Designation: D3858 – 95 (Reapproved 2014)

Standard Test Method for Open-Channel Flow Measurement of Water by Velocity-Area Method[1]

This standard is issued under the fixed designation D3858; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the measurement of the volume rate of flow of water in open channels by determining the flow velocity and cross-sectional area and computing the discharge therefrom (Refs (**1-7**)).[2]

1.2 The procedures described in this test method are widely used by those responsible for the collection of streamflow data, for example, the U.S. Geological Survey, Bureau of Reclamation, U.S. Army Corps of Engineers, U.S. Department of Agriculture, Water Survey Canada, and many state and provincial agencies. The procedures are generally from internal documents of the above listed agencies, which have become the defacto standards as used in North America.

1.3 This test method covers the use of current meters to measure flow velocities. Discharge measurements may be made to establish isolated single values, or may be made in sets or in a series at various stages or water-level elevations to establish a stage-discharge relation at a site. In either case, the same test method is followed for obtaining field data and computation of discharge.

1.4 Measurements for the purpose of determining the discharge in efficiency tests of hydraulic turbines are specified in International Electrotechnical Commission Publication 41[3] for the field acceptance tests of hydraulic turbines, and are not included in this test method.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[4]

D1129 Terminology Relating to Water

D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water

D4409 Test Method for Velocity Measurements of Water in Open Channels with Rotating Element Current Meters

D5089 Test Method for Velocity Measurements of Water in Open Channels with Electromagnetic Current Meters

2.2 *ISO Standard:*[5]

ISO 3455 (1976) Calibration of Rotating-Element Current Meters in Straight Open Tanks

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *current meter*—an instrument used to measure, at a point, velocity of flowing water.

3.2.2 *discharge*—the volume of flow of water through a cross section in a unit of time, including any sediment or other solids that may be dissolved in or mixed with the water.

3.2.3 *float*—a buoyant article capable of staying suspended in or resting on the surface of a fluid; often used to mark the thread or trace of a flow line in a stream and to measure the magnitude of the flow velocity along that line.

3.2.4 *stage*—the height of a water surface above an established (or arbitrary) datum plane; also termed *gage height*.

4. Summary of Test Method

4.1 The principal of this test method consists in effectively and accurately measuring the flow velocity and cross-sectional

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[1] This test method is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.07 on Sediments, Geomorphology, and Open-Channel Flow.

Current edition approved Jan. 1, 2014. Published January 2014. Originally approved in 1979. Last previous edition approved in 2008 as D3858 – 95 (2008). DOI: 10.1520/D3858-95R14.

[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[3] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland, http://www.iec.ch.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

area of an open channel or stream. The total flow or discharge measurement is the summation of the products of partial areas of the flow cross section and their respective average velocities. The equation representing the computation is:

$$Q = \sum (av)$$

where:

Q = total discharge,
a = individual partial cross-sectional area, and
v = corresponding mean velocity of the flow normal (perpendicular) to the partial area.

4.2 Because computation of total flow is a summation or integration process, the overall accuracy of the measurement is generally increased by increasing the number of partial cross sections. Generally 25 to 30 partial cross sections, even for extremely large channels, are adequate depending on the variability and complexity of the flow and the cross section. With a smooth cross section and uniform velocity distribution, fewer sections may be used. The partial sections should be chosen so that each contains no more than about 5 % of the total discharge. No partial section shall contain more than 10 % of the total discharge.

NOTE 1—There is no universal "rule of thumb" that can be applied to fix the number of partial sections relative to the magnitude of flow, channel width, and channel depth because of the extreme variations in channel shape, size, roughness, and velocity distribution. Where a rating table or other estimate of total flow is available, this flow divided by 25 can serve as an estimate of the appropriate flow magnitude for each partial section.

