54,700
	May	29	15.53		22,300
		29	16.5	P	26,100
	June	21-28		*	24,000
	July	23	16.09		23,600
		23	17.3	P	28,600
	Aug.	21	17.10		28,300
		21	25.1	P	66,900
	Sept.	20	19.25		36,900
		20	25.3	P	67,900
		22	19.86		39,100
	Oct.	11	18.8		35,600
		11	21.0	P	47,500
		17	18.6		34,300
		17	20.7	P	44,500
		23	25.2		64,400
		23	27.9	P	81,200
	Nov.	9	26.9	P	76,100
		10	21.6		48,600
		29	18.8		34,700
		29	22.8	P	55,200
1920	Jan.	12	16.0		23,300
		12	16.7	P	26,100
	May	8	16.4		28,100
		11	19.8		41,400
		11	22.4	P	53,100
		18	19.0		37,100
	June	21	15.1		22,900
		21	16.0	P	26,500
	Aug.	22	15.4		21,400
		25	16.7		26,500
		25	17.5	P	29,400
	Sept.	8	20.9		45,500
		8	23.3	P	57,700
1921	June	11	17.7		29,800
		11	17.95	P	30,900
1922	Apr.	4	26.4		73,500
		4	23.0	P	108,000
		11	17.3		27,700
		27	28.2		74,600
	May	10	34.3		117,000
		10	35.9	P	122,000
		15	22.4		40,400
		22	18.2		24,500
		22	25.8	P	70,500
	June	8	15.6		20,600
1923	Apr.	12	15.8		26,100
		27	24.6		66,900
	May	1	16.1		25,700
	June	13	17.5		32,900
	Oct.	18	17.1		27,700
	Dec.	13	20.2		41,900
1924	May	27	14.1	†	16,400
1925	Apr.	30			24,000
	May	9			47,600
		9	21.1	P	55,200
		13	15.06		20,500
	Sept.	14			38,600
1926	Apr.	10			28,000
		22			26,100
	June	22	18.44		39,000
		22	19.30	P	44,400
	Sept.	1	17.15		31,800
	Oct.	19	19.00		36,600
1927	June	5			41,300
		14			60,800
		14	26.4	P	89,000
1928	May	21	17.15		24,500
	July	30	16.56		20,900
1929	May	21			21,100
		31	16.40		21,400
	Sept.	13			45,700
		13	20.66	P	47,400
1930	May	15	25.10		48,300
		18			43,300
		18	28.90	P	74,800
	June	18			42,600
	Oct.	7			41,800
		7	31.4	P	93,500
		16	18.10		20,200
	Dec.	5			21,300
1931	Oct.	17	17.02	†	16,700
1932	Jan.	23			30,800
	Feb.	17			21,300
		19			54,600
		19	26.95	P	62,500
	Mar.	5			22,200
	May	9			36,000
		16			22,000
	July	5			28,600
		9	17.75		20,700
	Sept.	4			21,700
		8	17.65		20,000
		11	22.60		39,300
1933	May	25			25,500
		28			29,200

* Estimated
† Below base

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Colorado River at Austin, Tex.

Location.- At Congress Avenue Viaduct, in Austin, Travis County, half a mile above Waller Creek, half a mile below Shoal Creek, and 3½ miles below Austin Dam.
Drainage area.- 38,200 square miles (about 11,800 square miles is probably noncontributing).
Records available.- February 1898 to September 1933.
Sources of data.- U. S. Geological Survey records, except gage-height records furnished by U. S. Weather Bureau Jan. 1, 1912, to June 18, 1915.
Gage.- Nonrecording gage read to tenths once daily prior to June 18, 1915; recording gage thereafter. Zero of gage is 421.77 feet above mean sea level.
Stage-discharge relation.- Shifting control. Bank-full stage, about 21 feet.
Storage, regulation, and diversions.- Original Austin Dam (reservoir capacity, 49,300 acre-feet) regulated flow for power from 1893 until its failure in 1900. Silting reduced capacity of rebuilt reservoir to 1,477 acre-feet in 1926. Brownwood Reservoir (capacity, 140,000 acre-feet) has regulating effect on flood flows at Austin. Diversions sufficient to irrigate 36,000 acres of land.
Remarks.- Peak discharge of 236,000 second-feet for flood of Apr. 7, 1900, was caused by failure of Austin Dam. Natural peak of flood was 151,000 second-feet, determined from gage at dam just before failure.

Flood stages and discharges
(Base discharge 20,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1898	June	16	10.70		30,200
		19	10.20		28,000
1899	June	8	21.05		91,800
		8	23.80	P	113,000
1900	Apr.	7	26.9		145,000
		7	33.50	P	236,000
	May	5	11.60		36,200
	July	17	8.77		23,700
		20	9.40		26,500
	Sept.	27	21.95		98,400
1901	July	13	10.20		28,700
1902	May	21	8.85		22,400
	July	28	11.85		35,900
	Nov.	24	10.90		30,900
1903	Feb.	27	11.30		33,700
	Oct.	4	10.40		30,900
1904	June	8	10.35		31,500
1905	Apr.	25	9.2		25,600
		30	15.05		52,900
	May	9	10.5		31,100
		17	8.1		20,700
1906	June	7	11.3		38,000
	Aug.	12	19.5		78,500
		18	10.3		29,100
	Sept.	7	8.4		20,900
		13	8.3		20,500
1907	May	29	10.2		28,100
	July	14	10.1		27,800
	Oct.	9	8.3		20,700
	Nov.	19	9.9		27,000
1908	Apr.	23	21.6		100,000
	May	21	11.1		31,700
		25	17.0		64,600
		28	13.7		44,400
1909	June	4	10.6		29,700
	July	24	10.3		28,500
1910	Sept.	9	10.0		27,400
1911	Feb.	23	9.0		23,500
	Sept.	7	10.00		27,400
	Dec.	14	7.5	†	17,400
1912	Oct.	18	5.8	†	11,500
1913	May	9	12.7		40,300
		9	14.00	P	47,100
	June	21	8.30		20,500
	Oct.	2	10.50		29,700
		9	10.40		29,200
	Nov.	28	15.00	P	52,700
		29	14.5		49,900
	Dec.	4	25.2		141,000
		5	27.00	P	164,000
1914	May	7	10.00		27,400
		23	14.30		49,900
		30	11.50		34,400
	June	20	16.50		61,500
	Aug.	18	12.90		41,300
		30	9.50		25,300
1915	Apr.	26	17.8		68,000
	Apr.	29	12.0		39,000
	Sept.	17	21.0		84,000
1916	May	22	13.10	P	46,000
		22	9.5		28,200
	Oct.	21	4.75	†	9,750
1917	Sept.	7	4.1	†	7,840
1918	Apr.	16	12.10		38,400
		16	15.00	P	51,500
	June	6	8.12		22,400
		6	8.80	P	25,400
	Oct.	14	8.42		23,000
		14	8.65	P	24,000
		26	9.02		26,900
	Nov.	9	16.70		62,300
		9	19.50	P	74,800
		11	17.20		64,700
	Dec.	24	12.32		41,500
		24	14.77	P	53,000
1919	Jan.	25	7.96		23,800
		25	8.41	P	26,000
	Mar.	25	11.64	P	40,300
		26	8.32		24,800
		28	8.28		24,500
		28	8.62	P	25,900
	June	14	9.90		29,500
		14	10.02	P	29,800
		27	10.26		31,000
		27	10.72	P	34,200
	July	8	8.43		23,400
		8	10.33	P	31,400
		23	11.82		39,200
		23	12.85	P	43,900
	Aug.	23	8.33		24,100
		23	8.68	P	25,500
	Sept.	24	18.83	P	72,800
		25	17.11		64,200
	Oct.	11	12.5		44,600
		11	13.67	P	50,300
		17	7.99	P	24,700
		18-19	7.4		22,300
		25	7.4		22,300
		26	7.96	P	24,600
	Nov.	10	8.6		27,400
		10	10.70	P	36,600
1920	May	16	7.2		20,600
		16	9.72	P	30,900
	Aug.	8	9.0		28,100
		8	10.25	P	33,400
	Sept.	10	8.3		24,400
		10	8.42	P	24,800
1921	June	13	14.1		50,200
		13	19.10	P	74,700
	Sept.	10	12.9		45,800
		10	19.43	P	77,600
1922	Apr.	5	12.10		45,500
		5	14.40	P	57,400
		13	7.25		22,800

† Below base

Flood stages and discharges of Colorado River at Austin, Tex.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1922	Apr.	13	8.63	P	29,000
		28	20.94		103,000
	May	1	22.60	P	120,000
		3	20.60		100,000
		19	12.19		46,000
		19	12.62	P	48,100
1923	Apr.	16	7.8		25,300
		30	12.5		47,500
	May	1	13.04	P	50,200
	Oct.	21			38,100
	Nov.	3	12.60		48,000
		3	13.60	P	53,000
1924	June	2-3	5.88	†	16,800
1925	May	1	7.72		24,800
		13	8.21		27,100
		31			23,600
		31	9.30	P	32,000
	June	4	7.02		21,700
	Oct.	17	8.75		29,800
	Nov.	7	8.49		28,400
1926	Apr.	26	8.70		29,400
1927	Feb.	10			36,600
		10	12.25	P	46,000
	Oct.	3	10.9	P	39,500
	Oct.	4	10.15		36,100
1928	May	24	8.14		26,600
	June	16	7.09		22,200
	Aug.	1	8.48		28,400
1929	May	29			96,400
		29	27.35	P	132,000
1930	May	11			28,000
		11	11.00	P	37,300
		19			21,500
		22	8.46		26,500
	June	19	9.49		30,700
	Oct.	7			79,500
		7	22.50	P	97,600
		18			66,200
1931	Oct.	17	6.20	†	18,100
1932	May	13			36,200
	July	4			54,800
		8			31,900
	Sept.	3			61,800
		3	19.0	P	77,500
		12	8.12		25,400
1933	May	27			33,200
		27	10.80	P	44,200

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Rio Grande near Del Norte, Colo.

Location.- Oct. 11, 1889, to Sept. 30, 1907, above Los Pinos Creek in sec. 26, T. 40 N., R. 5 E., and about 2 miles above Del Norte; May 16, 1908, to Sept. 30, 1934, at highway bridge in sec. 30, T. 40 N., R. 5 E., below Wolf Creek, 6 miles above Del Norte and about 4 miles upstream from former location.

Drainage area.- 1,400 square miles.

Records available.- October 1889 to November 1906; May to September 1907; May 1908 to September 1934, except winters of 1892, 1893, 1903, 1903-4, 1908-9, 1912-13, 1916-17, and 1922-23 to 1933-34.

Sources of data.- Colorado State engineer; collaboration by U. S. Geological Survey 1889-1906, 1908-13, 1933-34.

Gage.- Nonrecording gage prior to Nov. 8, 1910; recording gage thereafter. Gage read only on odd days of month from October 1893 to October 1903.

Stage-discharge relation.- Control shifting. Considerably affected by ice.

Storage, regulation, and diverions.- Storage in Beaver Park, Santa Maria, and Rio Grande Reservoirs. Court decrees allow for diversions of 302 second-feet.

Remarks.- Flow at two locations not directly comparable because of inflow and diversions between.

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1890	May	27	6.34		5,930
	June	13	5.52		4,380
1891	May	7	6.20		5,650
		31	4.70		3,000
	June	13	6.15		5,560
		24	6.10		5,460
1892	May	24	5.70		4,710
	June	8	4.80		3,160
1893	May	18-19	4.9		3,320
1894	May	14	4.4		3,270
		20	4.6		3,570
1895	Apr.	19	4.26		3,060
		27	4.22		3,000
	May	13	4.24		3,030
	June	12	4.68		3,690
1896	May	3	4.56		3,510
1897	May	15	4.48		3,620
	May	27	5.70		5,230
	June	11	4.78		4,020
1898	Apr.	29	4.20		3,410
	June	3	5.30		5,270
		17	5.20		5,100
1899	May	11	3.62	†	2,320
1900	May	19	4.80		3,950
		29	5.80		5,450
1901	May	21	5.16		4,480
		27	4.42		3,350
1902	May	3	3.24	†	1,790
1903	May	15	5.64		5,100
	June	3	5.84		5,430
		17	6.20		6,020
1904	May	20	3.50	†	2,040
	Oct.	9	4.35		3,100
1905	May	25	6.5		7,460

† Below base

Flood stages and discharges of Rio Grande near Del Norte, Colo.--Continued

Date	Gage height (feet)	Discharge (second-feet)
1905 June 5	7.05	10,000
8	6.45	8,630
28	3.9	3,440
1906 May 11	4.35	4,180
21	5.9	6,860
28-29	4.3	4,100
June 2	4.5	4,420
7	5.35	5,870
13	6.35	7,670
1907 May 23		6,550
June 18		7,220
June 30-July 1		7,400
1908 May 20	3.5	3,440
June 11	3.85	4,130
26	3.5	3,440
1909 May 8	4.0	4,430
19	4.05	4,530
28	3.85	4,140
June 6	5.15	6,870
Sept. 6	4.3	5,050
1910 Apr. 29-30	3.7	3,860
May 12	4.4	5,260
31	4.35	5,160
1911 May 9	3.95	4,420
19	3.65	3,920
26	3.95	4,550
June 9	4.8	6,450
July 3	4.05	4,480
14	3.8	3,960
Oct. 6	6.0	14,000
1912 May 30	5.15	6,940
June 5	5.15	6,940
24	3.65	3,780
1913 May 13	3.2	3,140
27	3.55	3,800
1914 May 23-24		4,690
June 2-4		5,820
13		3,920
19-20		4,790
1915 June 2		3,830
12		4,300
20		4,500
July 27		3,040
1916 May 10-11		4,690
June 4		4,160
16-17		3,860
1917 May 18		3,720
June 5		3,260
15-16		8,250
1918 June 7		3,260
11		3,720
1919 May 22-23		5,770
28		5,300
June 17		4,010
July 3		3,100
1920 May 10		4,010
22		7,300
26		7,440
June 1		7,710
June 27		6,520
1921 May 6		3,320
16		3,330
June 4		5,940
13		9,630
1922 May 7		4,650
29-30		8,000
June 14		7,230
1923 May 11		3,130
21-22		4,150
26		5,210
June 4		3,820
14		4,490
17		4,490
27		3,610
1924 May 21		5,590
June 7		3,950
15		5,720
1925 May 30-31		3,270
June 5		3,400
21		3,250
1926 May 24		3,880
June 6		5,450
1927 May 5		3,280
18		3,780
26		3,370
June 11		3,420
30		12,600
Sept. 10		3,840
13		5,770
1928 May 2		3,400
9		3,240
31		4,520
June 8		3,420
1929 May 10		3,770
15		4,430
26		4,030
June 6-7		5,360
17		3,840
21		3,680
Aug. 11		3,140
1930 May 27		3,120
30		3,700
June 8		3,180
12		3,120
1931 June 3	†	2,430
1932 May 13		3,860
19		4,960
22		4,980
30		4,400
June 4		3,840
15		5,200
23		4,610
July 13		3,080
1933 June 2		4,030
5		3,630
12		3,850
1934 May 11	†	2,610

† Below base

Note.- All discharge quantities are average daily flows.

Rio Grande near Lobatos, Colo.

Location.- At highway bridge in sec. 22, T. 33 N., R. 11 E., 10 miles east of Lobatos, 7 miles below mouth of Conejos River, and 6 miles north of Colorado-New Mexico State line.

Drainage area.- 7,700 square miles.

Records available.- June 1899 to September 1934, except winters of 1907-8, 1911-12, 1912-13, 1913-14, 1916-17, and 1918-19. Gage-height record only for other winters prior to 1912, except 1902-3, which has discharge estimates.

Sources of data.- Colorado State engineer; collaboration by U. S. Geological Survey 1899-1913, 1933-34.

Gage.- Nonrecording gage prior to Mar. 23, 1910; recording gage thereafter.

Stage-discharge relation.- Control shifts. Backwater from ice.

Regulation and diversions.- Court decrees for diversions upstream total 11,657 second-feet.

Flood stages and discharges of Rio Grande near Lobatos, Colo.
(Base discharge 1,500 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1900	May	21	3.8	2,870
	May	30-June 1	5.0	4,700
1901	May	3	3.6	2,570
		14-17	3.1	1,830
		23	4.3	3,620
	June	9-10	3.2	1,970
1902	May	26-29	2.0	** 565
1903	May	17	4.4	3,840
		27	2.8	1,600
	June	18	10.0	12,800
1904	Aug.	10	2.2	** 751
	Oct.	2	3.0	1,730
		11-12	3.95	3,200
1905	May	3	4.65	4,040
		11	3.7	2,420
		26	8.4	11,700
	June	8	9.05	13,100
1906	Apr.	25-26	3.7	2,420
	May	12	4.7	4,130
		24	6.0	6,700
	June	17	6.75	8,280
	July	17	3.45	2,050
		30	3.1	1,590
1907	Apr.	16	4.5	3,770
	May	2-3	3.3	2,010
		25	6.4	7,540
	June	20	6.94	8,670
	July	3	7.0	8,800
		16	5.65	5,970
		28-29	4.05	3,140
	Aug.	5	3.65	2,520
		16	3.25	1,940
	Sept.	2	3.8	2,750
1908	June	14-15	3.4	2,150
		29	3.0	1,600
1909	Apr.	21	4.05	3,060
		30	3.15	1,800
	May	10	5.2	4,870
		21	5.1	4,710
		29-30	4.1	3,140
	June	10	6.7	7,460
		20	5.2	4,870
	Sept.	10	5.0	4,550
1910	Mar.	26	3.35	2,060
	Apr.	13-15	3.1	1,730
	May	1	5.5	5,360
		16	5.4	5,200
	June	2	4.35	3,530
1911	Apr.	30	3.0	1,520
	May	11	4.8	4,000
		20	3.5	2,130
	June	13	5.9	5,750
		24-25	5.3	4,790
	July	6-7	5.5	5,110
		22	4.9	4,150
	Oct.	10	6.95	7,510
1912	Apr.	11	3.0	1,520
	May	4	3.75	2,460
		10	3.85	2,600
		15	3.75	2,460
		29	7.6	8,680
	June	26	4.95	4,230
1913	June	14	3.25	1,810
1914	May	12		2,500
		25		3,210
	June	5		4,580
		22		3,580
	July	22		1,810
		30-31		1,790
	Oct.	6		1,910
1915	May	1		2,120
		18-19		3,790
		27		1,680
	June	4		2,920
		14		2,780
	June	22		3,140
	July	29		2,780
1916	May	1		2,500
		12		5,910
	June	6		1,880
		13		2,760
		20		2,760
	Aug.	9		2,310
		16		1,770
	Oct.	14		2,900
1917	Apr.	28		2,110
	May	20		4,980
	June	1		1,980
		6		2,370
		20		7,750
1918	June	8		1,510
		15		1,570
1919	Apr.	26-27		4,530
	May	8		4,450
		25		5,090
		31		4,850
1920	May	11		4,220
		27		9,320
	July	1		6,560
1921	May	7		2,580
		18		1,560
	June	16		12,200
	Aug.	27		2,280
1922	May	9		4,220
	June	1		7,220
		13		5,300
1923	May	12		2,550
		28		3,920
	June	9		3,010
		17		3,970
	Aug.	23		1,770
	Sept.	26		2,460
1924	Apr.	9-10		3,680
		16		4,760
		26		4,760
	May	7		5,880
		21		7,380
	June	8		2,000
		17		3,000
1925	May	6		** 922
1926	Apr.	28		1,800
	May	7		2,280
		23		3,230
	June	4		2,830
		8		3,240
1927	May	6		1,820
		20		2,990
	June	20-21		2,980
	July	3		9,580
	Sept.	16		3,900
		28		2,270
1928	May	3		1,770
		12		1,770
	June	1		3,960
1929	May	11		2,140
		17		2,740
		27		3,490
	June	10		2,980
	Aug.	13		3,090
	Sept.	14		1,570
		25		2,570
1930	June	1		1,530
1931	Mar.	22		** 900
1932	May	21		5,020
		24		5,670
	June	17		3,500
		28		5,580
	July	14		1,540
1933	June	3		2,130
1934	Feb.	19		** 582

** Below base

Note.- All discharge quantities are average daily flows.

Rio Grande at and near San Marcial, N. Mex.

Location.- Jan. 25, 1895, to Feb. 10, 1922, in sec. 19, T. 7 S., R. 1 W., at Atchison, Topeka & Santa Fe Railway bridge, about three-quarters of a mile south of San Marcial, Socorro County; Feb. 16, 1922, to Mar. 13, 1932, in sec. 17, T. 7 S., R. 1 W., at highway bridge half a mile northeast of San Marcial and about 1½ miles above former site; thereafter in Pedro Armendaris Grant 34, at new railroad bridge 1.1 miles south of San Marcial and about 0.3 of a mile below first site.
Drainage area.- 27,800 square miles.
Records available.- January 1895 to September 1934.
Sources of data.- Station maintained by U. S. Geological Survey prior to Jan. 1, 1900, and subsequent to Aug. 7, 1928; by American section of International Boundary Commission Jan. 1, 1900, to Mar. 31, 1914; by U. S. Bureau of Reclamation Apr. 1, 1914, to Aug. 7, 1928.
Gage.- Nonrecording gage read to tenths twice daily Jan. 25, 1895, to Feb. 10, 1922, and May 10 to Dec. 28, 1923; recording gage Feb. 16, 1922, to May 9, 1923, and subsequent to Dec. 28, 1923. Zero of gages: Jan. 25, 1895, to Feb. 10, 1922, 4,444.75 feet above mean sea level, U. S. Coast and Geodetic Survey datum; Feb. 16, 1922, to May 9, 1923, 4,461.53 feet; May 10 to Dec. 28, 1923, 4,463.33 feet; Dec. 29, 1923, to Mar. 13, 1932, 4,462.33 feet; thereafter 4,455.38 feet.
Stage-discharge relation.- Control and channel shifts. Discharge determination dependent upon frequent measurements. Ice effect slight.
Diversions.- Water diverted sufficient to irrigate 600,000 acres.
Remarks.- Temporary gage at highway bridge half a mile above San Marcial used June 14 to July 22, 1920; zero of gage was 4,452.33 feet above mean sea level.

Flood stages and discharges
(Base discharge 4,660 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1895	Apr.	23	9.5	7,800
	May	1	9.0	6,260
	June	7-8	8.9	5,960
		13	8.9	5,960
	July	11	9.35	7,340
		25	8.55	4,880
	Aug.	2	9.0	6,260
1896	Apr. 26-May	2	9.0	4,800
	July	21	9.0	4,800
	Oct.	15	11.0	11,300
1897	Apr.	23	9.75	7,020
	May	7	11.2	16,000
		21-22	12.35	21,800
		30	10.8	12,600
	June	14	9.25	7,370
	Sept.	14	8.5	6,050
		26	8.25	5,180
	Oct.	6	9.4	9,100
		10	11.0	15,500
		22	8.4	5,100
1898	Apr.	20	9.9	10,600
		30	10.0	11,300
	July	14	9.3	6,190
		17	10.75	16,800
1899	July	20	9.25	4,660
1900	May	22	9.3	6,250
	June	3	9.5	7,460
	Sept.	10	9.1	8,500
1901	May	5	9.7	5,570
		25	9.7	5,560
	June	2	9.7	4,740
	July	25	9.8	6,600
		31	9.1	4,940
	Aug.	20	9.5	5,860
	Sept.	11	9.65	6,210
1902	Aug.	26	11.1	10,500
1903	Apr.	5	9.9	5,500
	May	18	10.8	8,950
	June	12	12.25	16,500
		18	12.6	18,300
		24	12.4	18,900
1904	Aug.	28	9.8	** 2,260
	Oct.	3	12.7	19,100
		11	13.75	33,000
1905	Mar.	4	9.1	5,620
	Apr.	13	9.95	4,690
		25	11.0	14,200
	May	5	11.5	12,200
		24	13.05	29,100
		26	13.15	28,000
	June	12	12.35	18,500
	June	18	9.7	13,700
1906	Apr.	26	9.95	6,000
	May	2	9.6	5,380
		15	10.3	10,400
		22	10.9	10,800
	June	18	10.6	8,530
	Sept.	28	10.4	9,070
1907	Apr.	21-22	10.6	7,500
	May	28	11.4	11,500
	June	21	11.6	11,700
	Aug.	27	10.2	5,050
	Sept.	1	11.75	10,600
		22	11.05	5,840
1908	Apr.	19	11.2	** 4,070
1909	May	12	12.3	7,180
	June	12-13	12.7	7,890
	Sept.	7	13.3	9,490
1910	May	2	13.25	8,420
		16	12.55	6,390
1911	May	12	13.5	8,100
	June	18	12.9	6,120
	July	4	14.1	8,630
		15	12.85	6,270
		18	12.95	7,720
		21	13.45	11,000
		23	13.45	10,900
	Oct.	7	14.3	11,800
		10	14.0	11,500
1912	May	5	13.0	6,880
		31	14.6	15,300
	June	9	14.0	12,900
1913	June	13	13.0	6,230
	Oct.	5	13.85	5,040
1914	May	12	13.2	5,610
		15	13.2	6,000
		27	12.8	5,790
	June	5	12.85	5,880
	July	19	12.8	5,020
		25	13.45	7,920
		29	13.35	6,130
	Aug.	5	12.95	5,480
1915	Apr.	18	14.2	12,600
		28	12.95	4,970
	May	3	13.8	9,480
		8	12.6	4,980
		21	14.0	10,400
	June	5	13.75	8,100
		16	13.1	5,800
	July	27	14.55	9,000
1916	Mar.	24	14.2	7,110
	Apr.	7		4,800

** Below base

Flood stages and discharges of Rio Grande at and near San Marcial, N. Mex.--Continued

Date	Gage height (feet)	Discharge (second-feet)
1916 May 1		8,320
14		15,100
21-22		6,720
29		6,090
Oct. 15	15.25	11,400
1917 Apr. 29	13.8	5,240
May 22	14.0	9,080
26	13.55	6,430
29	13.4	5,440
June 9	13.55	5,250
23	14.3	8,630
1918 May 12	13.05	** 3,320
1919 Apr. 26	14.85	10,200
28	15.30	12,700
May 9	14.70	9,580
27	14.90	10,800
June 29	12.85	4,890
July 5	13.90	7,840
11	13.10	5,440
16	13.95	8,450
20	14.15	8,250
Aug. 2	14.25	7,600
1920 Feb. 25	13.70	4,840
May 13	15.20	13,200
16	15.0	12,600
May 27-June 4	16.1	22,500
July 2	11.05	8,400
1921 May 9		5,490
June 10		12,700
20	15.9	19,400
July 25		10,900
1922 May 11		10,400
June 4		9,480
15		5,330
1923 May 12		8,110
15		9,450
25		6,960
May 31-June 1		7,810
June 4		5,450
11		5,010
Sept. 3		6,230
1924 Apr. 18		10,000
27-28		12,200
May 18		12,400
1925 Apr. 20		** 3,300
1926 Apr. 30		7,180
May 9		8,550
29	4.5	10,900
June 6		7,080
13		6,420
1927 May 10		7,810
22		6,820
June 19		4,710
July 6		7,440
Aug. 7		5,030
25		4,800
Sept. 14		10,100
21		5,550
1928 May 5	3.90	7,500
13	3.53	6,020
June 4	3.42	5,330
1929 May 13	3.48	5,520
24	4.24	8,240
Aug. 13	6.04	16,300
Sept. 24-27		* 20,000
24	7.80	P 47,000
1930 Apr. 17	3.67	4,850
28	3.75	5,140
July 26	3.56	4,670
26	3.94	P 5,880
1931 Sept. 26		5,930
26	4.07	P 8,130
1932 Apr. 20	5.94	5,730
23	6.13	6,300
23	6.25	P 6,860
May 23	7.27	12,400
23	7.31	P 12,800
July 3	6.42	6,350
Aug. 30		5,070
1933 June 22		16,200
22	8.87	P 20,600
Sept. 14		4,670
14	8.69	P 14,200
1934 Aug. 28	8.35	P 9,910
29		7,210
Sept. 25	7.27	P 7,030

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Rio Grande near El Paso, Tex.

Location.- Original station at Old Fort Bliss, about 1,500 feet above Old Mexican Dam May 10, 1889, to June 30, 1893. Subsequent station established 1½ miles above Old Fort Bliss, 3 miles north of El Paso, El Paso County, Jan. 25, 1895; moved upstream about 1 mile May 1, 1897, to Courchesne lime kiln. Gage moved about 100 feet downstream after Sept. 3, 1925.

Drainage area.- 32,819 square miles (with all closed basins eliminated), according to International Boundary Commission.

Records available.- May 1889 to June 1893; January 1895 to March 1914; August 1914 to December 1933. Gage-height record only January 1895 to December 1896.

Sources of data.- Prior to May 1, 1897, U. S. Geological Survey; May 1, 1897, to Mar. 31, 1914, U. S. section of International Boundary Commission; Aug. 1, 1914, to June 8, 1915, Commission for the Equitable Distribution of the Waters of the Rio Grande; June 9, 1915, to July 31, 1928, gage-height record by U. S. Bureau of Reclamation; discharge record March 1923 to September 1926 by Mexican section of International Boundary Commission; Aug. 1, 1928, to June 30, 1931, U. S. Geological Survey; July 31, 1931, to Dec. 31, 1933, U. S. section of International Boundary Commission.

Gages.- Nonrecording gages during early part of record and recording gage during latter part. Exact date of establishment of recording gage not known, but it was in operation during 1923-24. Gage datum raised 9.00 feet Sept. 26, 1918. Zero of gage (present datum), 3,720.65 feet above mean sea level.

Stage-discharge relation.- Control shifts continually.

Storage, regulation, and diversions.- Considerable diversions. After March 1915 flow almost completely regulated at Elephant Butte Reservoir, which has a capacity of 2,627,000 acre-feet.

Flood stages and discharges of Rio Grande near El Paso, Tex.
(Base discharge 2,400 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1889	May	10-11	7.60	4,700
	June	8	7.50	4,460
		25	6.73	2,570
1890	Apr.	20	7.35	4,110
	May	1	7.30	4,060
	May 29-June 1		8.40	7,200
	June	23	7.10	3,500
	Aug.	29	6.75	2,500
1891	Feb.	25	6.85	2,780
	Mar.	2	7.15	3,640
		9	7.25	3,920
		28	7.5	4,640
	Apr.	13-14	7.25	3,920
		20	8.4	7,200
	May	17	11.6	16,600
	June	19	8.65	7,910
		30	8.15	6,480
	Sept.	29	9.2	9,480
	Oct.	4	6.8	2,640
		8	6.9	2,920
1892	Apr.	23	8.5	7,480
	May	8-9	9.4	10,000
		24	7.95	5,920
	June	1	8.15	6,480
		16	7.05	3,350
	July	13	6.85	2,780
1893	Apr.	16	7.1	3,500
		30	7.0	3,210
	May	5	8.1	6,340
		11-12	6.95	3,070
		25	8.2	6,630
....			....	.....
1895	Apr.	26	10.85	
	May	3-4	9.8	
		26	9.6	
	June	9	10.1	
		16	10.05	
	July	15	12.0	
		27	10.35	
	Aug.	4	10.95	
	Sept.	1	9.55	
1896	July	24	9.6	
	Oct.	17	10.6	
1897	May	10	13.4	8,200
		22	12.8	9,800
		27	15.3	17,000
	June	4	12.6	10,400
		19	10.15	5,450
	July	1	10.3	5,300
	Sept.	16	9.1	2,880
	Oct.	9	10.15	4,000
		13	11.15	5,000
1898	Apr.	24	10.8	4,750
	May	3-4	11.3	5,800
	June	7	9.4	2,420
		11	10.1	3,080
		26	9.8	2,680
	July	6-7	10.6	3,700
		10	9.75	2,700
		12	10.0	3,250
		20	13.65	9,900
1899	July	22-23	9.05	** 1,900
1900	May	25	9.8	2,500
	June	6	10.45	3,550
1901	May	8	10.35	3,100
		29-30	11.0	3,980
	June	6	10.8	3,620
	Aug.	1	10.2	3,070
		23	10.05	2,900
	Sept.	13	10.1	2,650
1902	Aug.	29	9.95	** 2,140
1903	May	20	12.3	5,340
	June	21	14.05	18,100
1904	Sept.	6	6.1	** 655
	Oct.	6	12.75	8,170
		15	13.95	17,100
1905	Mar.	10-12	10.8	4,910
		21-22	10.3	3,170
	Apr.	16	10.85	3,850
		28	13.1	7,700
	May	9	13.5	9,760
		15	12.2	6,680
	June	2	16.1	20,700
		12	14.9	23,700
1906	May	3	9.8	3,700
		18	11.95	7,330
		27	12.5	8,700
	June	22	11.85	6,500
	July	12	9.35	2,590
	Aug.	5	9.8	3,080
	Dec.	5	10.2	3,670
1907	Mar.	28	9.2	2,460
	Apr.	23	11.4	6,460
	May	4	10.4	4,030
	June	1	12.65	9,780
		13	11.9	7,320
		24	13.05	10,800
	July	8-10	11.3	7,650
		31	10.2	4,350
	Aug.	7	9.65	3,000
		25	9.8	2,590
		30	11.15	5,000
	Sept.	3	13.45	10,400
		24	10.9	4,820
1908	Apr.	22	10.6	3,420
	May	8	10.05	2,770
		25	10.3	3,230
1909	Apr.	25-26	11.2	3,780
	May	13	12.5	6,850
		18	12.1	6,350
		25	12.1	5,750
	June	17	12.2	6,430
	Aug.	25	10.15	2,680
	Sept.	9-10	11.75	5,140
		12	11.65	4,880
1910	May	6	12.95	7,720
		22	11.5	5,320
1911	May	4	11.1	3,290
		16	13.05	7,440
	June	5	10.8	3,460
		18	11.85	5,190
		23	10.85	4,100
	July	6	13.75	9,380
		12	13.8	9,550
		18	13.2	9,060
		21	13.0	8,060
		25	14.0	10,200
	Oct.	12-13	14.5	11,800
		20	11.35	4,920
		31	10.8	3,930
1912	Mar.	25	11.55	3,970
	Apr.	12	10.9	3,060
	May	7-8	12.5	5,530
	June	3	15.15	16,000
		30	11.1	5,260
1913	Apr.	27	10.85	3,160
	May	6	10.75	2,860
	June	15	11.6	3,900
1914	Aug.	1	11.5	4,040
		7	11.2	3,980
	Oct.	27		2,820
	Dec.	24		3,410
1915	May	2		2,450
		4		2,710
		24		3,740
	June	10	12.15	4,440
		16	11.6	3,940
		21	11.8	4,040
		30	11.05	2,750
	July	27	10.75	3,380
	July 31-Aug. 1		11.3	2,950
	Aug.	8	11.4	3,060
	Sept.	19	11.05	2,630
1916	May	21	11.3	2,600
		27	11.2	2,500
		31	11.2	2,500
	Oct.	15	13.15	5,300
	Dec.	31	11.18	2,480
1917	July	9	11.55	2,820
		13	11.4	2,560

** Below base

Flood stages and discharges of Rio Grande near El Paso, Tex.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1917	July	26-27	11.3		2,410
		31	11.38		2,520
	Aug.	3	11.35		2,480
1918	Aug.	12	11.25	**	1,900
1919	May	11	3.32	**	2,090
1920	June	6	4.14		2,940
	Aug.	6	3.63		2,760
		15	4.26		3,170
		26	3.45		2,440
1921	June	5	3.60		3,160
	July	31	3.30		2,700
	Aug.	19	4.06		3,110
		22	3.35		2,430
	Sept.	17	3.86		2,780
		26	3.48		2,630
1922	Aug.	21-22	3.38		2,400
1923	Aug.	11	4.08		3,190
		20	3.69		2,690
		27	3.71		3,050
1924	May	5	3.18		2,450
	June	23	3.30		2,500
	July	4	3.75		2,700
		11	3.55		2,850
	Aug.	16	3.52		2,900
		28	3.47		2,690
1925	July	30	4.10		3,600
	Aug.	1	5.80		6,150
	Aug.	11	3.30		2,610
	Sept.	3	7.10		9,160
1926	July	12	4.96		4,910
1927	July	26			3,750
		26	4.94	P	5,350
		29			2,750
	Aug.	6			2,560
		20			2,420
	Sept.	14			2,600
1928	July	22	3.16		2,450
	Aug.	13			2,810
		13	4.40	P	4,060
1929	May	23			2,530
	July	11			3,780
		30			2,790
	Aug.	1			3,190
		11			5,830
		11	6.18	P	6,870
		24			2,840
1930	Aug.	9	3.27	**	2,340
1931	Aug.	3			4,210
		3	5.20	P	4,710
1932	Aug.	31		**	1,990
1933	July	18			4,010
		18	5.78	P	4,940
	Aug.	5			3,550
		5	5.78	P	5,010

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Conejos River near Mogote, Colo.

Location.- Aug. 25, 1899, to Mar. 31, 1900, and Apr. 17, 1903, to Oct. 31, 1905, about 4 miles southwest of Mogote, Conejos County; Apr. 22 to June 21, 1906, and Mar. 21, 1907, to Oct. 5, 1911, at Jacob Ranch, 8 miles above Mogote; Jan. 1, 1912, to Sept. 30, 1934, at Broyles Bridge, in sec. 34, T. 33 N., R. 7 E., about 5 miles west of Mogote and 12 miles west of Antonio. Present site is about 1 mile above first location and 3 miles below second location.

Drainage area.- 282 square miles (at present location).

Records available.- August 1899 to March 1900 (gage-height records only), April 1903 to October 1905; April to June 1906; March 1907 to October 1911, and January 1912 to September 1934. No winter records 1903-4, 1904-5, 1907-8, 1908-9, 1911-12 to 1914-15, 1916-17, 1918-19, 1920, 1922 to 1933-34; gage-height records only 1909-10 and 1910-11.

Sources of data.- Colorado State engineer; collaboration by U. S. Geological Survey prior to October 1913 and subsequent to September 1933.

Gages.- Nonrecording gage prior to 1915; recording gage thereafter.

Stage-discharge relation.- Control shifts at first two sites; fairly permanent at present location. Ice causes backwater.

Diversions.- Court decrees allow for diversions of 66 second-feet above present location.

Flood stages and discharges
(Base discharge 1,800 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1903	May	16-17	3.85	2,020
		28	3.8	1,940
	June	2-3	4.35	2,880
		7	3.0	2,790
		18	4.65	3,380
		27	3.85	2,020
....	....	....	....	.....
1904	Sept.	30	4.0	1,900
....	....	....	....	.....
1905	May	26	4.85	2,760
	June	5	5.65	3,870
		8	5.35	3,440
....	....	....	....	.....
1906	May	21	3.3	2,450
	June	13	3.75	3,290
....	....	....	....	.....
1907	May	22-23	3.05	2,070
	June	6-7	3.0	1,980
		15	3.2	2,330
	July	1	3.45	2,770
		7	3.2	2,330
		14-15	3.25	2,420
1908	June	11	2.9	1,810
1909	May	19	2.9	1,810
	June	6	3.65	3,120
1910	May	12	2.9	1,920

Flood stages and discharges of Conejos River near Mogote, Colo.--Continued

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1910 May 30	2.85	1,840	1922 May 7		2,230
1911 May 8-9	2.8	1,830	28		3,310
25-26	2.8	1,860	June 9		3,240
June 2-3	3.2	2,500	1923 May 10-11		2,280
9	3.5	3,040	20-21		2,280
22	3.0	2,170	27-28		3,240
July 2	3.2	2,500	June 14		2,780
Oct. 5	4.4	# 4,500	27		1,840
....	...	.....	1924 May 21		2,360
1912 May 23	5.15	4,290	June 7		2,020
June 4	4.9	2,790	13		2,360
7	4.8	2,650	1925 May 20		** 1,570
15	4.25	1,920	1926 May 24		2,040
1913 May 26-27	4.5	1,840	June 7		2,320
1914 June 4		2,340	1927 May 18		2,330
13		2,020	June 8		1,920
16		1,840	29		3,130
1915 June 2		1,820	1928 May 31		2,200
12		1,940	1929 May 8-9		2,420
19		2,430	16		2,310
1916 May 10		2,380	21		1,910
June 11		2,960	26		2,310
1917 June 23		2,920	June 5		2,460
1918 June 7		1,850	1930 May 31		1,860
12-13		2,180	1931 June 3		** 1,280
1919 May 30		2,370	1932 May 19		2,740
1920 May 10		2,010	23		2,800
22		3,390	30		2,420
26		3,430	June 16		2,710
June 1		3,830	23		2,350
9		3,940	26		2,440
27		3,390	1933 June 2		2,290
1921 May 31		2,380	11		1,990
June 4		2,480	1934 May 10		** 1,080
15		2,870			

Last day of record; may not be peak
** Below base
Note.- All discharge quantities are average daily flows.

Pecos River near Comstock, Tex.

Location.- At high bridge of Galveston, Harrisburg & San Antonio Railway (now Texas & New Orleans Railroad), 12 miles northwest of Comstock, Val Verde County, 5½ miles above confluence with Rio Grande and below all tributaries.
Drainage area.- 38,283 square miles according to International Boundary Commission.
Period of record.- May 1900 to December 1933.
Sources of data.- U. S. Geological Survey records prior to July 1931; reports of U. S. section of International Boundary Commission thereafter. Station maintained by U. S. section of the International Boundary Commission from May 1900 to Mar. 31, 1914. Jointly maintained by the Commission for the Equitable Distribution of the Water of the Rio Grande, U. S. Bureau of Reclamation, and U. S. Geological Survey from Apr. 1, 1914, to June 30, 1915. Maintained by U. S. Geological Survey July 1, 1915, to June 30, 1931, and by International Boundary Commission thereafter.
Gage.- Nonrecording gage read to hundredths twice daily (sometimes oftener during floods). floods). Zero of gage is 1,059.01 feet above mean sea level.
Stage-discharge relation.- Control shifts continually.
Regulation.- Diversions and storage above station for irrigation. In lower part of basin return waters tend to equalize effects of diversions.
Remarks.- This station was published prior to 1915 as Pecos River near Moorhead.
Historical data.- Maximum stage prior to flood of Sept. 1, 1932, was 35.75 feet on Apr. 6, 1900 (discharge not determined).

Flood stages and discharges
(Base discharge 2,140 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1900 May 21	4.7	3,300	1902 May 18	10.4	11,100
July 17	5.8	4,600	Aug. 4	4.3	2,880
Sept. 23	3.85	2,200	Sept. 5	4.05	2,370
Oct. 29	3.8	2,430	1903 June 29	3.6	2,140
1901 Sept. 8	9.2	9,200	1904 May 29	4.0	2,630
Nov. 15	3.9	2,690	June 7	9.95	4,790

Flood stages and discharges of Pecos River near Comstock, Tex.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1904	June	27	11.45		13,000
	Sept.	7	10.1		10,600
		20	13.6		17,500
	Oct.	23	5.35		5,570
	Nov.	8	3.75		2,700
1905	Mar.	15	5.2		5,220
		20	3.7		2,210
	Apr.	1	6.7		8,950
		23	8.95		14,600
	May	6	3.6		2,430
	June	18	3.5		2,280
	July	9	4.4		2,760
	Aug.	12	5.6		5,530
1906	June	3	4.95		4,340
	Aug.	6	14.6		18,500
		11	23.65		35,600
		27	8.25		8,870
	Dec.	10	2.9	**	880
1907	Nov.	6	4.2		2,880
1908	Apr.	18	7.55		8,020
	July	7	10.8		11,700
1909	Aug.	1	3.4	**	1,780
1910	Sept.	6	19.6		26,000
1911	Feb.	19	5.25		3,560
	Apr.	4	9.3		10,800
	Aug.	6	3.95		2,550
1912	Apr.	7	2.05	**	1,110
1913	Apr.	24	12.35		18,300
	May	4	12.15		17,700
	June	30	4.6		3,600
	July	27	3.4		2,450
	Sept.	26	6.1		5,310
	Nov.	24	5.8		4,330
1914	May	1	8.0		8,310
		23	8.5		9,280
	June	9	6.25		5,380
		17	5.9		4,860
	July	2	5.25		3,980
	Aug.	27	7.7		7,760
	Oct.	23	19.0		36,700
	Nov.	1	8.0		8,310
1915	Apr.	15	4.05		2,740
		22	15.6		27,400
	May	2	6.65		6,310
		11	4.00		2,830
	Sept.	16	5.95		5,120
1916	Sept.	1	33.0	P	
		2	11.20		14,800
1917	May	12	2.02	**	1,100
1918	June	8	4.82		3,950
	Aug.	15	6.37		6,290
		15	6.90	P	7,140
1919	Mar.	25	3.40		2,270
	Apr.	4	4.46		3,400
		9	3.32		2,200
	May	8	3.88		2,740
		12	3.34		2,220
	June	26	3.64		2,500
	July	29	6.30		6,000
	Sept.	16	21.25		51,800
		16	30.00	P	
	Sept.	22	17.05		35,200
		29	5.70		5,080
	Oct.	4	5.8		5,220
		11	3.3		2,180
		20	4.2		3,090
1920	Aug.	22	5.4		4,660
1921	June	13	8.4		9,800
		13	12.8	P	18,500
		19	5.3		4,520
		29	5.2		4,380
1922	Apr.	3	8.4		9,800
		25	5.0		4,100
		27	4.5		3,450
	May	1	7.2		7,530
	June	18	19.2		43,600
		18	27.16	P	
1923	Sept.	17	1.60	**	800
1924	Sept.	21	9.80	P	12,800
		22	5.40		4,520
1925	May	28	23.6	P	65,000
		29	16.40		32,800
	June	25	3.40		2,230
	Aug.	1			5,820
1926	June	8	3.54		2,430
	July	23			2,210
		23	5.2	P	4,380
	Oct.	15			2,580
1927	Apr.	7			2,520
	June	13			2,740
		13	10.60	P	14,600
1928	May	3			3,320
		13			12,100
		13	12.47		19,800
	July	27			5,630
	Aug.	20			2,180
	Sept.	22			3,190
1929	June	30		**	1,690
	Oct.	14			2,140
		14	6.53	P	6,320
1930	Oct.	6			6,150
		14			12,400
		14	12.6	P	20,100
1931	Apr.	29			2,740
		29	7.80		8,620
	May	18			2,620
		18	6.10	P	5,680
1932	May	12			2,490
		12	6.25	P	5,630
	June	28			2,360
		28	6.30	P	6,020
	Sept.	1			57,900
		1	38.25	P	102,000
		7			8,310
		16			2,630
		22			8,240
		24			6,170
		29			7,960
	Oct.	16			6,220
		16	6.50	P	6,360
1933	Oct.	14			2,460
		14	5.25	P	4,500

** Below base

<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Part 9. Colorado River Basin

Colorado River at Glenwood Springs, Colo.

Location.- In sec. 9, T. 6 S., R. 8 W., at Glenwood Springs, Garfield County, half a mile above Roaring Fork.
Drainage area.- 4,560 square miles.
Records available.- January 1900 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths twice daily prior to May 10, 1910; recording gage thereafter. Zero of gages is 5,720.71 feet above mean sea level.
Stage-discharge relation.- Control shifts occasionally at high water. Banks overflow at extreme stages.
Storage, regulation, and diversion.- A few small reservoirs above station. Irrigation and transmountain diversions amount to about 260,000 acre-feet annually.
Remarks.- A station was maintained just above Roaring Fork May 12 to July 17, 1899, but record was affected by backwater from that stream.

Flood stages and discharges
(Base discharge 11,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1900	May	12-13	8.1		11,200
		30-31	10.15		19,700
	June	9	9.4		17,600
1901	May	22	10.15		19,700
		28-29	9.35		16,400
	June	10-11	8.2		12,000
		24-25	8.2		12,000
1902	May	16	8.2		12,000
1903	May	17	8.2		11,400
	June	8-10	8.8		13,900
		18	9.4		16,500
1904	May	25	9.3		16,100
		31	8.7		13,500
	June	14	8.7		13,500
		25	8.8		13,900
1905	May	24	8.6		13,300
	June	5-6	10.7		22,100
1906	May	23	9.2		15,700
		30	8.7		13,500
	June	7	8.7		13,500
		14	10.7		22,100
1907	May	23-24	9.1		15,200
	June	8	9.4		16,500
		17	10.3		20,400
	July	15	8.2		11,500
1908	June	12	8.2		11,500
1909	May	23-24	8.3		11,100
		30	8.2		11,100
	June	9-10	11.2		24,300
		21	12.0		27,300
1910	June	1	8.8		14,300
1911	May	19	8.2		11,600
	June	8-10	9.0		15,200
		16	8.5		13,000
1912	May	27	9.6		17,700
	June	9	12.0		29,700
		29	10.1		20,200
1913	June	1	8.5		12,100
1914	June	3	12.0		29,700
		14-15	10.5		22,200
1915	June	12-13	8.1		11,200
		21	8.5		13,000
		21	8.6	P	13,400
1916	May	11	8.4		12,600
	June	6	8.3		12,200
		14	8.9		14,600
		14	8.95	P	14,800
1917	May	19	9.1		15,200
	June	19	12.2		28,600
		19	12.4	P	29,400
1918	May	25-27	8.9		14,400
	June	14-15	12.4		29,400
		14, 15	12.55	P	30,100
1919	May	29-30	8.40		12,300
1920	June	1	11.1		23,800
		1	11.2	P	24,300
		9-10	10.8		22,500
1921	June	15-16	12.0		27,700
		15	12.3	P	29,000
1922	May	29-30	9.20		15,700
	June	9	9.20		15,700
		10	9.3	P	16,100
1923	May	28-29	9.20		15,700
	June	17	10.20		20,000
		17	10.3	P	20,400
1924	May	19	8.20		11,700
		28	8.10		11,300
	June	8	9.30		16,100
		15-16	11.00		23,400
		15	11.25	P	24,500
1925	May	31	8.00		11,000
		31	8.06	P	11,200
1926	May	6	8.00		11,000
		26	9.50		17,000
	June	7			22,700
	July	8	8.00		11,000
1927	May	22-23	9.70		17,800
		22	9.8	P	18,400
	June	11	8.86		14,400
		28-29	8.10		11,300
1928	May	11	9.19		15,700
		31	11.75		27,000
		31	11.88	P	27,400
	June	18-19	8.13		11,300
		30	8.36		12,400
1929	May	26	9.90		18,700
	June	10	10.45		20,800
		10	10.54	P	21,400
		23	8.70		13,600
1930	June	1	9.08		15,200
		1	9.17	P	15,500
		13-14	8.75		14,000
1931	June	8	7.59	†	9,240
1932	May	24	9.28		15,800
		24	9.64 6	P	17,300
	June	17	8.57		13,200
		25-26	8.28		12,100
1933	June	7	10.14		19,300
		13	10.32		20,200
		13	10.44	P	20,600
1934	May	13	7.06	†	8,010

† Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Colorado River at Yuma, Ariz.

Location.- Prior to Nov. 11, 1933, 1,000 feet below highway bridge at Yuma, Yuma County, and 5 miles below Gila River; thereafter, 1,800 feet below highway bridge at Yuma.
Drainage area.- 244,800 square miles.
Records available.- April 1878 to September 1934. Gage-height records only prior to January 1902. Mean monthly record only in 1902 and 1903.
Sources of data.- Gage-height records by Southern Pacific Railroad Co. prior to Jan. 1, 1902; records by U. S. Geological Survey January 1902 to December 1906 and July 21, 1928, to September 1934; records furnished by U. S. Bureau of Reclamation January 1907 to July 20, 1928.
Gages.- Nonrecording gage read daily or oftener prior to May 1, 1922; recording gage thereafter. Zero of gages is 102.79 feet above mean sea level.
Stage-discharge relation.- Control shifts. Owing to unstable stream bed, discharges for peak gage heights are not always peak discharges for given flood.
Storage, regulation, and diversion.- Many storage reservoirs on tributaries. Most important reservoirs are: Roosevelt on Salt River (capacity, 1,305,000 acre-feet in 1908 and 1,637,000 acre-feet in 1924); Horse Mesa on Salt River (capacity, 245,000 acre-feet), completed in 1927; San Carlos on Gila River (capacity, 1,165,000 acre-feet), completed in 1928; Boulder on Colorado River, in which storage began February 1935. Last-named reservoir will completely control floods on main river above Yuma. Many diversions, increasing throughout period of record. Since April 1913 increasing quantities of water have been diverted around gaging station for power development and returned to river below; records do not include these latter diversions.

