MEASUREMENT AND COMPUTATION OF STREAMFLOW

VOLUME 1. MEASUREMENT OF STAGE AND DISCHARGE

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CHAPTER 1.—INTRODUCTION

PURPOSE OF THE MANUAL

The purpose of this manual is to provide a comprehensive description of state-of-the-art standardized stream-gaging procedures, within the scope described below. The manual is intended for use as a training guide and reference text, primarily for hydraulic engineers and technicians in the U.S. Geological Survey, but the manual is also appropriate for use by other stream-gaging practitioners, both in the United States and elsewhere.

SCOPE OF THE MANUAL

The technical work involved in obtaining systematic records of streamflow is discussed, in two volumes, in accordance with the following six major topics:

Volume 1. Measurement of stage and discharge

a. Selection of gaging-station sites
b. Measurement of stage
c. Measurement of discharge

Volume 2. Computation of discharge

d. Computation of the stage-discharge relation
e. Computation of daily-discharge records
f. Presentation and publication of stream-gaging data

In order to make the text as broadly usable as possible, discussions of instrumentation and measurement are aimed at the technician, and discussions of computational procedure are aimed at the junior engineer who has a background in basic hydraulics.

Many of the procedures for determining discharge that are discussed in volume 2 require specialized instrumentation to obtain field data that supplement the observation of stage. The descriptions of such specialized equipment and associated observational techniques are given in appropriate chapters in volume 2 so that the reader may have unified discussions of the methodologies applicable to each type of problem in determining discharge.

In general the authors have attempted to prepare a manual that will stand independently—references are given to supplementary published material, but the reader should find relatively few occasions when there is pressing need to consult those references. There are three notable exceptions to that statement.

1. The subject of indirect determination of peak discharge (v. 1, chap. 9) is treated here only in brief because of space limitations; the subject is treated fully in five reports in the Geological Survey report series, "Techniques of Water-Resources Investigations." The five reports are named in the reference section of chapter 9.
2. Among the methods discussed in this manual for computing the discharge of tidal streams are four mathematical techniques for evaluating the differential equations of unsteady flow (v. 2, chap. 13). The four techniques are given only cursory treatment because a detailed description of the complex mathematical techniques is considered to be beyond the scope of the manual.
3. The processing of streamflow records by digital computer (v. 2, chap. 15) is a subject that is given only generalized treatment here. It was not practicable to include a detailed description of each step in the sequence of operation of an automated computing system because of space limitations, and also because the particulars of each step are somewhat in a state of flux in response to continual improvement in storage and access procedures.

STREAMFLOW RECORDS

Streamflow serves man in many ways. It supplies water for domestic, commercial, and industrial use; irrigation water for crops; dilution and transport for removal of wastes; energy for hydroelectric power generation; transport channels for commerce; and a medium for recreation. Records of streamflow are the basic data used in developing reliable surface-water supplies because the records provide information on the availability of streamflow and its variability in time and space. The records are therefore used in the planning and design of surface-water related projects, and they are also used in the management or operation of such projects after the projects have been built or activated.

Streamflow, when it occurs in excess, can create a hazard—floods cause extensive damage and hardship. Records of flood events obtained at gaging stations serve as the basis for the design of bridges, culverts, dams, and flood-control reservoirs, and for flood-plain delineation and flood-warning systems.

The streamflow records referred to above are primarily continuous records of discharge at stream-gaging stations, a gaging station being a stream-site installation so instrumented and operated that a continuous record of stage and discharge can be obtained. Networks of stream-gaging stations are designed to meet the various demands for streamflow information, including inventory of the total water resource. The networks of continuous-record stations, however, are often augmented by auxiliary networks of partial-record stations to fill a particular need for streamflow information at relatively low cost. For example, an auxiliary network of sites, instrumented and operated to provide only instantaneous peak-discharge data, is often established to obtain basic information for use in regional flood-frequency studies. An auxiliary network of uninstrumented sites for measuring low flow only is often established to provide basic data for use in regional studies of drought and of fish and wildlife maintenance or enhancement.

GENERAL STREAM-GAGING PROCEDURES

After the general location of a gaging station has been determined from a consideration of the need for streamflow data, its precise location is so selected as to take advantage of the best locally available conditions for stage and discharge measurement and for developing a stable stage-discharge relation.

A continuous record of stage is obtained by installing instruments that sense and record the water-surface elevation in the stream. Discharge measurements are initially made at various stages to define the relation between stage and discharge. Discharge measurements are then made at periodic intervals, usually monthly, to verify the stage-discharge relation or to define any change in the relation caused by changes in channel geometry and (or) channel roughness. At many sites the discharge is not a unique function of stage; variables other than stage must also be continuously measured to obtain a discharge record. For example, stream slope is measured by the installation of a downstream auxiliary stage gage at stations where variable backwater occurs. At other sites a continuous measure of stream velocity at a point in the cross section is obtained and used as an additional variable in the discharge rating. The rate of change of stage can be an important variable where flow is unsteady and channel slopes are flat.

Artificial controls such as low weirs or flumes are constructed at some stations to stabilize the stage-discharge relations in the low-flow range. These control structures are calibrated by stage and discharge measurements in the field.

The data obtained at the gaging station are reviewed and analyzed by engineering personnel at the end of the water year. Discharge ratings are established, and the gage-height record is reduced to mean values for selected time periods. The mean discharge for each day and extremes of discharge for the year are computed. The data are then prepared for publication.

SELECTED REFERENCE

Carter, R. W., and Davidian, Jacob, 1968, General procedure for gaging streams: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A6, p. 1–2.