4.3 Determination of the mean velocity in a given partial cross section is really a sampling process throughout the vertical extent of that section. The mean can be closely and satisfactorily approximated by making a few selected velocity observations and substituting these values in a known mathematical expression. The various recognized methods for determining mean velocity entail velocity observations at selected distances below the water surface. The depth selections may include choice of (*1*) enough points to define a vertical-velocity curve (see Fig. 1) (**2**), (*2*) two points (0.2 and 0.8 depth below water surface), (*3*) one point (0.6 depth), (*4*) one point (0.2 depth), (*5*) three points (0.2, 0.6, and 0.8 depth), and (*6*) subsurface (that is, just below the water surface) (see 10.9 for further description of each method).

5. Significance and Use

5.1 This test method is used to measure the volume rate of flow of water moving in rivers and streams and moving over or

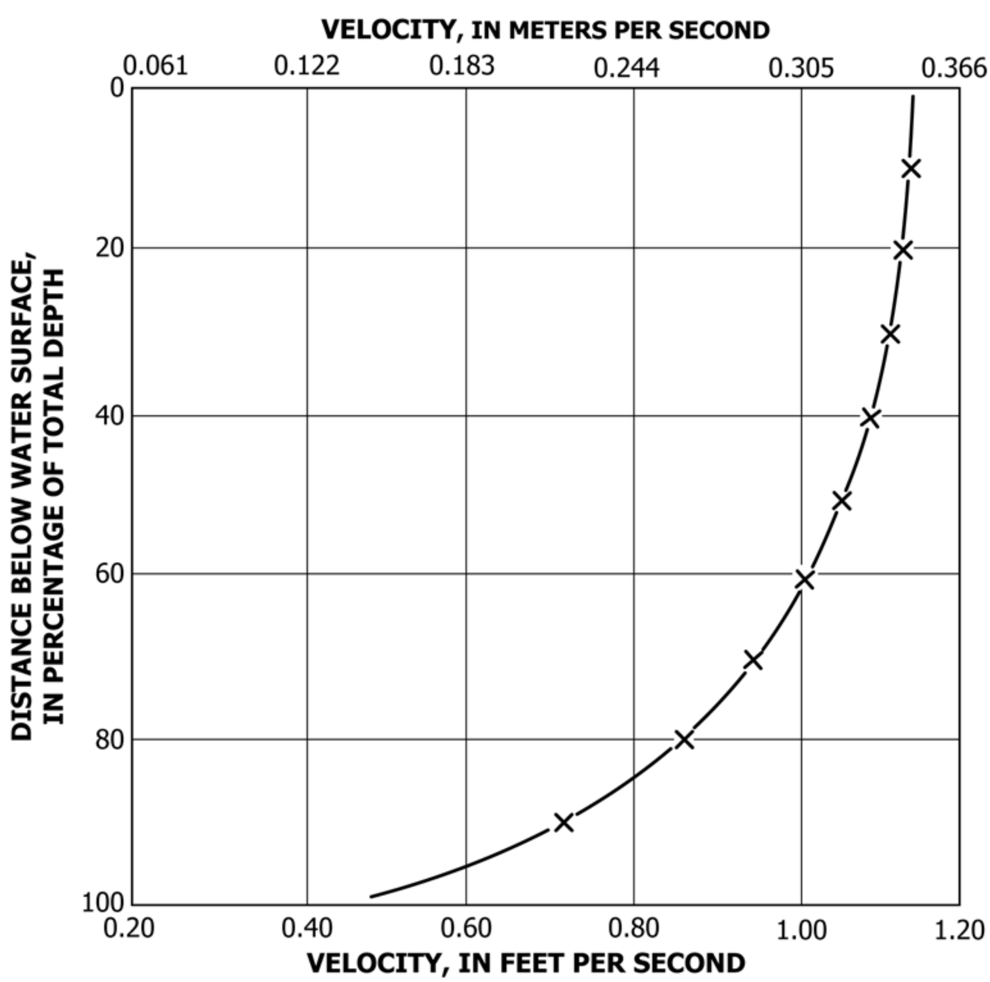

FIG. 1 Typical Open-Channel Vertical-Velocity Curve (Modified from Buchanan and Somers) (2)