Flood stages and discharges
(Base discharge 51,200 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1902	May	26	24.5		59,200
	June	11	24.3		56,200
1903	May	25	25.60		56,400
	June	29	27.60		72,200
1904	June	7	26.00		51,200
1905	Feb.	9	28.75		82,800
		22	25.85		54,700
	Mar.	3-4	26.70		70,200
		20	30.30		111,000
	Apr.	15	29.65		97,500
	May	11	26.30		52,000
	June	19	29.15		94,300
	Nov.	30	31.3		103,000
1906	Mar.	16	27.55		66,700
		29	27.95		75,000
	June	5	28.30		92,400
		27	28.10		99,200
	Dec.	7	25.30		60,000
1907	Mar.	8	27.0		68,700
	June	6	28.90		87,100
		27-30	28.70		115,000
	Aug.	3	23.30		61,900
1908	June	26	25.3		61,700
	Dec.	19	26.25		72,500
1909	May	20	26.2		70,400
	June	24	30.75		150,000
	Aug.	24	21.0		54,100
	Sept.	4	21.25		66,200
		13	23.7		93,200
1910	Jan.	5	22.95		67,500
	May	7	22.8		66,000
		24	23.0		70,300
	June	12	23.45		69,400
1911	May	20	23.9		64,200
		28	23.3		59,100
	June	24	25.85		78,300
	July	10	22.2		54,600
		30	22.75		56,100
	Oct.	14	24.1		60,200
1912	June	22	29.05		144,000
	July	9	23.45		65,200
1913	June	10	22.7		62,500
1914	June	14-15	28.95		137,000
1915	Feb.	3	25.8		90,000
	May	8	24.0		66,200
		27	21.85		51,300
	June	13	21.9		51,300
	June	30	21.75		57,800
1916	Jan.	22	33.2	*	240,000
		31	30.4	*	177,000
	Mar.	29	23.55		68,400
	May	24	25.00		74,800
	June	24	24.00		72,200
	Oct.	18	25.25		68,500
1917	Apr.	20	25.35		69,900
	May	7	22.75		53,700
	June	2	26.35		95,200
	July	4	29.05		143,000
1918	July	3	23.65		94,300
1919	June	6	23.25		57,600
	Nov.	30	26.50		82,600
1920	Feb.	25	31.50		165,000
	June	8	30.35		190,000
1921	May	28	24.80		68,000
	June	28	31.05		186,000
	Aug.	29	23.70		61,300
1922	May	18	24.70		76,000
	June	10	27.26		115,000
		19-21	25.19		110,000
1923	May	21	23.57		67,600
	June	8	25.35		100,000
		26	24.20		93,000
	Sept.	24	24.08		57,700
	Dec.	30	22.99		53,900
1924	May	31	23.92		60,700
	June	24	24.13		65,300
		24	24.3	P	66,500
1925	June	8	23.40		52,900
		8	23.45	P	53,200
1926	May	16	25.13		57,800
	June	16	25.18		73,100
1927	Feb.	20	27.25		81,200
		21	29.4	P	92,400
	May	15	25.15		58,700
	June	2	26.72		74,100
		25	25.62		65,100
	July	9	27.29		77,200
	Sept.	20	26.15		72,800
1928	May	23	26.21		71,900
	June	13	28.23		98,800
		13	28.3	P	99,400
1929	June	7	26.98		88,900
		7	27.26	P	91,000
		19	25.86		87,600

*Estimated

Flood stages and discharges of Colorado River at Yuma, Ariz.--Continued

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1929 Aug. 8	22.70	52,400	June 5	28.33	89,100
1930 June 9	25.03	55,600	5	28.56	P 90,800
9	25.16	P 54,500	July 7	24.83	62,000
21	23.91	53,000	1933 June 23	25.82	68,600
1931 June 16	22.06	** 26,900	23	26.10	P 70,700
1932 Feb. 16	25.82	52,900	1934 May 20	20.90	** 22,300

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Green River at Green River and Little Valley near Green River, Utah

Location.- Oct. 21, 1894, to Oct. 14, 1899, and Feb. 16, 1905, to Dec. 1, 1910, in SW¼ sec. 15, T. 21 S., R. 16 E., at Denver & Rio Grande Western Railroad bridge 1 mile southeast of Green River, Emery County; Dec. 2, 1910, to Dec. 31, 1911, and June 21, 1924, to Sept. 30, 1934, at highway bridge about 200 feet upstream; Dec. 18, 1910, to Nov. 6, 1914, in SW¼ sec. 5, T. 22 S., R. 16 E., at ferry at Little Valley near Green River, about 6 miles below first location; Nov. 7, 1914, to June 20, 1924, in sec. 4, about 1 mile above ferry.

Drainage area.- 40,600 square miles.

Records available.- October 1894 to October 1899, February 1905 to September 1934.

Sources of data.- U. S. Geological Survey. Cooperation with Utah Power & Light Co. Dec. 16, 1917, to June 30, 1927.

Gages.- Nonrecording gages prior to Nov. 7, 1914, and June 21 to Sept. 18, 1924; recording gages Nov. 7, 1914, to June 20, 1924, and subsequent to Sept. 18, 1924. Datum lowered about 1.7 feet when gage was reinstalled Feb. 16, 1905. Gage at highway bridge set Dec. 2, 1910, to read same as railroad bridge gage. Datum ofgage at Little Valley lowered 1.00 foot Oct. 22, 1922.

Stage-discharge relation.- Affected by ice. Control shifts. Bank-full stage at Green River, about 12 feet.

Regulation and diversions.- Storage capacity in Strawberry and other reservoirs probably does not exceed 350,000 acre-feet capacity. Diversions for irrigation of 230,000 acres in 1902 have increased to a present estimate of about 600,000 acres.

Remarks.- Early records published as at Blake and at Elgin. Gage heights not evaluated Oct. 1, 1897, to Oct. 14, 1899, because accuracy of rating table is questionable. Record at Little Valley not used prior to Jan. 1, 1912.

Flood stages and discharges
(Base discharge 19,200 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1895 May 2-3	6.9	19,800	June 3	9.8	21,300
19-20	7.7	26,300	1911 June 21	11.40	27,600
1896 June 3-4	9.65	43,500	1912 June 12	11.9	54,600
1897 May 13	9.95	46,800	June 29-July 2	8.4	28,800
29	11.4	67,300	1913 May 17	6.7	20,600
29	11.5	P 68,800	June 2-5	7.9	26,700
June 13	7.8	24,400	30	7.0	22,000
1898 June 4	7.0		1914 Apr. 27	6.5	19,600
25	7.9		May 1	6.5	19,600
1899 May 18-19	7.75		June 2	11.7	50,800
June 27	10.3		1915 June 14	6.08	19,200
....	.....		1916 May 2	6.9	22,800
1905 May 28	9.2	24,200	12-14	8.4	30,300
June 10	10.55	33,900	13	8.48	P 30,800
1906 Mar. 28	8.85	21,800	25	6.2	19,400
June 9-10	11.65	42,100	June 15-17	7.6	26,200
27	9.65	27,400	1917 Apr. 30	7.0	24,100
1907 Apr. 20	9.3	24,900	May 24-25	10.6	44,500
May 28	12.2	42,900	June 27	14.3	66,700
June 11	12.9	48,100	27	14.53	P 68,100
July 8-9	12.2	42,900	1918 June 25-26	10.4	43,300
1908 June 20-21	9.7	25,000	26	10.47	P 43,700
1909 Mar. 24	11.15	33,000	1919 May 30-June 2	6.20	19,900
May 15	10.2	26,400	June 1	6.27	P 20,200
27	11.1	32,700	1920 June 3	11.39	49,100
June 13	15.15	62,200	3	11.43	P 49,400
25	13.55	50,400	1921 May 11	7.77	29,200
1910 Mar. 10	9.6	22,400	21	8.72	34,100
May 2	10.35	27,500	June 16-17	14.07	64,100
16	10.55	28,800	17	14.12	P 65,500

Flood stages and discharges of
Green River at Green River and Little Valley near Green River, Utah--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1922	May	11	8.25		31,000	1927	Sept.	14	10.85		27,500
	June	1	10.7		45,600	1928	May	5	10.9		27,100
		12	10.75		45,800			15	12.55		40,300
		12	10.80	P	46,200			31	13.1	P	44,700
1923	May	14	9.07		29,700		June	1	13.05		44,400
		31	11.1		42,000	1929	Mar.	12	10.45		23,200
	June	16	10.40		37,800		Apr.	23	9.95		21,200
1924	Apr.	12	7.43		21,600		May	13	10.00		21,500
	May	22	7.92		24,300			29	12.90		41,900
		22	8.00	P	24,700			30	13.0	P	42,300
1925	May	26-27			20,100		June	14-15	11.92		33,900
		26	10.04	P	20,600	1930	June	4	10.20		22,500
	June	4			20,100			4	10.25	P	22,800
1926	May	9	10.38		24,000			17	9.90		20,600
		26	10.60		23,900	1931	May	21	8.60	**	12,800
		26	10.67	P	24,500	1932	May	26	12.15		36,600
1927	May	6	10.08		22,600			27	12.40	P	38,200
		11	10.14		23,000		June	29	10.75		26,200
		21	11.47		31,400	1933	June	16	11.20		27,400
	June	19	11.50		32,700			16	11.23	P	27,700
		28	13.20	P	46,300	1934	May	17	7.34	**	6,260
		29	11.23		30,500						

** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Duchesne River at Myton, Utah

Location.- In NW¼ sec. 25, T. 3 S., R. 2 W. Uinta meridian, at Myton, Duchesne county, 3 miles below mouth of Lake Fork.
Drainage area.- 2,750 square miles.
Records available.- October 1899 to July 1906, April 1907 to November 1910, July 1911 to September 1934. Prior to winter of 1911-12 no record during ice periods.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths twice daily prior to Feb. 25, 1922; to half-tenths once daily and sometimes oftener Feb. 25, 1922, to Oct. 14, 1933; recording gage thereafter. Subsequent to winter of 1910-11 gage read three times a week when river was frozen over. Sunday readings frequently omitted during seasons of low flow. Gages used prior to July 9, 1909, were set to same datum; subsequent gages set to new datum; relation between two datums not determined.
Stage-discharge relation. Affected by ice. Control shifts at high stages. Banks do not overflow.
Storage and diversion.- Storage in Strawberry Valley Reservoir (capacity, 250,000 acre-feet) since July 1912; water stored is diverted out of basin. Diversions for irrigation throughout period of record.
Remarks.- Record for June, July, and August 1925 fragmentary but believed to cover flows essential to this record. Published prior to 1906 as at Price road bridge, the site one quarter of a mile downstream from present location abandoned July 9, 1909.

Flood stages and discharges
(Base discharge 1,180 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1900	May	19	7.55	2,640		June	9	9.00	5,150
		28	9.35	5,880			14	8.45	4,160
1901	Apr.	27	6.49	1,190			21	7.60	2,720
	May	13	6.94	1,610		July	2-3	7.20	2,150
		20	9.45	6,680	...	...	...	....	.....
		27-28	8.65	4,790	1906	Apr.	24-25	6.90	1,770
1902	Apr.	20	6.64	1,360			30	6.80	1,650
	May	18	7.63	2,570		May	13	8.35	3,980
		31	9.20	5,820			24	8.90	4,970
	June	10	8.45	4,100			29	8.52	4,290
1903	May	17	7.47	2,300		June	6	8.50	4,250
	June	9	8.70	4,750			14	10.15	7,320
	July	17	6.34	1,180		July	2	8.28	3,850
1904	May	2	6.45	1,250	...	...	...	.....	.....
		25	9.50	6,080	1907	Apr.	17	7.65	2,650
	June	2	8.55	4,340			29	7.58	2,550
		12-13	8.85	4,880		May	13-14	7.85	2,940
	Aug.	30	7.15	2,080			23-24	9.40	6,000
1905	May	23	7.25	2,220		June	7	9.70	6,780

Flood stages and discharges of Duchesne River at Myton, Utah--Continued

Date			Gage height (feet)		Discharge (second-feet)
1907	June	22	9.52		6,300
	July	6	10.65		9,560
		26	8.30		3,660
	Sept.	1	6.65		1,400
		6-7	6.50		1,230
1908	Apr.	22	6.85		1,550
	May	4	6.75		1,310
		9	6.95		1,490
		20-21	6.8		1,280
		27	7.0		1,450
	June	1	6.85		1,240
		15	9.25		4,670
		22	8.55		3,300
	July	30	6.6		1,340
	Aug.	1	7.5		2,440
		23	6.55		1,280
1909	Apr.	29	7.0		1,480
	May	12	8.4		3,220
		23-24	8.8		4,000
		29	9.0		4,430
	June	6	10.35	#	8,080
.....	.....	.....	.....		.....
	July	10	7.15	#	3,270
		28	6.7		2,550
	Aug.	23	6.25		1,890
	Sept.	1	7.15		3,270
		7-8	6.4		2,100
1910	Mar.	12	6.5	#	2,240
		23-24	5.7		1,200
	Apr.	29	7.85		4,540
	May	12	8.3		5,440
		25	7.45		3,790
	May 30-June	1	8.0		4,840
	June	30	5.8		1,320
.....	.....	.....	.....		.....
1911	Sept.	28	2.8	**	770
1912	May	22	4.15		2,270
	June	2	5.6		4,330
		8	6.85		6,320
		24	5.15		3,810
1913	Mar.	31	3.2		1,300
	May	13-15	3.8		2,050
		20	3.8		2,050
		26	5.2		3,880
	June	28	5.4		4,160
	Sept.	9	3.4		1,530
1914	Apr.	22	3.3		1,410
	May	24-25	6.2		5,340
	June	3	6.8		6,240
		14-15	5.6		4,440
	July	11	3.3		1,410
		21	3.4		1,530
1915	May	1	3.24		1,360
		19	3.79		1,940
	June	2	4.96		3,360
		12	5.26		3,770
		18	5.06		3,490
1916	Mar.	21	3.3		1,410
	Apr.	29	4.08		2,200
	May	10	5.10		3,540
	June	1	4.92		3,280
		6	5.55		4,280
		11	5.70		4,560
	Oct.	11	3.3		1,410
1917	Apr.	25	3.4		1,500
		27	3.4		1,500
	May	18-19	4.4		2,560
		24	4.6		2,820
	June	1	4.3		2,440
		11	5.7		4,570
		20	7.4		7,690
	July	31	3.5		1,800
1918	May	27	3.2		1,420
	June	10-11	5.6		4,590
		10	5.7	P	4,790
	July	11	2.95		1,190
		13	3.5		1,710

Date			Gage height (feet)		Discharge (second-feet)
1919	May	6	3.48		1,610
		21	4.88		3,380
		21	5.0	P	3,560
		29	4.82		3,290
	June	7	3.08		1,220
1920	June	1	6.05		5,570
		1	6.1	P	5,690
		7	6.05		5,570
		22	4.35		2,640
	Aug.	1	3.21		1,340
1921	Mar.	2	3.22		1,340
	May	7	3.6		1,710
		18	4.3		2,530
		31	5.5		4,450
	June	12	7.75		9,350
		12, 13	7.8	P	9,470
		23	6.25		5,960
	July	18	3.6		1,710
		24	3.4		1,510
	Aug.	22	3.5		1,610
1922	May	9	5.40		4,260
		27	6.75		7,040
	June	10	7.51		8,770
		10	7.94	P	12,800
		19	6.69		6,910
1923	May	12	4.79		2,880
		22	5.54		3,850
		27	6.40		5,440
	June	13	6.93		7,120
		27	5.30		3,520
	July	11	4.00		1,960
		23	3.40		1,300
1924	May	19	4.92		3,030
1925	May	22	4.26		2,250
		22	4.35	P	2,350
		25	4.09		2,060
	June	5			1,200
		11			1,500
		22	3.98		1,940
	July	3	3.78		1,500
	Aug.	29	3.62		1,200
1926	May	6	3.78		1,660
		21	5.34		3,570
	June	2	4.90		3,000
1927	May	8-9	3.46		1,310
		18-19	5.39		3,640
		28-29	3.81		1,690
	June	10	5.28		3,490
		14	4.96		3,080
		19	4.71		2,770
		28	4.82		2,900
	July	5	4.36		2,350
	Sept.	10	6.50		5,700
		17	4.16		2,110
		25	3.98		1,900
1928	May	3	3.95		1,860
		12	4.95		3,060
		30	6.1		4,780
1929	May	25	4.85		2,940
	June	3	3.65		1,520
		9	4.80		2,880
		16	5.55		3,750
		23	4.55		2,440
	Aug.	6	3.55		1,340
	Sept.	3	3.93		1,730
1930	May	31	5.30		3,400
	June	12	5.90		4,270
1931	May	18	3.38		1,180
1932	May	23	5.25		3,750
	June	7	4.25		2,270
		17	5.20		3,370
		24	5.50		3,740
	July	18	3.70		1,430
.....	.....	.....	....		.....
1933	June	3-4	4.50		2,480
		12	4.47		2,440
1934	May	9	2.40	**	451

** Below base
# At beginning or end of break in record; may not be peak.

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: July 23 to Sept. 23, 1905; June 7 to July 9, 1909; Jan. 1 to Mar. 19, 1933.

Gila River at Kelvin, Ariz.

Location.- Prior to June 15, 1914, in SE¼ sec. 2, T. 4 S., R. 13 E., unsurveyed, half a mile below Mineral Creek and five-eighths of a mile below Kelvin, Pinal County; thereafter in NW¼ sec. 12, T. 4 S., R. 13 E., unsurveyed, 1,000 feet below Mineral Creek, 1,350 feet below highway bridge at Kelvin, 15 miles below San Pedro River, and 19 miles above Ashurst-Hayden Dam.
Drainage area.- 18,260 square miles.
Records available.- January 1911 to September 1934.
Source of data.- U. S. Geological Survey
Gages.- Nonrecording gage read to half-tenths twice daily prior to June 15, 1914; recording gage thereafter. Nonrecording and recording gages set to different datums.
Stage-discharge relation.- Control shifts at low and medium stages but is fairly permanent at high stage. Banks do not overflow.
Regulation and diversions.- Regulation of Gila River at San Carlos Reservoir after 1928. Increasing diversions above San Carlos throughout period of record.

Flood stages and discharges
(Base discharge 3,450 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1911	Mar.	7-8	8.0	6,100
	July	26	9.8	11,900
	Sept.	15	7.2	3,930
	Oct.	7	7.25	3,880
1912	Mar.	12	15.5	32,900
	July	25	9.5	10,800
		30	8.2	6,690
	Aug.	31	7.85	5,670
1913	Feb.	27	5.7	3,450
1914	July	20	3.40	3,800
		22	3.80	4,310
		26	3.40	3,800
		29	3.30	3,560
		31	3.40	3,800
	Aug.	19	4.60	7,550
		23	3.50	4,050
	Sept.	21	3.70	4,050
	Oct.	6	5.1	8,800
	Nov.	13	3.9	3,700
	Dec.	20-21	13.4	49,600
		24	14.0	55,000
1915	Jan.	31	12.3	40,400
	Feb.	12	4.6	4,930
		21	8.0	15,600
	Mar.	24	4.65	5,040
		27	4.7	5,360
	Apr.	1	4.9	6,250
		8	5.3	8,090
		18-19	3.9	3,690
	July	27	6.5	9,750
1916	Jan.	20	17.8	105,000
		20	19.5	P 132,000
		29	9.9	24,500
	Mar.	2	5.1	5,120
		24	4.85	4,440
	Oct.	15	11.83	36,800
		15	14.0	P 55,000
1917	Jan.	22	6.97	10,500
....			.....	......
1918	Aug.	6	7.9	P 15,100
		7	5.3	5,340
1919	July	6	4.52	5,180
		16	6.63	12,600
		28	4.32	4,260
	Aug.	4	6.90	11,400
	Aug.	3	9.23	P 20,800
	Dec.	5	6.25	8,500
		5	10.3	P 25,800
1920	Feb.	11	6.3	8,680
		21	6.1	8,600
1921	July	28	5.75	6,710
	Aug.	2		13,000
		9-10		6,000
		22	8.0	15,500
1922	Aug.	22	3.75	** 1,390
1923	July	14	5.0	4,800
		14	6.9	P 11,700
		23	6.2	8,480
	Aug.	10	6.0	8,200
		14	5.65	7,000
		16	5.55	6,720
	Dec.	29	6.65	10,700
		29	6.9	P 11,700
1924	Apr.	10	4.02	** 2,600
1925	Sept.	4	6.47	9,640
		4	6.9	P 11,200
1926	Mar.	30	4.64	4,250
	Apr.	7	5.17	5,620
	Sept.	28	11.04	36,600
		28	16.2	P 82,000
1927	Feb.	17	5.14	4,770
		18	6.09	P 8,350
	Sept.	13	4.84	3,960
1928	Aug.	2-3	5.0	4,500
		2	7.05	P 12,000
		28	4.62	3,790
1929	Sept.	24	5.30	5,410
		24	7.22	P 11,600
1930	Aug.	8	8.43	18,400
		8	12.6	P 42,800
1931	Feb.	16	5.29	4,020
	Aug.	10	5.72	5,410
		30	5.91	7,670
		30	10.6	P 28,600
	Oct.	2	4.80	3,580
		2	7.5	P 12,800
1932	Feb.	10	5.02	** 3,400
1933	July	24	4.50	** 2,570
1934	Sept.	23	4.05	** 1,620

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Verde River above Camp Creek, near McDowell, Ariz.

Location.- Prior to Feb. 17, 1925, at dam site on Salt River Indian Reservation, three-quarters of a mile above junction with Salt River and 5½ miles below McDowell, Maricopa County; Feb. 17, 1925, to Apr. 30, 1934, in sec. 17, T. 5 N., R. 7 E., 500 feet above mouth of Camp Creek and 10 miles north of McDowell; thereafter in sec. 16, T. 5 N., R. 7 E., half a mile above Camp Creek.
Drainage area.- 6,230 square miles at present station.
Records available.- August to September 1889, January 1895 to July 1896, April 1897 to November 1899, January 1901 to April 1902, July 1902, January 1903 to September 1934. Gage-height records in 1902. Mean monthly records only January 1910 to December 1912.
Sources of data.- U. S. Geological Survey records prior to January 1907 and subsequent to April 1934; records furnished by U. S. Reclamation Service January 1907 to September 1917 and by Salt River Valley Water Users' Association October 1917 to April 1934.
Gages.- A number of nonrecording gages prior to Feb. 17, 1925, and recording gages thereafter, all set to different datums.
Stage-discharge relation.- Control at all stations shifts.
Diversions.- Some diversions above first station for irrigation on Salt River Indian Reservation; minor diversions above subsequent stations.
Remarks.- Records for August and September 1889 and January 1895 to July 1896 not used because of unreliable rating.

Flood discharges
(Base discharge 5,000 second-feet)

Date				Discharge (second-feet)
1897	Sept.	11		5,000
1898	July	16	**	1,890
1899	Oct.	12	**	3,770
....				.....
1901	Feb.	23		6,610
....				.....
1902	July	25		1,200
....				.....
1903	Mar.	27-28		7,000
	Apr.	2		20,000
1904	July	27		5,600
		31		6,030
1905	Jan.	11		10,100
	Feb.	4-5		33,000
		18		9,770
		24		12,200
	Mar.	1		25,100
		14		25,500
		17		29,400
	Apr.	12		32,100
	Sept.	30		5,350
	Nov.	27		61,500
1906	Mar.	14		31,300
		27		30,400
	Dec.	4		15,400
		29		12,300
1907	Jan.	12		6,450
		31		15,200
	Feb.	24		8,040
	Mar.	6		32,200
		23		7,120
1908	Feb.	4		14,400
	Mar.	6		11,000
	Dec.	16		51,600
1909	Jan.	15		6,800
		24		7,000
	Mar.	29		5,050
....				......
1913	Apr.	2		5,710
1914	Jan.	29		6,700
	Feb.	23		17,100
1915	Jan.	30		15,700
	Feb.	22		6,640
	May	2		5,720
1916	Jan.	19		53,400
		29		22,600
	Feb.	29		5,000
	Mar.	24		18,500
	Sept.	10		20,700
1917	Jan.	21		15,200
	Feb.	27		6,750
	Apr.	18		26,600
		24		15,200
		30		7,250
1918	Feb.	26		8,950
	Mar.	9		29,800
		14		54,300
1919	Apr.	2		5,400
	July	16		7,350
		20		7,440
	Aug.	3		5,020
	Nov.	28		40,800
	Deo.	6		10,900
		9		5,790
1920	Jan.	6		12,100
	Feb.	9		20,100
	Feb.	23		48,200
	Mar.	5		5,300
1921	Aug.	2		7,170
		22		6,600
	Dec.	28		15,400
1922	Jan.	4		21,800
	Feb.	12		12,200
	Mar.	18		17,800
	Dec.	16		7,020
1923	Mar.	5		5,
	Sept.	19		25,300
	Nov.	12		6,820
	Dec.	28		40,800
		31		13,400
1924	Apr.	9	**	4,710
1925	Sept.	18		11,000
		20		6,190
1926	Apr.	7		27,500
		11		12,700
1927	Feb.	17		48,200
	Mar.	1		5,410
	Sept.	13		18,200
1928	Feb.	6		8,020
1929	Apr.	6		16,800
1930	Mar.	23	**	4,700
1931	Feb.	15		22,600
1932	Feb.	11		41,500
		20		5,850
	Mar.	3		7,550
		21		6,350
1933	Mar.	14	**	1,490
1934	Aug.	31	**	1,320

** Below base
Note.- All discharge quantities are average daily flows.

Weber River near Oakley, Utah

Location.- Prior to Oct. 26, 1933, in SW¼NE¼ sec. 15, T. 1 S., R. 6 E., near mouth of canyon, 2 miles below South Fork of Weber River, 3 miles northeast of Oakley, and 6 miles above Beaver or Kamas Creek; thereafter a quarter of a mile upstream.
Drainage area.- 163 square miles.
Records available.- October 1904 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths once daily prior to Aug. 1, 1924; to quarter-tenths Aug. 1, 1924, to Oct. 25, 1933; recording gage thereafter. Winter readings taken once a week prior to 1927. Nonrecording and recording gages set to different datums.
Stage-discharge relation.- Seriously affected by ice. Control practically permanent.
Regulation.- Some regulation after 1925; no material effect on flood flows.

Flood stages and discharges
(Base discharge 1,230 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1905	June	8	7.0	1,580
1906	May	24	6.6	1,230
		28	6.7	1,310
	June	13	8.0	2,480
		16	7.7	2,210
1907	May	22	7.0	1,850
	June	7	7.3	2,230
		12	6.8	1,620
		22	7.4	2,360
	July	6	8.5	4,010
1908	June	15	7.5	2,490
		22	6.7	1,510
		28	7.4	2,360
1909	May	28	6.8	1,620
	June	5-7	8.5	4,010
		18	8.0	3,220
		24-25	7.5	2,490
1910	May	11-12	6.4	1,330
	June	1	6.9	1,790
1911	June	6	7.0	1,890
		13	7.3	2,220
1912	May	30	6.6	1,510
	June	9	8.4	3,850
		13	7.3	2,220
		24	6.8	1,690
1913	May	26	6.8	1,690
		30	6.5	1,420
1914	May	23-24	7.3	2,210
	June	3	7.4	2,310
		14	6.8	1,700
1915	June	11	6.3	1,230
1916	May	9	6.3	1,240
	June	1	6.3	1,240
		6	6.7	1,620
		10-11	6.9	1,830
		13	7.0	1,940
1917	June	10	7.0	1,940
		18	8.0	2,760
		22	8.0	2,620
	July	7	7.0	1,580
1918	June	14	7.6	2,110
1919	May	29	7.0	1,580
1920	May	22	7.3	1,850
		25	7.3	1,850
		30-31	7.5	2,040
	June	8-9	7.8	2,340
1921	May	30	7.5	2,000
	June	13	9.0	3,480
		23	7.3	1,820
1922	May	26	7.4	1,700
	June	8-9	8.3	2,540
		14	7.8	2,060
		19	7.7	1,970
1923	May	21-22	6.9	1,290
		27	7.5	1,790
	June	12-13	7.8	2,060
1924	May	19	6.9	1,290
1925	May	21-22	6.9	1,290
		28-29	6.9	1,290
1926	May	21	7.3	1,610
1927	May	17-18	7.3	1,610
	June	9	7.5	1,790
		18-19	7.3	1,610
1928	May	9	7.0	1,370
		22	7.1	1,450
		29	7.7	1,970
1929	May	25	7.20	1,710
	June	8	7.05	1,560
		15	7.05	1,560
		22-23	7.00	1,510
1930	May	30	7.00	1,510
	June	8	6.80	1,330
1931	May	17	6.40	** 990
1932	May	22	7.10	1,600
		30	6.90	1,400
	June	6	6.90	1,400
		15	7.70	2,200
		23-24	7.10	1,600
1933	June	2-3	7.10	1,600
		14	7.70	2,200
1934	May	8-9	2.83	** 608

** Below base
Note.- All discharge quantities are average daily flows.

Weber River at Devils Slide, Utah

<u>Location</u>.- In $SW\frac{1}{4}$ sec. 19, T. 4 N., R. 4 E., 500 feet below highway bridge at Devils Slide and a quarter of a mile below Lost Creek.
<u>Drainage area</u>.- 1,090 square miles.
<u>Records available</u>.- February 1905 to September 1934.
<u>Source of data</u>.- U. S. Geological Survey.
<u>Gage</u>.- Nonrecording gage read to half or quarter-tenths once daily prior to 1917; to hundredths once daily thereafter. Gage datum changed several times since original installation. Exact dates and amounts not known, but changes thought to be small.
<u>Stage-discharge relation</u>.- Affected by ice. Control shifts occasionally.
<u>Regulation and diversions</u>.- Numerous small diversions above station for irrigation and domestic use. Flow regulated by storage in Echo Reservoir after 1930.
<u>Remarks</u>.- Early records published as Weber River near Croydon. Automatic gage installed 1 3/4 miles downstream to be used after Sept. 30, 1934.

Flood stages and discharges
(Base discharge 1,240 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1905	June	5	3.6		1,340
		8-10	3.9		1,650
1906	Apr.	24	3.55		1,300
	May	11-12	4.1		1,820
		25	4.3		2,020
		29	5.3		2,940
	June	6	5.0		2,730
		14	5.4		3,150
		29	3.5		1,260
1907	Mar.	21	4.7		2,430
	Apr.	5-6	3.7		1,440
		15	5.6		3,570
		28	4.5		2,220
	May	12-13	5.0		2,760
		22-23	6.3		4,620
	June	4	5.5		3,420
		10	5.7		3,150
		22-24	5.1		2,440
	July	6	5.4		2,790
1908	June	18	4.8		2,110
		25-28	4.2		1,550
1909	Apr.	18-20	4.9		2,220
		28	5.6		3,060
	May	5	5.8		3,340
		11	6.6		4,490
		15	5.8		3,340
		23	6.2		3,900
		28	7.0		5,120
	June	3-8	7.0		5,120
		18-19	6.0		3,620
		22	5.5		2,930
1910	Mar.	16-21	4.20		1,550
	Apr.	16	5.10		2,440
		28	5.20		2,550
	May	12-14	4.80		1,790
1911	Jan.	31	5.2		2,270
	Mar.	11	4.5		1,600
	May	7-9	4.5		1,600
	June	15	5.00		2,070
1912	May	20-21	5.6		3,090
		25	5		2,230
		30	5.5		2,930
	June	9	6.08		3,910
		24	4.25		1,380
1913	Apr.	2	5.1		2,460
		30	4.5		1,750
	May	12	4.2		1,450
		26	4.4		1,650
		29	4.3		1,550
	June	28-29	4.4		1,650
1914	Apr.	16	4.8		2,080
		21	4.8		2,080
	May	10	5.5		3,000
		24	5.8		3,420
	June	4	5.3		2,740
		14	4.5		1,750
		20	4.3		1,550
1915	June	2	4.02		1,270
		6	4.02		1,270
	June	11	4.20		1,430
1916	Mar.	21	5.6		2,910
		21	5.65	P	2,970
		23	4.8		1,970
	Apr.	11	4.4		1,530
		18	4.6		1,750
		29	5.6		2,910
		29	5.65	P	2,970
	May	7	5.6		2,910
		7	5.65	P	2,970
	June	11	4.8		1,970
1917	Apr.	12	4.2		1,330
		26	5.4		2,670
	May	16	6.6		4,120
		16	6.65	P	4,190
		30	6.0		3,220
	June	11	6.2		3,480
		19	6.3		3,610
1918	June	15	5.2		2,280
1919	May	30	4.60		1,630
1920	Apr.	10	4.38		1,410
	May	11	5.65		2,800
		22-23			5,500
		22	8.0	P	6,000
	June	8-9	5.40		2,500
1921	Mar.	19	4.65		1,800
	Apr.	5	4.42		1,610
		14	4.54		1,710
		23	4.25		1,460
	May	7	5.95		2,980
		17	6.78		3,810
		30	6.35		3,380
	June	7	6.58		3,610
		23	4.64		1,800
1922	Apr.	30	5.36		2,500
	May	8	7.01		4,140
		21	6.65		3,780
		26	6.75		3,880
1923	Apr.	19	4.46		1,690
		30	4.50		1,730
	May	11	6.45		3,580
		21	6.35		3,480
	June	13	5.29		2,300
		27	4.40		1,500
1924	May	19	4.01		1,360
1925	May	22	4.23		1,580
1926	May	6	3.98		1,260
		21	4.35		1,600
1927	May	1	4.90		2,180
		18	5.43		2,730
		28-29	4.11		1,420
	June	10	4.65		1,930
		15	4.68		1,960
1928	May	2	5.10		2,380
		13		*	2,800
		29		*	2,400
1929	May	26	6.36		2,740
	June	1	5.17		1,560
		8	5.33		1,710

* Estimated

Flood stages and discharges of Weber River at Devils Slide, Utah--Continued

Date			Gage height (feet)	Discharge (second-feet)		Date			Gage height (feet)	Discharge (second-feet)
1929	June	17	5.92	2,300			May	30	3.52	1,760
		23	5.22	1,610			June	16	3.12	1,400
1930	Apr.	25	2.93	1,240				21	3.14	1,420
	Nov.	25-26	1.81	** 462		1933	June	2	3.58	1,780
1931	May	18	1.69	** 399				12	3.46	1,670
1932	May	16	4.26	2,440		1934	Apr.	23-25	1.86	** 406

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Provo River at Forks, Utah

Location.- Prior to Oct. 5, 1915, in SW$\frac{1}{4}$NE$\frac{1}{4}$ sec. 26, T. 5 S., R. 3 E., at Forks, about 600 feet above mouth of South Fork of Provo River and about 1 mile below mouth of North Fork; Oct. 5, 1915, to July 21, 1920, in NW$\frac{1}{4}$ sec. 25, about 2,500 feet above first location; July 22, 1920, to June 2, 1931, in sec. 26, near highway bridge, about 400 feet above South Fork, and about half a mile below second location; June 3, 1931, to Nov. 12, 1933, about 300 feet downstream from third location; Nov. 13, 1933, to Sept. 30, 1934, in NW$\frac{1}{4}$ sec. 25, a quarter of a mile below North Fork and about 3,000 feet above fourth location.
Drainage area.- 600 square miles.
Records available.- November 1911 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to hundredths once daily prior to Nov. 13, 1933; recording gage thereafter.
Stage-discharge relation.- Seldom affected by ice; control shifts.
Regulation and diversions.- Slight regulation and small diversions upstream. Some diversions into basin in later years.

Flood stages and discharges
(Base discharge 1,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)		Date			Gage height (feet)	Discharge (second-feet)
1912	May	31	3.81	1,900			June	11	6.03	3,060
	June	7	4.03	2,110				11	6.13	P 3,180
1913	Apr.	2	2.90	1,090			Dec.	20	3.75	1,070
		30	3.00	1,160		1922	Apr.	29	4.35	1,500
1914	Apr.	16	2.6	1,000			May	8	5.08	2,200
		21-23	2.7	1,060				26	5.55	2,580
	May	11	3.2	1,260			June	9	4.95	1,880
		24	3.9	1,760		1923	Apr.	19	3.85	1,210
		29	3.4	1,400			May	11	4.88	2,060
	June	4	3.7	1,610				21	5.00	2,170
1915	June	2	2.20	** 714				27	5.18	2,330
1916	Mar.	21	4.40	* 1,820				27	5.30	P 2,440
	Apr.	29	* 2.91	1,140			June	6	3.97	1,260
	May	10	3.22	1,280				12	4.60	1,800
	June	10	2.98	1,180		1924	May	18	3.43	** 800
1917	Apr.	26	3.3	1,420		1925	May	22	3.26	** 695
	May	16-17	3.9	1,810		1926	May	21	4.28	1,190
	June	11	4.3	2,090		1927	May	1-2	4.50	1,380
		19	4.8	2,450				18	5.25	1,880
	July	8	2.6	1,020				18	5.35	P 1,960
1918	June	11	3.0	1,240			June	10	4.35	1,290
		11	3.12	P 1,310				15	4.10	1,140
1919	May	23	2.79	1,110		1928	May	3	4.04	1,120
		23	3.00	P 1,240				10-11	4.87	1,640
		30	2.74	1,080				15	4.96	1,700
1920	May	11	3.00	1,140				23	4.67	1,500
		22	4.90	2,300				29	4.62	1,470
		31	4.80	2,230		1929	May	26	4.72	1,510
	June	9	3.78	1,570			June	8	3.95	1,050
1921	Mar.	19	4.08	1,090				17	4.65	1,470
	May	6	4.42	1,340		1930	May	30-31	3.96	1,000
		18	4.93	1,810				30, 31	4.15	P 1,100
	June	1	5.68	2,640		1931	May	18	2.66	** 364

* Estimated
** Below base

Flood stages and discharges of Provo River at Forks, Utah--Continued

Date			Gage height (feet)		Discharge (second-feet)
1932	May	22-23	4.56		1,680
		23	4.88	P	1,860
		30	3.20		1,000
	June	6	3.62		1,210
	June	16	3.83		1,320
1933	June	4	3.92		1,370
		12	3.48		1,150
1934	Feb.	24	2.45	**	247

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

West Walker River near Coleville, Calif.

Location.- In sec. 28, T. 8 N., R. 23 E., below Rock Creek (Ross Canyon) at head of Antelope Valley, 5 miles southeast of Coleville and 10 miles below East Fork. Location changed about a quarter to a half mile each time station was reestablished but always remained in sec. 28.
Drainage area.- 245 square miles.
Records available.- October 1902 to July 1908, March 1909 to August 1910, June 1915 to September 1934.
Sources of data.- U. S. Geological Survey except records from March 1909 to August 1910, which were kept by Stone & Webster Engineering Corporation.
Gages.- Nonrecording gage read to tenths once or twice daily prior to June 18, 1915; recording gage thereafter. Datum was changed each time gage was reestablished and on Aug. 14, 1919. Relation between datums not known.
Stage-discharge relation.- Affected by ice. Control shifts.
Regulation and diversions.- Slight regulation. Station above all but one small diversion.

Flood stages and discharges
(Base discharge 1,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1903	May	7-8	3.40		1,020
		13	4.00		1,880
	June	1	4.10		2,030
		9	4.10		2,030
		20-22	3.60		1,300
		25-27	3.70		1,450
1904	May	13	3.90		1,160
		19	3.90		1,160
		25	4.90		2,100
		30-31	4.00		1,240
	June	6	4.30		1,500
		15	4.20		1,400
	July	10-12	3.70		1,020
1905	June	13-14	3.9		1,160
		20	3.9		1,160
1906	May	9-11	4.1		1,650
		19-21	3.8		1,320
	June	5	3.7		1,220
		12-13	5.2		2,970
		16	5.35		3,160
		20	5.25		3,040
		25	5.15		2,900
	July	3-4	5.45		3,300
		23	4.4		1,990
1907	Mar.	19	4.1		1,590
	May	19	4.1		1,590
	June	4	5.45		3,500
	July	3	6.9		4,170
		28	4.45		2,040
1908	June	13	3.4		1,050
.....	.....	.....	....		.....
1909	May	8			1,160
		21			1,160
		27-28			1,080
	June	4-5			2,220
		12			1,770
		15			2,040
	June	23			1,950
		30			1,680
	July	3-4			1,860
		12-13			1,080
1910	Apr.	28-29			1,320
	May	19			1,500
		25			1,680
	June	1			1,680
		7			1,320
		10-11			1,320
	July	18			1,240
.....	.....	.....			.....
1915	June	19	4.65		1,140
		23	4.7		1,170
	June	29-July 1	4.7		1,170
	July	11	4.55		1,060
1916	May	5-6	4.6		1,140
	June	16-17	5.1		1,560
		17	5.4		1,830
		26	4.9		1,380
	July	5-8	4.45		1,020
1917	June	10	5.4		1,960
		17		*	2,200
		17	5.75	P	2,400
1918	June	14	5.62		2,110
		14	5.77	P	2,280
		21	4.93		1,440
1919	May	29		*	1,960
		29	5.6	P	2,180
1920	May	18	4.62	P	1,500
		21	4.52		1,410
		30	4.35		1,260
	June	8	4.31		1,220
		11, 13	4.27		1,190
		21	4.14		1,070
1921	May	15	4.42		1,320
		27	4.45		1,340

* Estimated

Flood stages and discharges of West Walker River near Coleville, Calif.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1921	June	8	5.02		1,900
		11-12	5.28		2,190
		12	5.74		2,710
		22	4.64		1,520
	July	2	4.16		1,100
1922	May	7	4.49		1,180
		18	4.87		1,530
		25	4.90		1,560
	June	5	5.62		2,290
		5	5.95	P	2,640
		20	5.23		1,930
		26	5.45		2,180
	July	5	4.73		1,490
1923	May	10	4.13		1,100
		17	4.61		1,420
		25	4.51		1,360
	June	11	4.82		1,570
		11	5.10	P	1,770
	July	2	4.40		1,280
1924	May	9-10	3.69	**	711
1925	May	6	4.47		1,270
		27	4.75		1,490
		27	4.95	P	1,660
	June	13	4.4		1,210
		25	4.55		1,330
		29	4.36		1,280
1926	May	4	4.20		1,050
		20	4.34		1,160
	May	20	4.67	P	1,430
1927	May	17	5.01		1,720
		26	4.31		1,140
	June	7	5.05		1,760
		16	5.3		2,000
		16	5.7	P	2,350
	July	2	4.30		1,130
1928	May	21	4.13		1,000
		25	4.49		1,280
		26	4.74	P	1,480
1929	May	24	4.28		1,110
	June	16	4.25		1,090
		16	4.60	P	1,370
1930	May	28	4.14		1,010
	June	7	4.45		1,250
		12	4.54		1,320
		12	4.70	P	1,450
1931	May	6	3.73	**	743
1932	May	18	4.56		1,230
		27	4.44		1,150
	June	12, 14	4.67		1,310
		22	5.07		1,600
		26	5.15		1,660
		26	5.60	P	2,020
1933	May	31	4.30		1,130
	June	14	5.45	P	2,120
		15	4.90		1,620
1934	June	18	3.53	**	595

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Humboldt River near Oreana, Nev.

Location.- Jan. 27, 1896, to Sept. 7, 1897, Sept. 7, 1910, to Feb. 23, 1914, Aug. 23 to Oct. 3, 1914, at highway bridge near Oreana, Pershing County; Sept. 8, 1897, to Dec. 31, 1909, about 1½ miles above bridge; Feb. 24 to Aug. 22, 1914, Oct. 4, 1914, to Sept. 30, 1932, in sec. 2, T. 28 N., R. 32 E., 2 miles above bridge and 2 miles southwest of Oreana.

Drainage area.- 13,800 square miles.

Records available.- January 1896 to June 1898, June 1899 to December 1909, September 1910 to September 1922, September 1924 to September 1928, March 1930 to September 1932.

Gages.- Nonrecording gages read to tenths or half-tenths once daily prior to Feb. 24, 1914, and Aug. 23 to Oct. 3, 1914; recording gage Feb. 24 to Aug. 22, 1914, and after Oct. 3, 1914. Datum lowered 2.0 feet Oct. 1, 1904. Relation between datums at various locations not determined.

Stage-discharge relation.- Considerably affected by ice; control shifts.

Regulation and diversions.- Many diversions for irrigation. Regulation at reservoir upstream.

Flood stages and discharges
(Base discharge 300 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1896	May	24	4.90	
	July	10	7.65	
1897	May	12	12.00	3,050
1898	Mar.	9-10	4.60	642
.....	.....	.....	.....	.....
1899	July	18-21	5.00	2,400
	Dec.	24-26	2.60	561
1900	Mar.	7-12	2.10	316
	July	6	2.20	351
1901	Feb.	15	3.00	604
	Mar.	17	5.10	2,620
	Apr.	7	3.60	986
	May	4-6	2.80	511
1902	July	1	2.20	333
		9	2.70	511
1903	Apr.	16-21	2.40	458
	June	30	2.70	580
1904	Apr.	12-16	3.20	698
	May	2-3	4.00	950
	June	18	3.55	806
		30	3.45	774
1905	Jan.	1	3.9	440
	Feb.	12	3.45	322
		17	3.4	310
		21	3.75	398
		26	3.75	398
	Mar.	1	3.75	398
		12	3.45	322
	July	10	3.45	322
1906	Mar.	26	3.5	335
	Apr.	20	5.5	855
	May	12-14	5.9	995
		21	5.5	856
	June	6	5.95	1,010

Flood stages and discharges of Humboldt River near Oreana, Nev.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1906	June	9	4.5	530
		14	4.5	530
		23	5.4	820
		26	5.5	855
	July	1-2	5.5	855
		14-16	5.5	855
1907	Feb.	3-4	4.0	395
	May	4-5	8.75	2,220
		31	6.7	1,220
	July	11-12	8.55	1,760
		17	8.50	1,740
	Aug.	6	6.5	980
	Sept.	1	4.05	320
1908	Feb.	12-14	3.8	305
	Mar.	15	4.1	390
		28-29	4.0	375
	July	15	4.7	670
		27	4.4	580
1909	Feb.	5-6	4.5	610
	Apr.	3-5	4.7	640
		28-29	4.75	540
	May	22	4.2	462
	July	1-2	5.0	680
	Aug.	2-3	3.75	332
.....	.....	.....	....	.....
1911	Apr.	13-16	6.65	760
	May	21-22	4.4	322
	July	13	4.75	421
1912	May	8	4.5	348
		13	4.3	317
	June	6	4.8	436
	July	8	6.6	1,240
	Aug.	4	4.45	359
1913	Mar.	18	4.5	348
		25	4.4	322
	Apr.	1-2	4.35	309
		21	4.45	335
	June	30	5.0	522
	July	23	6.5	1,270
	Aug.	4	4.35	381
		12	4.45	407
		30	4.5	420
	Dec.	4	4.6	310
1914	Jan.	30-31	5.4	644
	Feb.	5	5.6	726
		11-12	6.1	970
	Apr.	4	6.5	1,690
	May	2-3	7.0	2,000
	June	30-July 1	6.2	1,520
1915	May	1	2.63	318
1916	Mar.	25	2.90	383
	Apr.	21	4.35	768
	May	2	4.42	788
		29	3.20	459
1917	Apr.	7	3.0	403
	May	16	5.2	1,100
	June	6-8	7.1	1,900
.....	.....	.....	....	.....
1918	Apr.	16	2.52	** 291
1919	Apr.	20	3.68	585
		24	3.38	502
		29	3.40	507
	May	18	2.81	357
		29		550
		29	5.65	P 1,280
1920	May	18	1.61	** 120
1921	Apr.	8	4.40	895
	May	10	4.64	979
	July	2	6.85	1,960
		2	6.89	P 1,980
1922	Feb.	19-28		* 350
	May	27	7.47	2,260
		27	7.50	P 2,280
.....	.....	.....	....	.....
1925	May	10	3.02	412
	June	14	3.54	567
		30	3.56	573
	July	15	3.37	# 513
.....	.....	.....	....	.....
1927	June	16	3.01	361
		25	2.80	309
	July	7	2.89	331
		19	2.87	326
.....	.....	.....	....	.....
1928	Apr.	13-14	3.31	495
		12, 13, 14	3.32	P 498
.....	.....	.....	....	.....
1930	May	6	1.75	** 136
1931	May	6-7	2.06	** 113
1932	June	10	4.18	692
		24	4.18	692
	July	18	4.25	716

* Estimated
** Below base
\# Last reading before a break in record; may not be peak.

<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: June 28 to Sept. 26, 1917; Nov. 1, 1924, to Feb. 19, 1925; Aug. 15 to Oct. 28, 1927. Fragmentary record: July 2, 1925, to Mar. 7, 1927.

South Fork of Humboldt River near Elko, Nev.

Location.- Prior to Feb. 26, 1907, several gages at slightly different sites near highway bridge about 6 miles above mouth of river and about 10 miles southwest of Elko, Elko County; Feb. 26, 1907, to Nov. 13, 1913, about a quarter of a mile above bridge; Nov. 14, 1913, to Mar. 2, 1927, in sec. 19, T. 33 N., R. 55 E., at head of canyon 1½ miles below highway bridge; thereafter in sec. 30, half a mile below bridge and about 1 mile upstream from last location.
Drainage area.- 1,150 square miles.
Records available.- August 1896 to September 1932.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths or half-tenths once daily prior to Nov. 14, 1913; recording gage Nov. 14, 1913, to Mar. 2, 1927; nonrecording gage read to hundredths twice daily thereafter.
Stage-discharge relation.- Considerably affected by ice. Control shifts.
Diversions.- Diversions for irrigation upstream.
Remarks.- Gage-height records not published because of frequent changes in location and datum of gages.

Flood discharges
(Base discharge 388 second-feet)

Date	Discharge (second-feet)
1897 Mar. 29	641
Apr. 20	1,020
May 7	1,170
25	1,330
June 9	760
1898 Feb. 16	434
May 19	434
29	460
June 18	473
1899 Mar. 25-26	469
Apr. 12-18	529
May 15-16	454
June 21	1,370
1900 May 31 -	
June 2	710
June 10	740
1901 Feb. 18-20	1,480
May 16-18	619
June 5-8	589
1902 Apr. 20-23	499
May 17	649
30-31	831
June 13-14	1,380
1903 Mar. 11-14	559
Mar. 29 -	
Apr. 1	410
May 14-16	469
June 11-13	1,170
1904 May 26	1,180
July 21	391
Aug. 15	526
1905 May 18-20	640
June 17	816
July 6	592
1906 May 10-12	480
June 16-24	1,400
1907 Apr. 16	698
May 13	514
22	732
June 8	1,260
18	1,220
July 5	1,170
26	470

Date	Discharge (second-feet)
1908 June 17	850
July 5	487
1909 Jan. 14	* 600
June 7-8	1,090
16-17	752
....	.....
1911 June 14	856
1912 May 21	698
June 9	1,470
14	1,470
1913 May 26-30	632
June 12	568
28-30	418
1914 Jan. 22	800
26	2,400
26	P* 4,000
28	886
Mar. 2	584
Apr. 11	415
16	396
24	418
May 11	566
25	948
June 3	1,240
20	756
1915 June 2	** 341
1916 June 18	388
18	P 438
1917 Mar. 28	P 1,700
29	1,450
Apr. 9	528
May 16	517
20	448
27	826
June 11	777
19	1,000
1918 June 21	** 297
....	.....
1919 May 5	** 365
....	.....
1920 May 23	411
31	411
June 10	418
....	.....

Date	Discharge (second-feet)
1921 Apr. 17	418
24	446
May 23	2,040
24	P 2,070
June 9-10	1,650
25	688
....	.....
1922 Apr. 28	620
May 8	692
21	708
26	612
June 7	1,050
15	720
....	.....
1924 May 18	430
18	P 470
1925 May 7-8	422
20	690
30	678
June 6	815
22	686
30	602
July 4	526
4	P 1,470
1926 May 22	** 218
1927 Feb. 20	393
May 17-18	622
20	1,160
June 13-14	778
1928 May 27	1,370
June 13	657
1929 Mar. 5	442
8	467
June 17	1,410
17	P 1,440
23	406
1930 May 29-30	475
June 12-14	475
1931 Mar. 9-10	** 48
1932 Mar. 12	1,380
Apr. 3	712
May 22	1,010
June 7	1,080
16	1,490
24	* 1,200

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Jan. 1 to Sept. 8, 1910; Oct. 17, 1918, to Mar. 2, 1919; Dec. 1, 1919, to May 9, 1920; Feb. 1 to Mar. 31, 1921; Dec. 1, 1921, to Mar. 27, 1922; Oct. 1, 1922, to Sept. 30, 1923.

Part 11. Pacific slope basins in California

San Gabriel River and Azusa (Southern California Edison Co.'s.) Canal near Azusa, Calif.

Location.- In $NW\frac{1}{4}$ sec. 23, T. 1 N., R. 10 W., 1 mile above Southern California Edison Co.'s power house and 2 miles north of Azusa, Los Angeles County.

Drainage area.- 214 square miles.

Records available.- Combined daily discharge October 1905 to September 1934; complete monthly summaries of combined discharge since October 1895.

Sources of data.- Records of diversions through canal furnished by Southern California Edison Co. (Pacific Light & Power Corporation prior to 1917) prior to October 1933 and by city of Pasadena thereafter; records at river station by U. S. Geological Survey.

Gages.- For flow in river, nonrecording gage read to hundredths at least once daily prior to Oct. 1, 1916; to hundredths twice daily Oct. 1, 1916, to October 1917; recording gage thereafter except Dec. 19, 1921, to Aug. 22, 1922, when temporary nonrecording gages were used. Owing to frequent channel changes, many temporary gages were used and were not to same datum.

Stage-discharge relation.- At river station the control shifts at high stages; at power plant control formed by two weirs accurately calibrated.

Storage, regulation, and diversions.- Average daily discharge records in this report are the combined flow of San Gabriel River and diversions of Azusa Canal, which heads 5 miles above river station. Momentary peak discharges are for river only and do not include diversions in canal. Beginning in 1934, water was diverted above station from Morris Reservoir through Azusa Canal for City of Pasadena; total diversions, 4,760 acre-feet May-October 1934. Evaporation from Morris Reservoir, 691 acre-feet January-October 1934.

Flood discharges
(Base discharge 330 second-feet)

Date	Discharge (second-feet)
1906 Jan. 19	430
Mar. 12	8,020
17	2,270
26	9,430
Apr. 28	426
May 28	1,110
1907 Jan. 10	4,670
30	896
Feb. 5-6	1,040
17-18	1,190
22	1,190
Mar. 5	6,810
21	* 2,320
26	* 2,370
1908 Jan. 25	1,240
Feb. 4	766
1909 Jan. 22	4,080
27	455
Feb. 7	7,100
13	2,760
Mar. 21	1,500
27	777
Apr. 4	710
Dec. 9	1,500
1910 Jan. 1	12,500
21	525
1911 Jan. 10	1,110
15	1,510
25	1,140
29	5,260
31	4,220
Feb. 4	3,250
Mar. 4	2,540
10	9,160
Apr. 3	763
19	449
May 14	400
1912 Mar. 6	1,240
10	3,020
Apr. 11	723
20	458
1913 Feb. 25	1,960
1914 Jan. 18	5,110
Jan. 26	9,150
Feb. 20	11,800
Mar. 30	425
Apr. 5	420
1915 Jan. 29	1,430
29	P 2,770
Feb. 2	1,080
10	1,190
20	530
24	480
Mar. 1	480
May 1-14	360
1916 Jan. 10	820
18	22,300
18	P 40,000
27	7,940
Feb. 27	1,010
Mar. 5	700
20	845
Oct. 2	410
Dec. 24	3,990
1917 Feb. 22	680
25	820
1918 Feb. 22	1,670
Mar. 7	4,210
7	P 8,680
11	5,030
1919 Mar. 21	** 146
1920 Feb. 22	1,610
Mar. 2	2,400
2	P 3,750
22	1,820
26	926
Apr. 5	636
1921 Jan. 18	340
Mar. 14	2,120
14	P 4,000
May 22	1,160
Dec. 19	16,900
19	P22,300
27	5,900
1922 Jan. 2	3,310
30	628
Feb. 9	8,200
20	1,620
Mar. 17	1,020
Apr. 25-26	498
May 9	600
Nov. 9	373
Dec. 13	2,330
13	P 3,670
1923 Jan. 30	** 199
1924 Mar. 26	P 510
27	332
1925 Apr. 4	668
4	P 3,000
1926 Feb. 13	806
Apr. 5	4,570
7	P14,900
8	5,530
18	710
Nov. 27	395
1927 Feb. 16	11,400
16	P18,200
Mar. 3	538
9	456
1928 Feb. 4	754
4	P 1,810
1929 Mar. 10	379
10	P 895
Apr. 5	492
1930 Mar. 15	476
15	P 586
May 4	421
1931 Feb. 5	446
Apr. 26	681
26	P 1,450
Dec. 28	984
1932 Feb. 9	5,910
9	P 7,500
29	620
1933 Jan. 19	1,690
19	P 5,820
1934 Jan. 1	2,380
1	P 6,120

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak); see Storage, regulation, and diversions, above.

Arroyo Seco near Soledad, Calif.

Location.- In sec. 21, T. 19 S., R. 6 E., half a mile below Vaquero Creek and 11 miles south of Soledad, Monterey County, since Apr. 30, 1901; from Jan. 1 to Apr. 30, 1901, at a point 4 miles upstream.
Drainage area.- 238 square miles.
Records available.- January 1901 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to hundredths once daily (oftener during flood periods) prior to June 16, 1929; recording gage thereafter. Datum unchanged at location used November 1901 to September 1934. Gage at original station set to independent datum.
Stage-discharge relation.- Control shifts at high water. Left bank wooded and overflows at about 10-foot stage.
Diversions.- Few small diversions above station.
Remarks.- Frequent periods of little or no flow, sometimes continuing two or three months. Gage washed out in flood of February 1915, leaving station without gage for 15 days. Record January-November 1901 too unreliable and fragmentary for publication in this report. Discharge records prior to Jan. 9, 1909, revised from previously published figures.

Flood stages and discharges
(Base discharge 1,040 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1902	Feb.	22	8.8		2,160
		25-26	9.1		2,430
		25	11.7	P	4,970
	Mar.	2	8.7		2,070
		8	8.3		1,710
	Apr.	7	8.1		1,540
1903	Jan.	28	8.6		1,870
	Apr.	1	9.9		3,120
		1	10.6	P	3,820
1904	Feb.	16	8.40		1,560
	Mar.	10	8.15		1,360
		23	8.50		1,640
	Apr.	18	8.00		1,240
1905	Feb.	2	8.60		1,520
		17	8.5		1,450
	Mar.	13	10.1		2,570
		16	8.0		1,230
		19	9.1		2,120
	May	7	7.9		1,150
1906	Jan.	13	8.18		1,390
		19	10.12		3,020
	Mar.	4	8.45		1,720
		12	11.3		4,530
		13	11.92	P	5,190
		15	10.1		3,320
		21	7.95		1,300
		23	8.94		2,130
		26	9.00		2,220
		31	9.08		2,320
	May	27	8.3		1,590
		27	11.4	P	4,640
	Dec.	11	13.0	*	6,500
1907	Jan.	9	10.2		3,420
		9-10	10.10		3,320
		17	8.4		1,680
		28	9.1		2,320
	Mar.	5	7.9		1,270
		10	8.6		1,860
		19	11.85		5,080
		19	12.0	P	5,300
		23	12.00		5,300
1908	Jan.	26	7.6		1,070
	Feb.	2	9.15		2,370
1909	Jan.	8	10.0	P	3,220
		9	7.9		1,270
		14	11.2		4,340
		21	13.0		6,150
		26	12.4		5,460
		30	8.2		1,390
	Feb.	3	10.3		3,200
		7	8.9		1,940
		12	12.3		5,340
	Mar.	29	7.75		1,080
	Dec.	8	9.25		2,220
1910	Jan.	1	8.15		1,360
	Mar.	21	8.7		1,780
1911	Jan.	14	11.85		4,850
		24	7.70		1,050
		29	12.75		5,910
	Mar.	3	11.50		4,460
		7	18.30		13,300
1912	Mar.	12	7.2		1,080
1913	Jan.	15		**	925
1914	Jan.	1	13.0		6,480
		13	10.5		3,980
		18	13.8		7,740
		25	17.9		13,300
	Feb.	20	13.2		6,970
1915	Jan.	30	8.5		2,770
	Feb.	2	10.0		4,180
		9		*	5,500
		17		*	4,000
		24		*	1,400
	Mar.	28	7.0		2,110
1916	Jan.	3	9.5		6,390
		10	6.38		1,720
		14	6.20		1,560
		17	15.15		18,800
		17	15.3	P	19,100
		21	6.85		2,090
		25	7.2		2,550
		28	6.9		2,190
	Feb.	5	7.6		3,120
	Mar.	5	6.60		1,900
	Dec.	24	10.75		8,960
1917	Feb.	21	11.88		11,300
		21	16.5	P	22,000
		25	11.4		10,200
1918	Feb.	22	6.03		1,420
	Mar.	7	5.8		1,300
		12	9.4		6,200
1919	Feb.	11	9.15		5,820
		26	5.72		1,240
	Dec.	11	5.80		1,300
		11	7.0	P	2,300
1920	Apr.	16	5.40		1,060
1921	Jan.	18	7.90		3,600
		27	6.60		1,900
		30	8.5		4,590
		30	12.0	P	11,500
	Mar.	13	5.40		1,060
	Dec.	24	9.50		6,390
		27	8.10		3,920
1922	Feb.	9	12.9		13,500
		9	15.8	P	20,300
		11	12.0		11,500
		20	6.00		1,420
		24	6.00		1,420
	Nov.	9	5.80		1,300
	Dec.	10	6.62		1,880

* Estimated
** Below base

Flood stages and discharges of Arroyo Seco near Soledad, Calif.--Continued

Date		Gage height (feet)	Discharge (second-feet)
1922 Dec.	10	6.75	P 2,020
1923 Jan.	25	6.1	1,350
Apr.	6	6.25	1,500
	8	6.40	1,640
	15	5.64	1,120
1924 Jan.	27	5.16	** 880
1925 Feb.	23	5.90	1,300
1926 Jan.	29	6.05	1,290
Feb.	3	7.9	3,370
	13	10.5	8,360
	13	12.0	P 11,500
	17	7.5	2,710
	23	5.8	1,170
Apr.	5	7.80	3,190
	8	10.90	9,180
Nov.	25	16.5	P* 22,000
1927 Feb.	4	6.30	1,450
	9	12.20	11,900
	24	6.80	1,890
Apr.	3	5.90	1,180
1928 Feb.	4	7.40	2,590
Mar.	24	10.0	P 7,300
	24	7.7	3,030
Apr.	2	6.00	1,230
1929 Feb.	3	8.20	3,850
	3	9.5	P 6,300
Mar.	10	7.60	2,880
1930 Mar.	4	9.03	P 5,300
	5		2,640
1931 Jan.	2		** 315
Dec.	24		3,980
	27	13.70	P 8,700
	28		5,170
1932 Feb.	9		3,360
1933 Jan.	29		1,040
	29	7.31	P 2,340
Dec.	13		1,780
	30	6.92	2,020
1934 Jan.	1	9.35	4,220
	1	11.01	P 5,820
Feb.	26		* 1,470

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: May 1-Nov. 5, 1901; Nov. 24-30, 1926.

Alameda Creek at Sunol, Calif.

Location.- In SE$\frac{1}{4}$ sec. 7, T. 4 S., R. 1 E., at Sunol Dam, 1 mile below junction with Arroyo de la Laguna and 1 mile west of Sunol, Alameda County.
Drainage area.- 622 square miles.
Records available.- October 1900 to September 1929.
Source of data.- Record furnished by Spring Valley Water Co.
Gages.- Nonrecording gage prior to 1914; recording gage thereafter.
Stage-discharge relation.- Dam acts as a control. Flow over Sunol Dam rated on the basis of discharge measurements.
Storage, regulation, and diversion.- No regulation prior to 1919. Increasing regulation from 1919 to completion of Calaveras Reservoir (capacity, 100,000 acre-feet) on Calaveras Creek in December 1924. Water diverted above dam for city of San Francisco. During period of record mean yearly diversion has ranged from 19.3 second-feet in 1905-6 to 73.6 second-feet in 1926-27. Daily record of diversions available 1903-29.

Flood discharges
(Base discharge 800 second-feet)

Date		Discharge (second-feet)
1900 Nov.	21	8,260
1901 Jan.	5	1,130
Feb.	5	3,840
	8	1,310
	20	1,730
	24	3,010
1902 Feb.	22	2,760
	24	2,230
	26	2,110
Mar.	2	4,130
	6	1,160
	9	2,900
1903 Jan.	27	3,490
Feb.	1	883
	8	1,880
Mar.	14	1,160
	20	1,230
	31	6,680
1904 Feb.	13	1,360
	16	1,670
	25	1,560
	27	1,670
Mar.	11	2,230
	20	2,340
	23	2,110
	29	1,360
1905 Mar.	19	1,880
	29	1,070
1906 Jan.	14	5,130
	17	3,200
	19	7,030
Feb.	21	2,000
	25	1,360
Mar.	4	1,440
	12	2,260
	15	5,350
	24	4,720
	29	1,590
	31	6,650
Dec.	11	2,730
	26	1,490
1907 Jan.	9	3,880
	15	1,080
	17	1,790
	25	2,340
	28	1,870
Feb.	2	2,570
Mar.	10-11	2,620
	19	10,900
	23	10,700
Apr.	1	957
Dec.	31	818
1908 Jan.	14	867
	26	883
Feb.	3	1,170
1909 Jan.	8	920
	13	5,090
	21	10,600
	25	4,130
Feb.	3	3,480
	8	5,800
	12	5,700
	21	1,880
Mar.	25	845
	29	1,270
Dec.	9	1,710
	31	2,060
1910 Jan.	16	1,500
	24	2,340
Feb.	7	872
Mar.	23	957
1911 Jan.	14	9,660
	25	2,720
	29	4,700
Feb.	11	1,100
	13	2,420
Mar.	3	3,730
	7	14,700

Flood discharges of Alameda Creek at Sunol, Calif.---Continued

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1912 Jan. 26	808	Jan. 14	4,730	Feb. 20	3,200
1913 Jan. 18	918	17	6,600	Mar. 11	848
1914 Jan. 1	4,100	25	3,540	16	1,180
14	2,860	28	4,700	Dec. 13	2,120
18	1,860	Feb. 5	5,740	28	960
21	5,630	Mar. 1	817	1923 Jan. 24	1,250
25	8,200	1917 Jan. 3	924	29	827
Feb. 20	7,620	Feb. 22	5,710	Oct. 1-10	** 23
1915 Feb. 2	6,680	25	7,110	1924 Jan. 3-9	** 1.5
9	5,580	1918 Mar. 19	** 570	1925 Feb. 6	1,050
17	1,610	1919 Feb. 11	6,300	10	845
20	1,310	26	2,870	13	839
22	1,430	Mar. 8	867	1926 Feb. 13	3,610
24	1,440	14	3,170	Apr. 9	905
28	1,190	1920 Mar. 22	** 500	1927 Feb. 4	1,000
May 5	846	Dec. 24	1,350	16	1,960
12	864	1921 Jan. 19	2,520	18	2,110
18	939	30	1,670	1928 Mar. 27	2,830
Dec. 14	856	Dec. 28	1,490	Apr. 3	960
1916 Jan. 3	6,720	1922 Feb. 10	7,150	1929 Feb. 4	** 205
10	5,250				

** Below base

Note.- All discharge quantities are average daily flows.

Kern River near Bakersfield, Calif.

Location.- In sec. 2, T. 29 S., R. 28 E., at mouth of lower canyon, 5 miles northeast of Bakersfield, Kern County.

Drainage area.- 2,345 square miles.

Records available.- Monthly discharge records October 1893 to December 1895; daily discharge records January 1896 to June 1907, March 1908 to September 1934.

Source of data.- Records furnished by Kern County Land Co.

Gage.- Recording.

Stage-discharge relation.- Control shifts. Banks do not overflow.

Regulation and diversions.- Regulation from power plants. Many small diversions above station for irrigation; water diverted for power development is returned to river above station.

Flood stages and discharges
(Base discharge 1,830 second-feet)

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1896 Jan. 21	3,100	June 4	2,940	Mar. 4	2,725
May 30	3,280	1905 May 22	2,620	19	2,280
June 10	3,380	June 15	3,040	Apr. 5	3,140
July 7	1,930	1906 Jan. 15	1,830	19	5,920
11	1,870	20	2,550	May 7	7,440
24	2,000	Mar. 17	5,530	28	6,040
1897 Feb. 2	2,060	27	4,150	June 5	8,850
Mar. 29	1,890	Apr. 1	2,980	25	6,470
Apr. 19	4,220	24	4,260	July 3	5,680
May 6	4,950	May 10	6,780	14	3,610
24	5,230	21	7,440	Dec. 10	4,660
June 17	1,850	27	7,830	1910 Jan. 1	3,320
1898 Apr. 28	** 1,240	June 21-22	9,500	Apr. 28	2,260
1899 Mar. 26	3,120	July 4	8,430	May 16	2,340
June 12	2,070	24	5,920	June 1	2,450
1900 May 28	1,850	1907 Mar. 21	2,070	1911 Jan. 31	3,670
1901 May 1	2,520	Apr. 15	4,260	Mar. 10	2,260
19	4,300	25	4,500	Apr. 6	2,880
June 8	4,210	May 12	3,340	27	3,040
23	3,610	20	3,690	May 6	3,250
July 1	3,610	June 5	4,270	24	3,810
1902 Apr. 8	3,440	12	3,420	June 7	3,820
20	2,810	22	2,940	18	4,620
May 13	2,160	30	3,320	28	3,750
31	2,320	....	.....	July 18	2,960
June 13	2,910	1908 May 2	2,080	1912 May 19	1,880
1903 May 14	3,300	1909 Jan. 14	8,780	June 4	2,920
June 8	2,780	22	7,500	4	P 3,220
22	2,310	Feb. 8	4,420	1913 May 25	1,830
1904 May 18	2,620	13	3,470	25	P 1,980
26	2,740	18	2,860	1914 Jan. 26	15,500

** Below base

Flood discharges of Kern River near Bakersfield, Calif.--Continued

Date	Discharge (second-feet)	Date	Discharge (second-feet)	Date	Discharge (second-feet)
1914 Jan. 26	P 18,300	June 21	3,160	May 21	2,310
Feb. 22	2,190	1919 Apr. 21	1,830	Nov. 27	3,670
Mar. 24	2,240	May 5	2,340	27	P 6,510
Apr. 22	3,470	30	3,850	1927 Feb. 17	4,410
May 21	4,250	30	P 4,300	19	P 6,570
June 3	4,740	1920 Apr. 16	3,450	19	5,170
19	3,430	16	P 4,460	26	2,070
July 2	3,560	May 2	2,280	Apr. 4	1,850
20	2,020	10	2,470	May 6	3,600
1915 Apr. 22	1,870	21	3,660	18	4,210
May 18	2,790	31	3,480	27	2,670
June 2	3,970	June 21	2,230	June 8	3,360
10	4,010	1921 May 16	2,060	15	3,300
10	P 4,250	28	2,120	1928 May 31	1,920
1916 Jan. 18	16,100	June 12	3,250	31	P 2,060
18	P18,000	1922 May 8	5,110	1929 May 20	1,910
28	10,200	8	P 5,300	20	P 2,000
Feb. 6	3,470	June 1	4,720	1930 June 14	2,240
28	4,780	18	3,260	14	P 2,420
Mar. 6	4,800	1923 Apr. 7	2,570	1931 May 8	**1,040
21	10,500	7	P 3,280	1932 Apr. 6	1,890
Apr. 11	8,500	May 18	2,810	21	2,540
28	9,460	26	2,320	May 4	1,860
June 10	7,830	June 12	2,300	22	3,540
1917 Mar. 30	1,860	1924 May 10	** 991	22	P 3,730
Apr. 9	2,580	1925 May 8	2,170	28	3,440
27	3,460	30	2,630	June 13	3,090
May 8	3,010	30	P 2,820	26	3,420
15	3,180	June 15	2,150	1933 June 1	2,110
June 10	3,660	1926 Apr. 27	1,850	16	3,440
19	P 4,330	May 6	2,140	16	P 3,770
19	3,980			1934 May 12	** 890
1918 June 14	3,130				

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Tule River near Porterville, Calif.

Location.- In NW¼ sec. 25, T. 21 S., R. 28 E., at highway bridge 1 mile above mouth of South Fork and 6 miles east of Porterville, Tulare County.
Drainage area.- 266 square miles.
Records available.- May 1901 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily prior to Oct. 1, 1912; to tenths once or twice daily Oct. 1, 1912, to March 1917; to hundredths twice daily April 1917 to Jan. 22, 1931; recording gage thereafter. Datum changed Jan. 23, 1931.
Stage-discharge relation.- Control shifts at medium and high stages; both banks have dense vegetation above and below control, which holds drift at high stages. First valley level floods at 6-foot stage; second level does not flood.
Regulation and diversions.- Regulation from power plants upstream. Several small ditches divert water above station for irrigation.
Remarks.- Discharge records prior to Jan. 15, 1909, revised from previously published figures.

Flood stages and discharges
(Base discharge 300 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1901 May 1-2	3.1	412	1903 Jan. 28	7.6	3,800
10	3.4	535	31	3.6	630
25	3.9	785	Mar. 4	2.8	316
June 1-2	3.1	412	25	3.7	680
8	2.9	346	Apr. 1	4.7	1,270
1902 Feb. 27	4.4	1,080	10	3.7	680
Mar. 2	4.4	1,080	25	3.3	490
9	5.6	1,940	May 12	3.4	535
25-27	3.0	378	1904 Feb. 16	4.1	900
Apr. 7	7.2	3,400	Mar. 20	3.0	378
21	3.7	680	23	6.15	2,440
May 11	3.1	412	29	3.8	730
28	3.0	378	Apr. 6-7	2.8	316

Flood stages and discharges of Tule River near Porterville, Calif.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1904	Apr.	11	2.8	316
		19	3.15	431
	May	12-14	2.9	346
1905	Mar.	13	3.1	412
		16-17	3.0	378
		19	4.1	900
		29	2.9	346
	May	2	3.0	378
		8	3.2	450
		17	3.3	490
1906	Jan.	14	7.35	3,600
		19	7.0	3,200
	Feb.	15	3.1	412
	Mar.	4	3.6	630
		12	6.6	2,800
		16	8.5	4,760
		26	7.25	3,400
		31	5.4	1,780
	Apr.	6	4.4	1,080
		10-11	3.8	730
		23	4.25	960
		28	4.6	1,200
	May	5	4.0	840
		12	4.5	1,140
		27	6.55	2,800
	June	12	4.5	1,140
1907	Jan.	15	3.2	450
		17	3.4	535
		29-31	3.2	450
	Feb.	22	3.85	758
	Mar.	8	2.9	346
		10	2.9	346
		24	4.8	1,340
	Apr.	2	6.0	2,260
		15	4.3	1,020
	May	20	3.2	450
	June	4	3.0	378
		12	2.9	346
	Dec.	7	2.9	346
1908	Feb.	3	3.1	412
		9	3.5	580
		22	4.6	1,200
		29	3.2	450
	Mar.	5	3.5	580
		16	3.1	412
1909	Jan.	14	8.4	4,650
		21	9.1	5,070
	Feb.	7	6.55	2,780
		12	5.85	2,180
		21	4.0	865
	Mar.	3	3.9	810
		16-18	3.2	483
		21	3.4	565
		29	3.9	810
	Apr.	4	3.8	757
		17	4.3	1,040
	May	4-5	4.3	1,040
	June	1	4.1	920
	Dec.	6	4.6	1,240
		8	9.5	5,430
1910	Jan.	1	5.55	1,940
		16	3.0	410
	Mar.	14	2.8	344
1911	Jan.	10	2.75	329
		21	2.80	344
		25	3.65	682
		29	4.90	1,440
		31	6.60	2,780
	Feb.	4	3.50	610
		14	2.90	376
	Mar.	8	4.90	1,440
		10	5.10	1,590
		21	3.05	428
	Apr.	5	3.60	657
		27	2.90	376
	May	6	2.78	338
1912	May	18-19	2.5	** 260
1913	Apr.	1	2.55	** 248
	Dec.	31	3.00	385
1914	Jan.	3	3.3	510
		18	4.0	865
	Jan.	22	5.7	2,060
		25	8.7	4,710
		25	10.8	P 6,600
	Feb.	21	3.6	670
	Apr.	10	3.65	692
		22	2.65	325
	May	20	2.6	310
1915	Feb.	2	2.65	325
		9	2.75	355
		11	2.65	325
	Apr.	13	2.6	310
		22	2.65	325
		30	3.6	670
	May	4	4.8	1,380
		4	5.3	P 1,740
		11-14	3.3	545
		17	4.4	1,100
	June	1	3.3	545
1916	Jan.	9	6.1	2,380
		17-18	8.0	4,080
		17	11.0	P 6,780
		25	7.2	3,360
		27	6.3	2,550
	Feb.	5	4.6	1,260
		17-19	3.2	538
		29	4.8	1,390
	Mar.	5	4.0	900
		21	5.2	1,680
	Apr.	11	3.8	800
	Apr.	28-May 6	3.7	755
	May	19	3.4	621
	Oct.	2	2.9	427
	Dec.	24	7.45	3,540
		24	8.2	P 4,260
1917	Jan.	3	4.1	955
	Feb.	20	3.95	900
		22	6.5	2,730
		25	3.6	710
	Mar.	9	2.65	344
		29	3.0	463
	Apr.	8-9	3.22	538
		14	2.85	410
		26	3.3	578
	May	7	3.02	463
		15	3.15	538
		18	3.15	538
	June	9	2.88	427
1918	Mar.	13	2.68	360
		18	4.0	P 900
		19	3.50	665
		27	2.87	410
1919	Feb.	27	3.10	500
		27	4.3	P 1,070
	Mar.	3	3.51	665
	Apr.	4	3.00	463
	May	4	2.78	344
	Dec.	12	2.95	393
1920	Mar.	2	5.02	1,520
		22	4.51	1,170
	Apr.	7	2.94	393
		15	7.3	P 3,450
		16	5.85	2,140
		30	3.10	445
	May	8	2.90	376
		20	3.25	483
1921	Mar.	14	3.42	565
		14	3.65	P 657
	May	21	3.18	483
	Dec.	21	2.78	341
1922	Jan.	2	4.73	1,310
	Feb.	11	5.93	2,220
		11	7.7	P 3,810
		27	2.82	341
	Mar.	24	3.48	610
	Apr.	1	2.86	358
		4	2.98	409
		26	3.31	523
	Dec.	13	3.60	600
1923	Apr.	6	6.89	2,820
		6	7.50	P 3,360
		10	4.85	1,190

** Below base

Flood stages and discharges of Tule River near Portersville, Calif.---Continued

Date			Gage height (feet)	Discharge (second-feet)
1923	May	9-10	2.90	360
		16	2.76	315
1924	Apr.	11	2.50	** 240
	Nov.	9	3.32	350
1925	Feb.	9	3.33	365
	Apr.	4	4.00	P 580
		5	3.59	440
		13, 15, 16	3.18	322
	May	4-5	3.13	309
1926	Feb.	14	3.38	380
	Apr.	8	3.98	580
		8	4.36	P 750
	Nov.	27	5.31	1,210
1927	Feb.	16	5.55	1,190
		18	7.1	2,270
		18	10.0	P 5,260
	Mar.	4	3.53	428
		9	3.58	452
		14	3.06	334
	Apr.	3	3.76	502
		26	3.36	404
	May	7	3.65	452
		16-18	3.21	357
	Nov.	10	3.08	334
1928	Mar.	25	5.55	1,190
		25	6.0	P 1,430
	Apr.	3	3.13	334
1929	Mar.	22-23	3.06	300

Date			Gage height (feet)	Discharge (second-feet)
	Mar.	22	3.80	P 468
1930	Feb.	23	3.85	468
		23	4.30	P 604
	Mar.	15	3.09	300
1931	Apr.	27	2.85	** 185
	Dec.	25		580
		28		2,230
		28	10.1	P 5,800
1932	Feb.	1		442
		7	5.65	881
		9	5.71	900
		29	3.86	354
	Mar.	30	3.77	330
	Apr.	2	3.77	330
		16	3.67	305
		20	3.74	322
	May	4	4.19	408
		17	4.59	520
		21	4.57	506
		26-27	4.15	395
1933	Jan.	19		510
		29		528
		29	7.15	P 1,670
	Mar.	17		496
	Apr.	5	3.88	340
	May	29	4.25	432
	Dec.	13		312
		13	4.75	P 580
1934	Jan.	1		** 240

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kaweah River near Three Rivers, Calif.

Location.- In SE¼ sec. 27, T. 17 S., R. 28 E., three-quarters of a mile below South Fork, 3 miles below North Fork, and 1¼ miles southwest of Three Rivers, Tulare County.

Drainage area.- 514 square miles.

Records available.- April 1903 to September 1934.

Source of data.- U. S. Geological Survey.

Gages.- Nonrecording gage read to tenths twice daily prior to Jan. 1, 1911; to half-tenths or hundredths twice daily Jan. 1, 1911, to June 30, 1929; recording gage thereafter.

Stage-discharge relation.- Control shifts. Right bank overflows at extreme high water.

Regulation and diversion.- Regulation from several small power plants on East Fork not sufficient to affect flood flow; total reservoir capacity, 1,152 acre-feet. Several small ditches above station divert water for irrigation and domestic purposes.

Remarks.- Discharge records prior to Jan. 15, 1909, revised from previously published figures.

Flood stages and discharges
(Base discharge 1,520 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1903	May	1	7.60	2,350
		13	8.25	3,480
		31	7.85	2,700
	June	5	8.00	3,080
		14	7.25	1,760
1904	Mar.	23	8.40	3,900
		29	7.15	1,760
	May	17	8.10	3,280
		24-25	7.90	2,890
	June	4	7.70	2,520
		11-12	7.30	1,900
	Oct.	11	8.00	3,080
1905	May	25	7.5	2,190
	June	6	7.45	2,040
		12	7.35	2,040
1906	Jan.	14	9.25	5,760
		19	9.3	6,010

Date			Gage height (feet)	Discharge (second-feet)
	Mar.	12	9.3	6,010
		15	10.3	8,520
		25	8.7	4,570
		31	8.35	3,900
	Apr.	10	7.35	2,040
		23	7.8	2,700
		28	7.45	2,040
	May	9-10	8.35	3,900
		19	8.35	3,900
		26	9.45	6,260
		28	9.75	7,260
	June	5	8.25	3,480
		21	9.5	6,510
	July	2-3	9.1	5,520
1907	Jan.	28	7.15	1,760
	Mar.	20-21	7.1	1,630
		25	8.0	3,080

Flood stages and discharges of Kaweah River near Three Rivers, Calif.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1907	Apr.	1	7.65		2,350
		3	7.3		1,900
		13-14	7.7		2,520
		20	7.65		2,350
		26	7.7		2,520
	May	3-4	7.4		2,040
		11	7.5		2,190
		19-20	7.85		2,700
		26	7.4		2,040
	June	3	8.2		3,480
		12	7.55		2,350
		21	7.5		2,190
		27-28	7.4		2,040
1908	May	1	7.1		1,630
1909	Jan.	14	10.3		8,520
		21	10.6		9,210
	Feb.	7	7.9		2,830
		12	8.7		4,470
	Apr.	17	7.4		2,010
		27-28	7.5		2,160
	May	7	8.35		3,700
		21	7.85		2,740
		27	8.0		3,010
	June	4	9.35		6,000
		24	8.55		4,140
	July	2	8.00		3,010
	Dec.	9	10.1		7,910
1910	Jan.	1	8.8		4,850
	Apr.	25	7.3		1,990
		29	7.0		1,600
	May	9	7.05		1,660
		13-15	7.1		1,720
1911	Jan.	25	7.10		1,720
		29	10.00		6,610
		31	9.70		5,920
	Mar.	8	8.75		4,000
		10	8.25		3,120
	Apr.	5	7.35		1,760
		26	7.20		1,580
	May	5	7.38		1,800
		8	7.50		1,950
		23	8.30		3,200
		28	7.30		1,700
	June	8	7.90		2,530
		13	8.20		3,030
		17	8.00		2,690
		26-27	7.20		1,580
1912	May	17-18	7.2		1,680
		29	7.7		2,360
1913	May	23-24	7.0	**	1,470
1914	Jan.	25	11.6		9,880
		25	13.0	P	13,300
	Apr.	10	7.2		1,690
		20-21	7.2		1,690
	May	9	7.4		1,920
		19	7.7		2,290
		30	7.8		2,420
	June	18	7.1		1,580
1915	May	13	7.6		2,160
		17	7.9		2,550
	May 31-June 1		8.4		3,280
	June	1	8.6	P	3,600
		7-9	7.9		2,550
1916	Jan.	9	8.1		2,830
		17	11.7		10,100
		17	13.5	P	14,700
		25	8.8		3,940
		27	8.8		3,940
	Feb.	5	7.3		1,800
	Mar.	5	7.6		2,160
		20	8.2		2,980
	Apr.	11	7.8		2,420
		27-29	8.2		2,980
	May	5	8.5		3,440
		19	7.7		2,290
	June	3	7.6		2,160
		8-9	8.2		2,980
		28	7.6		2,160
	Dec.	24	8.39		3,280
1917	Feb.	22	8.08		2,830
	Apr.	8	7.28		1,800
		26-27	7.50		2,040
	May	7	7.46		2,040
		14-15	7.69		2,290
	June	9	8.12		2,830
		16	7.86		2,550
1918	Mar.	19	6.96	**	1,400
1919	Apr.	24	7.08		1,570
	May	2	7.48		2,040
		13	7.20		1,680
		29	7.95		2,690
		29	8.1	P	2,830
	Dec.	12	7.85		2,420
1920	Mar.	22	8.00		2,690
	Apr.	16	9.30		4,850
		16	9.8	P	5,850
	May	23-24	8.18		2,980
	June	19-20	7.12		1,570
1921	Mar.	14-16	7.45		1,710
	Apr. 30-May 1		7.48		1,820
	May	14-15	7.70		2,060
		27	7.46		1,820
	June	10	8.00		2,450
1922	Jan.	2	7.40		1,710
	Feb.	11	8.05		2,450
	May	6	8.48		3,190
		15	7.90		2,320
		19	8.35		3,030
		24	8.60		3,350
		30-31	8.70		3,520
		31	8.85	P	3,690
	June	4	8.55		3,350
		16-17	7.58		1,940
1923	Apr.	6	9.20		4,410
		6	9.90	P	6,060
		10	7.75		2,190
	May	9	8.05		2,450
		24	7.6		1,940
	June	10-11	7.4		1,710
1924	May	1	6.60	**	940
1925	May	6	7.82		1,990
		27	7.75		1,990
		27	8.0	P	2,210
1926	Apr.	24	7.68		1,880
	May	5	7.75		1,990
		5	8.00	P	2,210
		18-21	7.42		1,570
	Nov.	24	8.15		2,430
		27	9.0		3,380
1927	Feb.	16	8.20		2,730
		18	9.95		5,950
		18	11.8	P	10,100
	Apr.	3	7.92		2,100
		26	7.98		2,210
	May	5	8.35		2,660
		17	8.55		2,900
		25-26	7.65		1,770
	June	1	7.35		1,570
		7	7.75		1,990
		14	7.75		1,990
	Nov.	10	7.60		1,770
1928	Mar.	27	8.15		2,430
		27	8.80	P	3,140
1929	May	5			1,600
		9	7.38		1,520
		14	7.50		1,620
		18-19	7.50		1,620
		23	7.38		1,520
	June	16	9.35		3,780
1930	May	28	7.59		1,720
1931	May	6	6.97	**	1,120
	Dec.	28			4,420
		28	11.84	P	8,900
1932	Feb.	7			3,030
	Apr.	19	7.58		1,760
	May	17	8.68		3,120
		21	8.75		3,200
		27	8.58		2,980
	June	2	7.84		2,040
		5	7.94		2,140

** Below base

Flood stages and discharges of Kaweah River near Three Rivers, Calif.--Continued

Date		Gage height (feet)	Discharge (second-feet)
1932 June	11-13	8.27	2,500
	21-22	8.22	2,440
1933 May	31-June 1	8.34	2,540
June	14	8.50	2,750
June	14	9.07	P 3,620
Dec.	13	7.42	1,520
	13	8.10	P 2,230
1934 Jan.	1		** 832

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Kings River at Piedra, Calif.

Location.- In NW¼ sec. 8, T. 13 S., R. 24 E., half a mile below highway bridge at Piedra and 12 miles northeast of Sanger, Fresno County.
Drainage area.- 1,694 square miles.
Records available.- September 1895 to September 1934.
Sources of data.- U. S. Geological Survey records; U. S. Weather Bureau gage used January 1914 to January 1920.
Gages.- Nonrecording gage read to tenths once daily Sept. 3, 1895, to Apr. 17, 1903, and twice daily Jan. 27, 1914, to Jan. 14, 1920. Recording gage Apr. 18, 1903, to Jan. 26, 1914, and subsequent to Jan. 15, 1920. All gages set to same datum.
Stage-discharge relation.- Control shifts during high water. Banks do not overflow except at extreme stages, when water passes around gage on left bank.
Storage, regulation, and diversions.- Storage in reservoir on Ten Mile Creek (capacity, 1,410 acre-feet) and in Sequoia Lake on Mill Flat Creek (capacity, 3,000 acre-feet). No regulating effect on flood flows from power plant on North Fork, built in 1927 (reservoir capacity, 310 acre-feet). No unreturned diversions.
Remarks.- Discharge records prior to May 2, 1908, revised from previously published figures.
Historical data.- Flood of Jan. 25-26, 1914, reached a stage of 21.8 feet (discharge, 59,700 second-feet) on Jan. 25. This is said to have been the highest stage since 1862 or 1863.

Flood stages and discharges
(Base discharge 6,750 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1896 Jan.	21	9.8	8,140
May	28-29	12.0	16,200
June	10-11	11.4	13,800
	18	11.0	12,200
1897 Apr.	18	10.1	9,100
May	1	9.9	8,460
	6	11.3	13,400
	14	11.6	14,600
	24	12.4	17,800
Dec.	8	9.8	8,140
1898 Apr.	28	9.7	7,840
1899 Mar.	25	13.8	24,000
Apr.	16	9.5	7,340
	22	9.3	6,820
June	12	10.5	10,500
1900 Jan.	3	11.3	13,400
May	23	10.2	9,440
	26	10.0	8,780
	30-31	10.0	8,780
Nov.	21	12.4	17,800
1901 Jan.	7	15.8	33,200
Feb.	22	9.4	6,980
Apr.	25	10.0	8,780
	30	10.5	10,500
May	18	12.4	17,800
June	4	12.3	17,400
	22	11.8	15,400
	30	11.8	15,400
July	6	10.3	9,780
1902 Apr.	7	13.1	20,800
May	12-13	10.0	8,780
	29	11.1	12,600
June	9	11.0	12,200
	13	11.0	12,200
1903 Jan.	28	11.0	12,200
May	13-15	11.7	15,000
May	31	10.7	11,200
June	2	10.9	11,900
	6	10.8	11,500
	14	9.9	8,460
	21	9.4	6,980
	26	9.4	6,980
1904 Mar.	23	9.7	7,840
May	17	11.45	13,800
	25	11.25	13,000
	29	10.35	10,100
June	3	11.2	13,000
	13	10.1	9,100
1905 May	17	10.25	9,440
June	7	9.35	6,980
	13	10.3	9,780
1906 Jan.	14	11.4	13,800
	19	13.8	24,000
Mar.	13	10.9	11,900
	16	13.0	20,400
	26	10.45	10,100
	31	9.4	6,980
Apr.	23	9.75	8,140
May	11	11.4	13,800
	20	11.5	14,200
	26	12.0	16,200
	28	12.2	17,000
June	5	10.95	12,200
	20	14.0	24,900
July	4	13.25	21,300
1907 Mar.	21	10.3	9,780
	25	10.3	9,780
Apr.	14	10.1	9,100
	27	10.25	9,440
May	3-4	9.9	8,460
	11	10.15	9,440
	19	11.2	13,000
June	3-4	12.05	16,200

Flood stages and discharges of Kings River at Piedra, Calif.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1907	June	11	10.9		11,900
		21	10.95		12,200
		30	11.25		13,000
	July	4	11.15		13,000
1908	May	1	9.25	**	6,460
1909	Jan.	14	12.9		19,800
		21	11.35		12,800
	Feb.	12	10.5		10,000
	Apr.	18	9.6		7,580
	May	7	11.3		12,600
		21	10.8		11,000
		27	10.95		11,500
	June	4	13.0		20,300
		24	11.8		14,600
	July	3	11.55		13,600
		14	9.55		7,460
	Dec.	9	10.4		9,750
1910	Jan.	1	11.85		14,700
	Apr.	26	10.5		9,750
	May	15	10.25		9,020
		24	9.9		8,070
		31	10.2		8,880
1911	Jan.	31	13.7		20,500
	Mar.	8	11.65		12,800
		10	10.7		9,860
	Apr.	6	9.5		6,840
		26	9.8		7,520
	May	5	10.45		9,160
		13	10.25		8,630
		23	11.85		13,500
	June	6	11.75		13,200
		13	12.5		15,800
		18	12.65		16,400
		27-28	11.55		12,500
	July	3-5	10.95		10,600
		17	11.1		11,100
1912	May	18	9.6		6,940
		30	11.6		12,400
	June	4	11.5		12,000
1913	May	23-24	9.8		7,210
1914	Jan.	18	9.6		6,770
		25	21.8	P	59,700
		26	16.0		30,400
	Feb.	21	10.5		8,900
	Apr.	15	9.6		6,770
		21	9.6		6,770
	May	8	10.6		9,150
		20	11.8		12,800
		23	11.2		10,900
		30-31	12.4		14,900
	June	14	11.0		10,300
		18	11.8		12,800
	June 29-July 1		11.2		10,900
1915	Feb.	9	9.7		6,990
	Apr.	20	9.7		6,990
	May	13	9.8		7,210
		17	10.8		9,700
	June	1	12.8		16,300
		1	13.3	P	18,300
		9	12.6		15,500
		16	11.2		10,900
		29	10.1		7,900
1916	Jan.	17	12.2		14,200
		17	19.0	P	45,400
		25	11.6		12,100
		28	11.2		10,900
	Mar.	20	10.6		9,150
	Apr.	11	10.4		8,650
	May	5-6	12.6		15,500
		22	11.0		10,300
	June	9	12.8		16,300
		17	12.7		15,900
		27	11.1		10,600
	July	8	10.2		8,150
1917	Feb.	22	10.7		9,400
		22	13.2	P	17,900
		25	9.65		6,770
	Apr.	26	10.1		7,900
	May	6-7	10.05		7,650
		15	10.75		9,700
	June	3	11.0		10,300
		9	11.9		13,200
		15	11.8		12,800
1918	May	5	10.13		8,150
	June	13	11.8		12,800
		12, 13, 14	12.0	P	13,500
		21	11.1		10,600
	Oct.	2	11.05		10,300
1919	May	4	10.55		8,960
		14	9.95		7,440
		29	11.45		11,200
		29	12.0	P	13,200
1920	Apr.	16	9.60		6,770
	May	20	12.40		14,900
		20	12.95	P	17,000
		29-30	11.30		11,200
1921	May	1	10.10		7,680
		13	11.0		10,100
		27-28	10.17		7,920
	June	8	11.90		12,800
		22	10.3		8,180
1922	May	7	12.35		13,700
		15	11.20		9,760
		18-19	12.20		12,900
		25	12.90		15,500
		31	13.00		15,900
	June	5	13.30		17,100
		5	14.02	P	19,900
		17	12.05		12,300
		27	11.45		10,300
1923	Apr.	6	10.45		7,870
	May	16	11.80		11,500
		16	12.54	P	13,600
		25	11.40		10,400
	June	11	11.15		9,870
1924	May	8-9	8.20	**	3,930
1925	May	7	10.76		8,510
		29	11.12		9,240
		29	11.89	P	11,300
	June	13	10.10		7,010
1926	Apr.	25	10.88		8,750
	May	5	11.22		9,490
		5	11.97	P	11,600
		20	11.11		9,240
	Nov.	27			7,630
1927	Feb.	18			9,260
		18	14.28	P	19,200
	May	5			10,800
		17	12.68		14,000
		26			9,180
	June	7	11.90		11,600
		14	11.90		11,600
		26			7,880
1928	May	15			6,750
1929	May	19	10.32		7,510
	June	16			9,560
		16	12.94	P	14,700
1930	May	28	10.07		7,070
		28	10.68	P	8,430
	June	13	10.00		6,850
1931	May	7	6.88	**	5,030
	Dec.	28			11,300
		28	12.12	P	20,100
1932	Feb.	7			10,300
		9			9,770
	May	17-18	9.90		12,800
		21	9.80		12,500
		27	9.75		12,500
	June	2	8.69		9,260
		12	9.47		11,600
		22	9.70		12,200
	July	2	8.52		8,700
1933	May 31-June 1		9.17		10,700
	June	14-15	9.65		11,900
		15	10.38	P	14,400
	Dec.	13		**	4,690
1934	Apr.	15	6.32	**	4,050

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Mokelumne River near Clements, Calif.

<u>Location</u>.- Prior to Apr. 9, 1931, in NW$\frac{1}{4}$ sec. 15, T. 4 N., R. 8 E., at highway bridge 1 mile north of Clements, San Joaquin County; thereafter 700 feet upstream.

<u>Drainage area</u>.- 630 square miles.

<u>Records available</u>.- October 1904 to September 1934.

<u>Source of data</u>.- U. S. Geological Survey.

<u>Gages</u>.- Nonrecording gage read to tenths or half-tenths daily prior to Apr. 19, 1926; recording gage thereafter. Datum lowered 2.00 feet Apr. 19, 1926.

<u>Stage-discharge relation</u>.- Control shifts at both high and low stages. Left bank overflows at about 15-foot stage for a distance of 200 feet. Different controls before and after Apr. 9, 1931.

<u>Storage, regulation, and diversions</u>.- Storage at five power developments on North Fork totalled 23,300 acre-feet by 1904; increased to 157,600 acre-feet in 1931 by completion of Salt Springs Reservoir and Tiger Creek development. Practically complete regulation of main river began Mar. 9, 1929, at Pardee Reservoir (capacity, 205,000 acre-feet). Several small diversions for mining and irrigation throughout record; some water diverted out of drainage basin through Amador Canal. Subsequent to June 25, 1929, water diverted to East Bay Municipal Utility District Aqueduct from Pardee Reservoir in amounts varying from 41,000 to 59,000 acre-feet annually.

<u>Remarks</u>.- Discharge records prior to Jan. 15, 1909, revised from previously published figures.

Flood stages and discharges
(Base discharge 2,960 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1905	Apr.	29	8.4	3,020
	May	17	10.55	4,940
		26	8.95	3,500
1906	Jan.	19	12.7	7,200
	Mar.	12	8.4	3,020
		15	11.5	5,840
		25	12.05	6,360
		31	13.45	8,160
	Apr.	11	8.5	3,100
		22-23	10.3	4,670
		28	8.5	3,100
	May	7	12.5	6,960
		20	10.9	4,690
		28	10.75	4,600
	June	4	12.2	6,000
		12	14.4	9,000
		16	13.3	7,380
		22	12.7	6,600
	July	4	13.2	7,240
	Dec.	11	10.8	4,600
1907	Jan.	28	9.65	3,520
	Feb.	2	13.55	7,800
	Mar.	10	9.7	4,130
		19	21.0	23,000
	Apr.	14	10.95	5,340
		20	10.8	5,140
	May	10	10.25	4,580
		19	11.5	5,840
	June	2	12.65	7,080
		11	11.5	5,840
		22	11.1	5,440
		29-30	11.6	5,940
1908	Apr.	30	8.35	3,020
1909	Jan.	14	16.15	12,600
		21	14.1	8,400
	Feb.	12	12.2	6,500
	Apr.	18	10.15	4,480
		27	9.7	4,100
	May	5	10.75	5,050
		21	9.85	4,220
		28	9.7	4,100
	June	2	12.5	6,800
		12	10.75	5,050
		23	9.75	4,140
		27	8.9	3,420
	Nov.	21	12.95	7,200
	Dec.	3	12.6	6,900
1910	Jan.	1	9.0	3,600
	Mar.	20	11.4	6,110
	Apr.	9-10	8.5	3,130
		20	10.05	4,650
		27	10.3	4,900
	May	9	10.3	4,900
		24	9.2	3,800
	June	1	8.35	3,000
1911	Jan.	13	8.85	3,500
		15	8.9	3,560
		25	10.35	5,240
		30	17.45	16,700
	Mar.	7	11.75	7,210
		19	8.55	3,350
	Apr.	6	11.4	6,720
		14	9.35	4,190
		19	8.6	3,400
		25	10.35	5,340
	May	5	10.2	5,160
		24	11.95	7,500
	June	6	12.2	7,880
		12	12.25	7,960
		18	12.3	8,030
	July	1	10.2	5,160
1912	May	17	9.2	4,020
		31	9.9	4,800
	June	3	10.0	4,920
1913	Apr.	26	8.4	3,340
	May	6	8.1	3,070
		10	8.2	3,160
		18	8.9	3,840
		26	8.4	3,340
1914	Jan.	1	13.0	9,250
		18	9.3	4,280
		22	11.8	7,470
		26	14.2	11,100
	Feb.	21	13.4	9,850
	Apr.	10	10.4	5,580
		16	8.8	3,740
		20	9.0	3,950
	May	8	10.2	5,340
		13	9.6	4,620
		15	10.2	5,340
		22	10.8	6,090
	June	2	10.9	6,220
		17	9.6	4,620
		25	8.4	3,340
1915	Feb.	2	8.0	2,980
		9	8.6	3,540
	Apr.	20	9.1	4,060
	May	13	11.2	6,630
		17	10.1	5,220
		24	8.6	3,540
		28	11.0	6,350
	June	1	12.0	7,750
		8	11.2	6,700
		8	12.3	P 8,290
		16	9.0	4,060
		23	8.0	3,090
1916	Mar.	5	8.4	3,690
		20	12.0	8,040

Flood stages and discharges of Mokelumne River near Clements, Calif.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1916	Mar.	20	13.8	P	10,700
	Apr.	11	9.5		4,840
		17	7.9		3,220
		27-28	9.2		4,510
	May	6	10.8		6,400
		17	8.1		3,400
		22	8.0		3,310
		30	7.7		3,040
	June	9	9.6		4,950
		16	9.0		4,290
1917	Feb.	22	10.25		5,660
		25	10.8		6,400
		25	11.0	P	6,660
	Apr.	26	8.95		4,570
	May	7	8.35		3,940
		11	8.75		4,350
		14	10.15		5,970
	June	3	9.95		5,730
		10	11.35		7,550
		15	10.1		5,850
1918	Mar.	12	10.75		6,940
		12	12.0	P	8,620
		19	10.25		6,160
	May	2	7.65		3,360
		5	8.2		3,920
1919	Feb.	11	10.5		7,060
		11	10.9	P	7,540
	Apr.	5	6.95		3,230
		19	6.7		2,960
		24	8.1		4,280
	May	1	9.6		5,980
		14	8.0		4,180
		22	7.9		4,080
		24	7.85		3,980
		29	8.0		4,180
1920	Apr.	16	8.65		4,820
		30	6.7		2,960
	May	9	6.95		3,230
		20	9.2		5,500
		20	10.3	P	6,820
		29	7.55		3,780
1921	Jan.	18	11.00		7,350
		18	14.4	P	11,100
		30	6.85		3,260
	Apr.	23	7.05		3,440
		30	8.10		4,440
	May	15	9.80		6,100
		27	10.07		6,400
	June	7	9.60		5,900
		22	6.55		3,090
1922	Feb.	20	8.45		4,630
	May	7	10.35		6,570
		18	11.5		7,670
		25	10.4		6,570
	June	3	11.8		7,970
		3	12.8	P	8,970
	June	12-13	7.9		4,180
		16	8.95		5,200
		26	7.1		3,480
	Dec.	13	8.4		4,630
1923	Jan.	24	7.1		3,580
	Apr.	6	8.45		4,710
		10	6.3		2,960
	May	10	9.1		5,340
		16-17	9.2		5,430
		17	10.2	P	6,400
		25	8.5		4,800
	June	10	6.6		3,180
1924	May	2-3	4.6	**	1,770
1925	Feb.	6	13.7		9,700
		6	18.6	P	15,100
		13	7.65		3,980
	Apr.	11	8.5		4,750
		16	10.9		6,910
		29	6.3		2,960
	May	3	10.5		6,550
		20	7.3		3,740
		25	8.6		4,840
	June	14	6.3		2,960
1926	Apr.	8	6.6		3,100
		17	6.4		3,100
		28			2,960
1927	Feb.	19	9.43		3,750
		22	10.79		4,840
	Apr.	4	9.97		4,200
		27	11.40		5,320
	May	6	10.16		4,360
		17	12.35		6,160
		17	14.28	P	7,870
		26	9.24		3,610
	June	7	10.59		4,680
		14	10.41		4,520
1928	Mar.	25	22.45	P	25,600
		26			20,300
	Apr.	2	8.08		3,220
	May	1			4,060
		8			3,810
		11			3,840
1929	May	19	8.14		3,220
	June	16			4,060
		16	11.69	P	6,220
1930	May	21	8.64		3,500
		21	9.35	P	4,060
1931	Aug.	8-9	4.37	**	629
1932	June	2	9.62		4,150
		2	9.72	P	4,240
		13	9.13		3,830
		21			3,380
		23			3,420
1933	Jan.	27	4.48	**	759
	Dec.	29		**	1,100
1934	Feb.	26		**	1,030

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Sacramento River near Red Bluff, Calif.

Location.- April 1895 to December 1901, at Jellys Ferry, 12 miles above Red Bluff; thereafter in SE¼ sec. 34, T. 28 N., R. 3 W., at lower end of Iron Canyon, 4 miles northeast of Red Bluff, Tehama County.
Drainage area.- 9,300 square miles (not including Goose Lake Basin) at present location.
Records available.- April 1895 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to half-tenths twice daily prior to Oct. 1, 1919; to tenths once daily Oct. 1, 1919, to Dec. 31, 1919; recording gage thereafter. No relation between datum of gage at Jellys Ferry and that of present gage.
Stage-discharge relation.- Control practically permanent. Flood stage, about 25 feet. Banks do not overflow.
Storage, regulation, and diversions.- About 80 reservoirs built on tributaries at various times throughout record; total storage capacity above Red Bluff, about 120,000 acre-feet in 1931. Low-water regulation. Small diversions for irrigation on tributaries; diversions from Sacramento River at Redding through Anderson-Cottonwood Canal began in 1918.
Remarks.- Flood flows at Jellys Ferry probably comparable with those at present location. Study of flow at adjacent stations indicates no flood flows during break in records Apr. 28 to May 17, 1919.
Historical data.- In 1879 the State engineer and in 1893 and 1894 the commissioner of public works made measurements at this point.

Flood stages and discharges
(Base discharge 44,800 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1895	May	6	15.3		38,200
1896	Jan.	18	28.85		122,000
		18	29.9	P	129,000
		20	27.85		115,000
		20	29.5	P	126,000
		25	21.95		76,500
		27	29.7		128,000
	Mar.	27	19.05		58,500
	Apr.	24	18.55		55,500
	May	4	21.2		71,700
	Nov.	24	15.4		38,700
	Dec.	15	24.0		90,000
		30	16.6		44,600
1897	Jan.	29	17.45		49,200
	Feb.	1	19.75		62,700
		5	23.75		88,400
		5	25.9	P	103,000
	Mar.	1	16.45		43,800
		28	15.9		41,100
1898	Feb.	28	15.15		37,500
		28	16.2	P	42,600
1899	Jan.	15	16.2		42,600
	Mar.	16	18.95		57,900
		25	23.0		83,400
		25	25.5	P	99,900
	Nov.	29	18.25		53,800
	Dec.	15	16.85		45,800
1900	Jan.	2-3	25.0		96,600
		7	19.0		58,200
	Mar.	8	29.0		123,000
		8	30.0	P	130,000
	Dec.	21	22.5		80,100
1901	Jan.	4	21.65		74,600
		4	27.5	P	113,000
		22	17.45		49,200
	Feb.	20	25.8		102,000
		23	22.65		81,100
	Nov.	29	16.55		44,400
	Dec.	4	19.6		61,800
1902	Feb.	10	23.65		140,000
		15	17.5		85,900
		25	24.8		151,000
	Mar.	9	14.0		61,700
	Apr.	7	12.7		53,800
	Nov.	10	21.4		118,000
1903	Jan.	25	22.8		131,000
	Mar.	14	15.3		70,200
		29	15.7		73,000
	Nov.	22	21.5		119,000
	Dec.	17	11.7		48,000
1904	Feb.	16	28.0		188,000
		16	31.0	P	224,000
		22	20.3		108,000
	Feb.	24-25	19.15		98,800
	Mar.	2	15.55		72,000
		8	24.4		147,000
		18	19.4		101,000
		29	18.2		91,300
	Oct.	11	11.2		45,300
	Dec.	31	13.7		59,800
1905	Jan.	14	14.35		63,900
		23	20.3		108,000
	Feb.	2	15.85		74,000
	Mar.	14	13.55		58,900
		19	11.4		46,400
		22	11.2		45,300
		29	15.5		71,600
1906	Jan.	16	13.7		59,800
		19	23.3		136,000
	Feb.	23	12.75		54,100
	Mar.	12	14.85		67,200
		22	12.95		55,300
		26	17.95		89,300
		31	23.35		137,000
	Dec.	27	13.65		59,500
1907	Jan.	4	14.45		64,600
		29	12.15		50,600
	Feb.	4	23.1		134,000
		25	13.1		56,200
	Mar.	20	28.7		195,000
		20	29.4	P	204,000
		23	21.65		120,000
	Apr.	7	11.7		48,000
1908	Jan.	14	11.35		46,100
		20	11.5		47,000
	Feb.	2	11.6		47,500
		9	17.15		83,300
1909	Jan.	6	16.9		81,500
		8	20.55		111,000
		16	28.45		188,000
		21	27.1		177,000
		26	18.65		94,800
	Feb.	3	33.4		254,000
		3	35.2	P	278,000
		10	12.75		54,100
		13	16.65		79,700
		17	14.6		65,500
	Mar.	4	11.2		45,300
	Dec.	9	18.15		90,800
1910	Jan.	24	11.75		48,300
	Feb.	25	18.0		89,700
	Mar.	23	12.75		54,100
1911	Jan.	28	13.20		56,800
		31	14.25		63,300
	Feb.	2	12.70		53,800
	Mar.	7	22.68		130,000

Flood stages and discharges of Sacramento River near Red Bluff, Calif.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1911	Apr.	6	11.65		47,800
1912	Jan.	26	12.9		55,000
1913	Jan.	14-15	12.6		53,200
		18	13.4		58,000
1914	Jan.	1	24.8		151,000
		14	19.0		97,600
		18	15.6		72,300
		22	21.8		122,000
		24	19.4		101,000
	Feb.	21	25.6		160,000
	Apr.	5	11.6		47,500
1915	Jan.	8	11.9		49,200
	Feb.	2	33.0		249,000
		2	34.0	P	262,000
		9	17.2		83,700
		18	14.8		66,900
		24	14.5		64,900
	Mar.	28	17.3		84,400
	Apr.	3	11.9		49,200
	May	11	14.0		61,700
	Dec.	14	14.0		61,700
1916	Jan.	9	11.3		45,800
		23	17.4		85,100
		25	17.4		85,100
	Feb.	8	14.6		65,500
		11	18.2		91,300
		11	19.4	P	101,000
	Mar.	5	14.6		65,500
		21	11.9		49,200
1917	Feb.	25	27.05		176,000
		25	28.0	P	188,000
1918	Mar.	19	12.35		52,100
		19	12.8	P	54,400
1919	Jan.	20	12.92		55,000
	Feb.	11	21.45		118,000
		11	23.4	P	137,000
	Mar.	2	13.10		56,200
....			.....		....
1920	Apr.	16	7.75	**	28,500
	Nov.	19	19.8		104,000
		27	12.4		52,000
	Dec.	11	13.3		57,400
		19	12.2		50,900
1921	Jan.	6	11.2		45,300
	Jan.	18	15.1		68,900
		28	14.16		63,000
		30	18.75		96,000
		30	22.36	P	127,000
	Feb.	21	12.22		50,900
1922	Feb.	20	11.60		47,500
		20	12.80	P	54,400
	Dec.	28	9.52	**	36,600
1923	Apr.	6	8.37	**	31,300
1924	Feb.	8	11.37		47,300
		8	14.83	P	66,900
1925	Feb.	5	15.30		70,200
		8	14.70		66,200
		11	25.18	P	156,000
		12	21.02		115,000
		23	15.29		70,200
1926	Feb.	5	16.94		82,900
		5	20.52	P	110,000
	Apr.	9	11.70		48,200
	Nov.	27	13.23		56,800
		30	14.95		68,200
	Dec.	3	17.63		86,600
1927	Feb.	4	14.00		61,700
		16	12.60		53,200
		21			137,000
		21	26.00	P	164,000
	Apr.	3	16.00		75,100
1928	Feb.	4			69,800
	Mar.	27			140,000
		27	26.1	P	166,000
1929	Feb.	4			57,800
		4	16.08	P	75,800
	Dec.	16			73,900
		16	18.48	P	93,600
1930	Mar.	5-6			55,700
1931	Jan.	23		**	31,500
	Dec.	27	16.80		80,800
		27	18.06	P	90,500
1932	Mar.	20	7.82	**	28,500
1933	Mar.	28			44,800
		28	12.73	P	53,800
	Dec.	30	11.51		46,400
1934	Jan.	1	14.50	P	64,900
		2	12.96		55,400

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Apr. 27-May 17, 1919.

Feather River at Oroville, Calif.

Location.- In sec. 8, T. 19 N., R. 4 E., just below highway bridge at Oroville, Butte County.

Drainage area.- 3,640 square miles.

Records available.- January 1902 to September 1934.

Sources of data.- U. S. Geological Survey records, except U. S. Weather Bureau gage-height records used on various occasions when gage was washed out.

Gages.- Nonrecording gage read to tenths once daily (oftener during flood periods) prior to Dec. 16, 1912; recording gage thereafter. Staff gage at cable 1,000 feet above bridge used Apr. 8, 1907, to Dec. 31, 1910; gage-height records prior to Apr. 8, 1907, and subsequent to Dec. 31, 1910, reduced to common datum to which Geological Survey and Weather Bureau gages at bridge are set. Datum of Weather Bureau gage at bridge 2 feet higher than U. S. Geological Survey bridge gage datum prior to Jan. 1, 1911.

Stage-discharge relation.- Control shifts at high stages. Banks do not overflow.

Storage, regulation, and diversions.- Storage totalling 1,513,000 acre-feet on about twenty-five power projects. Largest project is Lake Almanor (capacity, 224,000 acre-feet in 1913; 300,000 acre-feet in 1917; and 1,308,000 acre-feet in 1927). Other projects had total capacity of 205,500 acre-feet in 1932, of which 85,600 acre-feet was added in 1924 and 109,300 acre-feet added in 1928. Flow partly regulated by Lake Almanor since July 1913. Minor diversions from tributaries throughout period of record.

Flood stagss and discharges of Feather River at Oroville, Calif.
(Base discharge 14,100 second-feet)

Date			Gage height (feet)	Discharge (second-feet)
1902	Feb.	9	11.25	22,100
		15	11.75	24,400
		17	12.5	28,200
		24	13.5	34,600
		26-27	13.75	36,400
	Apr.	6-7	14.0	38,100
		16	11.5	23,200
		23	9.5	15,200
	Dec.	11	10.0	17,000
		27	11.0	21,000
1903	Jan.	25	12.5	28,200
		27	12.25	26,900
	Mar.	30	20.25	93,000
	Nov.	14	19.25	83,000
		21	19.1	81,500
1904	Feb.	16	20.35	94,000
		22	17.8	69,300
		24	21.5	106,000
	Mar.	4	13.05	31,400
		8	15.35	48,400
		10	15.65	50,800
		18	20.45	95,000
		29	16.7	59,600
	Apr.	14	14.3	40,400
		19	12.5	28,200
	May	13	11.8	24,600
		23	10.85	20,400
	Oct.	11	12.25	26,900
	Dec.	30	17.7	68,400
1905	Jan.	15	10.25	18,000
		23	11.95	25,400
	Feb.	2	11.3	22,300
	Mar.	13	10.25	18,000
		19	12.5	28,200
		29	10.65	19,500
1906	Jan.	16	18.1	54,100
		18	24.9	96,300
	Feb.	19	11.4	19,200
		28	11.6	19,900
	Mar.	13	11.2	18,400
		15	10.85	17,000
		26	17.95	53,200
		31	17.65	51,400
	Apr.	10	11.4	19,200
		23	12.05	21,700
	May	7	12.2	22,400
		15	11.55	19,700
		28	12.85	25,300
	June	4	13.0	26,000
		13	11.1	18,000
		17	10.5	15,800
	Dec.	26	16.25	43,400
1907	Feb.	3	22.1	78,500
		17	10.0	14,300
		23	10.6	16,300
		25	10.5	15,900
	Mar.	5	12.5	23,800
		19	30.2	187,000
	Apr.	19	16.0	42,000
	May	20-21	13.5	28,600
	June	13	13.0	26,000
1908	Jan.	21	11.0	16,300
	Feb.	3	11.0	16,300
	Apr.	16	10.5	14,400
1909	Jan.	3	13.0	26,000
		6	14.4	33,200
		8	20.2	66,700
		16	* 30.5	* 137,000
		21	21.8	76,700
	Feb.	3	11.3	18,600
		7	11.1	17,800
		12	15.0	36,500
		18	13.4	28,000
	Mar.	4	12.2	22,400
	Apr.	19	11.7	20,200
	May	5	11.3	18,600
	Nov.	22	10.7	16,300
		24	11.1	17,800
	Dec.	9	14.0	31,000
1910	Jan.	24	10.0	14,700
	Feb.	25	11.3	21,000
	Mar.	4-7	10.9	19,000
		21	12.7	29,200
	Apr.	11	10.0	14,700
1911	Jan.	20	7.4	18,100
		25	7.8	20,600
		31	13.3	75,400
	Mar.	7	10.2	41,500
	Apr.	6	12.4	65,100
		26	9.8	37,700
	May	5	9.1	31,400
		24	8.4	25,300
	June	3-4	8.1	22,800
1912	Jan.	26	7.1	16,400
1913	Apr.	27	6.7	14,100
	May	9	7.1	16,400
	Dec.	25	7.2	17,000
		31	17.0	121,000
1914	Jan.	14	9.5	35,000
		18	7.7	19,900
		22	9.6	35,900
		26	12.5	66,200
	Feb.	21	13.4	76,600
	Mar.	19-20	8.4	25,300
	Apr.	5	8.4	25,300
		10	10.2	41,500
		16	9.2	32,300
		20	8.8	28,700
	May	5	7.8	20,600
1915	Feb.	2	11.9	59,400
		9	8.3	24,400
		17	8.9	29,600
	Mar.	29	9.0	30,500
	Apr.	4	7.3	17,500
		13	7.2	17,000
		20	7.5	18,700
		29-30	7.2	17,000
	May	11	14.6	91,000
		11	16.3	P 112,000
		17-18	9.8	37,700
		27-29	7.4	18,100
	Dec.	13	6.80	15,300
1916	Jan.	3	10.15	41,900
		25	9.30	33,200
	Feb.	8	8.06	22,800
		11	10.44	43,500
		27	8.06	22,800
	Mar.	5	7.76	20,600
		20	11.70	57,200
		20	11.8	P 58,300
		29	8.0	22,000
	Apr.	11-12	9.00	30,500
		17-18	8.52	26,200
		28	8.20	23,600
	May	6	8.10	22,800
		19	6.80	14,600
	Dec.	4		25,000
1917	Feb.	25		99,000
		25	16.15	P 110,000
	Mar.	30		16,200
	Apr.	8		18,600
		12		38,300
		23		39,300
	May	9		20,700
		30		14,100
1918	Feb.	6		15,100
	Mar.	19	7.36	18,100
		26	9.53	35,000
		26	9.83	P 38,000
	Apr.	10	8.05	22,000
1919	Feb.	11	11.92	54,600
		11	14.58	P 84,200
	Apr.	5	8.60	23,100
		18-19	7.17	14,900
		24	7.32	15,400
	May	2		* 19,200
1920	Apr.	16	8.30	21,000
		16	9.05	P 25,900
	Nov.	19		62,500
		19	14.25	P 82,200

* Estimated

Flood stages and discharges of Feather River at Oroville, Calif.--Continued

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1920 Nov. 27		23,400	Feb. 6	13.34	66,300
Dec. 11		15,300	1926 Feb. 4		48,200
19		23,000	Apr. 8	12.70	56,700
1921 Jan. 6		20,000	8	13.20	P 62,200
18		* 64,200	Nov. 24		39,500
30		18,800	27	9.39	27,200
Feb. 15		16,200	1927 Feb. 4	9.69	29,800
21		14,900	18	11.75	49,800
Mar. 6		20,000	21		114,000
13		23,600	21	18.34	P 134,000
19		19,900	Mar. 14		21,600
Apr. 3		15,100	Apr. 2		27,600
May 1		17,000	27	7.90	17,900
16		17,400	1928 Feb. 4		18,800
27		14,200	Mar. 26		143,000
1922 Feb. 19		23,000	26	26.08	P 211,000
26		15,600	1929 Feb. 4		** 11,600
Apr. 27-28	9.21	25,600	Dec. 13		62,200
May 7	10.42	36,100	15	15.18	73,400
20	10.50	37,000	15	15.82	P 80,100
20	11.0	P 41,500	1930 Mar. 5	8.55	19,100
May 31-June 1	8.58	21,300	1931 Mar. 19	5.94	** 8,440
Dec. 13		17,200	Dec. 24		16,100
1923 Apr. 6		18,900	24	9.28	P 22,600
5	8.81	P 22,600	27		14,800
1924 Feb. 8	10.14	34,700	1932 Mar. 20	8.25	17,400
8	11.80	P 49,800	1933 May 30	5.51	** 7,840
1925 Feb. 4	15.25	P 90,600	1934 Mar. 29	7.81	14,100

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Yuba River at Smartville, Calif.

Location.- In SW$\frac{1}{4}$ sec. 22, T. 16 N., R. 6 E., at Narrows, 1 mile below mouth of Deer Creek and 1 mile north of Smartville, Yuba County.
Drainage area.- 1,201 square miles.
Records available.- June 1903 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read once daily prior to Oct. 11, 1928; recording gage thereafter. Datum lowered 10 feet Aug. 1, 1906; 5 feet more Aug. 12, 1930; and 0.20 foot more July 7-9, 1931.
Stage-discharge relation.- Control shifts and frequently lowers noticeably at high stages, washing out placer mining tailings, estimated to be about 80 feet deep at the station. Banks do not overflow.
Storage, regulation, and diversions.- Storage and diversions for power, irrigation, and mining above station throughout period of record. Storage reservoirs now number about forty; total storage capacity, 238,900 acre-feet, of which 33,200 acre-feet existed prior to 1903. Principal reservoirs are Lake Spaulding (1919), capacity, 70,500 acre-feet; Bowman Lake (1927), capacity, 68,000 acre-feet; Fordyce Lake (1926), capacity, 42,000 acre-feet; Bullards Bar (1925), capacity, 15,000 acre-feet. Some water diverted into Bear and American River drainage basins.

Flood stages and discharges
(Base discharge 9,900 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1903 June 1-2	8.2	** 5,800	Apr. 14-15	11.4	15,600
Nov. 14	10.4	11,400	19	11.3	15,200
21	16.0	34,600	26	9.7	9,980
1904 Feb. 12	10.5	11,700	May 14	11.2	14,800
16	20.0	58,000	22	11.2	14,800
22	20.3	59,800	Oct. 11	11.5	15,900
24	20.3	59,800	Dec. 30	12.0	17,900
Mar. 4-5	10.9	13,700	1905 Jan. 22	10.4	12,800
8	12.5	19,900	Feb. 2	9.4	10,000
10	13.1	22,400	Mar. 19	11.3	17,400
18	15.5	33,500	21	9.4	11,800
28	14.8	30,000	1906 Jan. 13	9.7	16,900

** Below base

Flood stages and discharges of Yuba River at Smartville, Calif.--Continued

Date			Gage height (feet)	Discharge (second-feet)
1906	Jan.	15-16	11.0	18,900
		18	17.0	48,000
	Feb.	15	8.3	10,200
		19	8.5	11,100
		21	8.4	10,700
		27	8.5	11,100
	Mar.	12	12.0	28,400
		24	12.2	29,400
		26	12.4	30,400
		31	14.0	40,600
	May	11	8.4	14,400
		15	7.3	10,000
		28	9.0	20,100
	June	4	10.0	25,600
		12	8.0	18,000
		16	7.0	14,100
		19	6.2	11,700
	Dec.	11	17.0	16,800
		26	18.9	22,800
1907	Jan.	28	16.8	17,700
	Feb.	2	27.0	78,000
	Mar.	19	29.2	100,000
		23	16.4	16,500
	Apr.	2	14.4	11,200
		15	16.4	20,700
		19	15.4	16,000
	May	19	15.3	12,300
	June	2	15.1	10,700
		11	15.0	10,400
1908	Apr.	20	12.9	** 8,410
1909	Jan.	3	13.5	10,600
		6	16.0	19,600
		8	20.5	41,000
		15	28.3	111,000
		21	19.4	41,600
	Feb.	7	13.0	11,300
		12	18.0	33,200
		17-18	14.0	14,600
	Mar.	4	12.7	10,200
	May	6-7	12.5	12,300
	June	3	12.0	11,800
	Nov.	21	18.0	37,000
		24	14.4	16,000
	Dec.	1	15.2	17,800
		9	18.0	32,000
		31	16.5	25,000
1910	Jan.	24	13.9	13,000
	Feb.	25	11.6	10,500
	Mar.	20	13.5	16,100
1911	Jan.	14	12.5	14,100
		20	14.0	19,000
		24	15.0	22,600
		31	19.0	39,000
	Mar.	7	15.1	23,000
	Apr.	2	12.5	15,200
		6	15.0	23,400
		26	11.9	14,000
	May	5	11.8	13,700
		23	10.6	10,600
	June	5	11.9	14,600
		11	11.6	13,700
		18	10.9	12,000
1912	Mar.	6	9.0	** 7,630
	Nov.	6	10.0	10,000
1913	May	5	10.0	10,000
		10	10.0	10,000
	Dec.	31	20.1	45,700
1914	Jan.	20	13.0	15,300
		27	16.0	25,800
	Apr.	10	14.0	18,700
		13	12.3	16,400
		20	11.5	14,000
	May	8	10.8	11,900
		11	10.7	11,600
		14-15	10.7	11,600
		22	10.3	10,500
		25	10.5	11,100
1915	Feb.	2	14.8	24,800
		17	11.5	14,700
	Mar.	28	10.4	12,300

Date			Gage height (feet)	(second-feet)
	Apr.	19	10.0	11,200
	May	12	20.0	46,500
		18	12.4	16,700
		29	10.0	10,000
	Dec.	13	10.9	15,400
1916	Jan.	3	13.6	25,100
		3	13.6	P 25,100
		25	12.8	19,700
	Feb.	7	9.8	10,300
		11	12.1	21,200
		27	8.9	10,700
	Mar.	5	10.6	15,900
		20	12.9	24,200
	Apr.	11	10.3	15,000
		17	8.9	10,700
		28	9.3	11,900
	May	6	10.4	15,300
	Dec.	4	11.6	19,300
1917	Feb.	22	10.9	16,900
		25	16.4	38,800
		25	18.0	P 45,800
	Apr.	12	10.8	15,400
		23	11.0	16,600
	May	14	10.4	14,500
	June	9	8.55	9,900
1918	Feb.	6	9.7	13,100
	Mar.	19	9.7	13,100
1919	Feb.	7	8.60	9,900
		11	14.2	29,400
		26	9.80	10,600
	Mar.	2	9.60	10,100
	May	4	9.80	12,200
1920	Apr.	15	12.00	19,500
		15	12.3	P 20,600
	Nov.	19	12.10	19,900
		27	9.50	11,500
	Dec.	11	10.60	14,700
		19	9.85	12,300
1921	Jan.	18	13.40	24,800
	Mar.	13	10.55	14,700
		22	8.90	11,400
	May	14	8.45	10,200
		27	8.30	9,900
1922	Feb.	10	9.0	11,700
		19	11.0	18,100
		19	12.1	P 22,200
		26	9.45	13,600
	May	6	9.2	13,000
		20	11.7	21,400
		25	9.55	14,200
	June	2	10.6	17,400
		17	8.6	11,300
	Dec.	13	13.5	28,000
		28	9.4	12,800
1923	Apr.	6	11.1	18,400
	May	17	8.4	10,700
1924	Feb.	8	8.1	9,960
1925	Feb.	6	16.1	39,000
		6	17.2	P 43,800
1926	Feb.	4	12.7	23,200
	Apr.	8	11.6	19,700
	Nov.	24-25	12.8	23,600
1927	Feb.	3	10.8	18,200
		16	11.0	18,800
		18	13.6	28,900
		21	18.4	49,000
	Apr.	2	11.3	18,800
		27	9.1	12,000
	May	7	8.9	11,400
		15	9.75	14,100
	Nov.	10	8.9	11,400
1928	Mar.	26		79,000
		26	26.0	P 120,000
	May	11	7.95	10,000
1929	June	16		** 4,700
	Dec.	13	11.02	17,800
		12	12.00	21,100
		15		10,300
1930	Mar.	5		14,200
1931	Mar.	19	10.17	** 4,780

** Below base

Flood stages and discharges of Yuba River at Smartville, Calif.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1931	Dec.	24			13,400
		24	15.00	P	16,400
		28	13.34		11,100
1932	May	13-14	12.80	**	9,820
1933	May	30	12.26	**	8,000
1934	Jan.	1			10,500
	Mar.	29			12,200
		29	15.20	P	16,200

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

American River at Fair Oaks, Calif.

Location.- Highway bridge at Fair Oaks, Sacramento County, 10 miles below South Fork.
Drainage area.- 1,921 square miles.
Records available.- November 1904 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths twice daily prior to Jan. 19, 1914; recording gage intermittently, supplemented by nonrecording gage read to half-tenths twice daily Jan. 19, 1914, to Nov. 6, 1930; recording gage thereafter. All gages set to same datum prior to Nov. 7, 1930, when datum was lowered 1 foot.
Stage-discharge relation.- Control shifts frequently. Banks do not overflow.
Storage, regulation, and diversions.- Storage and regulation for power, irrigation, and mining. About 25 reservoirs above station (total capacity, 64,300 acre-feet). Water diverted for irrigation throughout period of record. Some inflow from Yuba and Bear Rivers.

Flood stages and discharges
(Base discharge 11,600 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1904	Dec.	31	7.85		11,600
1905	Mar.	19	10.5		21,200
	Apr.	24	8.85		14,900
1906	Jan.	14	8.35		13,200
		19	15.5		44,500
	Feb.	19	8.35		13,200
		21	9.35		16,700
	Mar.	3	7.9		11,800
		14	12.85		31,600
		24	13.35		34,000
	Apr.	1	10.4		20,800
		18	8.1		12,400
		23	8.7		14,400
		28	8.45		13,500
	May	5	10.4		20,800
		11	10.1		19,600
		28	11.53		26,600
	June	3	10.3		20,400
		12	11.0		23,300
		17	9.85		18,600
		22-23	10.25		20,200
	July	2	8.35		13,200
	Dec.	11	10.25		20,200
		26	9.95		19,000
1907	Jan.	29	8.7		14,400
	Feb.	2	22.75		80,800
	Mar.	10	8.4		13,400
		19			105,000
		19	30.4	P	119,000
	Apr.	2	9.05		15,600
		14	10.15		21,000
		20	9.9		18,800
	May	11	8.8		14,700
		19	9.45		17,000
		29	8.45		13,500
	June	2	9.45		17,000
		12	9.3		16,500
	Dec.	27	6.7	**	8,460
1908	Apr.	14	6.1	**	7,030
1909	Jan.	8-9	9.4		16,900
	Jan.	14			98,000
		21			62,500
	Feb.	12	13.25		33,500
	May	4	8.3		13,000
		9	8.3		13,000
	June	4	8.0		12,100
	Nov.	21	14.75		40,800
		24	8.3		13,000
	Dec.	2	16.0		47,000
		9			33,200
1910	Jan.	1	9.8		19,600
		24	9.5		18,400
	Mar.	20	10.3		21,700
	Apr.	11	7.9		12,400
		21	7.9		12,400
1911	Jan.	14	11.6		27,500
		20	9.8		19,600
		25	12.3		30,700
		31	19.7		69,100
	Feb.	12	9.5		17,600
	Mar.	5	10.2		20,600
		7	14.2		39,800
	Apr.	2-3	9.8		18,900
		6	11.8		28,000
		26	9.7		18,400
	May	5	9.8		18,900
		13	9.0		15,500
		24	10.6		22,400
		31	9.7		18,400
	June	6	10.9		23,800
		12	11.2		25,200
.....	.....	.....	....		......
1912	June	2	7.8	**	11,100
1913	May	10	7.9		11,600
1914	Jan.	1	17.6		57,700
		15	9.6		17,400
		18	10.2		20,000
		22	13.0		36,500
		26	15.9		52,600
	Feb.	21			42,600

** Below base

Flood stages and discharges of American River at Fair Oaks, Calif.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1914	Apr.	6			11,800
		16	8.4		15,200
		20	8.6		16,000
	May	8-9	8.2		14,400
		16	8.1		14,000
		22	8.1		14,000
1915	Feb.	2	10.2		23,100
		9	9.2		19,300
		18	9.2		19,300
	Apr.	20	7.8		13,500
	May	12	13.9		41,800
		12	15.04	P	47,900
		28-29	8.4		15,900
	June	8	7.7		13,100
1916	Jan.	3	13.7	P	40,700
		4	8.72		17,400
		10	8.47		16,400
		18	7.2		11,700
		25	9.65		21,300
	Feb.	5	8.32		15,900
		11	8.36		16,200
		27-28	8.28		15,900
	Mar.	5	9.31		19,800
		12		*	14,500
		20	12.23		33,200
	Apr.	11	8.30		15,900
		16	7.15		12,100
		28	7.80		14,100
	May	6	8.61		17,000
1917	Feb.	22	10.97		27,400
		25	13.14		37,600
		25	13.98	P	42,300
	Apr.	12	8.05		14,500
		26	8.68		17,400
	May	9	7.69		13,800
		14	8.19		15,500
	June	9-10	7.79		14,100
.....	.....	.....	.....		......
1918	Apr.	10	6.50		12,400
.....	.....	.....	.....		......
1919	Feb.	11	14.5		45,000
		11	18.5	P	67,500
		27	7.5		12,100
.....	.....	.....	.....		....
	Apr.	5	7.21		13,400
		24	6.93		12,500
	May	1	8.00		16,200
1920	Apr.	16	10.20		18,800
		16	10.70	P	20,100
	Dec.	12	6.80		11,600
		31	6.85		11,700
1921	Jan.	18	12.60		32,800
		18	14.1	P	39,200
		30	8.10		15,700
	Mar.	14	7.50		13,800
		19	6.95		12,200
	May	14	7.50		13,800
		27	7.20		12,800
1922	Feb.	9	8.78		16,900
		20	10.15		22,200
		20	12.5	P	31,600
	May	7	10.12		21,600
		18	10.50		23,200
		20	10.45		22,800
		25	9.75		20,500
		31	9.95		21,300
	June	5	9.88		20,900
		16	7.08		11,700
	Dec.	13	12.10		29,800
		13	14.2	P	39,000
		28	7.58		13,200
1923	Apr.	6	11.00		24,800
		10-11	7.20		12,000
	May	10	8.12		14,900
		16	7.78		14,000
1924	Feb.	8	6.70	**	10,600
1925	Feb.	6	19.5		68,200
		6	25.0	P	99,500
		13	7.90		13,800
	Apr.	12	8.10		14,500
		16	9.65		19,800
	May	5-6	8.35		15,500
		16	7.28		11,800
1926	Apr.	6	10.40		22,700
		6	11.6	P	27,400
	Nov.	25	8.50		15,800
		29	7.42		12,200
1927	Feb.	4	9.7		20,300
		18	11.4		27,600
		21	15.7		48,200
		21	19.4	P	67,700
	Mar.	14	9.80		18,300
	Apr.	3	12.80		30,500
		27	9.40		17,600
	May	6	8.18		13,400
		16	9.22		16,900
	June	7	7.65		11,800
	Dec.	29	7.38		12,200
1928	Mar.	25			119,000
		25	30.45	P	182,000
	Apr.	3	9.15		15,300
	May	1	8.45		11,800
1929	Feb.	4	9.0		14,800
	Dec.	13	8.80		14,800
1930	Mar.	5	10.02		18,800
		5	11.33	P	24,400
1931	Mar.	19		**	7,920
	Dec.	28	11.63		17,500
1932	Feb.	7		*	18,900
		7	12.6	P	21,100
	May	12	10.73		14,800
1933	May	30	10.30		12,700
		30	11.52	P	16,500
1934	Jan.	1	13.50	P	22,600
		2			13,300
	Mar.	29			11,600

* Estimated
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Oct. 1 to Dec. 31, 1911; Mar. 11-30, 1918; Apr. 14-June 3, 1918; Mar. 19-30, 1919.

Cache Creek at Yolo, Calif.

Location.- 800 feet above highway bridge, 1,000 feet above Southern Pacific Co.'s railroad bridge and half a mile south of Yolo, Yolo County.
Drainage area.- 1,230 square miles.
Records available.- January 1903 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths twice daily prior to Jan. 1, 1912; to half-tenths twice daily Jan. 1, 1912, to Sept. 30, 1927; to hundredths twice daily Oct. 1, 1927, to Sept. 27, 1930; recording gage thereafter. Recording gage set to datum 1.97 feet lower than that used 1903-30.
Stage-discharge relation.- Possibly affected by backwater from Sacramento River in early years of record. Control shifts. Levees on banks subject to overflow at station.
Storage, regulation, and diversions.- Storage in Clear Lake regulates flow to some extent at high stages. Numerous diversions for irrigation.

Flood stages and discharges
(Base discharge 1,450 second-feet)

Date		Gage height (feet)	Discharge (second-feet)
1903 Jan.	28	10.2	6,340
	31	8.1	4,390
Feb.	8	10.2	6,340
Mar.	14	7.7	4,080
	29	5.9	2,580
Apr.	1	5.7	2,380
Nov.	21	9.3	5,020
Dec.	16	5.4	1,880
1904 Feb.	13	9.25	5,020
	16	16.75	11,200
	24	16.5	11,000
	27	16.5	11,000
Mar.	11	20.75	9,900
	11	28.2	P
	18	16.5	7,600
	23	11.0	4,800
	28	16.75	9,500
Dec.	31	15.2	9,700
1905 Jan.	14	9.95	4,960
	17	7.4	3,000
	23	15.55	10,300
Feb.	2	12.4	8,200
	17	5.3	1,820
Mar.	16	6.4	2,620
	23	6.3	2,540
	29	7.1	3,200
May	8	4.75	1,450
1906 Jan.	14	6.3	2,440
	19	25.7	18,900
Feb.	15	6.85	2,880
	19	6.65	2,720
	21	7.8	3,680
	24	8.3	4,100
Mar.	4	8.5	4,280
	12	9.3	4,960
	21	7.25	3,210
	24	10.7	6,140
	26	11.0	6,400
	31	15.85	10,500
May	7	12.1	7,340
Dec.	11	5.75	2,040
	27	7.55	3,470
1907 Jan.	5	7.3	3,410
	10	15.65	10,500
	28	7.1	3,250
Feb.	2	12.6	7,900
	18-19	4.9	1,570
	26	5.0	1,640
Mar.	6	5.3	1,850
	10	6.5	2,410
	19	25.9	19,200
	19	27.1	20,200
	23	20.85	14,900
	23	27.2	20,300
1908 Jan.	21	4.65	1,540
	25	4.65	1,540
Feb.	3	10.2	6,080
	6	6.2	2,740
	9	8.75	4,830
Mar.	1	7.4	3,710
1909 Jan.	6	5.65	2,100
	9	14.35	9,390
	16	23.45	17,100
	16	24.4	P 17,900
	21	17.85	12,400
	26	17.55	12,100
Feb.	3	27.0	20,100
	3	27.8	P 20,800
	7	14.2	9,260
	13	18.2	12,700
	21	14.0	9,090
Mar.	29	7.65	3,690
Dec.	9	6.3	2,610
1910 Jan.	24	8.15	4,120
Mar.	22	7.6	3,650
	28	5.1	1,720
1911 Jan.	20	4.9	1,590
	29	12.45	7,770
	31	9.15	4,970
Mar.	7	25.0	18,400
	7	27.8	P 20,800
Apr.	6	5.4	1,920
1912 Mar.	13	3.65	** 900
1913 Jan.	14	5.6	2,060
	19	7.5	3,790
Dec.	25	17.4	12,500
	31	25.8	19,100
1914 Jan.	15	15.5	10,900
	18	16.4	11,600
	21	25.0	18,700
	24	17.8	12,600
	26	19.0	13,600
Feb.	21	24.8	18,500
Mar.	30	5.1	1,910
Apr.	5	5.2	1,980
	10	4.9	1,780
1915 Jan.	9	5.4	2,180
	29	12.5	8,080
Feb.	2	25.7	19,300
	2	27.8	P 21,100
	9	21.2	15,500
	17	17.6	12,400
	25	11.0	6,800
	28	10.5	6,380
Mar.	28	11.6	7,310
May	12	4.8	1,860
Dec.	13	9.1	5,240
1916 Jan.	3	25.4	19,000
	3	26.9	P 20,300
	10	11.1	6,880
	14	11.2	6,970
	17	6.7	3,320
	23	19.0	13,600
	23	26.0	P 19,600
Feb.	2	6.9	3,370
	8	7.6	3,930
	27	5.9	2,570
Mar.	5	8.5	4,680

** Below base

Flood stages and discharges of Cache Creek at Yolo, Calif.--Continued

Date		Gage height (feet)		Discharge (second-feet)
1917 Feb.	25	23.8		17,700
	25	25.1	P	18,800
1918 Feb.	24	3.55	**	995
1919 Feb.	11	11.8		7,500
	11	12.1	P	7,750
	27	4.85		1,880
Mar.	3	4.8		1,880
	14	4.9		1,950
1920 Apr.	17	3.0	**	812
Nov.	19	6.90		3,480
Dec.	10	4.60		1,760
	12	5.90		2,680
	20	7.18		3,720
	24	4.90		1,950
1921 Jan.	19	13.0		8,500
	27	9.4		5,480
	30	17.5		12,300
	30	24.3	P	18,000
Feb.	11-12	6.00		2,620
	22	5.95		2,620
Dec.	27	4.6		1,640
1922 Feb.	11	6.4		2,940
	20	8.6		4,700
	20	11.5	P	7,100
	27	4.38		1,760
Dec.	13	5.10		2,060
	13	5.6	P	2,340
	29	4.30		1,830
1923 Jan.	1	3.42	**	1,250
1924 Feb.	9	2.4	**	700
1925 Feb.	6	4.3		2,030
	9	4.35		2,100
	12	17.38		13,000
	12	23.7	P	18,400
	23	6.7		3,900
Apr.	5	3.9		1,750
	26-27	3.5		1,700
May	21	4.78		2,620
1926 Feb.	1	6.5		3,520
	5	8.8		5,380
Feb.	13	7.6		4,420
Apr.	6	6.0		3,480
	8	12.6		9,090
	8	18.4	P	14,200
	19	4.6		2,240
Nov.	27	4.2		2,190
	29	5.45		3,070
Dec.	3	9.75		6,630
1927 Jan.	17	3.7		1,840
	20	5.05		2,770
	29	5.8		3,370
Feb.	4	9.0		5,500
	7	6.85		3,780
	18	17.8		13,000
	18	22.8	P	17,200
	21	15.6		11,100
Apr.	2	13.0		8,900
	20	3.8		1,680
1928 Feb.	4	8.0		4,940
Mar.	27	15.4		10,900
	27	20.3	P	15,100
Apr.	3	8.1		4,740
1929 Feb.	4	4.4		1,980
	4	4.5	P	2,050
Dec.	13	4.0		1,890
	16			4,260
1930 Jan.	17	3.50		1,620
Feb.	23			3,460
	23	9.85	P	6,550
Mar.	5			3,520
1931 Jan.	24		**	859
Dec.	27			8,410
	27	21.17	P	14,900
1932 Jan.	1			2,020
1933 Jan.	28			1,450
	28	6.38	P	2,210
Dec.	30			2,900
	30	8.82	P	4,240
1934 Jan.	2			2,420

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

North Fork of Snoqualmie River near North Bend, Wash.

Location.- Prior to Sept. 26, 1916, in sec. 34, T. 24 N., R. 8 E., at highway bridge an eighth of a mile above mouth and 2 miles north of North Bend, King County; thereafter in NE¼ sec. 26, 2 miles upstream.
Drainage area.- 105 square miles.
Records available.- July 1907 to June 1926, February 1929 to September 1933.
Sources of data.- Some gage-height records and discharge measurements by Puget Sound Power & Light Co.; discharge records by U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths every other day July 21, 1907, to Feb. 29, 1908; to tenths once daily July 1, 1908, to Sept. 2, 1912; recording gage thereafter.
Stage-discharge relation.- Control shifts at high stages.
Remarks.- Water was at or above top of gage (10.0 feet) four times during November 1909; exact stages and discharges not known.

Flood stages and discharges
(Base discharge 2,700 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1908	Nov.	18	6.0		3,180
1909	Jan.	3	5.7		2,900
		19	5.6		2,800
	June	2	8.0		5,170
....			...		.....
	Dec.	13	5.5		2,700
1910	Jan.	24	5.9		3,080
	Mar.	2	6.3		3,470
	May	10	6.8		3,970
	Oct.	3	6.3		3,310
	Nov.	7	6.4		3,020
		10	9.0		5,580
		21	10.0		6,580
1911	Nov.	7	6.2		2,830
		18	14.5		11,100
1912	Jan.	14	6.9		3,280
		25	6.2		2,750
1913	Sept.	5	6.22		2,990
	Oct.	11	8.20		4,700
1914	Jan.	6	6.90		3,300
1915	Apr.	2			3,660
	Nov.	19			3,110
1916	Feb.	16			3,470
	Mar.	9			5,080
		12			3,080
1917	Feb.	4	5.58		2,750
	June	24			2,770
	Dec.	13			6,230
		16			3,910
		18			7,170
		29			7,000
1918	Oct.	27			3,380
	Dec.	3			4,400
1919	Jan.	22-26			3,000
	Nov.	15	6.60		4,140
1920	Mar.	13			3,420
	Dec.	30			4,500
1921	Feb.	11			4,500
	Nov.	30			4,200
	Dec.	12			7,530
1922	May	4	5.97		3,360
		17	5.61		2,880
	Dec.	24			5,750
		24	9.05	P	7,370
1923	Jan.	7			5,000
		10			3,680
1924	Feb.	1			3,800
		12			7,170
	Nov.	19			2,960
	Dec.	11			4,290
		15			3,640
1925	Jan.	31			3,900
	Feb.	2-3			3,640
	Dec.	5			2,800
		11			3,460
		23			6,050
1926	Jan.	6			2,800
....			....		.....
1929	Dec.	14			2,740
1930	Feb.	5		**	2,640
1931	Jan.	28			3,580
		28	6.60	P	4,610
	Feb.	18			2,700
	Oct.	28			3,120
	Nov.	13			2,900
1932	Jan.	11			4,150
	Feb.	26			7,840
		26	11.55	P	11,000
	Mar.	5			3,330
		18			3,360
	Oct.	26	5.37		3,030
	Nov.	2	5.08		2,730
		5			2,920
		13			6,200
		17			6,880
		17	9.9	P	9,250
	Dec.	2			6,380
1933	Jan.	8	7.90		5,930

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Mar. 1 to June 30, 1908; record fragmentary October 1912 to May 1913.

Columbia River at The Dalles, Oreg.

Location.- Mar. 24 to Dec. 11, 1878, gage of Corps of Engineers, U. S. Army, at Umatilla, Umatilla County, 104 miles above The Dalles; Dec. 12, 1878, to Oct. 9, 1879, and July 1, 1881, to Jan. 31, 1892, upper gage of Corps of Engineers, U. S. Army, at Cascade Locks, Hood River County, 40 miles below The Dalles; Oct. 10, 1879, to June 30, 1881, gage of Corps of Engineers, U. S. Army, at The Dalles; Feb. 1, 1892, to Sept. 30, 1931, gage of U. S. Weather Bureau in NW¼ sec. 3, T. 1 N., R. 13 E., at foot of Court Street, at The Dalles; Oct. 1, 1931, to Sept. 30, 1934, in NE¼ sec. 20, T. 2 N., R. 15 E., gage of Corps of Engineers, U. S. Army, at head of Celilo Canal, at Celilo Falls, Wasco County.

Drainage area.- 237,000 square miles at The Dalles.

Records available.- March 1878 to September 1934. Annual floods 1858-77.

Sources of data.- Discharge records by U. S. Geological Survey; gage-height records Feb. 1, 1892, to Sept. 30, 1931, furnished by U. S. Weather Bureau; all other gage-height records and a few discharge measurements furnished by Corps of Engineers, U. S. Army.

Gages.- Nonrecording gages read to tenths once daily prior to Oct. 1, 1931; to tenths twice daily thereafter. Zero of gage at Cascade Locks is 52.56 feet below mean sea level (1929 general adjustment); readings reduced 96.0 feet before publication. Zero of U. S. Weather Bureau gage at The Dalles is 46.86 feet above mean sea level (1929 adjustment) and 8.9 feet above gage of Corps of Engineers, U. S. Army. All readings at The Dalles reduced to datum of U. S. Weather Bureau gage. Zero of gage at Celilo Falls is 37.59 feet above mean sea level (1929 adjustment). Zero of gage at Umatilla unknown.

Stage-discharge relation.- Affected by ice at The Dalles, necessitating use of gage at Cascade Locks for short periods prior to Oct. 1, 1928, and at Celilo Falls thereafter. Control permanent. Bank-full stage at Umatilla 25 feet, at The Dalles 51 feet, and at Cascade Locks 60 feet.

Diversions.- Diversion for irrigation only a small proportion of total flow.

Remarks.- All discharge quantities represent flow at The Dalles.

Historical data.- Gage-height records were obtained for annual floods 1858-77 by Oregon Steam Navigation Co. at Lower Cascade Landing. Discharges have been applied to represent flow at The Dalles. Flood of 1862 reached a gage height of 48.9 feet and flood of 1876 a gage height of 53.2 feet at The Dalles. Flood of 1849, of which there is no authentic record, reported to be 5 feet higher than that of 1862, discharge nearly equal to that of 1894.

Flood stages and discharges
(Base discharge 269,000 second-feet)

Date			Gage height (feet)	Discharge (second-feet)	Date			Gage height (feet)	Discharge (second-feet)
1858				563,000	1884	June	13	31.4	698,000
1859				874,000	1885	Apr.	17-18	14.1	290,000
1860				668,000		May	17-18	20.5	434,000
1861				618,000		June	23	22.5	482,000
1862			48.9	919,000	1886	June	9	30.4	673,000
1863				777,000	1887	May	2	17.4	361,000
1864				654,000		June	3	38.1	866,000
1865				714,000			19	39.3	896,000
1866				839,000	1888	May	19	19.6	412,000
1867				671,000		June	18	25.9	564,000
1868				483,000	1889	June	5	14.7	302,000
1869				328,000	1890	May	14	28.8	633,000
1870				777.000	1891	June	2	21.1	448,000
1871				856,000	1892	May	31	33.2	568,000
1872				737,000		June	22-23	35.0	607,000
1873				638,000	1893	May	21	35.3	613,000
1874				582,000		June	14	38.3	679,000
1875				684,000	1894	Apr.	1	20.4	322,000
1876			53.2	1,020,000			16	20.9	330,000
1877				486,000			29	28.2	465,000
1878	Apr.	9	12.8	298,000		June	6	59.4	1,160,000
	June	12	18.0	485,000			6	59.6 P	1,170,000
1879	Apr.	10	23.3	453,000	1895	May	31	28.7	475,000
	June	18	31.2	643,000		July	8	24.4	392,000
		25	31.0	638,000	1896	June	22	42.9	785,000
1880	May	7	26.1	424,000	1897	Apr.	22	30.0	501,000
	June	10-11	36.4	638,000		May	9-10	33.8	581,000
	June	30-July 2	48.5	914,000			24	42.7	780,000
1881	Feb.	6-7	22.7	361,000	1898	June	20-21	36.9	649,000
	Mar.	3	20.2	318,000	1899	May	14	22.0	349,000
	Apr.	6-9	24.9	401,000		June	22	43.0	787,000
		25	29.7	495,000	1900	May	19	32.2	547,000
	May	8	27.4	449,000		June	29-30	27.0	441,000
	June	17	34.6	598,000	1901	Mar.	4	17.1	269,000
1882	May	17	19.8	370,000		May	21	33.1	566,000
	June	13-14	40.8	883,000		June	1	37.5	662,000
1883	Mar.	31	16.4	298,000	1902	June	1	36.7	644,000
	May	25	26.3	525,000		July	7	29.1	483,000
	June	14	28.3	573,000	1903	May	18	23.1	368,000

Flood stages and discharges of Columbia River at The Dalles, Oreg.--Continued

Date	Gage height (feet)	Discharge (second-feet)
1903 June 18-19	43.0	787,000
1904 Apr. 19	28.9	479,000
May 26	36.0	629,000
1905 June 15	25.5	412,000
1906 June 1	23.4	374,000
1907 Apr. 19	18.4	289,000
June 5	34.1	587,000
1908 Apr. 25	19.3	303,000
June 18	37.1	653,000
1909 Jan. 21-22	17.5	275,000
June 19	38.1	675,000
1910 Mar. 6	20.6	325,000
25	24.4	392,000
Apr. 30-May 1	29.2	485,000
May 14	33.1	566,000
1911 June 17-18	33.5	574,000
1912 June 1	33.2	568,000
1913 Apr. 23	19.6	308,000
June 12	41.8	759,000
1914 May 27	29.6	493,000
1915 June 1	20.8	328,000
1916 Mar. 24	18.2	286,000
Apr. 18-20	18.5	291,000
May 9	28.1	463,000
July 1	40.4	727,000
1917 Apr. 29	18.2	286,000
May 18	28.7	475,000
June 2	38.0	673,000
20	40.4	727,000
1918 Jan. 1	19.9	313,000
May 19	24.9	401,000
June 25	33.7	578,000
1919 May 3	20.6	325,000
June 1	32.5	553,000
30	23.6	377,000
1920 May 25	21.6	342,000
June 26	26.3	428,000
1921 Apr. 25	18.8	295,000
June 11	42.4	773,000
1922 June 9	38.2	677,000
1923 June 14-15	33.8	581,000
1924 May 25-27	26.6	433,000
1925 Apr. 20-21	22.8	363,000
May 24-25	36.6	642,000
1926 May 8-9	17.1	269,000
1927 May 2	18.6	292,000
20	26.0	422,000
June 18	38.8	690,000
Nov. 28	17.7	278,000
1928 May 29	42.1	766,000
1929 May 27	20.7	340,000
June 19	27.7	460,000
1930 June 14	20.2	332,000
1931 May 19	18.8	308,000
June 18	17.8	292,000
1932 Apr. 18-20	98.3	279,000
May 24	106.2	565,000
24	106.4	P 578,000
June 18-19	105.5	540,000
1933 May 2	98.6	289,000
June 18	110.0	722,000
Dec. 25	100.8	368,000
25	101.0	P 376,000
1934 May 2	103.1	453,000
June 2-5	102.8	442,000

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Clark Fork near Plains, Mont.

Location.- On lot 7, sec. 7, T. 19 N., R. 26 W., 3 miles above Plains and 7 miles below mouth of Flathead River.
Drainage area.- 19,900 square miles.
Records available.- October 1910 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily prior to Nov. 28, 1911; recording gage thereafter.
Stage-discharge relation.- Affected by ice. Control practically permanent.
Regulation and diversions.- Natural regulation in Flathead Lake. Diversions from tributaries above station.
Historical data.- High water of 1913 is highest stage reached for a period of about twenty years.

Flood stages and discharges
(Base discharge 30,000 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1911 May 6	9.7	** 36,600	June 9	17.2	P 114,000
....	...	......	1923 May 28	13.7	77,200
July 9	10.9	** 46,600	June 14	15.3	94,300
1912 June 11	14.0	74,500	14	15.5	P 96,500
1913 Apr. 30	9.4	34,200	1924 May 20	13.9	79,200
June 5	17.9	115,000	20	14.0	P 80,300
1914 May 25	13.1	67,000	1925 Apr. 21	11.60	53,500
1915 June 7-9	9.7	37,400	May 22	16.40	104,000
7	9.76	P 37,900	22	16.55	P 106,000
1916 May 9		67,400	July 4	12.45	62,200
22-23		53,100	1926 May 6	10.9	46,800
July 1-2	17.8	114,000	6	11.0	P 47,800
2	17.9	P 115,000	22	10.4	42,300
....	....	....	1927 May 2-3	10.5	43,200
1917 May 30	16.6	102,000	19-20	13.9	77,600
June 11-12	16.0	95,400	June 14	17.6	117,000
20	17.0	106,000	1928 May 28	18.4	126,000
1918 May 7	13.3	69,100	1929 May 26-27	12.70	64,400
17	12.8	64,400	June 11-12	12.90	66,400
June 16	16.4	99,500	11	12.95	P 67,400
16	16.45	P 100,000	1930 May 5	10.68	46,400
1919 May 3	9.6	36,600	June 1	10.76	47,300
31	13.8	73,800	1931 May 19	10.78	47,300
1920 May 23	12.1	58,000	1932 May 24	14.47	83,600
June 18-19	13.7	72,900	June 18	13.41	71,200
18	13.80	P 73,800	1933 June 17	17.88	119,000
1921 May 28	15.90	99,000	17	18.00	P 120,000
28	16.0	P 100,000	1934 Mar. 31	8.96	33,300
June 9-10	15.9	99,000	Apr.30-May 1	13.8	74,800
1922 May 28	15.1	90,500	May 10	13.99	76,800
June 9	17.1	113,000			

** Last reading before or first reading after break in record; may not be peak.
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: May 7 to July 8, 1911; Oct. 1, 1916, to May 11, 1917.

Flathead River near Polson, Mont.

Location.- In sec. 19, T. 22 N., R. 21 W., at highway bridge at site of Old Mischell ferry at Norrisvale, 5 miles below Newell Tunnel, 12 miles below Polson, and 15 miles northwest of Ronan.
Drainage area.- 7,010 square miles.
Records available.- July 1907 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily prior to January 1922; to hundredths once daily January 1922 to Nov. 23, 1928; recording gage thereafter.
Stage-discharge relation.- Not seriously affected by ice. Control practically permanent. Banks not subject to overflow.
Storage, regulation, and diversions.- Natural regulation in Flathead Lake. Small diversions.
Remarks.- During short breaks in record or periods of unsatisfactory record, gage heights computed from relation to stations on Flathead Lake at Polson and Flathead River at Newell Tunnel (U. S. Bureau of Reclamation gage).

Flood stages and discharges of Flathead River near Polson, Mont.
(Base discharge 10,000 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1907 July 23	9.2	** 26,600	July 19	7.9	22,000
1908 May 17-19	10.4	33,600	1923 June 15	13.43	55,900
June 12-15	14.6	62,100	1924 May 26	12.09	47,000
Aug. 6-7	6.9	14,900	June 10	11.59	43,700
1909 June 22-23	13.75	58,800	1925 Apr. 21	9.8	32,700
July 24	8.75	25,300	May 25-27	15.0	67,000
Dec. 2	5.55	10,500	25, 26	15.02 P	67,100
1910 May 15-16	11.55	42,800	1926 May 8-9	9.22	29,300
May 27-June 3	11.00	38,900	Oct. 22-Nov. 1	5.3	10,300
1911 May 22	9.7	30,400	Dec. 11-12	5.2	10,000
June 20	11.9	44,200	1927 June 19-20	16.1	75,000
1912 June 15		* 36,500	Sept. 18-21	5.4	10,700
1913 June 10	16.4	75,400	Oct. 24	6.0	12,400
1914 May 26	11.4	41,000	....	...	......
1915 May 16	8.0	21,000	Dec. 20	6.5	14,500
July 1-6	7.6	19,000	....	...	......
1916 May 15-16	9.6	29,800	1928 May 29-30	17.1	82,100
July 1	16.3	74,700	1929 June 11-16	11.62	44,600
Sept. 14	6.3	13,200	13	11.70 P	45,500
1917 June 23	14.1	59,100	1930 May 7-9	9.50	28,200
1918 Jan. 9	5.8	11,300	June 9-14	9.82	30,300
May 19	10.4	34,600	11	9.98 P	31,700
June 19-21	14.0	58,400	1931 May 20	10.48	35,400
1919 May 6	8.2	22,000	1932 May 24	13.60 P	51,800
June 1	12.5	48,200	25	13.46	51,200
1920 May 27	9.50	29,300	1933 June 19-20	17.14	76,600
June 23-25	11.9	44,200	19	17.25 P	77,400
1921 June 11	14.3	62,000	1934 May 11-13	13.2	51,500
1922 June 10-11	13.5	56,400	12	13.3 P	52,200
28	11.95	46,100			

* Estimated
** May not be peak; first day of record.
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Nov. 4 to Dec. 4, 1927, and Dec. 24, 1927, to Mar. 31, 1928.

Boise River near Twin Springs, Idaho

Location.- In sec. 27, T. 4 N., R. 6 E., a quarter of a mile above Birch Creek, 1½ miles above flow line of Arrowrock Reservoir, 4 miles below Twin Springs, and 13 miles above Arrowrock.
Drainage area.- 830 square miles.
Records available.- March 1911 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage prior to Apr. 4, 1915; recording gage thereafter.
Stage-discharge relation.- Affected by ice. Control practically permanent; shifts only in extreme floods. Banks not overflowed.

Flood stages and discharges
(Base discharge 2,850 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1911 Apr. 27-28	4.7	3,430	May 28	7.0	7,220
May 5	5.4	4,550	1914 Apr. 12	4.6	3,270
16-18	5.2	4,230	16	5.5	4,710
23-25	5.1	4,070	21		4,000
June 4	6.2	5,860	May 4	5.0	3,910
8	6.5	6,370	10	5.4	4,550
13	7.2	7,560	23	6.0	5,520
1912 Apr. 10	4.7	3,430	June 3	5.7	5,030
May 19	7.0	7,220	20-21	4.5	3,120
26-27	6.2	5,860	1915 May 19	4.55	3,030
June 8-9	7.2	7,560	19	4.62 P	3,140
13	7.4	7,900	1916 Apr. 12	5.0	3,990
21	5.7	5,030	27	6.1	6,030
1913 Apr. 15	5.0	3,910	May 7	6.8	7,390
22	4.8	3,590	21	5.0	3,990
28	4.7	3,430	June 10	5.9	5,650
May 10	5.8	5,190	19	7.1	7,990
19	4.9	3,750	19	7.37 P	8,530

Flood stages and discharges of Boise River near Twin Springs, Idaho--Continued

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1916 June 28	5.7	5,270	1924 May 17	4.38	2,850
July 2	5.35	4,630	17	4.51	P 3,000
9	5.25	4,440	1925 Apr. 12	5.65	4,940
1917 Apr. 27	4.50	3,110	17	5.57	4,940
May 15	7.3	8,390	May 7	6.05	5,700
15	7.82	P 9,430	20	6.59	6,860
29	5.9	5,650	20	6.69	P 7,060
June 10	6.3	6,410	29	6.09	5,890
18	6.8	7,390	June 21	5.17	** 4,130
Dec. 28	4.6	3,280	1926 May 5	4.97	3,640
1918 Apr. 25	4.65	3,360	5	5.29	P 4,250
May 5	5.9	5,650	1927 Apr. 30	6.20	5,920
15-16	4.65	3,360	May 17	7.94	9,400
June 13	6.9	7,590	17	8.30	P 10,300
14	7.10	P 7,990	27	5.04	3,820
1919 Apr. 25	5.58	5,080	June 8	7.48	8,560
29	5.45	4,800	26	6.54	6,510
May 22-23	6.01	5,840	1928 Apr. 28	5.68	4,970
29	7.08	7,990	May 1-2	5.42	4,430
29	7.50	P 8,790	10-11	7.68	8,980
June 7	4.45	3,020	10	7.93	P 9,400
1920 May 16-17	5.81	5,460	26	7.33	8,140
17	6.04	P 5,840	1929 May 24	5.67	5,130
29-30	4.87	3,720	24	5.81	P 5,320
June 8	5.23	4,440	June 10	4.57	3,080
16	5.14	4,260	16	5.18	4,220
1921 Apr. 3	4.62	3,280	1930 Apr. 25	4.51	3,000
13	4.43	3,020	May 29	4.88	3,680
23	4.49	3,110	29	5.0	P 3,860
May 17	7.38	8,600	June 11	4.83	3,540
27	7.00	7,790	1931 May 7	4.41	2,870
June 12	7.37	8,600	7	4.52	P 3,020
12	7.67	P 9,210	1932 Apr. 14	4.69	3,340
24	5.44	4,810	May 14	6.70	7,060
1922 Apr. 28	4.72	3,330	14	6.87	P 7,460
May 6	5.40	4,580	21	6.34	6,270
18-20	6.52	6,660	June 5	4.73	3,240
25	6.76	7,260	15-16	5.58	4,760
June 6	6.95	7,660	23	5.65	4,940
7	7.10	P 7,860	1933 Apr. 29	5.05	3,770
14	6.67	7,060	June 1	6.34	6,270
1923 May 9-10	5.21	4,220	14-16	6.59	6,660
26	6.21	6,080	16	6.91	P 7,260
June 12	5.80	5,320	1934 Mar. 29	4.82	3,440
22	4.60	3,160	29	4.96	P 3,680
July 1	4.71	3,330	Apr. 24	4.48	2,970

** May not be peak; last reading before short break in record.
Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

South Fork of Boise River near Lenox, Idaho

Location.- In NW¼ sec. 24, T. 2 N., R. 6 E., 1½ miles above mouth of Smith Creek, 4 miles above flow line at Arrowrock Reservoir, 4 miles west of discontinued Lenox post office, 13 miles above mouth of river, and 17 miles above Arrowrock Dam.
Drainage area.- 1,090 square miles.
Records available.- March 1911 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage prior to Apr. 11, 1915; recording gage thereafter.
Stage-discharge relation.- Not seriously affected by ice. Control practically permanent, but shifting control method used occasionally.
Remarks.- This station was published for 1911 as near Prairie.

Flood stages and discharges
(Base discharge 3,300 second-feet)

Date	Gage height (feet)	Discharge (second-feet)	Date	Gage height (feet)	Discharge (second-feet)
1911 Apr. 28	6.6	3,790	June 4	8.0	5,870
May 6	7.7	5,480	13	8.4	6,420
16	7.3	4,960	1912 May 20	7.8	5,800
24-25	6.8	4,310	26-27	7.0	4,700

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Flood stages and discharges of
South Fork of Boise River near Lenox, Idaho--Continued

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1912	June	8-10	7.6		5,520		May	20	8.68		6,500
		21	6.1		3,520			26	8.89		6,680
1913	May	10	6.8		4,210			26	9.05	P	7,060
		28-30	7.7		5,440		June	6-7	8.44		5,760
1914	Apr.	16	7.4		4,880			14	7.96		5,580
		21	7.0		4,220	1923	May	10	6.71		3,960
	May	4	7.1		4,360			26	7.29		4,910
		23	7.9		5,450			26	7.42	P	5,080
	June	2	6.5		3,560		June	12	6.80		4,100
1915	May	19	5.15	**	2,050	1924	May	16	5.07	**	2,000
1916	Apr.	12	6.8		4,150	1925	Apr.	12-13	7.40		5,080
		27	8.0		6,240		May	7-8	7.71		5,620
	May	7	8.5		7,180			21	8.17		6,560
		7	8.68	P	7,530			21	8.25	P	6,660
		21-22	6.5		3,690		June	22	6.45		3,590
	June	10	7.2		4,810	1926	May	5	5.75	**	2,660
		19	7.8		5,880	1927	Apr.	30-May 1	8.02		5,390
		28	6.5		3,690		May	17	9.79		7,990
1917	May	15	9.3		8,740			17	10.1	P	8,440
		15	9.53	P	9,200			27-28	7.00		4,080
		24	7.8		5,880		June	8	8.61		6,230
		29-30	7.8		5,880			13	8.40		6,290
	June	10	8.2		6,620	1928	Apr.	28	6.66		3,950
		18	8.3		6,810		May	10-12	8.63		7,360
1918	May	5	6.7		3,990			11	8.7	P	7,570
	June	13	7.2		4,810			26	7.99		6,180
		13	7.33	P	5,040	1929	May	24-25	6.36		3,440
1919	Apr.	25	7.05		4,470			25	6.48	P	3,660
		29-30	6.96		4,470	1930	May	30	6.26		3,300
	May	29	7.23		4,810			30	6.33	P	3,440
		29	7.56	P	5,520	1931	May	15-16	5.06	**	2,000
1920	May	17	6.33		3,460	1932	May	14	7.60		5,550
		17	6.42	P	3,640			14	7.69	P	5,730
1921	Apr.	23	6.32		3,460			21	7.47		5,370
	May	17	9.14		8,420		June	6	6.27		3,380
		17	9.44	P	9,020			16	7.05		4,510
		27	8.82		6,870	1933	Apr.	9	6.46		3,660
	June	9	9.01		6,870		June	3	7.31		5,020
		24	6.68		3,540			3	7.4	P	5,190
1922	Apr.	28	6.63		3,680			13-16	7.05		4,510
	May	6-7	7.74		5,240	1934	Mar.	29		**	2,000

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Clearwater River at Kamiah, Idaho

Location.- In sec. 1, T. 33 N., R. 3 E., at highway bridge at Kamiah, 6 miles below mouth of South Fork of Clearwater River.
Drainage area.- 4,850 square miles.
Records available.- August 1910 to September 1934.
Sources of data.- Gage-height records prior to Jan. 1, 1912, and all discharge records by U. S. Geological Survey; gage-height records subsequent to Jan. 1, 1912, by U. S. Weather Bureau.
Gages.- Nonrecording gage read to tenths once daily prior to July 28, 1929; to hundredths once daily thereafter; supplemented by recording gage Mar. 3 to May 20, 1934.
Stage-discharge relation.- Usually affected by ice. Control practically permanent. Bank-full stage, about 12 feet.
Diversions.- Small diversions above station.

Flood stages and discharges
(Base discharge 28,200 second-feet)

Date			Gage height (feet)		Discharge (second-feet)	Date			Gage height (feet)		Discharge (second-feet)
1911	May	6	10.8		34,600	1912	May	21	13.4		53,600
		17	10.0		29,400			27	13.2		52,000
	June	4	11.0		35,900			30	14.2		60,200
		8	10.6		33,200		June	9	13.7		56,000
		13	11.1		36,600			9	13.95	P	58,100
		13	11.5	P	40,500			21	11.0		35,900

Flood stages and discharges of Clearwater River at Kamiah, Idaho--Continued

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1913 Apr.	20	10.0	29,400	June	12	12.1	43,200
	27	10.2	30,700	1924 May	4	12.4	45,600
May	11	12.4	45,800		13	14.0	58,900
	26	16.1	76,600	1925 Apr.	13	11.8	41,000
June	2	14.9	66,200		17	11.9	41,800
1914 May	18	11.9	42,200	May	7	12.3	44,800
	23	11.8	41,500		20	14.1	59,800
	30	9.8	28,200	1926 Apr.	19	11.1	35,900
June	3	10.2	30,700	May	1	11.1	35,900
1915 May	19	9.8	28,200		21	10.6	32,400
1916 Apr.	28	10.1	30,000	1927 Apr.	28	12.4	46,400
May	7	12.2	44,400	May	17	14.5	64,200
June	5	11.1	36,600	June	8	15.0	68,600
	9	11.1	36,600	Nov.	5	12.2	43,900
	19	13.7	56,000		26	10.1	29,200
	29	11.1	36,600	1928 Apr.	29	10.6	32,400
1917 May	15	14.7	63,600	May	1	10.7	33,100
	30	15.4	69,700		9	14.8	65,700
June	9	13.8	56,800		26	15.5	72,100
	17	15.4	70,500	1929 May	24	13.0	50,200
	21	14.9	66,200		24	13.28	P 52,700
Dec.	29-30	11.3	37,300	June	1	10.0	28,500
1918 May	5	13.3	52,800		9	11.1	35,800
	15	10.9	35,200	1930 Apr.	25	10.45	31,000
June	10	13.3	52,800	1931 May	7	11.77	40,800
1919 Apr.	29	10.3	30,700		14	11.23	36,500
May	23	13.3	52,000		16	11.15	36,500
	29	12.4	45,100	1932 Apr.	14	10.04	28,500
1920 May	9	10.8	35,200	May	14	15.54	72,100
	18	12.0	43,600		21	14.44	62,200
	29	10.0	30,000	June	13-15	11.04	35,100
June	9	11.5	40,000	1933 Apr.	27	11.13	35,800
	16	11.9	42,900	June	4	15.43	71,200
1921 Apr.	23	10.9	35,200		10	16.53	81,400
May	20	15.3	69,700		14	15.83	74,900
June	4	13.2	51,800	Dec.	23	11.97	42,100
1922 May	19	14.2	60,600		23	12.19	P 43,600
	26	13.2	52,100	1934 Mar.	30	9.57	28,400
June	6	14.4	62,400	Apr.	14	10.48	33,600
1923 May	8-10	11.5	38,800		24-25	12.03	39,900
	26	12.9	49,600	May	8	10.43	29,700
June	2	10.2	29,600				

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Umatilla River near Umatilla, Oreg.

Location.- In $NW\frac{1}{4}$ sec. 21, T. 5 N., R. 28 E., $1\frac{1}{2}$ miles below West Division Main Canal of Umatilla project and 2 miles above Umatilla and mouth of river.

Drainage area.- 2,280 square miles.

Records available.- October 1903 to September 1934.

Sources of data.- Gage-height records by U. S. Bureau of Reclamation 1903 to June 30, 1926; by West Extension Irrigation District July 1, 1926, to Jan. 22, 1931. Subsequent gage-height records and all discharge records by U. S. Geological Survey; collaboration by State engineer of Oregon subsequent to Sept. 30, 1925.

Gages.- Nonrecording gage read once daily during floods and less often at lower stages prior to Jan. 21, 1931; recording gage thereafter.

Stage-discharge relation.- Permanent except as affected by ice. Banks high and not subject to overflow.

Storage and diversions.- Storage in McKay, Furnish, and Cold Spring Reservoirs. Considerable diversions for irrigation above station.

Remarks.- Discharges for gage heights above 5.7 feet revised from previously published figures.

Flood stages and discharges
(Base discharge 3,000 second-feet)

Date		Gage height (feet)	Discharge (second-feet)	Date		Gage height (feet)	Discharge (second-feet)
1904 Mar.	9	7.30	8,140	Apr.	21	5.80	4,460
	30	6.45	5,830	1905 Mar.	28-29	4.3	** 1,890
Apr.	15	7.65	9,010	1906 Apr.	1	5.4	3,680

** Below base

Flood stages and discharges of Umatilla River near Umatilla, Oreg.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1906	May	31	10.2		16,800
		31	11.0	P	19,600
	Dec.	22	6.1		5,140
1907	Feb.	7	6.3		5,600
	Mar.	21-23	5.5		3,860
	Apr.	11	5.9		4,680
	Dec.	25		*	3,000
1908	Mar.	16	8.0		10,200
1909	Jan.	19	6.0		4,910
1910	Mar.	4	6.5		6,060
		21	6.5		6,060
1911	May	20	4.5	**	2,130
1912	Jan.	15	5.5		3,860
	Feb.	19	5.2		3,310
	Apr.	5	5.2		3,310
		13-14	5.6		4,050
	May	4	6.0		4,910
1913	Feb.	18	5.8		4,460
	Mar.	19	5.1		3,140
		31	7.7		9,300
	Apr.	6	5.5		3,860
		14	6.8		6,790
		20	5.8		4,460
1914	Mar.	2	5.1		3,140
1915	Apr.	3	4.7	**	2,450
1916	Jan.	24	5.8		4,460
	Feb.	11	7.7		9,300
	Mar.	11	6.6		6,300
		21	5.8		4,460
		28	5.1		3,140
	May	27	5.7		4,260
1917	Apr.	9	7.1		7,570
		12	6.4		5,830
		27	7.9		9,880
		27	8.0	P	10,200
	May	14	7.8		9,590
		14	8.0	P	10,200
		31	6.1		5,140
	Dec.	29		*	6,500
1918	Jan.	18-19		*	3,060
		26		*	5,050
	Mar.	26	5.1	*	3,100
....			...		.....
1919	Apr.	1		* #	3,600
		5		*	4,680
		12		*	3,060
	Dec.	21	6.6		6,300
1920	Jan.	18	5.20		3,310
		27	5.10		3,140
	Apr.	6	6.50		6,060
		11	6.35		5,720
		14	6.80		6,790
	Dec.	31	6.60		6,300
1921	Jan.	3			7,340
		3		P	8,300
	Feb.	11-12	6.70		6,540
		15	6.20		5,370
	Mar.	5	5.85		4,570
		19	6.75		6,790
	Dec.	1			5,340
1922	Apr.	5	5.95		4,800
		9	6.20		5,370
		23	6.15		5,260
	May	6	5.10		3,140
1923	Jan.	7	5.10		3,130
1924	Feb.	1	5.65		4,050
		9	5.60		4,050
1925	Jan.	2	5.20		3,310
	Feb.	5-6	5.75		4,460
1926	Feb.	7	5.80		4,460
		7	6.00	P	4,910
1927	Apr.	27-28	5.32		3,490
	Nov.	26	5.62		4,200
1928	Jan.	9	5.21		3,410
		14	6.10		5,140
		31	5.04		3,050
	Mar.	12	5.55		4,200
	Apr.	2	5.80		4,460
		16	5.10		3,230
1929	Mar.	22	5.30		3,600
1930	Mar.	26	4.80	**	2,590
1931	Apr.	2	8.06		10,500
		2	9.60	P	14,900
1932	Feb.	28	5.22		3,180
	Mar.	7	5.75		4,350
		19	8.78	P	12,500
		20	7.95		10,200
		26	5.50		3,810
	Apr.	3	5.56		3,920
		15	5.74		4,350
1933	May	5-6	5.10	**	2,970
1934	Mar.	7	5.17		3,080
		7	5.28	P	3,390

* Estimated
** Below base
\# First reading after break; may not be peak.

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak). Records fragmentary Mar. 1-31, 1919.

John Day River at McDonald Ferry, Oreg.

Location.- In NW¼ sec. 11, T. 1 N., R. 19 E., at McDonald Ferry, half a mile below mouth of Rock Creek.
Drainage area.- 7,580 square miles.
Records available.- November 1904 to September 1934.
Source of data.- U. S. Geological Survey.
Gages.- Nonrecording gage usually read to quarter-tenths twice daily (oftener during floods) prior to Aug. 30, 1930; recording gage thereafter.
Stage-discharge relation.- Affected by ice. Control shifts slightly. Banks not subject to overflow.
Diversions.- Many diversions for irrigation.
Remarks.- Record published prior to 1931 as John Day River at McDonald, Oreg.
Historical data.- Maximum known stage, 12.8 feet probably in 1894 (estimated discharge, 33,000 second-feet).

Flood stages and discharges of John Day River at McDonald Ferry, Oreg.
(Base discharge 7,250 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1905	May	10	4.77	#	5,130
1906	Mar.	26	6.55		9,730
	Apr.	1	7.50		12,700
		8	6.00		8,150
	May	31	7.85		13,800
	June	6	6.82		10,500
1907	Feb.	2	5.7		7,320
		6	10.38		22,800
		27	5.85		7,730
	Mar.	21	8.80		17,100
	Apr.	18	7.85		13,800
1908	Mar.	17	7.15		11,600
	Apr.	22	5.75		7,460
1909	Jan.	18	6.05	# *	6,220
1910	Mar.	3	7.8		14,000
		3	8.4	P	16,000
		21	7.8		14,000
		24	7.75		13,800
1911	Mar.	24-25	5.8		7,910
1912	Jan.	14	5.8		7,910
		27	6.1		8,780
	Feb.	19	5.9		8,200
	Mar.	29	5.6		7,350
	Apr.	5	6.7		10,600
		12	7.6		13,400
		19	5.9		8,200
		26	6.4		9,670
	May	3	7.3		12,400
		11	7.9		14,300
		28	7.0		11,500
		31	7.6		13,400
	June	14-15	5.9		8,200
1913	Apr.	2	6.8		10,900
		6	6.3		9,370
		14	7.4		12,700
		17	7.3		12,400
		21	7.5		13,000
		28	6.5		9,970
	May	10	6.8		10,900
		20	5.7		7,630
		29-30	5.8		7,910
	June	8	5.9		8,200
1914	Mar.	9	6.0		8,300
		19	6.0		8,300
	Apr.	7	5.9		8,010
		12	6.0		8,300
		17	6.8		10,700
		17	6.95.	P	11,100
1915	Apr.	5	5.0	#	5,620
1916	Feb.	11	8.6		16,800
		11	9.2	P	18,900
	Mar.	13	7.6		13,300
		21	8.1		15,000
	Apr.	3	6.1		8,440
		12	7.1		11,600
		28-29	6.6		10,000
	May	7-8	6.5		9,700
		21	5.7		7,260
		27	6.3		9,060
1917	Apr.	9	8.55		16,800
		12	7.81		14,000
		27	9.4		20,800
		27	9.6	P	22,600
	May	14	9.4		20,800
		26	6.6		10,500
		31	7.6		14,000
	June	10	6.5		10,200
		18-19	5.9		8,280
1918	Feb.	8	6.40		9,880
		8	6.80	P	11,200
	Mar.	27	6.22		9,240
1919	Apr.	5	8.0		15,400
		5	8.5	P	17,200
	Apr.	12	6.78		11,200
		26	6.70		10,900
	Dec.	21	5.9		8,280
		26	5.55		7,360
1920	Apr.	10-11	6.64		10,500
		14	6.65		10,500
	Apr.	30-May 1	5.92		8,280
	May	11	6.6		10,500
1921	Jan.	4	6.50		10,200
	Feb.	15	8.50		17,200
		15	8.8	P	18,400
	Mar.	5	7.75		14,700
		19	7.10		12,200
	Apr.	4	6.30		9,560
		13	6.60		10,500
		24	6.55		10,500
		30	7.20		12,600
	May	20	7.50		13,600
	Dec.	2	6.00		8,600
1922	Mar.	25	5.9		8,180
	Apr.	4	7.9		15,000
		9-10	8.2		16,100
		16	6.55		10,500
		23	8.3		16,400
	May	7	6.95		11,900
		20	8.1		15,800
	June	11-12	6.25		9,180
1923	Jan.	8	6.0		8,500
	Apr.	1-2	5.65		7,260
		9	5.85		7,860
		19	6.55		10,500
	May	11-12	6.0		8,500
1924	Feb.	9	6.32		9,180
1925	Feb.	6	7.62		14,000
		6	7.92	P	15,000
	Apr.	13	6.68		10,500
		18	6.55		10,200
	May	22	6.02		8,500
1926	Feb.	8	5.68		7,560
		8	5.9	P	8,180
1927	Feb.	22	6.30		10,000
	Apr.	28	7.02		12,500
		28	7.12	P	12,900
	May	18	5.63		7,590
	June	10	6.95		12,500
1928	Jan.	15	6.64		11,100
		15	7.04	P	12,500
		31	5.63		7,590
	Mar.	13	6.06		9,300
		24	6.64		11,100
		28	6.62		11,100
	Apr.	2	6.16		9,650
		29	6.06		9,300
	May	10	6.08		9,300
1929	Mar.	23	5.54		7,250
		23	5.8	P	8,270
1930	Feb.	22	3.86	#	3,500
1931	Apr.	2	6.48		10,700
		2	6.84	P	11,800
1932	Feb.	29	6.07		9,290
	Mar.	20	10.07		22,900
		20	10.60	P	24,900
		26	6.75		10,500
		30	5.99		8,060
	Apr.	4	6.72		10,200
		15	6.96		11,200
	May	15	6.47		9,590
1933	Apr.	29	5.88		7,760
		29	5.97	P	8,060
	May	6	5.76		7,470
	June	1		*	8,000
	Dec.	28	4.20	#	3,460

Below base
* Estimated

Note.- All discharge quantities are average daily flows except as designated by "p" (momentary peak).

Deschutes River at Moody near Biggs, Oreg.

Location.- In SE¼ sec. 26, T. 2 N., R. 15 E., at Moody, 1½ miles above mouth and 5 miles southwest of Biggs.
Drainage area.- 10,500 square miles.
Records available.- October 1897 to December 1899, July 1906 to September 1934 (records incomplete 1908 and 1910).
Sources of data.- U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths or half-tenths once daily (sometimes oftener during floods) prior to 1925; to quarter-tenths once daily 1925 to July 18, 1930; recording gage thereafter.
Stage-discharge relation.- Not affected by ice. Control shifts slightly at high stages.
Diversions.- Diversions for irrigation materially reduce flow, being progressively greater during period of record and probably reaching about 20 percent of summer flow by 1926.
Remarks.- Records 1897-99 taken at Moro about 7 miles upstream, but discharges are comparable.

Flood stages and discharges
(Base discharge 9,800 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1897	Dec.	14	4.1		11,700
1898	Feb.	16	3.8		10,800
1899	Jan.	22	4.1		11,700
	Feb.	10	5.0		14,400
	Mar.	1	5.5		16,000
		26	3.5		10,000
	Apr.	14	4.9		14,100
		23-24	4.1		11,700
	May	12-13	4.4		12,600
	May 31-June 3		4.0		11,400
	Nov.	28-30	4.1		11,700
	Dec.	14-15	4.1		11,700
....			...		......
1906	Nov.	15	4.10		12,200
1907	Jan.	4	3.98		11,600
	Feb.	6	7.50		30,600
		23-24	4.33		13,300
	Mar.	22	4.75		15,500
	Apr.	9-13	4.50		14,200
	Dec.	27	6.00		22,200
1908	Mar.	16	4.80		15,800
	Apr.	19	3.65		10,100
....			....		......
1909	Jan.	20	4.50		14,200
	Feb.	18	4.00		11,700
	Mar.	30	3.70		10,300
	Nov.	24	6.70		26,000
	Dec.	13	4.20		12,700
1910	Jan.	15	3.6		9,860
		25	5.3		18,400
	Feb.	26	4.65		15,000
	Mar.	2	6.85		26,900
....			....		......
1911	Mar.	24-25	3.7		10,300
	Apr.	2	3.8		10,800
1912	Jan.	14	5.2		17,900
		28-29	3.7		10,300
	Feb.	13	3.7		10,300
		18-19	4.7		15,200
	Apr.	11-13	4.0		11,700
	May	14-17	3.8		10,800
1913	Jan.	25	4.1		12,200
	Apr.	1-2	3.9		11,200
		14	4.4		13,700
1914	Jan.	22	4.1		11,800
	Mar.	2	3.7		9,850
		17-20	4.0		11,300
	Apr.	7	3.8		10,300
		17	3.9		10,800
1915	Apr.	4	3.7		9,850
1916	Feb.	10	7.4	P	27,000
		11	6.7		23,500
	Mar.	14	4.8		14,100
		21-22	5.5		17,500
	Apr.	12	4.4		12,300
1917	Apr.	12	4.0		10,500
	Apr.	30	4.8		14,500
	May	14	4.5		13,000
	Dec.	19	4.90		15,100
		29	5.30		17,500
1918	Feb.	7	4.00		10,500
1919	Apr.	6	4.6		13,500
		13	4.0		10,500
	Dec.	21	4.1		11,000
		24-25	4.0		10,500
1920	Jan.	27	5.1		16,300
		27	5.2	P	16,900
	Dec.	31	3.95		10,300
1921	Jan.	3	4.78		14,300
		3	4.85	P	14,600
	Feb.	13	4.48		12,800
	Mar.	6	4.15		11,300
		19	4.50		12,800
	Nov.	22	4.70		13,800
		27	3.95		10,300
	Dec.	1	6.40		22,900
1922	Mar.	23-24	4.00		10,300
	Apr.	4	4.0		10,300
		25-27	4.2		11,300
	May	17-19	4.0		10,300
1923	Jan.	7	9.3		37,800
		7	10.2	P	43,600
	Apr.	2-5	4.1		9,860
		19	4.1		9,860
1924	Feb.	1-2	3.65	**	8,240
	Nov.	22	4.0		9,800
1925	Feb.	6	5.95		19,200
	Apr.	17	4.0		9,800
	May	21	4.25		10,600
1926	Feb.	7	4.80		13,300
	Nov.	29	4.60		12,400
1927	Feb.	2	4.5		12,000
		21	7.1		25,200
		21	8.4	P	32,400
	Mar.	3	3.95		9,800
	Apr.	29	4.40		11,500
	Nov.	26	4.08		10,200
1928	Jan.	12	4.25		10,600
	Mar.	12	4.28		11,000
		25	4.40		11,500
1929	Mar.	2	3.38	**	7,400
1930	Feb.	2	3.69	**	8,550
1931	Apr.	1			14,200
		1	5.26	P	15,700
1932	Mar.	21	4.60		12,400
1933	June	10	3.98		9,800
		10	4.03	P	10,000
	Dec.	23	4.65		12,400
		23	4.76	P	13,300
1934	Jan.	24	4.12		10,200
		24	4.35	P	11,200

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Klickitat River near Glenwood, Wash.

<u>Location</u>.- Oct. 29, 1909, to Dec. 16, 1910, in SW$\frac{1}{4}$ sec. 11, T. 7 N., R. 12 E., about 2 miles below mouth of Big Muddy Creek and about 7 miles north of Glenwood; Dec. 17, 1910, to Sept. 30, 1934, in SE$\frac{1}{4}$ sec. 14, half a mile below Dairy Creek, 5 miles north of Glenwood, and about 1 mile below former location.
<u>Drainage area</u>.- 350 square miles Oct. 29, 1909, to Dec. 16, 1910; 356 square miles thereafter.
<u>Records available</u>.- October 1909 to September 1934, except winters of 1920-21 to 1924-25 and 1927-28, and June 28, 1926, to Apr. 1, 1927.
<u>Sources of data</u>.- Gage-height record prior to Apr. 1, 1913, by Klickitat Valley Development Co. Gage-height record thereafter and all discharge records by U. S. Geological Survey.
<u>Gages</u>.- Nonrecording gage prior to July 19, 1910; recording gage thereafter. Datum lowered 1.0 foot Oct. 1, 1918, raised 0.50 foot Nov. 7, 1928, and lowered 1.0 foot July 15, 1934 (applicable as of Oct. 1, 1934). Zero of present gage is 1,703.71 feet above mean sea level.
<u>Stage-discharge relation</u>.- Control shifts during high flows.

Flood stages and discharges
(Base discharge 2,100 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1909	Nov.	3	3.10		2,100
		24	5.20		6,250
		30	3.40		3,700
1910	Jan.	25	2.40		2,280
	Mar.	3	2.45		2,350
		20-22	3.25		3,490
	Apr.	25	3.20		3,410
	May	10	3.15		3,340
		24	2.40		2,280
1911	June	2	2.62		2,750
		13	2.55		2,700
1912	May	15	2.76		2,620
		15	2.87	P	3,150
		20	2.68		2,490
		27	2.50		2,220
	June	8	2.44		2,140
1913	May	10	2.64		2,210
		27	3.14		2,980
	June	3	3.22		3,120
		3	3.33	P	3,560
1914	Jan.	7	2.86		2,780
		7	2.93	P	2,870
	Apr.	15	2.90		2,740
		20	2.75		2,500
	May	3	2.80		2,580
		15	2.90		2,740
1915	Apr.	3	2.55		2,100
		3	2.62	P	2,200
1916	May	5	3.20		3,400
		20-21	2.45		2,280
		28	2.60		2,520
	June	9	3.05		3,290
		18	3.40		4,490
		18	3.47	P	4,620
		27	2.60		3,070
	July	2	2.95		3,670
		9	2.45		2,820
		16	2.40		2,730
1917	May	14	2.09		2,240
		29-30	2.67		2,900
	June	9	2.82		3,140
		9	2.90	P	3,300
		16	2.80		3,140
	Dec.	18		*	4,600
		23-24		*	2,400
		29	3.8	*	5,500
		29	4.2	P	6,200
1918	May	4	1.72	**	2,070
1919	Jan.	23	3.98		4,100
		23	4.26	P	4,600
	May	1-2	2.92		2,240
		22	3.08		2,560
	May	27	3.30		2,710
1920	May	17	2.50	**	1,700
	Nov.	18-19	2.87		2,190
.....	.....	.....	....		.....
1921	May	25-26	3.78		3,590
		25	3.90	P	3,770
	June	4,5,7	3.90	P	3,770
		5-7	3.87		3,680
.....	.....	.....	....		.....
	Dec.	13	3.33	#	2,510
.....	.....	.....	....		.....
1922	May	18	3.70		3,080
	June	5	3.83		3,340
		5	3.90	P	3,420
.....	.....	.....	....		.....
1923	May	9	3.74	P	3,160
		10	3.63		3,000
	June	10	3.22		2,280
.....	.....	.....	....		.....
1924	May	13-14	3.25		2,160
		13	3.28	P	2,230
.....	.....	.....	....		.....
1927	Apr.	28	3.44		2,470
	May	8	3.83		3,580
		8	4.18	P	4,490
		16	3.79		3,450
	June	8	4.13		4,360
	Nov.	25	3.22		2,180
.....	.....	.....	....		.....
1928	May	21	3.63		3,100
1929	May	23-24	3.76		2,500
		24	3.80	P	2,560
1930	Apr.	23	2.88	**	1,520
1931	May	2	3.70		2,150
		2	3.77	P	2,200
1932	May	10-11		*	2,500
		10	4.09	P	2,700
	Nov.	17	3.65		2,290
1933	Apr.	28-29	3.85		2,570
	May	26	3.94		2,710
		30	4.31		3,200
	June	5	4.31		3,200
		9	4.58		3,650
		9	4.76	P	3,950
		15	4.67		3,720
		15	4.76	P	3,950
	Dec.	10	4.57		3,580
		22			8,790
		22	6.9	P	9,870
1934	Jan.	3	2.16		2,180
		23	3.45		3,620
	Mar.	29	2.46		2,520

* Estimated
** Below base
\# First reading after break in record; may not be peak.

<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: Nov. 21, 1920, to May 21, 1921; Nov. 22 to Dec. 12, 1921; Dec. 19, 1921, to Apr. 8, 1922; Nov. 15, 1922, to Apr. 14, 1923; Nov. 26, 1923, to Apr. 19, 1924; Nov. 11, 1924, to May 24, 1925; June 28 to Aug. 3, 1925; May 21, 1926, to Mar. 31, 1927; Dec. 10, 1927, to May 14, 1928.

Bull Run River near Bull Run, Oreg.

<u>Location</u>.- Prior to July 28, 1909, in SE¼ sec. 26, T. 1 S., R. 5 E., about 100 feet above intake of Portland water supply pipe line and 4 miles east of Bull Run; thereafter in SE¼ sec. 25, about 1½ miles upstream.
<u>Drainage area</u>.- 102 square miles.
<u>Records available</u>.- January 1895 to December 1903, November 1904 to November 1906, August 1907 to September 1934.
<u>Sources of data</u>.- All gage-height records and discharge records prior to August 1907 by city of Portland; subsequent discharge records by U. S. Geological Survey.
<u>Gages</u>.- Nonrecording gage read to tenths daily prior to July 28, 1909; recording gage thereafter. Datum raised 2.00 feet July 26, 1916, and lowered 0.50 foot July 22, 1924. In this report all gage-height records at present location have been corrected to present datum.
<u>Stage-discharge relation</u>.- Seldom affected by ice. Control shifts in extreme floods.
<u>Storage</u>.- Storage in Bull Run Lake affects summer flow. Bull Run Reservoir (capacity, 26,930 acre-feet) about 3½ miles upstream, completed in 1929.
<u>Remarks</u>.- Unreliability of records prior to 1907 made it inadvisable to include them in this report.

Flood stages and discharges
(Base discharge 3,320 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1907	Nov.	22	5.12		3,500
		24	8.00		9,030
	Dec.	13	5.15		3,540
		22	7.1		7,050
1908	Mar.	15	8.8		10,900
	Dec.	28	5.18		3,590
1909	Jan.	19	6.50		5,860
	Nov.	2	9.10		8,360
		19	7.37		6,380
		22	9.90		9,490
		29	5.80		4,100
	Dec.	12	5.28		3,370
1910	Jan.	23			4,520
	Mar.	1			9,490
		1		P	10,400
	Nov.	10	5.60		3,820
		21			4,100
1911	Jan.	19	* 6.5		5,080
	Nov.	14	6.60		5,230
		19	5.80		4,100
1912	Jan.	11	10.55	P	11,400
		12			10,400
		29			3,960
	Feb.	16-17	5.90		4,240
	Nov.	12			4,520
	Dec.	30			4,270
1913	Jan.	1			4,610
	Mar.	29	7.1		5,980
		29	8.8	P	8,620
	Nov.	23	5.25		3,330
1914	Jan.	5	6.6		5,230
		5	7.30	P	6,280
		23			4,270
	Nov.	13			3,320
		13	5.3		3,400
1915	Nov.	17	6.6		5,380
		23			4,960
		25			7,920
	Dec.	21			8,830
		21	11.0	P	13,800
1916	Feb.	7			4,620
	Mar.	26	6.6		5,670
	Nov.	27			4,720
		27	7.90	P	7,970
1917	Jan.	5			4,400
	Dec.	13	* 10.10		12,900
		13	11.5	P	15,800
		18	* 9.40		11,400
		18	11.15	P	15,800
		22	* 5.40		3,770
		28	8.00		8,450
1918	Jan.	12	5.30		3,620
		16	5.30		3,620
	Feb.	6	6.02		4,700
	Dec.	14	5.07		3,410
1919	Jan.	17	6.25		4,920
		22	6.40		5,060
		22		P	6,400
	Mar.	2	5.73		4,380
	Nov.	4	7.45		8,240
		30	5.25		4,140
	Dec.	24	5.05		3,340
1920	Jan.	25	11.22	P	16,000
		26			9,890
	Mar.	13			4,280
	Apr.	5			4,550
	Dec.	28			6,480
		30			6,900
1921	Jan.	2	9.40		11,400
		2	11.20	P	15,000
	Feb.	10			8,080
	Mar.	17			7,500
	Apr.	22			4,910
		28	5.13		3,620
	Nov.	20			14,500
		20	13.56	P	20,200
		26	4.98		3,400
		30	9.5		11,600
1922	Dec.	24			7,900
		27	5.92		4,810
		31	* 5.10		3,540
1923	Jan.	5	12.87	P	18,700
		6	9.99		17,200
		10	4.45		3,900
	Dec.	6			6,000
		28	6.00		8,200
		28		P	15,300
1924	Jan.	30			4,300
	Feb.	4	4.97		3,700
	Nov.	2			4,100
		21			6,020
		21	8.35	P	9,400
	Dec.	29			4,980
1925	Jan.	5			3,630
		30-31	5.72		4,720
	Feb.	4			5,670
	Dec.	21	6.36		5,840
1926	Feb.	6			7,090
		6	8.75	P	10,200
		24	6.18		5,520
	Nov.	29			5,710
		29	8.3	P	10,200
1927	Jan.	2			4,360
	Feb.	2	4.65		3,530
		20			7,250
	Sept.	11	5.05		4,160
		29			4,200
	Oct.	3			4,360

* Estimated

Flood stages and discharges of Bull Run River near Bull Run, Oreg.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1927	Nov.	16			6,020
		25			10,600
		25	10.58	P*	15,000
		28	6.07		5,710
	Dec.	1	4.56		3,580
1928	Jan.	6	4.72		3,710
		13			4,870
	Mar.	11			5,910
		30-31	4.94		3,970
1929	Mar.	21		**	2,510
	Dec.	14			4,550
1930	Feb.	1			4,990
		1	7.84	P	8,020
		14	5.14		3,740
1931	Mar.	31			16,400
		31	13.8	P	20,600
1932	Feb.	27	5.61		3,610
	Mar.	6			3,830
		18			9,070
		18	10.2	P	12,300
		24			3,460
	Mar.	28			3,480
	Nov.	6			4,320
		8			3,860
		17	6.13		4,540
	Dec.	2	5.31		3,440
		26			4,060
1933	Jan.	5	5.99		4,390
		8	6.17		4,690
	June	9			6,820
		9	8.98	P	9,740
	Oct.	29			3,570
	Nov.	2			4,640
	Dec.	6			11,100
		6	10.8	P	13,900
		22	10.06		12,300
		22	11.2	P	14,700
		26	6.16		4,690
1934	Jan.	22	7.33		6,660
		22	7.80	P	7,610
	Mar.	2	5.66		3,970

* Estimated
** Below base
Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

Willamette River at Albany, Oreg.

Location.- In SW¼ sec. 6, T. 11 S., R. 3 W., at and near highway bridge in Albany, Linn County, just below mouth of Calapooya River.
Drainage area.- 4,840 square miles.
Records available.- November 1878 to April 1888 (fragmentary), January 1892 to September 1934.
Sources of data.- Gage-height records by U. S. Weather Bureau; discharge records by U. S. Geological Survey.
Gages.- Nonrecording gage read to tenths once daily (sometimes twice daily during floods) prior to Nov. 14, 1934; recording gage thereafter. Zero of gages is 171.70 feet above mean sea level (1929 general adjustment).
Stage-discharge relation.- High-water control permanent. Bank-full stage, about 17 feet.
Diversions.- Water diverted into basin through Albany Power Canal.
Remarks.- Discharge records prior to 1932 revised from previously published figures above 48,000 second-feet.
Historical data.- Maximum known flood about Dec. 8, 1861, stage 36.0 feet (estimated discharge, 274,000 second-feet). Second largest flood Feb. 4, 1890, during break in record, stage 33.8 feet (estimated discharge, 243,000 second-feet).

Flood stages and discharges
(Base discharge 50,000 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1879	Jan.	25	13.7		51,100
	Feb.	14	14.5		55,200
	Mar.	12	14.4		54,700
		28	22.6		109,000
	Dec.	7	23.5		118,000
		18	13.5		50,200
1880	Jan.	4	23.0		113,000
		8	21.2		97,600
....			....		......
	Dec.	31	14.3		54,100
1881	Jan.	14	32.5		225,000
		14	32.8	P	229,000
		16	30.5		198,000
	Feb.	5	27.7		162,000
	Mar.	2	19.5		84,900
....			....		......
	Nov.	1	15.4	#	59,900
	Dec.	29	15.4		59,900
1882	Jan.	7	15.0		57,800
	Mar.	2	23.2		115,000
....			....		......
1883	Dec.	27	18.0		75,000
1884	Feb.	23	20.1		89,200
....			....		......
	Dec.	21	19.5		84,900
		24	14.2		53,600
....			....		......
1885	Feb.	7	16.0		63,200
		16	16.2		64,300
		19	14.3		54,100
....			....		......
1887	Dec.	8	14.3		54,100
....			....		......
1892	Apr.	11	8.5	**	26,300
....			....		......
	Dec.	28	17.4		71,400

\# Last value before or first value after break in record; may not be peak.
** Below base

Flood stages and discharges of Willamette River at Albany, Oreg.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1893	Feb.	14	17.4		71,400
	Oct.	11	15.0		57,800
	Nov.	30	19.9	#	87,800
....			....		....
1894	Jan.	16	28.2		168,000
		23	21.4		99,200
	Mar.	18	24.4		126,000
		31	14.3		54,100
....			....		....
1895	Jan.	5	17.5		72,000
		14	18.4		77,600
	Dec.	21	16.2		64,300
1896	Jan.	2-3	14.0		52,600
		19	20.8		94,500
		23	25.0		132,000
	Mar.	1	15.4		59,900
		26	13.9		52,100
	Apr.	15	20.8		94,500
	May	5	15.4		59,900
	Nov.	10-11	14.5		55,200
		18	28.5		172,000
	Dec.	7	13.5		50,200
		15	18.0		75,000
1897	Feb.	7	16.3		64,900
		13	13.9		52,100
		17	18.4		77,600
	Mar.	27	17.5		72,000
	Nov.	21	14.2		53,600
	Dec.	9	15.5		60,500
		16	17.5		72,000
1898	Nov.	20	16.4		65,500
	Dec.	3	14.5		55,200
1899	Jan.	22	16.6		66,600
	Feb.	11	18.4		77,600
	Mar.	3	23.0		113,000
	Dec.	1	15.5		60,500
		13	21.2		97,600
1900	Jan.	15	24.0		122,000
	Feb.	23	16.7		67,200
	Dec.	23	18.5		78,200
1901	Jan.	15	30.4		196,000
	Feb.	18	26.0		142,000
	Mar.	1	14.0		52,600
	Dec.	11	18.4		77,600
1902	Feb.	11	17.0		69,000
	Nov.	20	14.0		52,600
	Dec.	6	24.5		127,000
		11	19.4		84,200
1903	Jan.	26	31.3		208,000
	Nov.	23	14.5		55,200
1904	Jan.	12	15.6		61,000
	Feb.	17	24.5		127,000
		24	16.9		68,400
		28	16.7		67,200
	Mar.	5	17.0		69,000
		10	21.0		96,000
		16	13.8		51,600
	Dec.	31 to			
1905	Jan.	1	16.8		67,800
1906	Jan.	18	14.2		53,600
	Feb.	26	14.6		55,700
1907	Jan.	6	25.0		132,000
	Feb.	6	30.7		200,000
	Apr.	9	20.0		88,500
	Dec.	24	22.5		108,000
		28	26.5		148,000
1908	Mar.	18	13.8		51,600
1909	Jan.	9	15.3		59,400
		22-23	23.4		117,000
	Nov.	25	29.3		182,000
	Dec.	14	14.5		55,200
1910	Mar.	3	20.0		88,500
	Dec.	1	18.8		80,200
		5	14.6		55,700
1911	Jan.	20	19.4		84,200
	Nov.	17	14.1		53,100
1912	Jan.	9	16.5		66,000
	Jan.	15	25.0		132,000
	Feb.	19	18.7		79,500
1913	Jan.	1	13.5		50,200
		20	14.9		57,300
	Apr.	1	21.2		97,600
1914	Jan.	26	17.6		72,600
1915	Jan.	16	13.9		52,100
	Nov.	27	18.6		78,900
	Dec.	8	16.6		66,600
1916	Feb.	8	27.7	P	162,000
		9	26.7		150,000
	Mar.	8	14.8		56,700
		28	15.8		62,100
1917	Apr.	9	13.4	**	49,700
	Dec.	20	17.2		70,200
		25	20.2		90,000
1918	Jan.	14	20.0		88,500
	Feb.	8	17.4		71,400
1919	Jan.	21	19.0		81,500
		24	19.9		87,800
		24	20.0	P	88,500
	Feb.	11	16.1		63,700
	Mar.	4	17.3		70,800
	Nov.	6	15.3		59,400
	Dec.	22	13.8		51,600
		26	14.1		53,100
1920	Jan.	28	17.1		69,600
	Nov.	21	15.2		58,900
		28	14.6		55,700
	Dec.	13	16.0		63,200
1921	Jan.	1	23.2		115,000
		1	23.5	P	118,000
		5	21.1		96,800
	Feb.	12	16.7		67,200
		22	13.5		50,200
	Nov.	23	23.0		113,000
		23	23.2	P	115,000
	Dec.	3	22.6		109,000
1922	Dec.	28	13.0	**	47,800
1923	Jan.	2	17.1		69,600
		8	29.6		186,000
		8	30.0	P	191,000
1924	Feb.	3	13.2	**	48,700
	Nov.	3	19.4		84,200
		24	18.2		76,300
1925	Jan.	1	19.7		86,300
		7	13.6		50,700
		31	19.3		83,500
	Feb.	6	23.2		115,000
		6	23.5	P	118,000
1926	Feb.	8	23.5		118,000
		8	24.7	P	129,000
		26	16.8		67,800
	Dec.	1	18.8		80,200
1927	Jan.	6	18.0		75,000
	Feb.	3	16.2		64,300
		22	27.3		158,000
		22	29.2	P	181,000
	Nov.	30	17.25		70,500
		30	17.5	P	72,000
1928	Jan.	5	14.5		55,200
	Mar.	13	17.6		72,600
	Apr.	2	16.6		66,600
1929	Mar.	23	13.30	**	49,200
	Dec.	21	19.4		84,200
		21	20.4	P	91,500
1930	Feb.	3	13.2	**	48,700
1931	Apr.	3	22.8		111,000
		3	22.9	P	112,000
1932	Jan.	2	13.5		50,200
	Mar.	21	24.4		126,000
		21	25.5	P	137,000
		26	14.6		55,700
1933	Jan.	4	20.2		90,000
		4	20.8	P	94,500
	June	11	13.7		51,100
	Dec.	23	16.0		63,200
1934	Jan	25	17.2		70,200

Last value before or first value after break in record; may not be peak.
** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Breaks in record: May 1 to Nov. 13, 1880; May 1 to Oct. 31, 1881; May 1, 1882, to Oct. 31, 1883; May 1 to Nov. 13, 1884; Jan. 1-31, 1885; May 1, 1885 to Mar. 23, 1886; May 1 to Nov. 14, 1886; Dec. 16, 1886, to Feb. 14, 1887; Mar. 1 to Nov. 14, 1887; Dec. 16, 1887, to Feb. 14, 1888; July 1 to Oct. 31, 1892; Dec. 1-31, 1893; Oct. 1 to Dec. 31, 1894.

Umpqua River near Elkton, Oreg.

Location.- In sec. 8, T. 23 S., R. 7 W., 4 miles south of Elkton and 8 miles (by river) above Elk Creek.
Drainage area.- 3,680 square miles.
Records available.- October 1905 to September 1934.
Sources of data.- Gage-height records prior to 1914 furnished by J. G. Kelley. Gage-height records thereafter and all discharge records by U. S. Geological Survey.
Gages.- Nonrecording gage read to inches twice daily prior to Sept. 3, 1910; usually to tenths twice daily Sept. 3, 1910, to Aug. 25, 1929; to hundredths usually twice daily thereafter. Gage datum lowered 0.52 foot Sept. 3, 1910 (applied as of Jan. 1, 1910); lowered 0.96 foot Sept. 15, 1929 (applied as of Oct. 1, 1929). In this report all gage-height records corrected to present datum. Zero of present gage is about 95 feet above mean sea level.
Stage-discharge relation.- Sometimes affected by aquatic growth. High-water control permanent.
Diversions.- Small diversions for irrigation.
Remarks.- Discharge records revised from previously published figures.
Historical data.- Flood of 1861 reached stage of about 45.5 feet on present gage.

Flood stages and discharges
(Base discharge 29,100 second-feet)

Date			Gage height (feet)		Discharge (second-feet)
1906	Jan.	17	19.81		61,000
	Feb.	21	16.86		48,000
		27	12.36		29,200
	May	29	14.69		38,400
....			.....		......
1907	Dec.	14	16.48		46,200
		26	25.48		88,500
1908	Jan.	9	12.81		30,700
1909	Jan.	5	13.98		35,500
		8	17.48		50,600
		20	27.48		98,500
	Feb.	4	12.98		31,500
		17	13.98		35,500
		20	12.98		31,500
	Nov.	23	37.98		155,000
		23	39.48	P	163,000
	Dec.	10	13.98		35,500
1910	Mar.	1	16.46		46,200
	Nov.	29	26.96	P	96,000
		30	20.96		66,600
1911	Jan.	21	21.96		71,300
		21	23.96	P	81,000
1912	Jan.	8	16.66		47,100
		13	27.96		101,000
		26	17.16		49,300
	Feb.	18	24.96		86,000
	May	2	16.26		45,300
1913	Jan.	18	17.96		52,800
	Mar.	30	14.46		37,600
1914	Jan.	1	12.96		31,500
		3	12.36		29,200
		23	16.16		44,900
		26	18.76		56,400
		26	20.96	P	66,600
1915	Feb.	3	11.96	**	27,600
	Nov.	26	15.96		44,000
	Dec.	6	16.96		48,400
1916	Jan.	24	18.26		54,200
	Feb.	7	29.96		111,000
		7	30.96	P	116,000
	Mar.	5	17.26		49,700
1917	Mar.	25	14.36		37,200
		25	14.76	P	38,900
		28	14.16		36,300
	Apr.	8	13.71		34,300
		12	12.96		31,500
	Dec.	1	13.96		35,500
1918	Jan.	13	18.96		57,300
		13	20.96	P	66,600
		15	15.21		40,600
	Feb.	7	18.46		55,000
1919	Jan.	19	22.96		76,100
		19	25.96	P	91,000
		23	18.46		55,000
	Feb.	10	22.46		73,700
	Feb.	10	25.96	P	91,000
		26	16.96		48,400
	Mar.	2-3	16.96		48,400
		6	13.46		33,500
		19	12.86		31,100
	Nov.	4	12.96		31,500
	Dec.	9	15.96		44,000
		9	17.96	P	52,800
		20	13.96		35,500
1920	Jan.	27	13.46		33,500
	Nov.	19	15.96		44,000
		26	15.46		41,800
	Dec.	11	21.46		69,000
		30	19.96		61,900
		30	23.96	P	81,000
1921	Jan.	5	19.96		61,900
	Feb.	6	13.46		33,500
		21	16.96		48,400
	Nov.	22	18.46		55,000
		30	20.46		64,200
		30	22.96	P	76,100
	Dec.	3	19.46		59,600
1922	Mar.	20	14.46		37,600
1923	Jan.	6	26.46		93,500
		6	26.96	P	96,000
	Dec.	7	13.96		35,500
		7	14.46	P	37,600
1924	Feb.	8	13.06		31,900
	Nov.	1	27.06		96,500
		10	13.16		32,300
		20	15.46		41,800
	Dec.	30	24.36		83,000
		30	30.96	P	116,000
1925	Jan.	6	12.46		29,600
		31	14.46		37,600
	Feb.	5	21.56		69,400
		9	17.21		49,300
	Apr.	20	14.46		37,600
1926	Feb.	5	19.46		59,600
		5	20.96	P	66,600
		25	15.96		44,000
	Nov.	30			69,200
	Dec.	3	13.71		34,300
1927	Jan.	3	17.21		49,300
	Feb.	3	14.11		35,900
		21			157,000
		21	40.96	P	172,000
	Nov.	29			43,000
1928	Mar.	12			46,900
		27	19.76		61,000
		27	20.96	P	66,600
	Apr.	1	14.96		39,700
1929	Apr.	15	15.81		43,100
		15	16.16	P	44,900
	Dec.	15	15.45		41,400

** Below base

Flood stages and discharges of Umpqua River near Elkton, Oreg.--Continued

Date		Gage height (feet)		Discharge (second-feet)	Date		Gage height (feet)		Discharge (second-feet)
1929 Dec.	19	18.9		56,800	Mar.	19	28.70	P	104,000
	20	19.90	P	61,400		25	13.38		33,100
1930 Feb.	3	11.88	**	27,200	Dec.	27	13.06		31,900
1931 Apr.	1	17.40	P	50,200	1933 Jan.	3	24.7		84,500
	2	15.66		42,700		3	28.0	P	101,000
Dec.	27			36,400		27	12.9		31,100
1932 Jan.	1	15.24		40,600	Feb.	16	12.8		30,700
	19	13.36		33,100	1934 Jan.	24	16.3		45,300
Mar.	19	26.20		92,000		24	18.1	P	53,200

** Below base

Note.- All discharge quantities are average daily flows except as designated by "P" (momentary peak). Break in record: Jan. 1 to May 11, 1907.

Rogue River at Raygold, near Central Point, Oreg.

Location.- In sec. 18, T. 36 S., R. 2 W., at Raygold, just below dam and power house of The California Oregon Power Co. (originally Conder Water & Power Co., later Rogue River Electric Co.), half a mile below Bear Creek, and 6 miles northwest of Central Point.

Drainage area.- 2,020 square miles.

Records available.- August 1905 to September 1934.

Sources of data.- Gage-height records by The California Oregon Power Co.; discharge records by U. S. Geological Survey.

Gages.- Nonrecording gage read to tenths twice daily prior to Oct. 1, 1914; recording gage thereafter. Zero of gage is about 1,124 feet above mean sea level.

Stage-discharge relation.- Control practically permanent.

Regulation and diversions.- Normal daily flow affected by power plant just above station. Considerable diversions for irrigation.

Remarks.- Early records published as at Gold Ray and near Tolo. Discharge quantities prior to Oct. 1, 1932, revised from previously published figures.

Flood stages and discharges
(Base discharge 7,000 second-feet)

Date		Gage height (feet)		Discharge (second-feet)	Date		Gage height (feet)		Discharge (second-feet)
1906 Jan.	16	11.4		28,800	Nov.	28	12.05		31,100
Feb.	21	4.7		7,000		28	13.0	P	35,100
Mar.	31	5.1		7,920	Dec.	3	7.85		15,800
May	29	4.7		7,000		9	4.9		7,450
Dec.	26	4.75		7,220	1911 Jan.	19	8.8		19,200
1907 Jan.	4	12.25		31,900		19	11.5	P	29,200
	29	5.20		8,160	Feb.	2	5.0		7,680
Feb.	4	17.00		52,600	1912 Jan.	10	5.8		9,720
	24	4.75		7,220		13	8.3		17,500
Mar.	18	13.25		35,900		26	7.6		15,100
	20	8.75		19,200	Feb.	17	13.2		35,900
Apr.	6	8.25		17,100		17	14.2	P	40,100
Dec.	13	5.25		8,160	May	1	6.7		12,400
	22	7.00		13,300	1913 Jan.	18	6.0		10,300
	24	7.25		13,900	Apr.	18	5.2		8,160
	26	11.60		29,500	1914 Jan.	2	4.7		7,000
	29	4.70		7,000		22	9.2		20,600
1908 Jan.	9	5.65		9,180		26	6.4		11,500
	14	6.55		12,100	1915 Feb.	1	7.4	P	14,500
	20	5.55		9,180		2	5.5		8,920
1909 Jan.	5	8.85		19,200	1916 Jan.	24	6.1		10,600
	8	10.6		25,700	Feb.	7			14,900
	16	11.7		29,900		7	9.15	P	20,600
	20	11.25		28,000		18			7,590
Feb.	17	6.3		11,200	Apr.	11			7,800
Nov.	20	10.35		25,000	1917 Feb.	25	5.4		8,660
	23	17.0		52,600		25	6.68	P	12,400
	23	20.00	P	67,000	Mar.	29			8,920
	30	6.35		11,500	Apr.	8			8,540
Dec.	9	7.05		13,300		11			8,920
	13	5.05		7,680		26			9,040
1910 Feb.	19	4.85		7,220	May	13			8,960
	25	6.1		10,600	June	9			8,150
Mar.	1	7.85		15,800	Dec.	24	6.0		7,680
	23	4.85		7,220	1918 Jan.	12			17,000
Nov.	23	5.45		8,660		12	10.9	P	26,800

Flood stages and discharges of
Rogue River at Raygold, near Central Point, Oreg.--Continued

Date			Gage height (feet)		Discharge (second-feet)
1918	Feb.	7	5.7		9,450
1919	Jan.	17			7,060
	Feb.	9			12,800
		9	9.0	P	19,900
		26	5.69		9,450
	Mar.	2			10,200
		2	7.6	P	15,100
	Apr.	5-6	5.51		8,920
		11	4.69		7,000
		18	5.06		7,920
	Dec.	25	4.94		7,450
		25	5.52	P	8,920
1920	Nov.	19			7,890
		27			9,710
	Dec.	11			9,390
		30			20,000
		30	10.52	P	25,400
1921	Jan.	5	8.69		18,800
	Feb.	5	5.2		8,160
		10	6.93		13,000
		14	8.74		18,800
		21	7.45		14,500
	Mar.	6	5.1		7,920
	May	20	5.1		7,920
	Nov.	30			15,700
		30	9.10	P	20,300
1922	Mar.	24	5.05		7,680
	May	18	4.78		7,220
	Dec.	28	5.35		8,660
		31			15,900
		31	8.78	P	19,200
1923	Jan.	7	5.40		8,660
1924	Feb.	7	5.65		9,180
		7	7.3	P	14,200
	Oct.	31			12,900
	Nov.	9			7,490
		20	8.03		16,500
	Dec.	30			33,900
	Dec.	30	15.22	P	44,400
1925	Jan.	30	6.36		11,500
	Feb.	5	8.69		18,800
		8	7.55		15,100
		12	5.55		9,180
	Apr.	19	6.26		11,200
1926	Feb.	5	4.30	**	6,140
	Nov.	30	8.33		17,500
	Dec.	3			19,000
1927	Jan.	2			10,600
	Feb.	3	5.00		7,680
		21	16.2		48,900
		21	24.8	P	91,500
		23	7.30		14,200
	Apr.	2	5.60		9,180
	Nov.	29	6.45		11,500
1928	Jan.	14	4.85		7,220
	Mar.	12	5.60		9,180
		26	10.7	P	26,100
		27			17,400
	Apr.	1	5.72		9,450
1929	Apr.	15	4.81		7,220
	Dec.	15	4.99		7,680
		19	6.74		12,400
		19	7.50	P	14,800
1930	Feb.	2	6.36		11,500
1931	Apr.	1		**	6,540
	Dec.	27	5.26		8,410
1932	Mar.	19	11.32		28,400
		19	12.2	P	31,900
		24	5.30		8,410
	May	4	4.75		7,220
1933	Jan.	2	8.45	P	17,800
		3			8,620
	June	10	5.66		9,450
1934	Jan.	23			7,830
		23	6.06	P	10,600

** Below base

<u>Note</u>.- All discharge quantities are average daily flows except as designated by "P" (momentary peak).

A STUDY OF METHODS OF ESTIMATING FLOOD FLOWS APPLIED TO THE TENNESSEE RIVER

by

Thorndike Saville*

INTRODUCTION

This paper is an attempt to apply all the more generally used statistical methods of estimating flood flows to the 57-year record (1875-1931) on the Tennessee River at Chattanooga, Tenn., where the drainage area is 21,400 square miles. The investigation was designed to afford an impartial and unprejudiced analysis of the applicability of the various methods to a long-term series of observations on a single stream and to compare results obtained by different methods.

As the study is confined to a single river, and in general to a single record on that river, too broad generalizations from the results are probably not warranted. However, a comprehensive comparative study of this kind has not appeared in the literature of flood flows, and it is believed that the results here presented will have some general significance and may stimulate similar investigations of records on streams having different characteristics. The paper presents in a series of sections the application of generally similar methods advanced by different investigators.

1. Fuller method

In 1914, Fuller# developed a formula for computing the annual flood (Q)[o] which on the average would be the greatest in a given period of years (T). That is, in any large number of 100-year periods, for example, the average of the maximum annual floods for each 100-year period would be Q when T = 100. Q is the average of the maxima for several periods of T

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Fuller, W. E., Flood flows: Am. Soc. Civil Eng. Trans., vol. 77, pp. 564-617, 1914.

o Annual flood is defined on page 463 as the maximum daily average flow occurring during 12 consecutive months. In the study reported in this chapter the calendar year January to December was used.

years each and therefore is the most probable maximum annual flood for any period of T years. This concept is fundamental to the Fuller method and differs from the reasoning underlying most other statistical procedures utilizing annual floods.

The Fuller formula has been widely used and is expressed as

$$Q = Q_{ave} (1 + 0.8 \log T)$$

where $Q =$ the most probable maximum annual flood to be expected in T years and $Q_{ave} =$ average of the annual floods.

Where a sufficiently long period of record (10 years or more, according to Fuller) does not exist to determine the average flood, this may be found from the expression $Q_{ave} = CA^{0.8}$, in which $A =$ drainage area in square miles and $C =$ a constant for the region, determined from other streams having longer periods of record.

The average annual flood is computed from column 3 of table 4 and is 208,600 second-feet. Using this figure in the formula gives results shown in columns 2 and 3 of table 4.

The method utilized by Fuller to derive his formula is shown in columns 1 to 7 of table 4. In figure 9 column 6 is plotted against column 7. On this figure is also shown the plot of Fuller's formula. It is apparent that the formula does not fit the plotted points for annual floods on the Tennessee River at Chattanooga. The results given by this formula are much larger than those by any curve of best fit. The equation for such a curve in a Fuller type expression, where $T = 1$ when $\frac{Q}{Q_{ave}} = 1$, is $Q = Q_{ave} (1 + 0.5 \log T)$, determined by the method of averages. It will be seen that this curve does not fit the lower points as well as the upper points. By the more accurate least-square method the general equation for the curve of best fit is $Q = Q_{ave} (1.067 + 0.433 \log T)$. This curve fits the plotted points well but gives slightly lower values in the higher magnitudes. The curves are plotted in figure 9, and data in columns 4 and 5 of table 11 are taken from the curve whose equation is $Q = Q_{ave} (1 + 0.5 \log T)$.

Inasmuch as the factor C is presumed to be more or less constant for a given station, and indeed for a considerable region about the point where C is determined, it is interesting to note the variations in C for different periods of record. The drainage area above Chattanooga is

Table 4.- Computations for Fuller, Foster, and Hazen methods

Year	No. of flood	Annual flood (second-feet)	Ratio to average flood	Cumulative sum of column 4	Column 5 / Column 2	Time (years)	Percentage of time
1	2	3	4	5	6	7	8
1875	1	361,000	1.731	1.731	1.731	57.00	0.877
1886	2	349,000	1.674	3.405	1.703	28.50	2.632
1917	3	310,000	1.487	4.892	1.631	19.00	4.386
1884	4	285,000	1.367	6.259	1.565	14.25	6.140
1890	5	283,000	1.357	7.616	1.523	11.40	7.895
1920	6	275,000	1.319	8.935	1.489	9.50	9.649
1902	7	271,000	1.300	10.235	1.462	8.14	11.404
1896	8	269,000	1.290	11.525	1.441	7.12	13.158
1882	9	267,000	1.280	12.806	1.423	6.33	14.912
1899	10	266,000	1.276	14.082	1.408	5.70	16.667
1918	11	266,000	1.276	15.358	1.396	5.18	18.421
1891	12	259,000	1.242	16.600	1.383	4.74	20.176
1880	13	254,000	1.218	17.818	1.371	4.38	21.930
1883	14	254,000	1.218	19.036	1.360	4.07	23.684
1879	15	252,000	1.208	20.245	1.350	3.80	25.439
1892	16	252,000	1.208	21.454	1.341	3.56	27.193
1897	17	252,000	1.208	22.663	1.333	3.35	28.948
1901	18	248,000	1.189	23.852	1.325	3.17	30.702
1926	19	248,000	1.189	25.041	1.318	3.00	32.456
1929	20	246,000	1.180	26.221	1.311	2.85	34.211
1922	21	229,000	1.098	27.319	1.301	2.71	35.965
1893	22	221,000	1.060	28.379	1.290	2.59	37.720
1906	23	220,000	1.055	29.434	1.280	2.48	39.474
1895	24	212,000	1.017	30.451	1.269	2.37	41.228
1903	25	210,000	1.007	31.458	1.258	2.28	42.983
1921	26	210,000	1.007	32.465	1.249	2.19	44.737
1876	27	205,000	.983	33.448	1.239	2.11	46.492
1913	28	202,000	.969	34.417	1.233	2.03	48.246
1885	29	201,000	.964	35.381	1.220	1.96	50.000
1889	30	145,000	.935	36.316	1.211	1.90	51.755
1911	31	195,000	.935	37.251	1.202	1.89	53.509
1927	32	195,000	.935	38.186	1.193	1.78	55.264
1912	33	190,000	.911	39.097	1.189	1.73	57.018
1877	34	189,000	.906	40.003	1.176	1.68	58.772
1919	35	189,000	.906	40.909	1.169	1.63	60.526
1923	36	188,000	.902	41.811	1.162	1.58	62.281
1914	37	183,000	.878	42.689	1.154	1.54	64.035
1915	38	183,000	.878	43.567	1.147	1.50	65.789
1928	39	181,000	.868	44.435	1.139	1.46	67.544
1887	40	180,000	.863	45.298	1.132	1.42	69.298
1888	41	178,000	.854	46.152	1.126	1.39	71.052
1894	42	167,000	.801	46.953	1.180	1.36	72.807
1916	43	166,000	.796	47.749	1.110	1.32	74.561
1898	44	164,000	.787	48.536	1.103	1.29	76.316
1909	45	163,000	.782	49.318	1.096	1.27	78.070
1908	46	162,000	.777	50.095	1.089	1.24	79.824
1900	47	157,000	.753	50.848	1.082	1.21	81.579
1881	48	146,000	.700	51.547	1.074	1.19	83.333
1905	49	146,000	.700	52.247	1.066	1.16	85.087
1924	50	143,000	.686	52.933	1.059	1.14	86.842
1904	51	142,000	.681	53.614	1.051	1.12	88.596
1925	52	134,000	.643	54.257	1.043	1.09	90.350
1907	53	133,000	.638	54.897	1.036	1.07	92.105
1878	54	125,000	.599	55.494	1.028	1.05	93.859
1931	55	123,000	.590	56.084	1.020	1.04	95.613
1930	56	108,000	.518	56.602	1.012	1.02	97.368
1910	57	85,900	.412	57.014	1.000	1.00	99.122
Average		208,600					

Table 4.- Computations for Fuller, Foster, and Hazen methods--Continued

Year	No. of flood	Variation from mean (column 4-1) Plus	Minus	(v^2) Variation²	Variation³ Plus	Minus	Variation⁴
1	2	9		10	11		12
1875	1	0.731	0.5344	0.5344	0.3906		0.2855
1886	2	.674		.4543	.3062		.2064
1917	3	.487		.2372	.1155		.0562
1884	4	.367		.1347	.0494		.0181
1890	5	.357		.1275	.0455		.0162
1920	6	.319		.1018	.0325		.0104
1902	7	.300		.0898	.0269		.0081
1896	8	.290		.0841	.0244		.0071
1882	9	.281		.0790	.0222		.0062
1899	10	.276		.0762	.0210		.0058
1918	11	.276		.0762	.0210		.0058
1891	12	.242		.0586	.0142		.0034
1880	13	.218		.0475	.0102		.0022
1883	14	.218		.0475	.0102		.0022
1879	15	.209		.0437	.0091		.0019
1892	16	.209		.0437	.0091		.0019
1897	17	.209		.0437	.0091		.0019
1901	18	.189		.0357	.0068		.0013
1926	19	.189		.0357	.0068		.0013
1929	20	.180		.0329	.0058		.0010
1922	21	.098		.0097	.0010		.0001
1893	22	.060		.0036	.0002		.0000
1906	23	.055		.0030	.0002		.0000
1895	24	.017		.0003	.0000		.0000
1903	25	.007		.0001	.0000		.0000
1921	26	.007		.0001	.0000		.0000
1876	27		0.017	.0003		0.0000	.0000
1913	28		.031	.0010		.0001	.0000
1885	29		.036	.0013		.0001	.0000
1889	30		.065	.0042		.0003	.0000
1911	31		.065	.0042		.0003	.0000
1927	32		.065	.0042		.0003	.0000
1912	33		.089	.0079		.0007	.0001
1877	34		.094	.0088		.0008	.0001
1919	35		.094	.0088		.0008	.0001
1923	36		.098	.0097		.0010	.0001
1914	37		.122	.0149		.1018	.0002
1915	38		.122	.0149		.0018	.0002
1928	39		.132	.0174		.0023	.0003
1887	40		.137	.0188		.0026	.0004
1888	41		.146	.0213		.0031	.0005
1894	42		.199	.0400		.0080	.0016
1916	43		.204	.0416		.0085	.0017
1898	44		.214	.0458		.0098	.0021
1909	45		.218	.0475		.0104	.0023
1908	46		.223	.0497		.0111	.0025
1900	47		.247	.0610		.0151	.0037
1881	48		.300	.0898		.0269	.0081
1905	49		.300	.0898		.0269	.0081
1924	50		.314	.0986		.0310	.0097
1904	51		.319	.1018		.0325	.0104
1925	52		.357	.1275		.0455	.0162
1907	53		.362	.1310		.0474	.0172
1878	54		.401	.1608		.0645	.0259
1931	55		.410	.1681		.0689	.0282
1930	56		.482	.2323		.1120	.0540
1910	57		.588	.3457		.2033	.1195
Total		64.65	64.51	4.3697	1.1379	0.7378	0.9562
Average				$\sum v^2 = 4.3697$	$\sum v^3 = 0.4001$		

$$CV = \sqrt{\frac{\sum v^2}{n-1}} = \sqrt{\frac{4.37}{56}} = \sqrt{0.078} = 0.28 \qquad CS = \frac{\sum v^3}{(n-1)(CV)^3} = \frac{0.4001}{56.283} = 0.325$$

Adjusted CS:

Foster (Pearson) type I curve: CS_{adj} = computed CS (1+ 6/n) =

0.325 (1+ 6/57) = 0.360

Foster (Pearson) type III curve: CS_{adj} = computed CS (1+ 8.5/n) =

0.325 (1+ 8.5/57) = 0.375

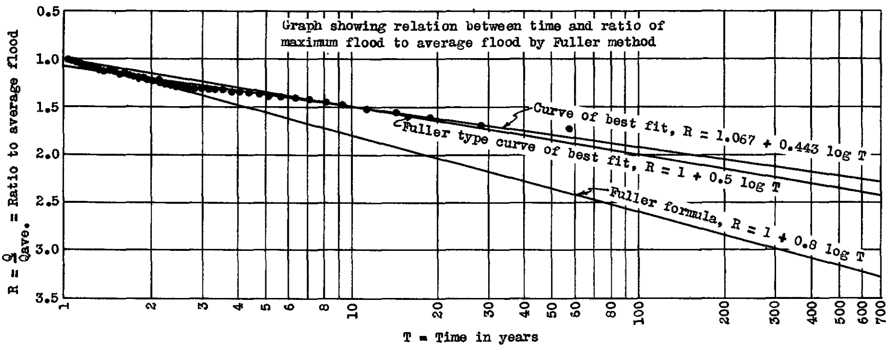

Figure 9.

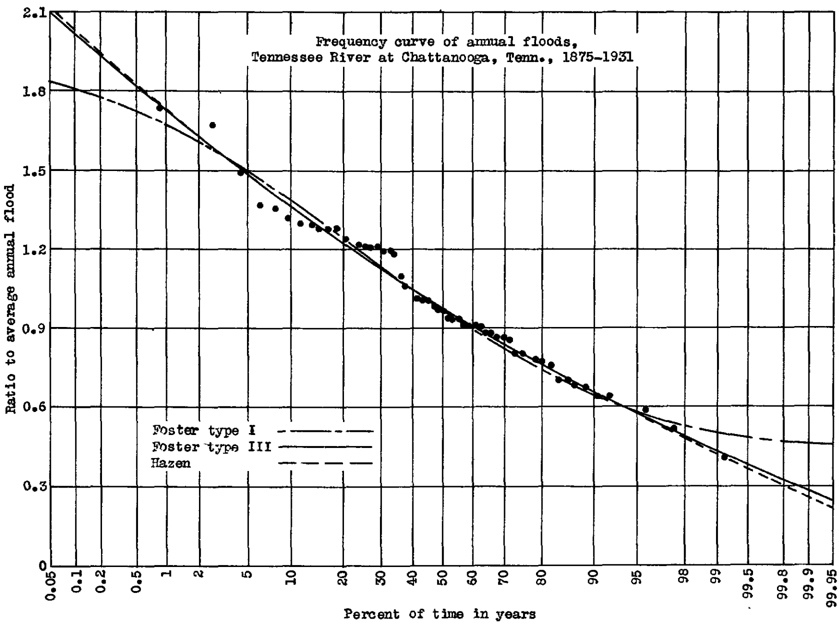

Figure 10.

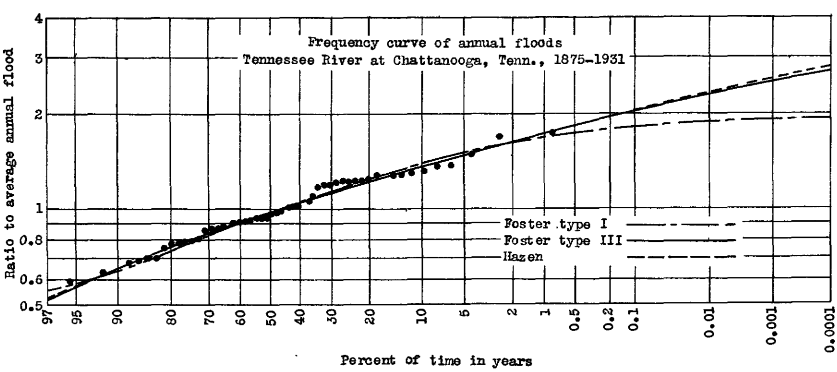

Figure 11.

21,400 square miles. The complete 57-year record gives a value of C = 71.6. The value for 21 years used by Fuller was 79. The value for 49 years used by Hazen was 73. Other values are given in table 5. The maximum variation of C for different periods of 20 calendar years and more, chosen at random, is from 80.0 to 64.1, a variation of nearly 25 percent. Consequently, estimates of flood flows for regions where the Chattanooga data might be assumed to apply might differ by this percentage, depending upon what period of record happened to be used in computing C.

Table 5 also shows the average annual floods and resulting values of C when the water year (October 1 to September 30) is used instead of the calendar year. A comparison indicates that either 12-month period gives substantially similar results for records of 20 years or more.

Table 5.- Variation of C in $Q_{ave} = CA^{0.8}$ for different periods of record, Tennessee River at Chattanooga, Tenn.

Period (years)	Dates	Calendar year Q_{ave} (second-feet)	Calendar year C	Water year (Oct.-Sept.) Q_{ave} (second-feet)	Water year (Oct.-Sept.) C
57	1875-1931	208,559	71.6	206,733	71.0
41	1875-1915	211,635	72.6	209,632	72.0
41	1890-1930	203,022	69.7	202,922	69.6
41	1882-1922	214,388	73.6	211,583	72.5
36	1890-1925	204,053	70.0	201,719	69.2
36	1875-1910	214,553	73.7	214,525	73.7
31	1875-1905	224,600	77.1	224,258	77.1
31	1890-1920	207,800	71.3	204,965	70.3
26	1875-1900	228,577	78.5	229,462	78.7
26	1890-1915	201,381	69.1	197,342	67.8
20	1875-1894	231,150	79.4	232,300	79.9
20	1890-1909	209,850	72.0	208,650	71.7
20	1883-1902	233,150	80.0	230,250	79.2
20	1897-1916	186,945	64.1	182,545	62.6

2. Foster method

In a paper by Foster,* published in 1924, methods are deduced for fitting two types of the Pearsonian frequency curves# to hydrologic data. The method is shown in table 4 and consists in (a) arranging the items in order of magnitude (column 3); (b) computing the ratios to the

* Foster, H. A., Theoretical frequency curves and their application to engineering problems: Am. Soc. Civil Eng. Trans., vol. 87, pp. 142-173 1924.

Elderton, W. P., Frequency curves and correlation, London, C. & E. Layton, 1927.

average (column 4); (c) computing the deviations from the average (column 9); (d) computing the squares and cubes of the deviations (columns 10 and 11); (e) computing the coefficients of variation and skew; (f) determining ordinates to the theoretical frequency curve having the same coefficients of variation and skew; and (g) plotting the observed data (column 4) and the theoretical frequency curve against the average time of occurrence (column 8).

Calculations for the coefficients of variation and skew by Foster's method are shown at the bottom of table 4. Table 6 shows the calculation of the theoretical skew frequency curve factors from tables in Foster's paper. Computations were made to determine frequency curves of both type I and type III. The resulting curves are shown in figures 10 and 11, and the flood estimates taken from them in columns 6 to 9 of table 11 Figure 10 represents plotting on arithmetic probability paper, and figure 11 plotting on extreme-value logarithmic probability paper.

The coefficients of variation and skew as computed by the Hazen-Foster procedure were checked by grouping the annual floods in groups of 5 percent of the mean, computing the first to fourth moments respectively, finding the coefficient of variation by the usual procedure, and calculating the skewness by the Pearson method.* The results gave for the coefficient of variation 0.26 and 0.28 by the Foster and Pearson procedures respectively, and for the coefficient of skew 0.31 and 0.34 respectively. For this series it appears that the approximate coefficient of skew used by Hazen and Foster, requiring only the computation of the third moments, gives essentially the same results as the Pearson procedure, requiring the fourth moments. This is likely to be the case only when, as in the present instance, the coefficient of skew is small.

3. Hazen method

Hazen# presents a method of computing theoretical skew-frequency curves by a series of logarithmic factors. The procedure used in plotting the flood flows in terms of the average annual flood and calculating ordinates to the theoretical frequency curve of best fit is similar to that

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* The Pearson "skewness" is approximately one-half the "coefficient of skew" as used by Hazen and Foster.

Hazen, Allen, Flood flows, ch. 8, New York, John Wiley & Sons, 1930.

Table 6.- Skew-curve factors

(Coefficient of variation (CV) = 0.28; coefficient of skew (CS) = 0.326;

adjusted CS (type I) = 0.36; adjusted CS (type III) = 0.375.)

	Foster type I			Foster type III			Hazen		
Percent of time	Factor from table	Factor x CV.	Factor for plotting (column 3+1)	Factor from table	Factor x CV.	Factor for plotting (column 6+1)	Factor from table	Factor x CV.	Factor for plotting (column 4+1)
0.000001	3.44	0.96	1.96	7.60	2.13	3.13			
.00001	3.40	.95	1.95	6.94	1.94	2.94			
.0001	3.35	.94	1.94	6.15	1.72	2.72			
.001	3.27	.91	1.91	5.35	1.50	2.50			
.01	3.11	.87	1.87	4.55	1.27	2.27	4.65	1.30	2.30
.1	2.89	.81	1.81	3.64	1.02	2.02	3.68	1.03	2.03
1	2.39	.67	1.67	2.60	.73	1.73	2.62	.73	1.73
5	1.78	.50	1.50	1.73	.49	1.49	1.76	.49	1.49
10	1.39	.39	1.39	1.32	.38	1.37			
20	.87	.25	1.24	.82	.23	1.23	.82	.23	1.23
30	.51	.14	1.14	.48	.13	1.13			
40	.19	.05	1.05	.19	.05	1.05			
50	- .08	.02	.98	- .06	.02	.98	- .06	.02	.98
60	- .36	.10	.90	- .31	.09	.91			
70	- .62	.17	.83	- .57	.16	.84			
80	- .93	.26	.74	- .85	.24	.76	- .85	.24	.76
90	-1.27	.36	.64	-1.22	.33	.66			
95	-1.49	.42	.58	-1.52	.43	.57	-1.54	.43	.57
99	-1.78	.50	.50	-2.05	.57	.43	-2.07	.58	.42
99.9	-1.93	.54	.46	-2.57	.72	.28			
99.99	-2.01	.56	.44	-2.97	.83	.17			
99.999	-2.02	.57	.43	-3.33	.93	.07			
99.9999	-2.03	.57	.43	-3.63	1.02	.02			
99.99999	-2.03	.57	.43	-3.88	1.09	.09			
99.999999	-2.03	.57	.43	-4.11	1.15	.15			

described above for the Foster method, except that Hazen's factors are used instead of Foster's. The results of computations for the theoretical curve are shown in table 6, and the resulting curves are plotted in figures 10 and 11. The flood estimates taken from this curve are shown in columns 10 and 11 of table 11. It will be seen that the Hazen curve and the Foster type III curve give almost identical results.

4. Goodrich method

In a paper by Goodrich* equations designed to represent the distribution of skew-frequency data are developed by purely empirical methods. The methods have been amplified by Harris.#

The general Goodrich equation may be written

$$t = n - n\,(10)^{-h(fR)^c}$$

where
- t = percent of time.
- n = number of terms in record.
- h = coefficient of (fR).
- c = exponent of (fR).
- R = ratio to mean.
- (fR) = term having different forms depending upon type of frequency curve. These forms are

I $(fR) = R$	IV $(fR) = \dfrac{R}{R - a}$
II $(fR) = R - a$	V $(fR) = \dfrac{R - a}{b - R}$
III $(fR) = R - a$	VI $(fR) = \dfrac{R + a}{b + R}$

where
- a = lower limit of curve.
- b = upper limit of curve.

The method is designed to produce a straight line that will fit the observations after they have been adjusted by selecting appropriate values of a and b for (fR). On page 61 of Goodrich's paper are presented six types of curves conforming to different forms of the expression (fR). In a preliminary study of this method made by H. Thielhelm in 1933 under the writer's direction, it appeared from the resulting drawing that the

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* Goodrich, R. D., Straight-line plotting of skew-frequency data: Am. Soc. Civil Eng. Trans., vol. 91, pp. 1-118, 1927.
# Harris, R. M., Straight-line treatment of hydraulic duration curves: Univ. Washington Eng. Exper. Sta. Bull. 65, 1932.

original data plotted in the upper portion of figure 12 would be best represented by a Goodrich type VI curve. This form was stated by Goodrich to be extremely rare but was found by Harris to apply to several California streams.

After repeated trials values of a = 0.29 and b = 4 were selected as representing the upper and lower limits of the curve, and computations for (fR) are shown in columns 4, 5, and 6 of table 7. Values in column 6 plotted against values in column 3 of table 7 and the resulting straight line (drawn by judgment) are shown in the lower part of figure 12. From the straight line computations were made to plot the theoretical Goodrich frequency curve of best fit to the original data. This is shown by the dashed line in figure 12. Estimates of flood magnitude taken from this curve are shown in columns 12 and 13 of table 11, and are plotted in figure 14.

Further study of the Goodrich type VI curve indicated certain inconsistencies which appear to make it theoretically inapplicable to hydrologic data. In the expression $(fR) = \frac{R + a}{b + R}$, when t = 0 in the general equation, R = -a, and when t = n, R = -b, both of which are absurd values for the limits. Therefore, values of the upper and lower limits of the R curve cannot theoretically be found by extending the first tentative curve on the plotting paper. Furthermore, it was found that an almost infinite number of pairs of values of estimated a and b could be used and produce curves of equally good fit to the plotted points. This form of expression therefore appears fundamentally objectionable mathematically. The same objections apply to the Goodrich type III curve.

All the other types of Goodrich curves have R = a when t = 0 and R = b when t = n, which is mathematically sound. The type I curve was manifestly not adapted to the series of flood data being investigated, and hence studies were made of the type II and type V Goodrich curves. The results are shown in figure 13, and it is apparent that curves of very good fit to the original data may be obtained. However, as in the computation for a type VI curve, it makes little difference what values of a and b are selected, so long as a is small enough and b is large enough. Therefore, for data such as represented by the annual floods on the Tennessee at Chattanooga, the type II curve is to be preferred as being the simplest to calculate. The estimates from the type II and type III curves

Table 7.- Tabulation of (fR) for Goodrich frequency curve, type VI,

Tennessee River at Chattanooga, Tenn.

Annual discharge (second-feet)	Ratio to mean	Percentage of time	(fR)		
			0.29+R	R+4.00	$\frac{0.29+R}{R+4.00}$
1	2	3	4	5	6
85,900	0.4119	0.877	0.7019	4.4119	0.159
108,000	.5180	2.632	.8080	4.5180	.179
123,000	.5899	4.387	.8799	4.5899	.192
125,000	.5993	6.142	.8893	4.5993	.194
133,000	.6378	7.897	.9279	4.6379	.200
134,000	.6427	9.652	.9327	4.6427	.201
142,000	.6811	11.407	.9711	4.6811	.208
143,000	.6858	13.162	.9758	4.6858	.209
146,000	.7000	14.917	.9900	4.7000	.211
146,000	.7000	16.672	.9900	4.7000	.211
157,000	.7530	18.427	1.0430	4.7530	.219
162,000	.7766	20.182	1.0622	4.7722	.223
163,000	.7817	21.937	1.0717	4.7817	.224
164,000	.7861	23.692	1.0761	4.7861	.225
166,000	.7962	25.447	1.0862	4.7962	.227
167,000	.8007	27.202	1.0907	4.8007	.228
178,000	.8535	28.957	1.1435	4.8535	.235
180,000	.8631	30.712	1.1531	4.8631	.237
181,000	.8681	32.467	1.1581	4.8681	.238
183,000	.8776	34.222	1.1676	4.8776	.239
183,000	.8776	35.977	1.1676	4.8776	.239
188,000	.9017	37.732	1.1917	4.9017	.243
189,000	.9062	39,487	1.1962	4.9062	.244
189,000	.9062	41.242	1.1962	4.9062	.244
190,000	.9113	42.997	1.2013	4.9113	.244
195,000	.9350	44.752	1.2250	4.9350	.248
195,000	.9350	46.507	1.2250	4.9350	.248
195,000	.9350	48.262	1.2250	4.9350	.248
201,000	.9638	50.017	1.2538	4.9638	.253
202,000	.9688	51.772	1.2588	4.9688	.254
205,000	.9828	53.527	1.2720	4.9820	.255
210,000	1.0071	55.282	1.2971	5.0071	.259
210,000	1.0071	57.037	1.2971	5.0071	.259
212,000	1.0168	58.792	1.3068	5.0168	.260
220,000	1.0552	60.546	1.3452	5.0552	.266
221,000	1.0596	62.302	1.3496	5.0596	.267
229,000	1.0983	64.057	1.3883	5.0983	.272
246,000	1.1798	65.812	1.4698	5.1798	.283
248,000	1.1894	67.567	1.4794	5.1894	.285
248,000	1.1894	69.322	1.4794	5.1894	.285
252,000	1.2083	71.077	1.4983	5.2083	.288
252,000	1.2083	72.832	1.4983	5.2083	.288
252,000	1.2083	74.587	1.4983	5.2083	.288
254,000	1.2178	76.342	1.5078	5.2178	.289
254,000	1.2178	78.097	1.5078	5.2178	.289
259,000	1.2418	79.852	1.5318	5.2418	.293
266,000	1.2757	81.607	1.5657	5.2757	.297
266,000	1.2757	83.362	1.5657	5.2757	.297
267,000	1.2802	85.117	1.5702	5.2802	.298
269,000	1.2902	86.872	1.5802	5.2902	.299
271,000	1.2997	88.627	1.5897	5.2997	.300
275,000	1.3189	90.382	1.6089	5.3189	.302
283,000	1.3569	92.137	1.6469	5.3569	.307
285,000	1.3665	93.892	1.6565	5.3665	.309
310,000	1.4868	95.647	1.7768	5.4868	.324
349,000	1.6734	97.402	1.9634	5.6734	.346
361,000	1.7309	99.157	2.0209	5.7309	.352

Table 8.- Tabulation of (fR) for Goodrich frequency curves, type II and V, Tennessee River at Chattanooga, Tenn.

Percentage of time	Ratio to mean	$(fR) = \frac{R-a}{b-R}$, type V curve			(fR) = R-a, type II curve
		R-a = R-0.4	b-R = 3.4-R	(fR)	R-a = R-0.25
1	2	3	4	5	6
0.877	1.7314	1.331	1.669	0.800	1.481
2.632	1.6743	1.274	1.726	.740	1.424
4.386	1.4868	1.087	1.913	.567	1.237
6.140	1.3669	.967	2.033	.476	1.117
7.895	1.3573	.957	2.043	.468	1.107
9.649	1.3189	.919	2.081	.441	1.069
11.404	1.2997	.900	2.100	.428	1.050
13.158	1.2901	.890	2.110	.422	1.040
14.912	1.2805	.880	2.120	.415	1.030
16.667	1.2757	.876	2.124	.412	1.026
18.421	1.2757	.876	2.124	.412	1.026
20.176	1.2422	.842	2.158	.390	.992
21.930	1.2182	.818	2.182	.375	.968
23.684	1.2182	.818	2.182	.375	.968
25.439	1.2086	.809	2.191	.369	.959
27.193	1.2086	.809	2.191	.369	.959
28.948	1.2086	.809	2.191	.369	.959
30.702	1.1894	.790	2.210	.357	.939
32.456	1.1894	.790	2.210	.357	.939
34.211	1.1798	.780	2.220	.351	.930
35.965	1.0983	.698	2.302	.299	.848
37.720	1.0598	.660	2.340	.282	.810
39.474	1.0551	.655	2.345	.279	.805
41.228	1.0168	.617	2.383	.259	.767
42.983	1.0072	.607	2.393	.254	.757
44.737	1.0072	.607	2.393	.254	.757
46.492	.9832	.583	2.417	.241	.733
48.246	.9688	.569	2.431	.234	.719
50.000	.9640	.564	2.436	.231	.714
51.755	.9352	.535	2.465	.217	.685
53.509	.9352	.535	2.465	.217	.685
55.264	.9352	.535	2.465	.217	.685
57.018	.9112	.511	2.489	.205	.661
58.772	.9064	.506	2.494	.203	.656
60.526	.9064	.506	2.494	.203	.656
62.281	.9017	.502	2.498	.201	.652
64.035	.8777	.478	2.522	.190	.628
65.789	.8777	.478	2.522	.190	.628
67.544	.8681	.468	2.532	.185	.618
69.248	.8633	.463	2.537	.183	.613
71.052	.8537	.454	2.546	.178	.604
72.807	.8001	.400	2.600	.154	.550
74.561	.7961	.396	2.604	.152	.546
76.316	.7865	.387	2.613	.148	.536
78.070	.7817	.382	2.618	.146	.532
79.824	.7769	.377	2.623	.144	.527
81.579	.7530	.353	2.647	.133	.503
83.333	.7002	.300	2.700	.111	.450
85.087	.7002	.300	2.700	.111	.450
86.842	.6858	.286	2.714	.106	.436
88.596	.6811	.281	2.719	.104	.431
90.350	.6427	.242	2.758	.088	.393
92.105	.6378	.238	2.762	.086	.388
93.859	.5993	.199	2.801	.071	.349
95.613	.5899	.190	2.810	.068	.340
97.368	.5180	.118	2.882	.041	.268
99.122	.4119	.012	2.988	.004	.162

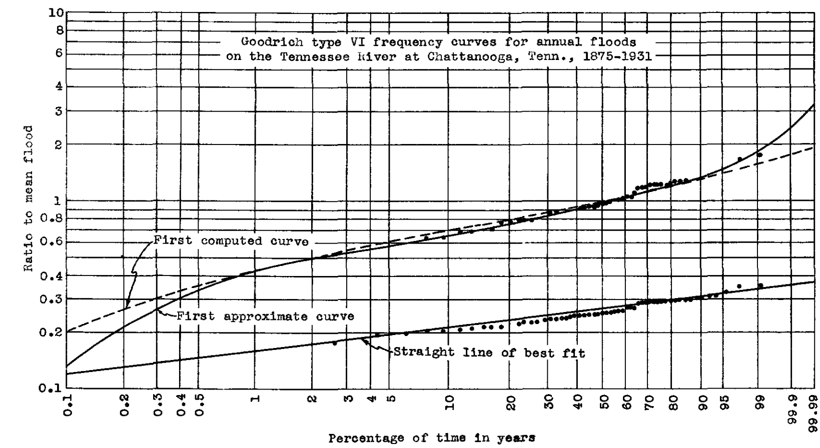

Figure 12.

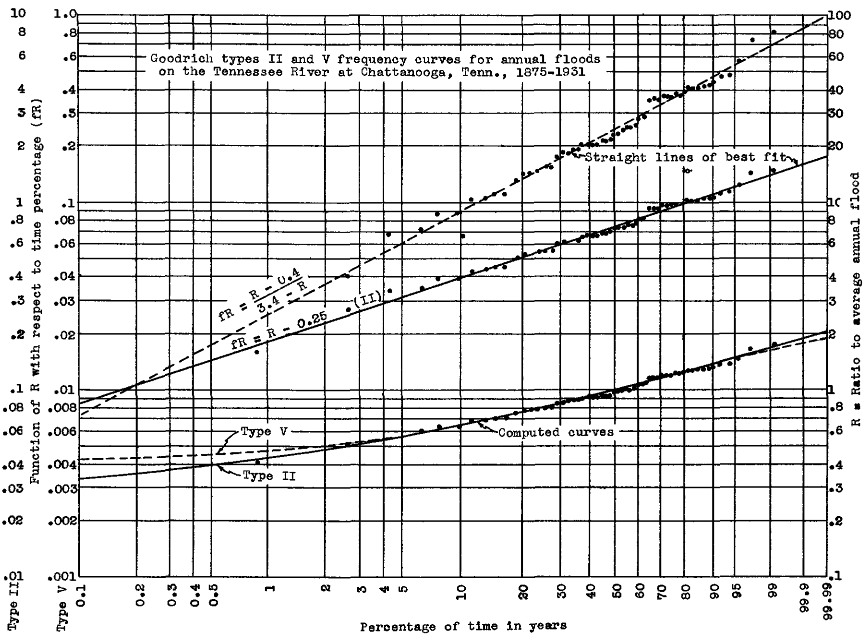

Figure 13.

are shown in the lower part of columns 12 and 13 of table 11, and it is evident that there is no significant difference between estimates made from any of the three types of curves, and that all give essentially the same results as the Foster-Pearson type I curve.

5. Slade method

In a paper by Slade,* which appeared in 1934, there is developed a totally bounded function that "differs as little as it seems possible to let it differ from the 'normal' in its general characteristics, while allowing it an unlimited degree of 'skewness.'" The function depends upon the determination of four constants, all calculated from the statistical data. The first two are the mean and standard deviation; the other two are constants (b) and (g) representing the minimum and maximum deviations from the mean which the data are believed capable of reaching. These constants have to be estimated or determined by other than strictly statistical procedures.

In applying the Slade method to the 57 annual floods on the Tennessee River at Chattanooga, the preliminary computations for plotting are similar to those for the methods previously described, data from column 8 of table 4 being plotted against those of column 4 on figure 14.

In determining the constants (b) and (g) values of one-half the smallest annual flood and 80 percent greater than the maximum annual flood respectively were used. These values are more or less arbitrary, but so long as (b) is estimated small enough and (g) is estimated large enough, the resulting theoretical curve is affected surprisingly little.

From the four constants indicated, the equation of the Slade probability function is calculated as shown in table 9. Calculation of values of t in this equation for plotting the curve is shown on table 10. As the Slade method requires calculation of only the first and second moments, it may be less laborious than the Foster procedure. If the coefficient of skew is used in the Slade method instead of the constant (b), the third moment must be computed. For other details of this method Slade's paper should be consulted.

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* Slade, J. J., Jr., An asymmetric probability function: Am. Soc. Civil Eng. Proc., pp. 1097-1123, October 1934.

Table 9.- Calculation of constants for Slade method, Tennessee River at Chattanooga, Tenn., 1875-1931

Mean = 208,560 second-feet = 1

Standard variation = $\sigma = 0.276$; $\sigma^2 = 0.07618$

Maximum upper variation from mean = g = 450,000 second-feet = 2.15765 in terms of mean.

$\mu = g/\sigma = 7.8176.$

Maximum lower variation from mean = b = 160,000 second-feet = 0.76716 in terms of mean.

$\lambda = b/\sigma = 2.7796.$

Ratio of upper to lower variation = $\theta = g/b = 2.8125$; $\theta^2 = 7.9101$;

$\lambda^2 = 7.7262$; $1/\lambda^2 = 0.12943.$

$$p^2 = \frac{\theta - 1}{\theta + 1} \quad 0.47541 \qquad p = 0.6895$$

$$d^2 = \theta^2 \frac{\theta^2 (1+1/\lambda^2) - 4\,\theta/\lambda^2}{(\theta^2+1/\lambda^2) - 4\,\theta/\lambda^2}$$

$$d = 2.8125 \sqrt{\frac{7.4778}{6.5834}} \qquad d = 2.9975$$

$$1/c^2 = \log_e \frac{\theta^2 (1+1/\lambda^2) - 4\,\theta/\lambda^2}{(\theta^2+1/\lambda^2) - 4\,\theta/\lambda^2} \qquad c = 2.8017$$

$$pc = 1.9318$$

$$Z = pc \log_e \left(d \frac{\lambda + t}{\mu - t}\right)$$

$$t = \frac{\mu \frac{e^{Z/pc}}{d} - \lambda}{\frac{e^{Z/pc}}{d} + 1} \qquad x = \sigma t$$

Ratio to mean for a given percent of time = X = x + 1

When g = b, $Z = \frac{\sqrt{\lambda^2 - 3}}{2} \log_e \frac{\lambda + t}{\lambda - t}$ and $t = \frac{\lambda \left(e^{\frac{Z}{\frac{1}{2}\sqrt{\lambda^2-3}}} - 1 \right)}{\left(e^{\frac{Z}{\frac{1}{2}\sqrt{\lambda^2-3}}} + 1 \right)}$

Table 10.- Theoretical total frequency curve, Slade method

Y percent	Z	$\frac{Z}{pc}$	e	$\frac{\text{Col.4}}{d}$	μ x Col.5	Col.6 − λ	Col.5 + 1	t = $\frac{\text{Col.7}}{\text{Col.8}}$	x = σt − 1
1	2	3	4	5	6	7	8	9	10
0.0000001	6.00	3.1000	22.2000	7.405	57.900	55.120	8.405	6.560	2.811
.000001	5.61	2.9000	18.1700	6.055	47.400	44.620	7.055	6.326	2.745
.00001	5.20	2.6870	14.6900	4.895	38.240	35.460	5.895	6.020	2.661
.0001	4.75	2.4550	11.6500	3.833	30.360	27.580	4.883	5.650	2.560
.001	4.26	2.2020	9.0430	3.019	23.590	20.810	4.019	5.180	2.430
.01	3.72	1.9220	6.8350	2.280	17.830	15.050	3.280	4.590	2.267
.1	3.09	1.5980	4.9430	1.648	12.880	10.100	2.648	3.815	2.052
1.0	2.33	1.2030	3.3330	1.111	8.695	5.915	2.111	2.802	1.774
10	1.28	.6620	1.9390	.646	5.050	2.270	1.646	1.379	1.380
20	.84	.4344	1.5440	.515	4.025	1.245	1.515	.823	1.227
30	.52	.2687	1.3080	.436	3.410	.630	1.436	.439	1.121
40	.25	.1292	1.1380	.379	2.961	.181	1.379	.1313	1.036
50	.00	.0000	1.0000	.3335	2.605	- .175	1.334	- .131	.9638
60	- .25	- .1292	.8788	.293	2.290	- .490	1.293	- .379	.8953
70	- .52	- .2687	.7644	.255	1.992	- .788	1.255	- .628	.8268
80	- .84	- .4344	.6477	.2163	1.692	- 1.088	1.216	- .895	.753
85	-1.04	- .5376	.5841	.195	1.524	- 1.256	1.195	-1.050	.710
90	-1.28	- .6620	.5158	.172	1.347	- 1.433	1.172	-1.220	.663
95	-1.64	- .8480	.4283	.143	1.126	- 1.654	1.143	-1.446	.601

Table 11.- Flood Estimates, Tennessee River at Chattanooga, Tenn.

Flood period (years)	Fuller formula		Fuller curve, best fit		Foster type I curve	
	Second-feet	Ratio to mean	Second-feet	Ratio to mean	Second-feet	Ratio to mean
1	2	3	4	5	6	7
10	375,500	1.80	312,900	1.50	290,000	1.39
20	425,500	2.04	344,200	1.65	312,900	1.50
50	492,300	2.36	385,910	1.85	333,800	1.60
100	542,400	2.60	417,200	2.00	348,400	1.67
500	659,200	3.16	490,200	2.35	371,300	1.78
1,000	709,200	3.40	521,500	2.50	377,600	1.81
10,000	876,100	4.20	625,800	3.00	390,100	1.87

Flood period (years)	Foster type III curve		Hazen method		Goodrich method	
	Second-feet	Ratio to mean	Second-feet	Ratio to mean	Second-feet	Ratio to mean
1	8	9	10	11	12	13
					Type VI	
10	287,900	1.38	285,800	1.37	271,200	1.30
20	310,800	1.49	310,800	1.49	296,200	1.42
50	340,000	1.63	340,000	1.63	323,300	1.55
100	360,900	1.73	360,900	1.73	337,900	1.62
500	404,700	1.94	404,700	1.94	371,300	1.78
1,000	421,400	2.02	423,500	2.03	375,500	1.80
10,000	475,600	2.28	479,800	2.30	400,500	1.92
					Type II	
10					281,600	1.35
20					304,600	1.46
50					329,600	1.58
100					346,300	1.66
500					379,700	1.82
1,000					396,300	1.90
10,000					427,600	2.05
					Type V	
10					281,600	1.35
20					304,600	1.46
50					327,500	1.57
100					340,000	1.63
500					360,900	1.73
1,000					373,400	1.79
10,000					394,300	1.89

Flood period (years)	Slade method		Monthly maxima (second-feet)	Daily duration (second-feet)	Flood peaks (second-feet)
	Second-feet	Ratio to mean			
1	14	15	16	17	18
			Foster III	Foster III	Free-hand curve
10	288,200	1.380	301,000	350,000	320,000
20	317,500	1.520	335,000	390,000	340,000
50	348,500	1.670	385,000	430,000	360,000
100	370,500	1.774	419,000	468,000	375,000
500	416,500	1.995	500,000	545,000	390,000
1,000	428,000	2.052	530,000	578,000	400,000
10,000	474,000	2.267	638,000	690,000	
			Foster I	Foster I	
10			299,000	310,000	
20			320,000	330,000	
50			350,000	350,000	
100			368,000	360,000	
500			410,000	390,000	
1,000			420,000	400,000	
10,000			450,000	425,000	

Estimates of flood magnitudes by the Slade procedure have been tabulated in columns 14 and 15 of table 11 and are plotted in figure 15. It will be observed that the estimates and curve vary little from those deduced by the Foster procedure. This is usually the case if the coefficient of skew is small, but if it is large the estimates by the two methods may differ considerably. It is alleged in support of the Slade method that it is not only superior but more reliable because the coefficient of skew calculated from the small number of observations usually available in flood studies may be quite unreliable. The fact that the Slade method does not require the calculation of this factor is stated to be an advantage.

6. Interpretation of results

As stated in section 1 the Fuller method gives results that represent the estimated average annual flood, or most probable magnitude of annual flood, to be expected in a period of T years. In other words, there is an even chance that in this period of years the estimated magnitude of annual flood will occur.

The Foster, Hazen, Goodrich, and Slade methods give results that represent the estimated magnitude of annual flood likely to be equaled or exceeded in a given period of years. The results are therefore comparable among themselves but not comparable with those obtained by the Fuller method. The differences in the two methods have been discussed by W. E. Fuller and E. W. Lane on pages 1077 and 1050 respectively in the Transactions of the American Society of Civil Engineers, volume 89, 1926.

It should be emphasized that all these methods have been applied to annual floods - that is, the maximum daily flows in 12-month periods. The results must be interpreted as frequency of annual floods, as distinct from frequency of flood peaks of flood events and from frequency of daily (24-hour) flows (involving the construction of at least the upper end of a daily duration curve). Results obtained by applying the Foster procedure to such arrays are shown in columns 16, 17, and 18 of table 11. As would be expected from the larger number of items used, the estimates give greater values for given frequencies than those derived by the use of annual floods. This is indicative of the care needed to specify the character of the data used in statistical studies, and also the uncertainties inherent in any such methods of making flood estimates.

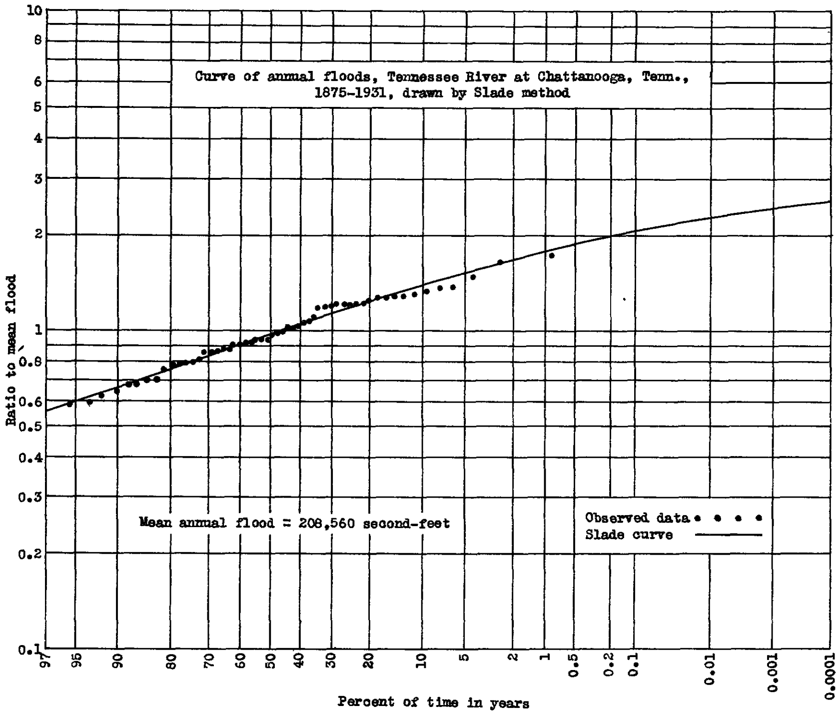

Figure 14.

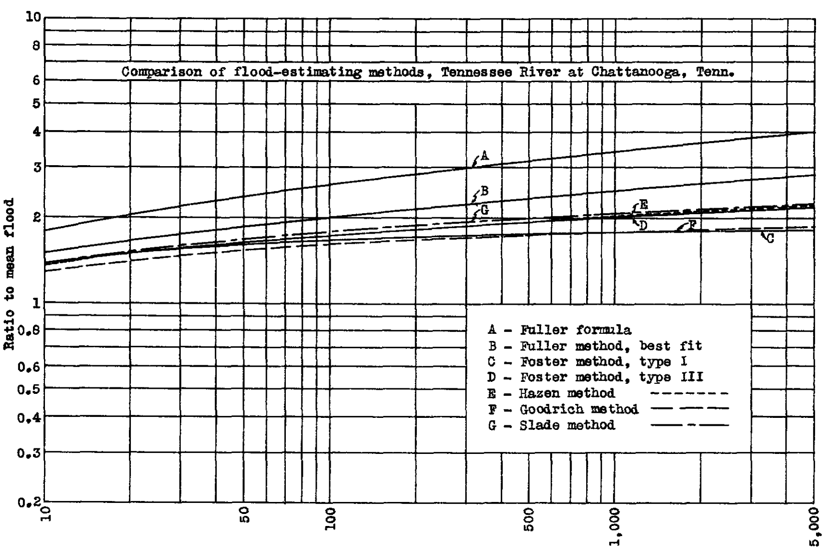

Figure 15.

7. Discussion of results

In table 10 and figure 15 are shown the estimates of annual floods by the several methods investigated. The following conclusions appear evident:

1. The estimates by the Fuller formula or the Fuller method applied to the Chattanooga data are much larger than those by other methods, even for values within the record period of 57 years. This appears logical when it is realized that, as has been pointed out in the preceding section, the Fuller method gives estimates of events of a different kind from those covered by the other methods - that is, average annual floods as contrasted with annual floods to be equaled or exceeded. It is clear that the Fuller method is not comparable with the others. By the Fuller method (not the Fuller formula) applied to the Tennessee River at Chattanooga it is estimated that in a series of 500-year periods, the average value of the maximum annual floods in each 500-year period will be 490,200 second-feet. By the Foster method (type III curve) it is estimated that in a very long period (say 1,000 years) the annual flood will equal or exceed 404,700 second-feet once in 500 years. The two results differ by 85,500 second-feet; by the Fuller formula the difference would be 254,500 second-feet. This illustrates the danger inherent in considering the two procedures at all equivalent.

The difference in plotting procedures is shown by comparing the figures in column 4 of table 4 (Foster) with those in column 6 (Fuller). The latter are always larger (except for the first item, which is always the same), and hence results by the Fuller method must be greater for similar time periods than those by the other methods. The point to be emphasized is that the underlying principles of the two methods are essentially different, and therefore the results are not comparable. Whether the average annual flood or the annual flood to be equaled or exceeded is desired must be decided by the individual investigator. The fact (shown by table 10) that the 20-year average annual flood (Fuller formula) is of about the same magnitude as the annual flood to be equaled or exceeded once in 1,000 years (Hazen or Foster type III) is a striking example of the danger in considering the Fuller formula in any way equivalent to the procedures giving annual floods to be equaled or exceeded.

2. The Fuller formula is not applicable to flood frequencies on the Tennessee River at Chattanooga, as it gives results that appear to be materially larger than the data warrant. A separate study, not reported here, utilizing a composite of 129 years of record at three stations on the Tennessee River indicates similar results. It is concluded that if the type of result given by the Fuller method is desired, the Fuller formula is not reliable for the Tennessee River. It should be stated, however, that Fuller's paper, presented in 1914, could of course utilize only the flood data available at that time. Since then a large amount of additional data has become available, and it is entirely conceivable that should Fuller undertake a similar analysis now, his recommended formula would differ from that originally presented.

3. The value of C in the formula $Q_{ave} = CA^{0.8}$ is materially affected (table 5) by the particular period of record used in computing Q_{ave}. The value of C cannot be regarded as a constant for a single region, any more than the average annual flood is a constant. The variations in average annual flood (and hence in C) are greater than have sometimes been realized. The average annual flood from one 20-year record on the Tennessee River at Chattanooga may depart as much as 25 percent from the average from another 20-year record. The average annual flood for a 20-year period may depart as much as 12 percent from that for a 41-year period. However, the maximum variation of the average for any period of 20 years or more from the 57-year average is only 5.6 percent.

4. Whether the calendar year or some other 12 month period (such as water year) is used (table 5) in computing frequency relations of annual floods will have little effect on the results if the data are expressed as ratios to the average annual flood.

5. Considering the strictly comparable procedures of Foster, Hazen, Goodrich, and Slade, the following conclusions are drawn from table 10 and figure 7.

(a) The estimates by the Foster type III curve and the Hazen curve are essentially the same. As the Foster procedure not only has a more rigorous mathematical basis but is easier to use on account of more complete tables and a clearer exposition of its development, it is preferred. For the particular data used in this study the Slade method presents estimates similar to but generally slightly more conservative than the other two procedures; that is, it gives somewhat higher estimates

(b) Although by both the Foster and the Pearson criteria the data should be represented best by a type I curve, it is evident from figure 10 that the type III curve fits the plotted points at least as well as the type I curve. Indeed, the type III curve fits the two highest points best. On the whole perhaps the type I curve fits the lowest points best, and the type III curve fits the highest points best, there being little difference in the curves between 5 and 95 percent of the time. Both Hazen and Foster lean toward using the type III curve as a general procedure; the Hazen factors and the discussion in his book relate only to type III curves. The type I curve gives estimates for floods occurring less frequently than once in 100 years much smaller than those derived from the type III curve. For these particular data the type III curve represents most nearly what would be drawn by judgment as a curve of best fit, and inasmuch as the type III curve is not mathematically the curve to represent the data best, the conclusion is that for these particular data a curve drawn by judgment is likely to give about as accurate estimates as the type III curve, and more conservative if not more accurate estimates than the type I curve.

(c) It was alleged by Hazen that one of the major advantages in the theoretical curves is in permitting coefficients of variation and of skew for various streams to be compared. The coefficient of variation is not affected by the type of curve, and in this set of data the adjusted coefficients of skew are nearly the same. Therefore, if a mathematical curve is desired, the type III curve is to be preferred notwithstanding its theoretical deficiencies in this particular case. However, there seems a distinct inconsistency in the reasoning involved in citing the advantages of theoretical curves, and then abandoning the type of curve which theoretically best represents the data because in fact it does not, and substituting another type of curve which fits the data better but which mathematically is not the proper curve to use. As stated above, it would appear that one might better draw a curve of best fit by judgment, so far as these particular data are concerned. These deficiencies are removed in the Slade method, which is perfectly general and does not require the calculation of the usually unreliable coefficient of skew to determine the type of curve to use.

The estimates by the Foster type I curve and by the Goodrich type II, V, and VI curves are essentially the same.

(d) The procedure for a Goodrich type II curve is simpler than the procedure for a Foster type I curve. The procedure is largely graphic, and although different investigators might use different estimates of the limit a, this appears not to have any marked effect on the results. On the other hand, the Foster and Slade procedures have a mathematical basis, and by them the coefficients of variation and of skew can be computed, although the coefficient of skew is not needed for the Slade method as used here. The coefficient of skew cannot be computed for the Goodrich curves, and calculation of the coefficient of variation and standard variation (deviation) is about as laborious as by the usual methods.

(e) The Slade method of fitting frequency curves gives estimates for the Tennessee River essentially the same as the Foster - Pearson type III and Hazen curves. It appears to have certain theoretical advantages over the Foster procedure, and from tables to be published it will be at least no more laborious to apply. It fits the entire range of plotted data better than any of the other curves.

6. The comments and conclusions presented relate only to a study of annual floods on the Tennessee River at Chattanooga. It is intended in a later paper to present somewhat similar but briefer analyses of the annual floods on the Tennessee River at Johnsonville and Florence. These stations are below Chattanooga and have records of over 35 years. More general statements may be made when this study is completed, but the results thus far tend to confirm the conclusions presented herein.

7. All the statistical procedures mentioned herein are based on the theory of sampling - that is, the assumption that the period of record used is a fair sample of what might be obtained from any equal period chosen from a much longer record. The effect of the length of the period of record upon flood estimates by the procedures described will be presented in a later study, but preliminary investigations indicate that the period of record chosen may very markedly affect the magnitude of the flood estimates.

8. It is believed that none of the methods thus far presented for estimating frequency of flood magnitudes offers more than an approximation for the guidance of an engineer's judgment. The method, the period, and the character of the data (whether annual floods, daily flows, flood peaks, etc.) may all produce results that are of considerably different magnitudes. In the last analysis the engineer should satisfy himself that he has used an adequate number of methods, whether mathematical, graphic, or otherwise, which have real support from either theory or experience, and then form his own judgment after taking into account his knowledge of the character and accuracy of the data, the purpose for which the estimate is made, and other pertinent conditions.

THE RELIABILITY OF STATISTICAL METHODS IN THE DETERMINATION OF FLOOD FREQUENCIES

By J. J. Slade, Jr.*

The aim of statistical analysis is to determine the manner in which the variable quantities are distributed in a "population" of which a sample has been observed. The relation between the magnitudes and frequencies of the individuals that constitute the population is called the "frequency distribution function," and its characteristics (mean, standard variation, skewness, kurtosis, etc.) constitute the statistical elements of the population. As the observed sample is the only known section of the population, statistical analysis attempts to infer the characteristics of the population from those of the sample. Obviously, the characteristics of a sample will seldom, if ever, be the same as those of the population from which it is taken. The difference between the magnitude of a characteristic of a population and that of the corresponding characteristic computed from a sample is known as the "error of sampling" in the characteristic. As the characteristics of a whole population are never known,# neither are the errors, but estimates may be made of the probability that an error in a sample will have a certain magnitude. The errors that have the same chance of occurring as a variation or deviation in the observations equal to the standard variation are called the "standard errors." In the case of a "normal" distribution this probability is about 0.68.

Karl Pearson and his coworkers have solved the problem of determining the errors of sampling in the moments of the most general frequency distribution. This done, it is a relatively simple matter to compute the standard errors of all the statistical characteristics obtained from the sample, for these may be expressed in terms of the moments. The most important errors have been given the following expression:

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# This statement applies strictly to the problem of floods, where only a small sample is ever known, the population being made up of all the floods that occur in the life of the stream.

$$\sigma_M = \frac{\sigma}{\sqrt{N}}$$

$$\sigma_{\mu_2} = \sqrt{\frac{\mu_4 - \mu_2^2}{N}}$$

$$\sigma_{\beta_1} = \sqrt{\frac{\beta_1 (4\beta_4 - 24\beta_2 + 36 + 9\beta_1\beta_2 - 12\beta_3 + 35\beta_1)}{N}}$$

$$\sigma_{\sqrt{\beta_1}} = \frac{1}{2} \frac{\sigma_{\beta_1}}{\sqrt{\beta_1}}$$

where $\beta_1 = \frac{\mu_3^2}{\mu_2^3}$; $\beta_2 = \frac{\mu_4}{\mu_2^2}$; $\beta_3 = \frac{\mu_3 \mu_5}{\mu_2^4}$; $\beta_4 = \frac{\mu_6}{\mu_2}$
M is the arithmetic mean, N the number of items in the sample, σ_x the standard error of the characteristic x, and μ_r the r-th moment of the distribution. The fourth formula gives the error of the skewness; that of the kurtosis is not given, as the expression for it is quite long. (The kurtosis, which does not usually appear in engineering literature, is a measure of the flatness of the distribution function - that is, for a given standard variation, which measures the spread of the statistics, the distribution may be flatter or sharper about the mean than the corresponding normal.)

From these formulas it is seen that the determination of the error of the skewness requires the computation of moments through the sixth. However, if the distribution function is assumed to be Pearson's type III, then the higher moments are found to be expressible in terms of the first three. This assumption is not altogether justifiable; but it is a convenient though not necessary assumption. The errors obtained in this way will be comparable to those obtained by making more elaborate assumptions.

From the type III curve we get the following recurrence formula:

$$\mu_{n+1} = \frac{n}{\gamma}\mu_n + \frac{n(p+1)}{\gamma^2}\mu_{n-1}$$

where $$\gamma = \frac{2\mu_2}{\mu_3} \qquad p = \frac{4}{\beta_1} - 1$$

From these we therefore have:

$$\mu_4 = \frac{3\mu_3^2}{2\mu_2} + 3\mu_2^2$$

$$\mu_5 = \frac{2\mu_3\mu_4}{\mu_2} + 4\mu_2\mu_3$$

$$\mu_6 = \frac{5}{2}\frac{\mu_3\mu_5}{\mu_2} + 5\mu_2\mu_4$$

Or, in terms of the β's defined above, these become:

$$\beta_2 = 3/2\beta_1 + 3$$

$$\beta_3 = 2\beta_1\beta_2 + 4\beta_1$$

$$\beta_4 = 5/2\beta_3 + 5\beta_2$$

In this way we are able to compute the standard errors of the coefficients of variation and skew in terms of the second and third moments only. For this particular type of variation the error of the kurtosis is readily determined to be $\sigma_{\beta_2} = 3/2\,\sigma_{\beta_1} = 3\sqrt{\beta_1}\,\sigma_{\sqrt{\beta_1}}$ which, for large skewness, is seen to be vastly greater than that of the skewness.

The standard errors of the coefficient of variation and skewness are exhibited in the accompanying diagrams. Figure 16 shows the errors of the coefficient of variation, when CV = 1, for several values of $\beta_1 = (CS)^2$, plotted against the number of items in the series from which the computations were made. When the CV has a value other than 1, its standard error will be that obtained from the diagram multiplied by the magnitude of the CV. This diagram clearly shows that, even for a small number of items and a greatly skewed distribution, the coefficient of variation is a significant statistical characteristic - that is, only in a very small range of the diagram does its standard error exceed one-third of its computed value.

Figure 17 shows the standard error of the coefficient of skew, for several values of $\beta_1 = (CS)^2$, plotted against the number of items in the series from which the computation was made. The dashed lines represent the position of points along which the CS equals once, twice, and three times the corresponding error. A sample whose computed characteristics place it above and to the right of the line along which the CS is

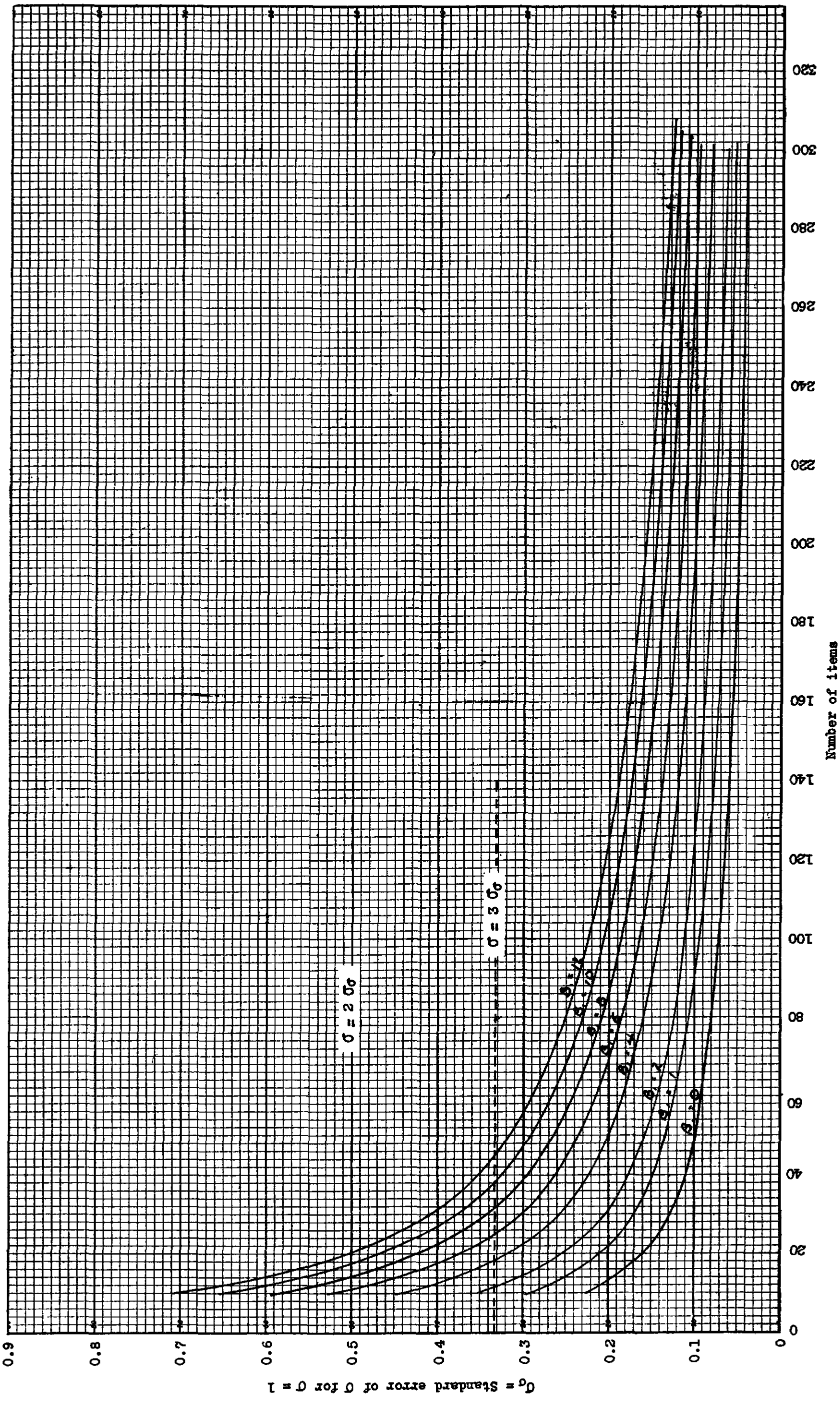

Figure 16.-Standard errors of the coefficient of variation for varying number of items.

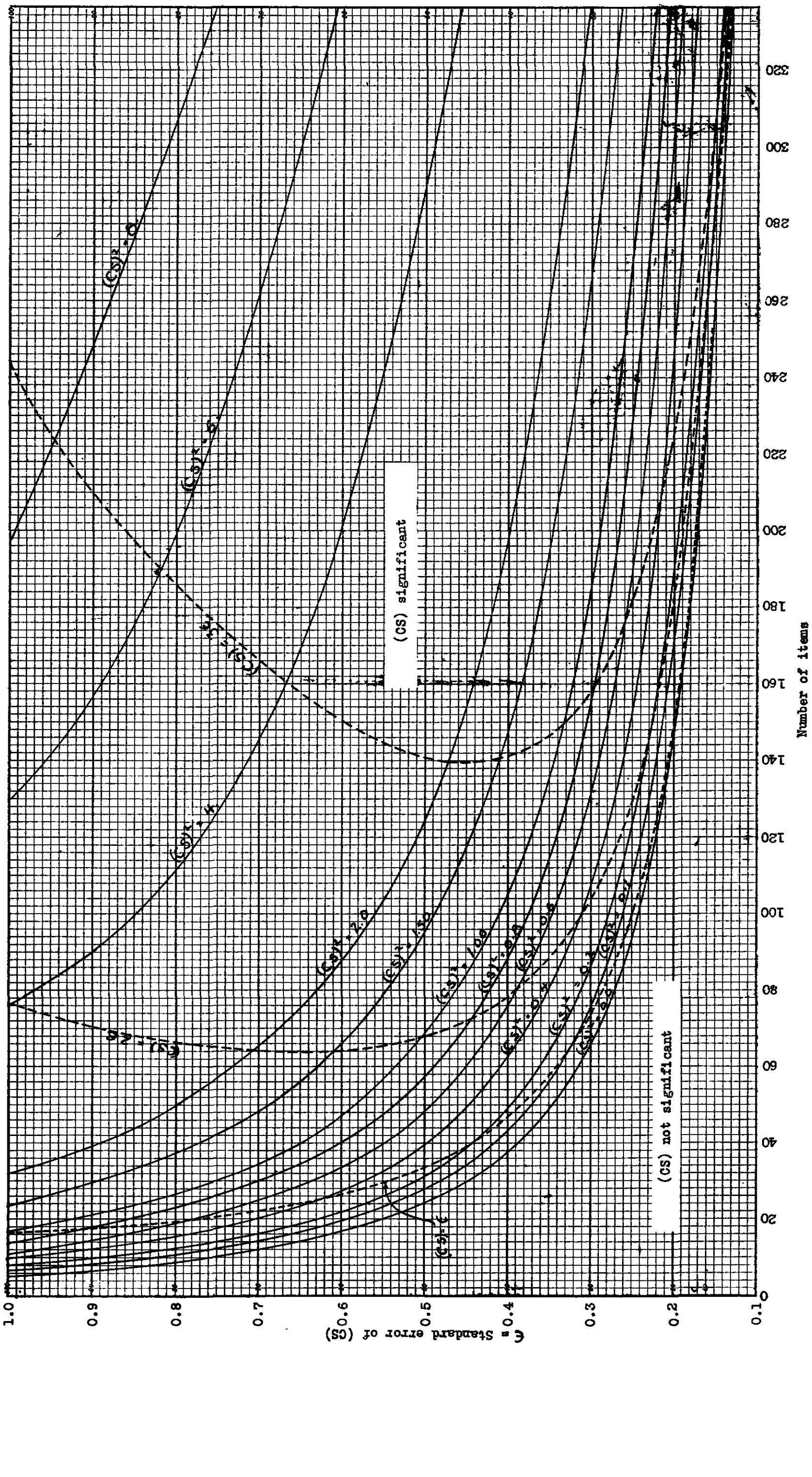

Figure 17.-Standard errors of the coefficient of skew for varying number of items.

three times its standard error must be considered as coming from a significantly skewed population. Below and to the left of this contour the reliability of the measure of skewness decreases. Below the boundary along which the CS is equal to its standard error the skewness computed from the sample cannot be taken as a measure of the skewness of the population. This does not mean, of course, that the population is not skewed - only that the sample is inadequate to give a reliable measure of this characteristic. This diagram indicates that skewness is never a truly significant characteristic when the sample from which it is computed has less than about 140 items, no matter what the magnitude of β_1 may be, and that it is quite meaningless to use this measure when there are 50 or fewer items.

To illustrate the effect of these errors on a statistical determination of flood frequencies the annual floods of the 57-year record of the Tennessee River at Chattanooga will be taken. The two constants, CV and CS, were computed for this series and by means of them Foster's type III curve was fitted to the duration series. This curve is represented by the solid line in figure 18, the points representing the observations. Adding their standard errors to the (CV) and (CS) gives a Foster type III curve which is represented by the dashed line 1; subtracting these errors gives the dashed line 2. All that can be said about the true duration curve is that it is pretty certain to lie somewhere within the region bounded by the dashed lines 1 and 2. These two curves are thus seen to be the boundaries of a region of indeterminacy. This region, however, is not definite, for there is a small chance that the true duration curve falls outside it.

A Foster type III curve was used for this illustration. Any other curve would yield similar results, of course, when the errors of sampling are taken into account in computing the constants that determine it.

In order to show the variation in characteristics of samples taken from the same population, 34 25-year samples were taken from the 57-year record of the Tennessee River at Chattanooga. The CV and CS of each sample were computed. These characteristics are given in the following table, in order of magnitude. (The CV and CS listed opposite each other do not necessarily correspond.)

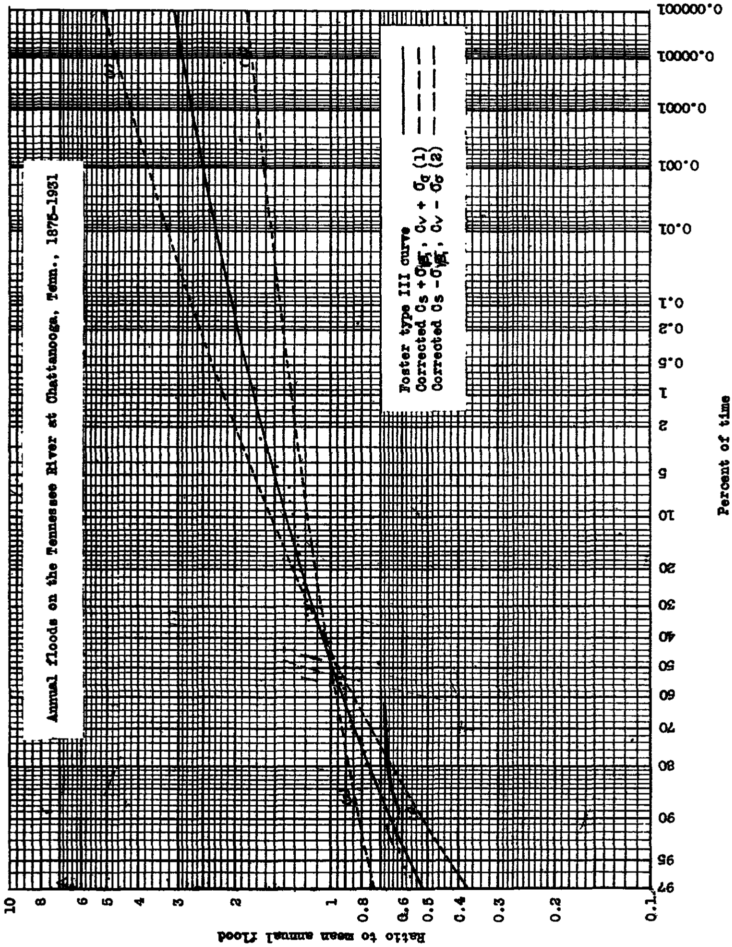

Figure 15.- Range of standard errors of CV and CS for a Foster type III curve

Table 12.- Coefficients of variation and skew for selected flood records

(CV)	(CS)	(CV)	(CS)	(CV)	(CS)
0.2110	-0.1938	0.2545	0.1155	0.2835	0.2730
.2279	- .1876	.2555	.1347	.2839	.2440
.2332	- .1800	.2561	.1426	.2845	.2471
.2345	- .1210	.2562	.1474	.2855	.2585
.2351	- .1156	.2600	.1516	.2895	.2960
.2420	- .1024	.2655	.1607	.2959	.3060
.2470	+ .0457	.2745	.1633	.3000	.3315
.2482	.0706	.2780	.1710	.3008	.3381
.2502	.0992	.2786	.1923	.3016	.4685
.2509	.1030	.2809	.2290	.3023	.4900
.2535	.1125	.2816	.2370	.3031	.6410
				.3081	.7740

The total range of variation of the CV is 0.0971; the total range of variation of the CS is 0.9678, ten times as great. Theory requires that the range of these variations be greater, and this requirement would undoubtedly be met if variations during the whole life of the stream were considered instead of the variations occurring in the known 57-year sample. Even this small sample, however, shows that the predictions of theory conform closely to what actually happens.

Independent characteristics of a population

A population is determined in terms of its statistical characteristics. The question naturally arises, How many of these characteristics are there? Obviously, we are interested only in a set of mutually independent characteristics, for any others may be expressed in terms of these. For instance, in any law of variation the mean can never be inferred from a knowledge of the standard variation, and these two characteristics are thus mutually independent. On the other hand, in a "normal" variation the average variation is a function of the standard variation, and these two characteristics are, therefore, not mutually independent for this law.

It is known that the moments of a distribution constitute an independent set of statistical characteristics. Pearson has recognized four fundamental statistical characteristics, readily expressible in terms of moments - the mean, the standard variation, the skewness, and the kurtosis. Though there are undoubtedly many more, these appear to be the most significant. In general, it might be said that they are equally important in describing the population; it is not true, however, that they are equally reliable as computed from a sample, as has been shown above. The general conclusion, then, is that though the skewness and kurtosis may be as important as the mean and standard variation for a reliable description of a statistical population, they are not reliably determined from a small sample.

The frequency curve

The population from which a sample is taken is usually represented by a smooth frequency curve fitted over the observed distribution of the observed magnitudes. For some purposes the cumulative frequency or duration curve is used; this is the integral of the frequency curve. Either of these curves is completely determined when its parameters (the constants that enter into the mathematical description of it) have been determined. There are a great many methods of determining these parameters; the most reliable are the methods that make use of the complete set of plotted points, such as the method of least squares or the method of moments. In general, the reliability of a method of curve fitting decreases as the number of plotted points utilized in determining its parameters decreases. In general, no method is more reliable than the method of moments, and this will be taken as a criterion.

The flexibility of a curve depends on the number of constants employed in its mathematical description. These constants can always be expressed in terms of the moments. The probable errors of these constants will therefore depend on those of the moments. When the method of moments is not used to determine these constants their standard errors will, in general, be greater than when this method is employed. It must be pointed out that the formulas for the standard errors of functions found in treatises on least squares are not applicable to the present determination, because in these treatises the distribution of variations is always assumed to be normal. There will be as many moments required in the determination of a frequency curve as there are constants to be determined. We are thus led to the conclusion that at most two constants may be determined reliably from a small sample. If more than two constants are determined from the observed series, then it becomes necessary to make a complete investigation of the effect of the errors of sampling in the predictions made from this curve, as was done for the Foster type III curve above.

Of the many curves employed to represent flood distribution some have only two parameters. By some reasonable method of curve fitting these can be determined reliably. The question arises whether these curves indeed represent the variation through their whole range. These two-parameter curves are usually of the logarithmic type, and their derivatives do not bound a finite area. Consequently, if they represent the variation at all, they do so only up to the point that represents 100 percent of the time; any extension beyond that point is meaningless. Now, if the curve has been fitted closely over the plotted points, the point on it representing 100 percent of the time will be very close to the last observed item, and so the curve cannot be used for extrapolation.

Limitations of the statistical method

From the foregoing discussion it is obvious that the statistical method is subject to great limitations, not because curves cannot be found to fit a sample closely, but because a small sample itself is subject to great errors of sampling. If the four statistical characteristics - mean, standard variation, skewness, and kurtosis - are taken as fundamental, then it is necessary to employ a curve that has four independent constants. Of these only two can be determined with any degree of reliability by means of statistical methods, and so it becomes necessary to use purely nonstatistical processes to determine the other two. Now, the end points of a four-parameter curve of finite range are equivalent to the skewness and kurtosis - that is, given the mean, standard variation, and end points, the skewness and kurtosis are uniquely determined, and, conversely, given the mean, standard variation, skewness, and kurtosis, the end points are uniquely determined. As the end points of the curve correspond to the limits of the variation, therefore, if these limits can be found by nonstatistical methods, the two remaining constants of the curve can be found by making use of this information. This applies to any four-parameter curve of limited range.

Range of the statistics

It appears to be generally conceded not only that there is a definite upper limit to the magnitude of floods in a stream, but also that this limit is not enormously in excess of the greatest flood observed in a long record. The existence of this limit may be directly inferred from a consideration of the fact that the energy represented by precipitation over a given drainage area is derived entirely from energy, latent and kinetic, resident in the atmosphere, and that only a definite amount of this energy can possibly be concentrated over the drainage area.

The factors that contribute to the magnitude of a given flood are many, yet a great flood may be considered as arising from one of the following concurrences of circumstances:

(1) A series of storms passes over a drainage area. The first storms prepare the ground by saturating it, so that the precipitation from the last storm, or storms, is converted principally into run-off.

(2) A single great storm, well centered, continues over the drainage area long enough to saturate the ground and convert the precipitation of its later stages into the maximum run-off that the ground will permit.

(3)* A single storm, well centered over the drainage area, produces rates of precipitation so high as to prevent the ground, whatever its absorptive capacity may be, from absorbing an appreciable part of the rain, thus giving rise to very high rates of run-off.

These several types of occurrence may produce essentially the same effect insofar as the resulting flood peak is concerned. As we do not yet know enough about the mechanics of storms to deduce the maximum storm configuration that may form over a given area, we may, to construct the limit flood, employ a modification of the method originated by Sherman and developed by Bernard.

Such a concurrence of circumstances is very improbable, but the resulting flood is certainly possible. The peak determined in this manner would be a reasonable estimate of the limit flood; zero, of course, may be taken as the lower limit.

Conclusions

To represent adequately a stream-flow distribution a curve with four arbitrary constants is necessary; this is the required degree of flexibility in order that the curve correspond to the population in mean, standard variation, skewness, and kurtosis.

Because of the errors of sampling only two of these constants can be determined with any degree of reliability from the items of a small sample. No method of curve fitting can circumvent the indeterminacies introduced by these errors, because the errors are inherent in the sample.

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* Added at the suggestion of G. H. Matthes, chairman, Am. Soc. Civil Eng. Committee on Flood Protection Data.

Two more constants may be determined from a knowledge of the limits of the variation.

Zero flow may be taken as a reasonable estimate of the lower limit of floods. A modification of the Sherman-Bernard unit-graph method, designed to give the peak flow from a possible storm, the probability of whose occurrence, however, is negligible, can be used to give a reasonable estimate of the upper limit of floods.

In the writer's opinion the statistical method, in whatever form employed (graphic or analytical), is an entirely inadequate tool in the determination of flood frequencies. When used in conjunction with nonstatistically inferred data, however, it may attain a high order of precision.

HYDROLOGIC CONDITIONS AS AFFECTING THE RESULTS OF THE APPLICATION OF METHODS OF FREQUENCY ANALYSIS TO FLOOD RECORDS

By Robert E. Horton*

A simple illustration of the necessity of considering hydrologic conditions in connection with statistical analyses of floods or other hydrologic data is afforded by variation in methods of sampling or selection of data to be utilized. Some writers on flood frequency use analyses based on a tabulation of maximum annual floods. Others hold that with the view of utilizing all the available data, the best determination of flood frequencies requires the use of all the stream discharges at all stages, from the highest to the lowest. Both these extremes are subject to serious objections. With regard to annual maximum floods it may happen that the highest flood in a certain year is exceeded by several floods in other years. A statistical analysis based on maximum annual floods alone is certain to lead to predicted frequencies of major floods less than their actual frequencies of occurrenc.

In general, major floods on not too large areas are caused by rain which not only covers substantially the entire drainage basin but which has such an intensity that surface run-off is produced from substantially the entire drainage basin. Storms of this class may be called "general storms." In order to obtain consistent results it appears that in a given array of data for a statistical analysis, with a view, in particular, to determining frequencies of major floods, only floods or stream rises resulting from general storms should be included. If floods resulting from local storms or storms covering only part of a drainage basin are included, then the data which such storms represent include at least two additional independent variables - namely, (1) storm area and (2) location of storm area - which are not included or required in connection with general storms.

The lower limit of flood magnitudes to be included in major floods resulting from general storms can be fixed approximately from

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hydrologic considerations. It is not true, as might at first appear, that general floods may range in magnitude from zero up to the highest. With minor exceptions, surface run-off, which is the main cause of flood discharges, will occur if and only if there is a rain intensity in excess of the infiltration capacity for some time interval during the storm. A general rain that has a sufficient intensity to produce rainfall excess and surface run-off around the margins of a drainage basin will invariably have an average intensity considerably greater than the infiltration capacity and will produce a flood rarely, if ever, less than some certain magnitude. For example, to consider winter conditions, if the infiltration capacity of a given drainage basin is 0.01 inch an hour or one-fourth inch a day, a storm that is central over the basin and that has an intensity of at least one-fourth inch a day around the margins of the basin is likely to have an average intensity of at least one-half inch a day over the drainage basin as a whole. Therefore any storm on such a drainage basin that is capable of producing a general flood under winter conditions would produce a flood run-off rate of at least one-fourth inch a day.

In selecting the minimum flood magnitude to be utilized, the minimum should be low enough to include all general floods but not low enough to include either any considerable number of stream rises resulting from local rainfall or of stream rises in which a large proportion of the total measured run-off is derived from ground-water flow. Wide variations in this limit occur in relation to floods occurring at different seasons of the year and on drainage basins of different types. For a perfectly impervious drainage basin, obviously all stream rises should be included as major floods if they result from general rains. In a highly permeable drainage basin there may be relatively few if any floods that can properly be included in the category of general floods or that represent direct surface run-off from the entire drainage basin.

Inasmuch as the value of the constants in the writer's formula for maximum flood limits (formula 1) and the flood frequencies obtained by the application of other frequency methods is somewhat affected by the magnitude used for the minimum flood, it is obviously important to give this matter careful consideration.

HYDROLOGIC CONDITIONS AS AFFECTING THE RESULTS OF THE APPLICATION OF METHODS OF FREQUENCY ANALYSIS TO FLOOD RECORDS

It is not unusual to include all floods in a single statistical analysis, regardless of the season of the year at which they occur. This usually means the combination of several sets of data in which the occurrence of events in any one set is governed by independent variables differing from those that govern other sets. The effect is precisely the same as that resulting from the use of a nonhomogeneous series of events, as illustrated by the winter floods on the Tennessee River drainage basin: it may lead to a statistical result indicating a frequency of major floods less than their actual frequency.

Floods on a given drainage basin may be of several different hydrologic types - for example, (1) fall floods resulting from general rains of the cyclonic type, either alone or accompanied by widespread intense rains of the thunderstorm type; (2) winter floods resulting from rains of the purely cyclonic type on bare or frozen ground or ground with low infiltration capacity; (3) winter or spring floods resulting from a combination of general rains and melting of snow; (4) summer floods resulting from highly intense thunderstorm rains, with moderate or light general rain. The independent variables governing each of these types of floods are different.

A homogeneous record may be defined as one in which the independent variables producing the events are the same throughout the period of record and in which all the events included are produced by one set of independent variables. From this definition it will be seen that there are two kinds of homogeneity - (1) homogeneity with reference to type or independent variables involved, (2) homogeneity with reference to time. If a record is homogeneous with reference to time, then the results of statistical analyses of the first and second halves of the record, taken separately, should be the same except for the effect of errors of sampling. If the record is not homogeneous with reference to time, such an analysis applied to portions of the record before and after the changes took place may give correct results with reference to each set of conditions and will, furthermore, be indicative of the extent and magnitude of the effect of the changes on hydrologic conditions.

It is desirable to have a clear understanding of the variables controlling the events. As a rule hydrologic events - flood magnitudes, for example - are not functions of an infinite number of direct, independent variables. In summer floods due to surface run-off, exclusive of ground water flow, the principal variables that are directly operative are: (1) rain intensity, (2) rain distribution in time, (3) areal rain distribution, (4) duration of rain intensity, (5) storm path, (6) form and character of stream drainage net, (7) infiltration capacity, (8) depression storage, (9) lake, swamp, and marsh storage, (10) initial channel storage, (11) surface slope, (12) surface roughness, (13) length of overland flow, (14) vegetation, particularly as affecting interception of rainfall, (15) temperature, mainly as affecting interception of rainfall by vegetation.

If there is no progressive change in rainfall factors included in the first five of these items, the principal changes likely to affect magnitude of summer floods on streams without natural storage regulation are (1) drainage, which is likely to affect items 6, 11, and 13; (2) changes in cultural conditions, such as a change from cultivated to fallow land, or the reverse, which will affect items 7, 8, and 12; (3) changes in vegetation, such as deforestation and subsequent growth of grass or crops, which will generally affect items 7, 8, 12, 14, and 15 and which are often accompanied by changes of infiltration capacity.

In summer floods, the variable changed most by human operations is usually item 7, infiltration capacity.

As regards winter floods, the same variables are involved and, in addition, (1) condition of the soil - whether frozen or unfrozen and, if frozen, the percentage of soil moisture which it contains; (2) snow cover - its depth, density, structure, and distribution. Infiltration capacity becomes smaller, less variable, and relatively less important in winter than in summer.

For the purpose of illustrating the effect of changes in hydrologic conditions on flood magnitudes and frequencies, the record of winter floods on the Tennessee River drainage basin above Chattanooga for the 60-year period 1874 to 1933 will be utilized. As results of the same general character would be obtained by the application of any one of several existing frequency formulas or methods of frequency analysis applied to the flood data, an anlaysis by a single formula or method will serve for purposes of illustration. A formula developed by the writer* will be utilized.

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* Horton, R. E., Determining the mean precipitation on a drainage basin: New England Water Works Assoc. Jour., vol. 38, no. 1, pp. 21-24, 1924.

$$q = q_g - (q_g - q_0)\mathcal{E}^{-k(t-t_0)^n} \quad \text{. . . . . (1)}$$

in which q = magnitude of a flood having either an average recurrence interval t or an exceedance interval t_e. The formula may be applied for the determination of either recurrence intervals or exceedance intervals.

Recurrence interval may be defined as the average interval of occurrence of floods or other hydrologic events equaling or exceeding a given magnitude. Recurrence intervals are given by the formula

$$t = \frac{T}{N - n + 1} \quad \text{. . . . . (2)}$$

in which T = total period, in years, covered by the record.

N = total number of events in the record.

n = the number of a given event or flood in order of magnitude, beginning with the lowest.

Exceedance interval may be defined as the average interval in years at which an event of a given magnitude is exceeded. Exceedance intervals are given by the formula

$$t = \frac{T}{N - n} \quad \text{. . . . . (3)}$$

If, as has been done in formula 1, recurrence intervals are used, the data are arranged in order of magnitude, the recurrence intervals for the different observed events are computed by formula 2, and the magnitudes of the events are plotted in terms of their recurrence intervals.

In formula 1, q_0 is the minimum value or magnitude of a flood or event of a given type, and t_0 is its recurrence interval. These quantities are determined from the data and from hydrologic considerations as above outlined. The form of equation 1 is such that as $t \rightarrow \infty$, the flood magnitude q approaches a limiting or maximum value q_g asymptotically. Formula 1 generally resembles other frequency formulas applied to flood data except in this respect. Some formulas indicate that flood magnitudes increase without limit - in other words, the calculated flood magnitude approaches infinity as the average recurrence interval approaches infinity. This is true, for example, with the normal or Gaussian law of error.

In accordance with formula 1, flood magnitudes always continue to increase as the recurrence interval increases, but they increase toward a definite limit and not toward infinity. This is believed to be the more rational form of expression. No terrestrial stream can produce an infinite flood. A small stream cannot produce a major Mississippi River flood, for much the same reason that an ordinary barnyard fowl cannot lay an egg a yard in diameter: it would transcend nature's capabilities under the circumstances.

If the data are good and homogeneous, it will generally be found that the lower or left-hand portion of the recurrence-interval curve plotted directly from the data is clean-cut and sharply defined. Above a certain point there is often a break in the plotted curve, and the data became scattered. An underlying principle is that the constants in equation 1 should and can be determined from the sharply defined, consistent lower portion of the plotted curve. The observations on which this portion is based are so numerous that it is less affected by errors of sampling than the higher portion.

For the purpose of determining the constants in equation 1, three pairs of values of q and t are to be selected from the curve plotted from the observed data. It should be strongly emphasized that unless these data give a sharply defined, consistent curve for the lower portion of the record, accurate results may be unobtainable. At least two of the pairs of values used in determining the constants are always to be taken from this sharply defined part of the curve. The third pair may generally be taken from the less well-defined part of the curve, corresponding to a little longer recurrence interval, provided the points are well balanced and well distributed. If this rule is followed, different persons working with the same data but using, perhaps, different pairs of values of q and t in determining the constants, will arrive at nearly though not always precisely the same limiting magnitude.

Formula 1 may be referred to as a frequency formula. It is, however, primarily a formula for determining the maximum or minimum of hydrologic events as closely as these limits can be determined from statistical considerations alone. Formula 1 can be applied as a frequency formula in the ordinary sense when and only when these limits have been determined.*

* The method of deriving the constants in equation 1 has not heretofore been published and is given, for the sake of completeness, in an appendix.

From data listed on pages 204 and 205, the items representing winter floods on the Tennessee River at Chattanooga, occurring in the months of December to April, were compiled for plotting on figure 19. The two upper curves on this drawing furnish a basis for comparison of flood-recurrence interval and magnitude for the two 30-year periods, 1874 to 1903 (April 1894 to September 1903) and 1904 to 1933. The minimum magnitude for general winter floods has been taken at 112,000 second-feet. For the first 30-year period the total number of winter floods is 106 and the average flood 178,700 second-feet. For the second 30-year period the total number of winter floods is 87, and the average flood 158,000 second-feet.

If, however, floods of over 200,000 second-feet, which may be regarded as major floods, are considered the first 30-year period contained 32 such floods, and the second only 10. This apparent change in frequency of major floods is reflected in the records for different months, as shown by the following table:

Table 13.- Variation in frequency and magnitude of Tennessee River floods at Chattanooga, Tenn., for 30-year periods

Month	Floods over 112,000 c.f.s.				Floods over 200,000 c.f.s.					
	Number		Average*		Number		Average*		Maximum*	
	1874-1903	1904-33	1874-1903	1904-33	1874-1903	1904-33	1874-1903	1904-33	1874-1903	1904-33
1	2	3	4	5	6	7	8	9	10	11
Dec.	9	14	151.0	149.5	1	1	227	248	227	248
Jan.	18	16	188.9	152.8	8	2	241	245	271	261
Feb.	25	22	170.6	161.2	5	3	240	229	254	266
Mar.	32	29	191.0	159.1	11	3	260	253	361	310
Apr.	22	6	172.8	174.5	7	1	239	275	349	275
	106	87	......	.....	32	10	...	...	...	...
Average	...	..	178.7	158.0	..	..	247	245.7	361	310

* Thousands of second-feet.

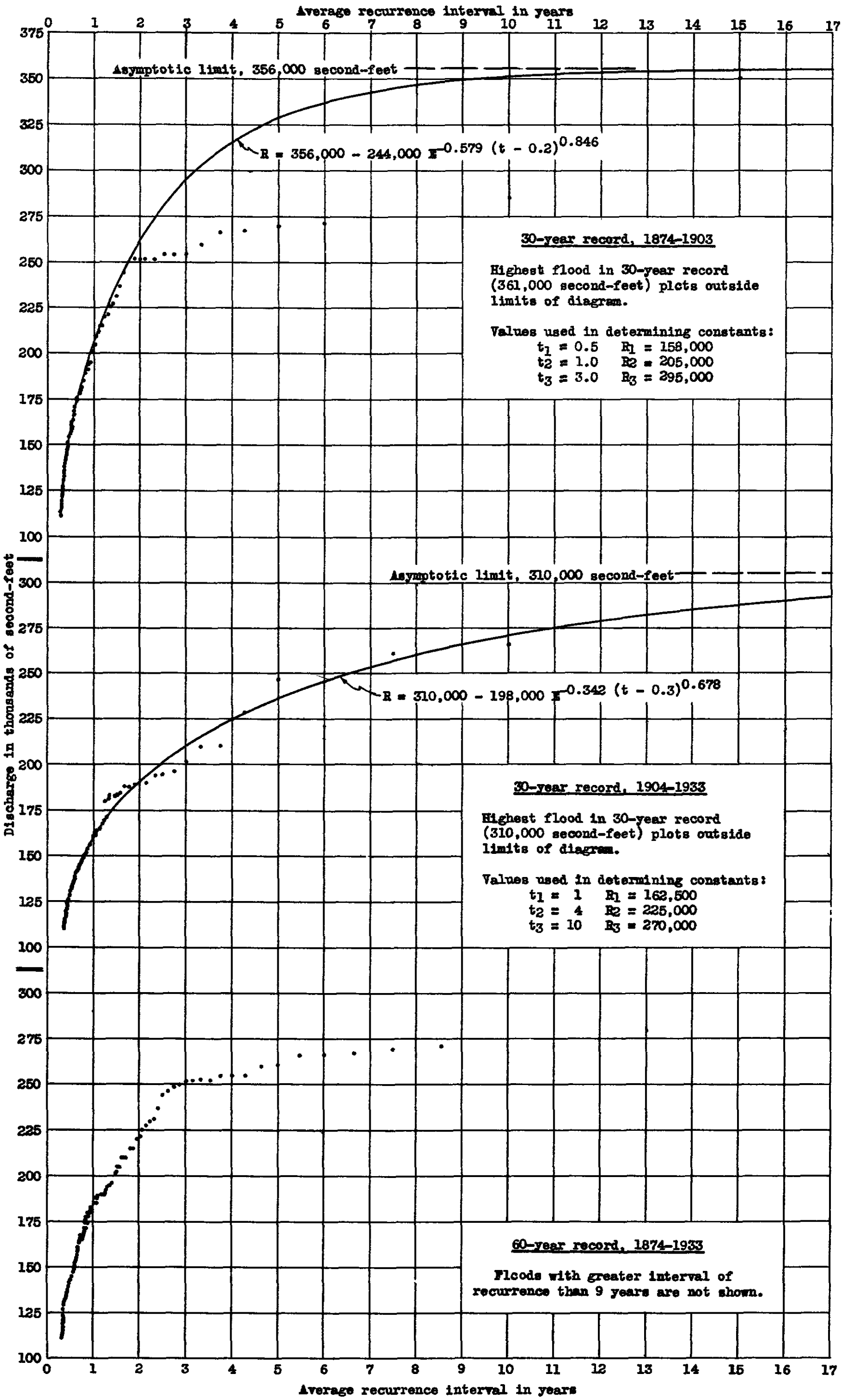

Figure 19.—Flood intervals and magnitudes, Tennessee River at Chattanooga, Tenn., 1874-1933

The average date of winter floods of 200,000 second-feet or more was March 1 in the first half of the record and February 17, or 12 days earlier, in the second half.

These figures suggest the possibility of a systematic change in hydrologic conditions, which has decreased the tendency to production of extremely high floods since about 1904 and has set back the occurrence of the higher floods by 12 days.*

Large summer floods are infrequent, and the data considered are too meager to provide a basis for a definite conclusion. The indication is that there has been little change in summer floods. If the difference in frequency and magnitude of winter floods is due to a change in the hydrologic conditions, this change should be reflected in the hydrologic cycle in other ways.

The following data in relation to water losses in the Tennessee River drainage basin - that is, the portion of the rainfall removed from the basin - are taken from a memorandum prepared by W. G. Hoyt for inclusion in Water-Supply Paper 772, in the chapter dealing with relations between rainfall and run-off in the Tennessee River basin.

For the 10-year period 1885 to 1894, with 49.32 inches of rainfall, the water losses were 23.63 inches. For the last 10-year period of the record, 1925 to 1934, with 49.09 inches, or almost identical rainfall, the water losses were 28.48 inches, or nearly 5 inches greater than in the first period. (Rainfall and water losses are average annual values.)

Other 10-year comparisons show similar evidence of a progressive increase in water losses. For example, the period 1900 to 1909, at about the beginning of the second half of the flood record, shows water losses of 26.04 inches, with 50.69 inches of rainfall. The last 10-year period, 1925 to 1934, shows water losses of 28.48 inches, or about 2 1/2 inches more than the earlier period, with 1.6 inches less rainfall.

Applying formula 1 to the entire 60-year flood record at Chattanooga leads to an apparent flood magnitude considerably below the observed maximum.**

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* The average date of major floods is 20 days earlier in the second period if November floods are included.

** In a study of flood data on ten large rivers in the United States, dated February 3, 1920, the writer found that the record of the Tennessee River at Chattanooga was the only one of the ten for which formula 1 did not give consistent results or lead to a maximum at least equal to the highest observed flood.

A recurrence interval curve was plotted from the first half of the record, and the following equation was derived from it:

$$q = 356{,}000 - 244{,}000\,\mathcal{E}^{-0.579\,(t-0.2)^{0.846}} \quad \ldots\ldots \quad (4)$$

The curve computed from this equation is in exceedingly good agreement with the well-determined lower portion of the curve plotted from the observed data.

The highest recorded flood in the first half of the period is 361,000 second-feet as compared with a maximum of 356,000 second-feet calculated by the writer's formula.

The data for the second half of the record, 1904 to 1933, were also plotted and yielded the equation

$$q = 310{,}000 - 198{,}000\,\mathcal{E}^{-0.342\,(t-0.2)^{0.678}} \quad \ldots\ldots \quad (5)$$

This equation gives a maximum of 310,000 second-feet, the same as the observed maximum for this period.

That a statistical method should give better results for each of two 30-year periods than for the complete 60-year record is an unusual result, of itself indicative either of progressive change or else of lack of homogeneity in the data.

Of course formula 1 will not give exactly the limiting flood magnitude. Usually it gives a calculated maximum somewhat greater than the highest observed maximum. For example, application of formula 1 to flood stages on the Pee Dee River at Cheraw, S. C.,* (drainage area 7,380 square miles), for the 38-year period 1893 to 1930 gave the result:

$$H = 49.4 - 22.4\,\mathcal{E}^{-0.362\,(t-t_0)^{0.347}} \quad \ldots\ldots\ldots\ldots \quad (6)$$

This indicates a limiting maximum flood stage at Cheraw of 49.4 feet, as compared with the observed maximum stage of 44.3 feet during the period of record.

The agreement of observed and calculated maxima for each of the two periods for the Tennessee River at Chattanooga is really too good. The calculated maxima should have been greater. The probable reason for this will subsequently be discussed.

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* Report on Yadkin-Pee Dee River, N. C. and S. C.: 73d cong., 1st sess., H. Doc. 68, p. 125.

HYDROLOGIC CONDITIONS AS AFFECTING THE RESULTS OF THE APPLICATION OF METHODS OF FREQUENCY ANALYSIS TO FLOOD RECORDS

There are several reasons why the true maximum flood magnitude cannot be exactly determined by formula 1 and also reasons why true flood frequencies cannot be determined by other flood formulas or methods of frequency analysis, even though the data are homogeneous in all respects:

1. Most of the available flood data are 24-hour averages for the highest record day. This is invariably less than the true average for the highest 24-hour period, the difference usually increasing as the size of the drainage basin decreases.

2. Most flood data are subject to the condition that ground-water flow may vary over a wide range under conditions where the surface run-off intensity is the same. In some basins more consistent results in the application of frequency formulas could probably be obtained by deducting the ground-water flow and using flood data representing surface run-off only.

3. The data themselves are always subject to errors of observation, and some of them to serious errors of method. At Chattanooga the first current-meter measurements were made in 1891, and few discharge measurements have been made at stream stages corresponding to discharges of more than 200,000 second-feet. On October 22, 1913, the Chattanooga gage became affected by backwater from the Hales Bar dam, 33 miles downstream. Between that date and 1921 discharges were determined in part from the observed slope between two gages, in part from gage readings at Bridgeport, Ala., in conjunction with discharge measurements at Chattanooga. Since January 5, 1921, various gages at the Hales Bar dam have been used in conjunction with discharge measurements at Chattanooga and Hales Bar.

The writer has no desire to disparage the use or belittle the value of mathematical analyses in hydrology. The study of the Chattanooga record reveals, however, many respects in which such analyses, particularly statistical analyses, should be accompanied by a study of the hydrologic conditions. In this case application of statistical analysis to the complete flood record leads to inconsistent results. Statistical methods applied to the same record, after taking into consideration changes in hydrologic conditions, lead to consistent results. Furthermore, they aid in the interpretation of the hydrologic conditions.

The data and the statistical analysis indicate the possibility of a change in conditions in the Tennessee drainage basin which has brought about a decrease in magnitude and frequency of measured floods, has resulted in making earlier by 12 days the average date of major floods, and has materially increased the water losses from the drainage basin. In this case, as in others where the results of statistical analyses may be affected by changes in conditions, it is desirable not only to determine the effect but, if possible, to determine whether an adequate cause can be found. This may aid in making correct statistical interpretation of the data and in avoiding misleading results. A full discussion of the possible causes of the hydrologic changes in the Tennessee drainage basin indicated both by the data themselves and by the analysis of flood frequency would lead too far afield. The following suggestions are offered as worthy of consideration but are not necessarily conclusive:

The observed changes in hydrologic conditions may be the result of changes in meteorologic conditions, or changes in topographic or cultural conditions.

The studies of W. G. Hoyt, above referred to, indicate an increase of mean annual air temperature of about 2°F. in the Tennessee River drainage basin since 1888, when maximum and minimum thermometers were generally installed at United States Weather Bureau stations. Kincer* has found evidence of a similar widespread increase of air temperature, and there seems to be little doubt of its reality. The records used for the Tennessee River drainage basin, however, were all made in cities, and it may fairly be questioned whether there has been a corresponding increase of air temperature in the purely rural areas. Even an increase of 2° in air temperature is apparently inadequate to account for more than about one-third of the observed increase of water losses.

Mr. Hoyt's studies also indicate some decrease of mean rainfall. Under conditions such as exist in the Tennessee River drainage basin, this should produce a decrease in water losses. Instead there has been a substantial increase.

A decrease in rainfall and an increase of air temperature might tend, however, to decrease flood magnitudes and also to make earlier the date of snow melting. The observed changes in these factors appear inadequate to account for the relatively much larger change in the magnitudes and intensities of major floods.

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* Kincer, J. B., A study of long-time temperature trends: Monthly Weather Review, vol. 61, no. 9, pp. 251-259, September 1933.

As to changes in cultural conditions, the census report for 1880* states, with reference to Tennessee:

> "The eastern part of the State, occupied by the Cumberland plateau and the high ranges of the southern Allegheny Mountains, is covered with a heavy forest of oak and other hard woods, mixed at high elevations with hemlock, pine, and spruce and constituting one of the finest bodies of timber now standing in the United States. It contains, besides white and chestnut oak of fine quality, much yellow poplar, black walnut, and cherry. In the southeastern counties, especially in the valley of the Tennessee River, the hard-wood forests have been, however, already destroyed over large areas to furnish charcoal for the iron-manufacturing industry established here."

The same report states with reference to the portion of western North Carolina lying within the Tennessee River drainage basin**:

> "The high ridges and deep valleys of the Appalachian system which culminate in the western part of the State are still everywhere covered with dense forests of the most valuable hard-wood trees mingled with northern pines and hemlocks. The inaccessibility of this mountain region has protected these valuable forests up to the present time, and few inroads have yet been made into their stores of oak, cherry, yellow poplar, and walnut."

Map accompanying the census report show the entire Tennessee River drainage basin above Chattanooga covered with dense forest.

Exhaustive study of the history of deforestation in the Tennessee drainage basin has not been made. However, from general knowledge and information readily available# it appears that unquestionably extensive deforestation took place in this basin beginning about 1890 and continuing into the second half of the period of record. In some places this deforestation was partial, the smaller growths being left standing; in others it was followed by clearing and cultivation and the growth of crops, such as corn.

This raises the interesting question, What if any effect may the cutting of timber in this drainage basin have had on water losses and flood magnitudes? Deforestation might either increase or decrease water losses, the effect depending in part on the kind of vegetation, if any, that replaces the forest.

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* Forest trees of North America: U. S. 10th Census, vol. 9, p. 545.
** Idem, p. 515.
# Relation of forestry to the control of floods, 70th Cong., 2d sess., H. Doc. 573. A national plan for American forestry, 73d Cong., 1st sess., S. Doc. 12, pp. 109, 193.

In dealing with so complicated a subject as the effect of changes in vegetation and soil conditions it is in general necessary to study each drainage basin as an independent problem. Few safe generalizations can be made.

Flood magnitudes, particularly for summer floods, are highly sensitive to changes of infiltration capacity of the soil. For example, a long-continued rain intensity of 1 inch an hour on a small area, with an infiltration capacity of one-third inch an hour, would produce a run-off intensity of about 400 second-feet per square mile. The same rain intensity on the same area but with double the infiltration capacity would produce a maximum run-off intensity only one-half as great, or about 200 second-feet per square mile. Infiltration capacities vary over a wide range on different areas and under different conditions, particularly in summer.

Evidence of lack of change in summer flood frequencies and magnitudes on the Tennessee River drainage basin indicates, so far as it goes, that there has been no important change of the infiltration capacity as between the two periods considered. On some drainage basins a change of infiltration capacity may follow deforestation and subsequent methods of land use. For such basins the results of deforestation may be widely different from those in the Tennessee drainage basin.

The effect of deforestation on water losses depends both on changes of infiltration capacity and on changes in soil temperature. The experiments of Ebermayer* and others show generally, for summer conditions, an increase of temperature in open areas of 4° to 8°F., both at the soil surface and at a depth of 4 feet as compared with temperatures in adjacent forest-covered land. There is also generally an increase of wind velocity close to the ground in the open as compared with that under forest cover. The differences in soil temperature and wind velocity under summer conditions would apparently be adequate to account, by increased evaporation, for the observed increase of water losses, in spite of the apparent decrease of rainfall, in the Tennessee River basin.

In a drainage basin like that of the Tennessee River, more than half of the rainfall is derived - in effect, at least - from local evaporation. If the water losses are increased, the rainfall should

* Ebermayer, Ernst, Die physikalischen Einwirkungen des Waldes, Berlin, 1873.

theoretically also be increased. The fact that rainfall in the Tennessee basin shows decrease, in spite of increased water losses, may mean merely that the effect of increased local evaporation has appeared elsewhere or that the local increase of rainfall has been less than the decrease of rainfall in the same region due to more widespread meteorologic conditions.

Changes in widespread meteorologic conditions alone are apparently inadequate to account for the observed change of conditions in the Tennessee River drainage basin.

It is possible that deforestation, with the accompanying changes in soil temperature and wind velocity, may adequately account for the observed change in water losses, but such losses, which occur largely in summer, appear to have no direct relation to winter floods.

There are, however, circumstances under which the cutting of the timber might have materially decreased maximum winter flood magnitudes and at the same time increased the water losses. Before the timber was cut, snow might tend to remain unmelted in the woods, accumulating until removed by heavy spring rains, then producing a flood of high intensity. After the timber was cut, the snow might generally not accumulate but melt or be carried away by rain between successive snowstorms, producing more floods but these of smaller magnitude. If this were true then the average date of maximum floods would be expected to fall considerably earlier in the second half than in the first half of the period of record, as is found to be the case.

On the assumption that the reduction of flood magnitudes and frequencies in the Tennessee River drainage basin is due to deforestation, as active deforestation did not begin until the later half of the first 30-year period, it would be expected that analysis of the flood records of the first period by the use of formula 1 should show maximum flood volumes less than or not materially greater than the highest observed flood, as, in fact, it does show, instead of showing a higher maximum, as it should if the record were homogeneous. The same would be true to a less extent for the second period.

As shown in figure 19, there was an abrupt break in the plotted data for the first period for floods having a recurrence interval of more than 2 years. Such a break might be attributed, at least in part, to a change in conditions during the period. An assumption that deforestation is partly the cause of a decrease in flood magnitudes in the Tennessee drainage basin is therefore consistent with the findings resulting from the statistical analysis.

The slope of the left-hand portion of the plotted curve for the entire 60-year record (fig. 19) is intermediate between that for the first and that for the second 30-year period. The equation of this curve would necessarily give a maximum limiting flood less than that for the first half of the record and hence less than the larger observed floods. If the record were homogeneous, the slopes of the left-hand portions of the three curves would necessarily be identical except for the effect of ordinary errors of sampling. Whether due to changes in meteorological conditions, changes in cultural conditions, or combination of the two, it is evident that the flood record of the Tennessee River at Chattanooga is not homogeneous throughout the sixty-year period.

Finally, it is evident that not only more consistent results but a greater amount of information can be obtained from a flood record by the proper use of statistical analysis in conjunction with an intimate knowledge of the hydrologic conditions than from a consideration of either one alone.

Appendix.- Determination of maximum or limiting magnitude and determination of the constants in the Horton integral frequency formula

For convenience let G be the maximum or limiting value and L the minimum value of the flood or other magnitude under consideration, L and t_0 being known. R is the magnitude having a recurrence interval t, and t_0 is the recurrence interval for the minimum value L. The equation can then be written as follows:

$$R = G - (G - L)\varepsilon^{-k(t-t_0)^n} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

from which

$$G - R = \frac{G - L}{\varepsilon^{k(t-t_0)^n}} \quad \text{and} \quad \varepsilon^{k(t-t_0)^n} = \frac{G - L}{G - R}$$

and taking natural logs,

$$k = \frac{1}{(t-t_0)^n} \ln \frac{G - L}{G - R} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Three pairs of values - $(R_1 t_1)$, $(R_2 t_2)$, and $(R_3 t_3)$ - are taken off from the plotted portion of the plotted integral frequency curve within the region where the curve is well determined and can be drawn in accurately from the plotted points.

For points 1 and 2,

$$k = \frac{1}{(t_1 - t_0)^n} \ln \frac{G - L}{G - R_1} = \frac{1}{(t_2 - t_0)^n} \ln \frac{G - L}{G - R_2} \quad \ldots (3)$$

For points 2 and 3,

$$k = \frac{1}{(t_2 - t_0)^n} \ln \frac{G - L}{G - R_2} = \frac{1}{(t_3 - t_0)^n} \ln \frac{G - L}{G - R_3} \quad \ldots (4)$$

The unknown quantities are G and n.

From equation 3,

$$\left(\frac{t_2 - t_0}{t_1 - t_0}\right)^n = \frac{\ln F\ (R_2)}{\ln F\ (R_1)} = F(t_{2,1})^n \quad \ldots\ldots\ldots\ldots (5)$$

From equation 4,

$$\left(\frac{t_3 - t_0}{t_2 - t_0}\right)^n = \frac{\ln F\ (R_3)}{\ln F\ (R_2)} = F(t_{2,3})^n \quad \ldots\ldots\ldots (6)$$

where

$$F(R) = \frac{G - L}{G - R} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

and

$$F(t_{2.1}) = \frac{t_2 - t_0}{t_1 - t_0}, \text{ etc.} \quad \ldots\ldots\ldots\ldots (8)$$

Taking common logs of equations 5 and 6, we get

$$n \log F(t_{2,1}) = \log \frac{\ln F(R_2)}{\ln F(R_1)} \quad \ldots\ldots\ldots\ldots (9)$$

$$n \log F(t_{3,2}) = \log \frac{\ln F(R_3)}{\ln F(R_2)} \quad \ldots\ldots\ldots\ldots (10)$$

Hence,

$$n = \frac{\log \dfrac{\ln F(R_2)}{\ln F(R_1)}}{\log\ F(t_{2,1})} \quad \ldots\ldots\ldots\ldots\ldots (11)$$

In these two right-hand terms of equations 5 and 6, G is the only unknown quantity. Assume a series of values of G, compute the corresponding values of the two right-hand fractions, and plot both in terms of G. The point of intersection of the graphs will give the required values of G and n. A check on the value of n can be made by substituting the value of G in equation 11 and computing for n. The value of k can be found by substituting the values of n and G in equations 3 or 4.

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The calculation of constants is direct and not difficult. The writer is accustomed to using natural logarithms for F(R) and common logarithms elsewhere. Natural logarithms may be used in both cases; or, using the conversion factor,

$$\ln x = 2.3026 \log x,$$

common logs may be used throughout, permitting the use of a log log slide rule.

If pairs of points used in determining constants are not so chosen that they fall on a curve represented by equation 1, an intersection cannot be obtained.

Note.- In United States Geological Survey Water-Supply Paper 234, reprinted from a report of the National Conservation Commission, February 1909, consideration is given on pages 22 to 24 to the relation between storms and floods in the Tennessee basin above Chattanooga during the periods December to May, 1884-95 and 1896-1907. On the basis of information then available it is there stated that, along with deforestation of the Tennessee basin, "a decided decrease in the number and duration of floods during the period of record" is attributable to a decrease in rainfall, or that "the rainfall has decreased, even to a greater relative extent than the floods." The basis adopted for comparison consisted of the number of flood-producing rains and the number of flood days. The result showed an average increase of 18.75 percent in the number of days of flood per storm during the 24-year period of record. What would be indicated in this regard by a similar study of the rainfall and run-off records available at the present time has not been determined. However, the data referred to further emphasize the point made by Horton to the effect that adequate knowledge of hydrologic conditions is essential to an understanding of the significance of flood phenomena.- R. W. D.

DETERMINATION OF FLOOD FLOW BY UNIT-HYDROGRAPH METHOD

By Merrill M. Bernard*

The unit-hydrograph method is a procedure for determining the rates of surface run-off from a particular basin, by analogy from observed rainfalls and the corresponding observed hydrographs of surface run-off from the same basin. The method is comparatively new, having been originated by L. K. Sherman in 1932 and amplified by the writer in 1934. Mr. Sherman in a memorandum, made a part of the report of the special advisory committee of the Section of Hydrology of the American Geophysical Union, states in substance that the hypothesis upon which the method is based is that in any drainage basin surface run-off from rainfall that is distributed with satisfactory uniformity as to area and time and that occurs in a given unit of time will produce hydrographs in which the bases are approximately equal and the ordinates vary with the intensity of net rainfall (rainfall minus infiltration and other losses). In other words, the ordinates vary with the magnitude of that portion of the rainfall which produces surface run-off. The method has since been investigated and used by others in a variety of hydrologic problems. It was a subject of study in the investigation of the relation of rainfall and run-off carried on coordinately with the flood study. (See U. S. Geological Survey Water-Supply Paper 772.)

Within the scope of the study of rainfall and run-off, consideration was given to the use of the unit-hydrograph method as a means of determining flood flow. The advantages of this method are, briefly,

(a) It gives a result in terms of the flood hydrograph rather than the peak value only, and therefore for some purposes it may be more informatory than several otherwise acceptable methods of estimating floods.

(b) It is adaptable to sources of basic data that are generally available, such as the published records of the United States Weather Bureau and the United States Geological Survey.

(c) It affords a means for dealing quantitatively with drainage-basin characteristics.

(d) Where flood flow only is to be considered, it presents a direct and reasonably consistent means of grouping many indeterminate factors into one coefficient.

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The unit-hydrograph method lends itself particularly well to determination of flood flows by storm superposition or transposition. Previous application of storm superposition has been at some disadvantage, owing to the inadequacy of the technique for taking into account the effect of drainage-basin characteristics on run-off when translating the records of flood occurrence on one basin into terms of possible occurrence on another basin. The results have often been disappointing, even though the basins were in the same general region and of approximately the same area. Also no similarly adaptable device has been available heretofore for directly comparing, in the final terms of flood flow, the effect of placing a storm of a given pattern in various positions on the basin. An illustration of such treatment of the flood-flow problem is presented in United States Geological Survey Water-Supply Paper 772, in the chapter contributed by Merrill M. Bernard, to which the reader is referred for details of the procedure. A brief digest of the more notable features follows.

Distribution graphs

A unit hydrograph is defined as the hydrograph of surface run-off resulting from rainfall within a unit of time, as a day or an hour. A distribution graph is a unit hydrograph of surface run-off modified to show the proportional relations of its ordinates in percentage of the total surface run-off.

The development of distribution graphs, which reflect the combined influence of all drainage-basin characteristics on stream flow, is presented in Water-Supply Paper 772, in the chapter devoted to the unit hydrograph and distribution graphs. The distribution graphs for the basins here considered were obtained from that source.

Storm analysis

It is believed that the record of storms published by the United States Weather Bureau, notwithstanding the comparatively short period covered, provides a means of making approximate estimates of maximum storms and gives an indication of ultimate extremes of storm magnitudes. An analytical treatment of sources of air moisture, storm paths, and other meteorologic considerations may sometime furnish more complete information as to possible storm magnitudes. Available records of excessive rainfall, as analyzed by the Miami Conservancy District, provide detailed information regarding the 250 greatest storms visiting that part of the United States lying east of the 103d meridian. In that analysis the storms of such areal extent that they embraced at least five precipitation stations recording 6 inches or more of 3-day rainfall are compared and classified on the basis of the fifth highest 3-day rainfall, which is referred to as the storm index.

Figure 20 shows a sufficient number of storm indexes plotted at their approximate storm centers to define the position of isohyetal lines embracing areas in which storms of equal or greater index have occurred.

The present analysis has adopted the division of the year suggested by the Miami Conservancy Report, into quarters beginning November 1, February 1, May 1, and August 1. It then eliminated from consideration in each basin those quarters of the year in which the Miami report has shown no qualifying storm (3-day precipitation at five or more stations equaling or exceeding 6 inches) to have visited that locality. It is then assumed that the superposed storm could have occurred in any of the remaining quarters of the year. Table 14, based on figures 50 to 57 of the Miami report, shows, for four of the basins studied, the seasons in which it is assumed that great storms could have occurred.

Table 14.- Seasons in which great storms have occurred on designated river systems

Basin	Quarters considered	Months
Delaware River	3d and 4th	May 1 to October 31
French Broad River	3d and 4th	May 1 to October 31
Wabash River	2d, 3d, and 4th	February 1 to October 31
Skunk River	3d and 4th	May 1 to October 31

An analysis of available information on storm magnitudes, geographic distribution, and seasonal distribution of great storms occurring throughout the eastern and central United States made it possible to determine for each of these basins the greatest storm that had visited the general locality within the period 1892-1931. The data in the technical reports of the Miami Conservancy District, as they are now being revised,

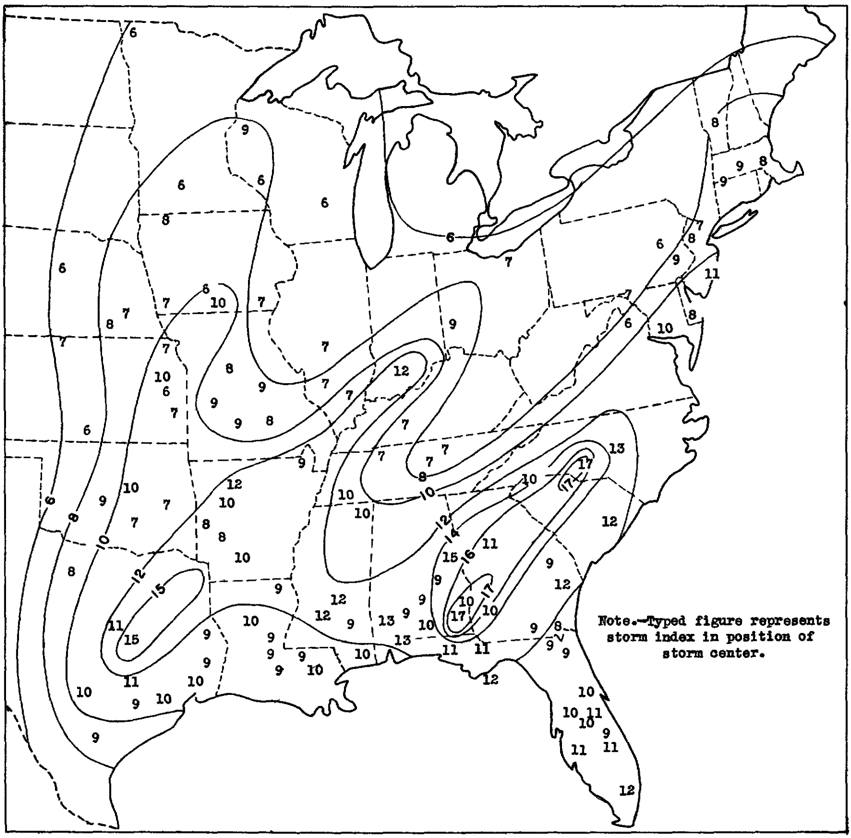


Figure 20.—Map of eastern United States showing storm indexes and geographic position of their centers.

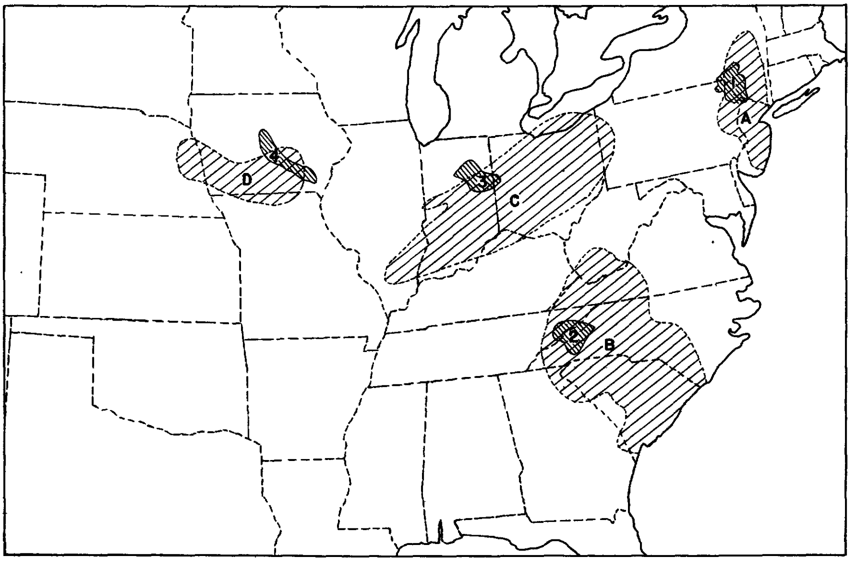
were used as the basis for the study. The storm selected for each basin except the French Broad occurred so near the particular basin as to seem to justify the assumption that it could, with reasonable probability, have centered on the basin itself. For the French Broad Basin the storm was not shifted. The relative position of the basins and storms is shown in figure 21 and general data pertaining to them are given in table 15.

Table 15.- General data relating to drainage basins and selected storms

No.	Drainage basin	Gaging station	Drainage area above station (square miles)
1	2	3	4
1	Delaware River	Port Jervis, N. Y.	3,070
2	French Broad River	Dandridge, Tenn	4,450
3	Wabash River	Logansport, Ind.	3,830
4	Skunk River	Augusta, Iowa	4,290

	Storm selected for transposition				
No.	Symbol*	Date	Index (inches)	Center	Distance transposed (miles)
1	5	6	7	8	9
1	A	Oct. 8-11, 1903	10.65	Paterson, N. J.	90
2	B	July 15-16, 1916	16.75	Altapass, N. C.	0
3	C	Mar. 23-27, 1913	9.00	Richmond, Ind.	80
4	D	Aug. 25-28, 1903	10.15	Woodburn, Iowa	60

* See fig. 21.



Explanation

1 Delaware River Basin above Port Jervis, N.Y.
2 French Broad River Basin above Dandridge, Tenn.
3 Wabash River Basin above Logansport, Ind.
4 Skunk River Basin above Augusta, Iowa

A Storm of October 8-11, 1903
B Storm of July 15-16, 1916
C Storm of March 24-26, 1913
D Storm of August 25-28, 1903

Figure 21. —Map of eastern United States showing location of storm areas relative to selected drainage basins.

Flood coefficients

The unit-hydrograph or distribution-graph method, as applied to the determination of flood flow, utilizes the approximate proportionality between the ordinates of the hydrograph of surface flow and the ordinates of the pluviagraph. The pluviagraph is the graph of 100 percent run-off, or that produced by distributing average daily rainfall before any of the losses are taken into account. The ratio of the greatest ordinate of the flood hydrograph of surface run-off to that of the pluviagraph is taken as the "flood coefficient."

Although this flood coefficient is not an average coefficient for the flood period, it insures agreement between the observed and computed maximum daily flows with only a slight sacrifice in agreement between other portions of the actual and computed hydrographs. It is generally agreed that losses, of which infiltration is the principal one, may very appropriately be considered a deduction from rainfall, but no method of dealing with infiltration in this manner, utilizing only basic data made available in the published rainfall records of the Weather Bureau, or stream-flow records as 24-hour averages, has come to the writer's attention.

The coefficients for a particular basin are found to show systematic variation by seasons, and the seasonal relationship thus disclosed is used to estimate and evaluate the conditions that might reasonably be assumed to prevail in relation to the great storms used in superposition. The coefficients are presented in Water-Supply Paper 772, under appropriate headings. The flood coefficients were developed by selecting for each season of the year (exclusive of winter periods) the greatest flood occurring within the time covered by the record of stream flow. It was found that as a rule the month having the greatest flood was also the month of greatest monthly run-off, and it was always a month of considerable rainfall. Also, with only a few exceptions, the critical phase of the flood occurred toward the middle or end of an extended wet spell, when the infiltration and absorption capacity of the basin was appreciably decreased.

Determination of flood flow

Having available, then, the distribution graph of the basin, a storm of known magnitude and areal distribution, and a knowledge of approximate relations between surface run-off and pluviagraph under accompanying seasonal and antecedent conditions, we can construct the hydrograph of surface flow.

The procedure of determining flood flow through storm superposition may be demonstrated by using the Skunk River at Augusta, Iowa, as an example.

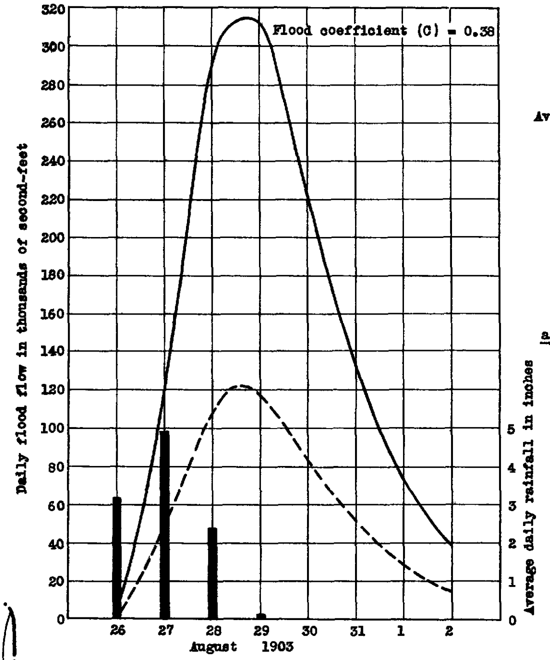
1. The seasonal flood coefficients developed by the storm studies are listed by date in table 16.

Table 16.- Flood coefficients as derived for Skunk River at Augusta, Iowa

Date	Maximum pluviagraph value (second-feet)	Maximum recorded daily surface run-off (second-feet)	Flood coefficient
Third quarter			
May 4, 1919	58,000	16,500	0.29
June 5, 1917	87,500	24,500	.28
June 15, 1930	130,500	41,000	.32
July 11, 1915	50,000	20,000	.35
Fourth quarter			
Sept. 15, 1926	78,500	26,000	.38

2. The storm of August 25-28, 1903, centering at Woodburn, Iowa was found to be the greatest that has visited the general region within the period of record.

3. The pattern of the storm, showing isohyetal lines (lines of equal rainfall depth) and accompanying rainfall stations, was superposed upon a map of the basin in such position as to give the greatest average depth of rainfall over the basin. (See fig. 22.) This involved a shifting of the storm position a distance of about 60 miles.



Average distribution graph

Day	Percent
1[a]	1
2	32
3	27
4	18
5	11
6	5
7	3
8	2
9	1
	100

[a] Day on which rainfall was recorded.

Explanation

——— Pluviagraph

– – – – Computed flood flow

Rainfall station	Total storm depth (inches)
Iowa	
Afton	10.37
Chariton	11.64
Corning	11.87
Corydon	8.50
Council Bluffs	12.18
Hopeville	11.27
Lacona	6.20
Lenox	7.61
Leon	7.50
Mount Ayr	4.76
Osceola	10.01
Pacific Junction	3.32
Red Oak	7.37
Villisca	7.15
Woodburn	15.46

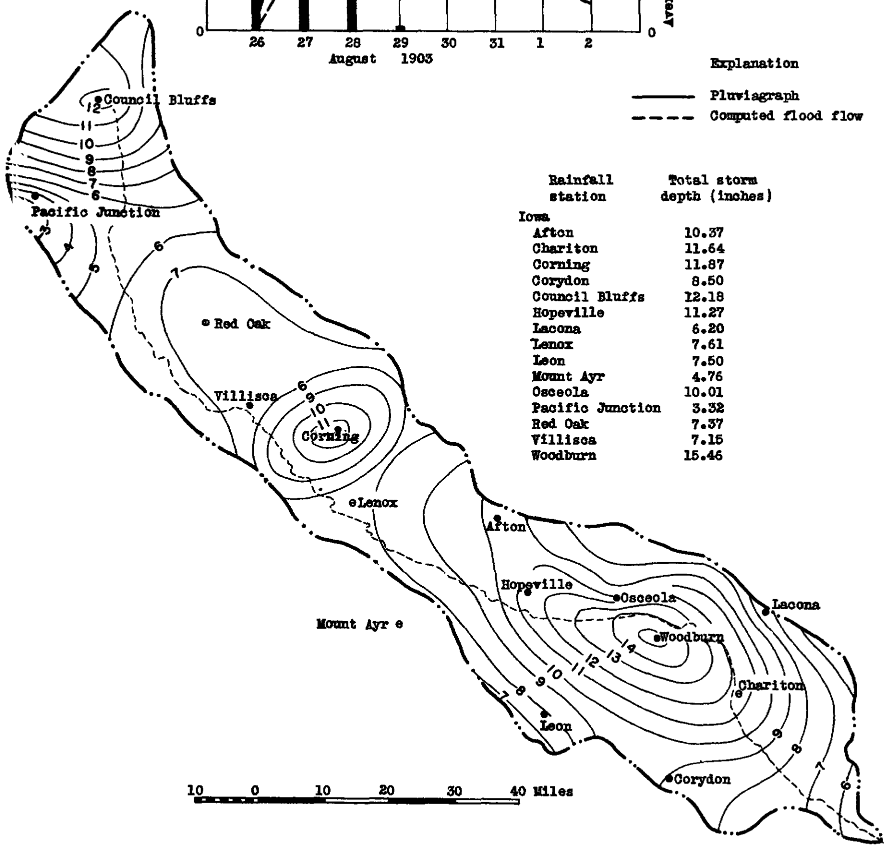


Figure 22. —Storm of August 25-28, 1903, with relative location of Weather Bureau stations superposed on Skunk River Basin, Iowa, and resulting pluviagraph and computed flood hydrograph.

4. The transposed station records were then treated as if the storm had occurred on the Skunk River basin in the position shown. Daily rainfall was weighted and average depth, day by day throughout the storm period, was computed (fig. 22).

5. The pluviagraph for the storm was constructed as explained in Water-Supply Paper 772. It is shown graphically in figure 22.

6. From table 14 it was found that great storms can be expected to visit the vicinity of the Skunk River from May 1 to October 31. Table 16 shows that, in this period, for the years covered by the record of stream flow, the greatest flood coefficient developed was 0.38, on September 15, 1926. This, then, was taken as the coefficient equal to or greater than that which would be developed by the superposed storm under its seasonal and antecedent conditions.

7. The flood coefficient, applied to the ordinates of the pluviagraph, produced the hydrograph of flood flow shown in figure 22.

Conclusions

The fact that such a synthetic flood may never occur within the period to be identified with the economic life of a particular structure that is being designed, or the fact that such a flood is not subject to classification in terms of frequency, should not detract from its value as a suggestion of what the limiting flood of a basin may be. It is to be emphasized, of course, that the significance of the results must be weighed in relation to the reliability of the basic data and the soundness of the various steps in the procedure.

It is believed that such knowledge of the possible limiting flood will make it possible to consider more intelligently the element of safety in the design of flood-protection works, particularly where life and high property values are involved. In addition the method may ultimately become a valuable adjunct to studies of magnitude and frequency of floods, as a means of estimating, for a particular basin, its approximate potential limit of flood discharge.

This special study has been primarily intended to examine the possibilities of storm superposition as a means of determination of flood flow and does not attempt to treat the several refinements believed to be practical and essential to its ultimate development. It is intended to direct attention to the possibility of a fuller use of available storm data, rather than to indicate that such storms are to be taken conclusively as limiting storms for their respective localities. The use of such storms as a basis for estimating limits of flood flow should be made with caution and with appreciation of their significance, and the impression should not be created that the estimated maxima are necessarily to be accommodated by any contemplated design.

DEFINITIONS OF TERMS AS USED IN THIS REPORT

(Definitions marked with one asterisk (*) are adopted from the report of the American Society of Civil Engineers' special committee on irrigation hydraulics, 1935; those marked with two asterisks (**) from the Boston Society of Civil Engineers Journal, October 1922.)

1. Array.- A group of significant data or figures arranged in a prescribed order for comparison and analysis.

2. Backwater.- The increase in height of the water surface or the accumulation of the water of a stream above and due to an obstruction in the stream channel.

3. Climatic year.- * A year selected for the presentation of data on water supply, precipitation, etc. The climatic year used by the United States Geological Survey in the publication of discharge records extends from October 1 to September 30.

4. Coefficient of skew (abbreviation CS).- As applied to the Pearson type III curve by Hazen and Foster, the ratio of the summation comprising the cubes of all the separate variations of a series to the product derived from multiplying the cube of the standard variation by the number of terms minus 1: $\frac{v^3}{(n-1)\ (SV)^3}$.

5. Coefficient of variation (abbreviation CV).- The ratio of the standard variation to the mean of the series. (Where the members of a series are all expressed in terms of the mean, the standard variation and the coefficient of variation are identical).

6. Control.- A section, either natural or artificial, or a reach of a channel which determines the stage of the water in relation to the quantity of discharge. A control may be partial or complete, stable or unstable. A complete and stable control is independent of downstream conditions and is effective at all stages. An overflow dam, a ledge of rock crossing a channel, a boulder-covered reach, an indurated bed are examples of controls.

7. Crest.- (1) The top of a dam, dike, spillway, or weir, frequently restricted to the overflow portion. (2) The summit of a wave; the peak of a flood.

8. Datum.- * Plane of reference for altitudes.

9. Discharge.- The quantity of water, silt, or other mobile substances passing along a channel per unit of time; the rate of flow (cubic feet per second, liters per second, million gallons per day, etc.).

10. Discharge curve.- * A rating curve showing the relation of stage to discharge of a stream.

11. Drainage.- * (1) The process of removing surplus ground or surface water by artificial means. (2) The mode in which the waters of an area are carried off.

12. Drainage area.- (1) The area (square miles, acres, etc.) of a drainage basin. (2) Catchment area; drainage basin.

13. Drainage basin.- The area from which water is carried off by a drainage system; a catchment area.

14. Duration curve.- A cumulative frequency curve; a curve that shows on the percentage scale the length or proportion of time during which given limits of flow are equaled or exceeded. It may be applied likewise to show either length or proportion of time during which the flow is equal to or less than successive amounts.

15. Flood.- (1) A relatively high flow as measured by either gage height or discharge quantity. (2) Any flow equal to or greater than a designated basic flow. Ordinarily, the item of record is the average discharge for a 24-hour period, generally taken as a calendar day, midnight to midnight.

16. Flood, annual.- The maximum daily average flow occurring during 12 consecutive months. (In the United States Geological Survey practice and in these studies, the water year extends from October 1 to September 30, and the 24-hour period is the calendar day, from midnight to midnight.)

17. Flood, average annual.- The mean of the annual floods during the period of record.

18. Flood, basic stage.- An arbitrarily selected rate of flow to be used as the lower limit in selecting floods to be analyzed, usually taken as the minimum annual flood.

19. Flood, minimum annual.- The smallest of the annual floods.

20. Flood, monthly.- The maximum daily flow during a calendar month.

21. Flood, 10-year (or other periodic flood).- The daily flow which is equaled or exceeded, on the average, once in 10 years (or in other designated periods).

22. Flood event.- The series of flows constituting a distinct, progressive rise, culminating in a peak, crest, or summit, together with the recession that follows the crest; arbitrarily selected for consideration as a unit of flood occurrence.

23. Flood peak, daily.- The maximum daily flow during the given flood event.

24. Flood peak, momentary.- The maximum momentary rate of flow attained during a flood event; the crest flow as determined by the highest point on the hydrograph of flow - for example, that determined by means of an automatic recording gage.

25. Flow.- The rate of movement of water, silt, sand, or other mobile material in terms of volume per unit of time.

26. Frequency curve.- A graphic representation of the frequency of occurrence of designated events.

27. Gage.- * (1) A staff graduated to indicate the height of a water surface. (2) A device for registering water levels, flow, velocity, pressure, etc.

28. Gage, slope.- * A gage placed on an incline and graduated to read vertical heights.

29. Gage, staff.- * A graduated scale on a staff, plank, metal-plate pier, wall, etc., by which the height of the water surface may be read.

30. Gage height.- * The height of a water surface above or below a datum corresponding to the zero of the staff or other type of gage by which the height is indicated; synonymous with stage.

31. Gaging.- * A measurement of discharge corresponding to a certain stage.

32. Gaging station.- * A selected section in a stream channel equipped with a gage and facilities for measuring the flow of water; a place on a stream where data are gathered by which continuous discharge records may be developed.

33. Hydrograph.- * A graph showing the stage, flow, velocity, or other property of water, with respect to time.

34. Hydrology.- The science treating of the waters of the earth, their occurrence, distribution, movements, etc.

35. Infiltration.- The percolating flow of ground water into the soil or into a drain, gallery, or other underground conduit.

36. Isohyetal map.- A map which shows variation in amount of average precipitation over contiguous areas. Isohyetal lines are used to connect contiguous points of equal precipitation, similarly to contour lines.

37. Mean.- The arithmetic average; the summation of a series divided by the number of items included; the length of ordinate to the center of gravity of distribution about the axis of abscissas.

38. Mode.- The characteristic that occurs most frequently; the abscissa corresponding to the maximum ordinate of the frequency curve.

39. Pondage.- ** The water capacity created by any dam that tends to take care of the variations in draft at a water-power development. It is the retention for one or more days of the flow of a stream during hours of light load, for use during hours of heavy load.

40. Precipitation.- * The total measurable supply of water received directly from clouds, as rain, snow, and hail; usually expressed as depth in a day, month, or year and designated as daily, monthly, or annual precipitation.

41. Probable error (abbreviation p. e.).- 0.67449 times the standard variation.

42. Rainfall.- * Precipitation in the form of water. Usage includes snow and hail (converted to equivalent in rain) in the term.

43. Rating.- * The relation, usually determined experimentally, between two mutually dependent quantities, such as stage and discharge of a stream; current-meter vane revolutions and water velocity.

44. Rating curve.- * A graphic representation of a rating; a calibration.

45. Rating table.- * A tabulation of the relation between stage and discharge of a stream, or between current-meter revolutions and velocity of water, or between any other mutually dependent quantities.

46. Reach.- * A comparatively short length of a stream or channel.

47. Recorder.- * A device that makes a graph of the stage, pressure, depth, velocity, or other property of water, or the movement or position of water-controlling devices.

48. Regulation.- ** The artificial manipulation of the run-off of a stream.

49. Reservoir.- * A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.

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50. Retarding basin.- A basin with outlet sluice designed and operated as an open conduit; or a natural basin with an outlet so constricted as to reduce the flood flow materially. Either insures continuity of regulated outflow until the flood has passed.

51. Run-off.- That portion of the precipitation which flows from an area in surface streams, in either natural or artificial channels, at or below the ground surface, or through the ground. There may be occasional or frequent changes from ground water to surface water, or the reverse. The natural low-water flow is largely derived from ground-water sources.

52. Run-off, direct or surface.- That part of the run-off which consists of water that has not passed beneath the surface since it was last precipitated out of the atmosphere.

53. Skewness (or deviation from symmetry).- The difference between the mean and the mode, divided by the standard variation:

$$\text{Skewness} = \frac{\text{Mean} - \text{Mode}}{\text{SV}}$$

54. Slope.- The total fall between two points, divided by their distance apart, expressed in the same or other designated units.

55. Stage.- Gage height; the height of a water surface above its minimum; also above or below an established "low water" plane; hence above or below any datum of reference.

56. Stage-discharge relation.- The relation between gage height and discharge.

57. Standard variation (abbreviation SV).- The square root of the quotient obtained by dividing the summation comprising the squares of all the separate variations of a series, by the number of terms minus 1: $\sqrt{\frac{v^2}{n-1}}$ (This is employed as a convenient measure of the "spread," range, or tendency to scatter as shown by the data.)

58. Statistics.- The science of counting; systematic compilation of instances for the inference of general truths; the science of utilizing the characteristics and relationships of what is known in making logical and fair estimates of unknown numbers or quantities.

59. Storage.- (1) Artificial storage, that water capacity which may be available to increase the extremely low flows for several days, weeks, months, or even years. It is the retention of the stream flow for use ordinarily during times of scarcity. (2) Natural storage, as distinguished from artificial storage, that which occurs in swamps, lakes, ponds, and channels.

60. Variation or deviation (abbreviation v).- The amount by which a term in a series differs from the mean of the series.

61. Water-stage recorder.- ** An instrument for automatically recording the height of the water surface, and the corresponding time.

62. Watershed.- * The divide between drainage basins. (For the sake of clearness the use of watershed to mean catchment basin or drainage area is avoided by the United States Geological Survey and others.)

63. Water year.- * A special grouping of the periods of a year to facilitate water-supply studies. The United States Geological Survey uses October 1 to September 30.

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d. 96. Destructive floods in the United States in 1903, by E. C. Murphy, 1904.
e. 109. Hydrography of the Susquehanna River drainage basin, by J. C. Hoyt and R. H. Anderson, 1905.
f. 147. Destructive floods in the United States in 1904, by E. C. Murphy and others, 1905.
g. 162. Destructive floods in the United States in 1905, with a discussion of flood discharge and frequency and an index to flood literature, by E. C. Murphy and others, 1906.
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i. 426. Southern California floods of January 1916, by H. D. McGlashan and F. C. Ebert, 1917.
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