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This SOP is adopted from U.S. EPA (2013) chapter 8, section 8.14 Stream Discharge, with minor revisions for clarity and brevity. The full source methods are available at:

https://www.epa.gov/sites/production/files/2016-04/documents/nrsa1314_fom_wadeable_version1_20130501.pdf

Introduction

This SOP explains the procedure for measuring the discharge of wadeable streams. Stream discharge, the volume of water passing a point over a standard unit of time (usually seconds), is equal to the product of the mean current velocity and vertical cross sectional area of flowing water. Discharge is critical for assessing chemical and biological trends in stream communities. This can be due to either dilution of solutes or its effects on sampling efficiency. For example, specific conductivity is typically lower at higher discharge levels, and the collection efficiency of macroinvertebrates decreases at above 400 cubic feet per second in smaller streams.

Discharge is typically measured close to the middle of the sampling reach (i.e. transect six). However, if no suitable location for discharge is near the transect six, it can be conducted anywhere along the sample reach.

If transect six (T6) of the stream reach is dry and more than 50 percent of the stream permanent reach is dry on a sampling visit, one additional attempt will be made to sample the site that year. If the site remains dry on the second attempt, the site will not be sampled and will instead be classified as “Dry-visited”. The sampling site will then be further evaluated for future viability as a monitoring location.

Stream Discharge

No single method for measuring discharge is applicable to all types of stream channels. The preferred procedure for obtaining discharge data is based on “velocity-area” methods (e.g., Rantz et al. 1982, Linsley et al. 1982).

Velocity-Area Procedure

Because velocity and depth typically vary greatly across a stream, accuracy in field measurements is achieved by measuring the mean velocity and cross-sectional area of many increments across a channel (Figure 1). Each increment gives a subtotal of the stream discharge, and the whole is calculated as the sum of these parts. Discharge measurements are made at only one carefully chosen channel cross-section within the sampling reach. It is important to choose a channel cross-section that is as much like a canal as possible. A glide area with a “U” shaped channel cross-section that is free of obstructions provides the best conditions for measuring discharge by the velocity-area method. You may remove rocks and other obstructions to improve the cross-section before any measurements are made. However, because removing obstacles from one part of a cross-section affects adjacent water velocities, you must not change the cross-section once you commence collecting the set of velocity and depth measurements. The procedure for obtaining depth and velocity measurements is outlined in Procedure: Determining Stream Discharge – Velocity-Area below. Record the data from each measurement on the Stream Discharge Form as shown in Figure 2.

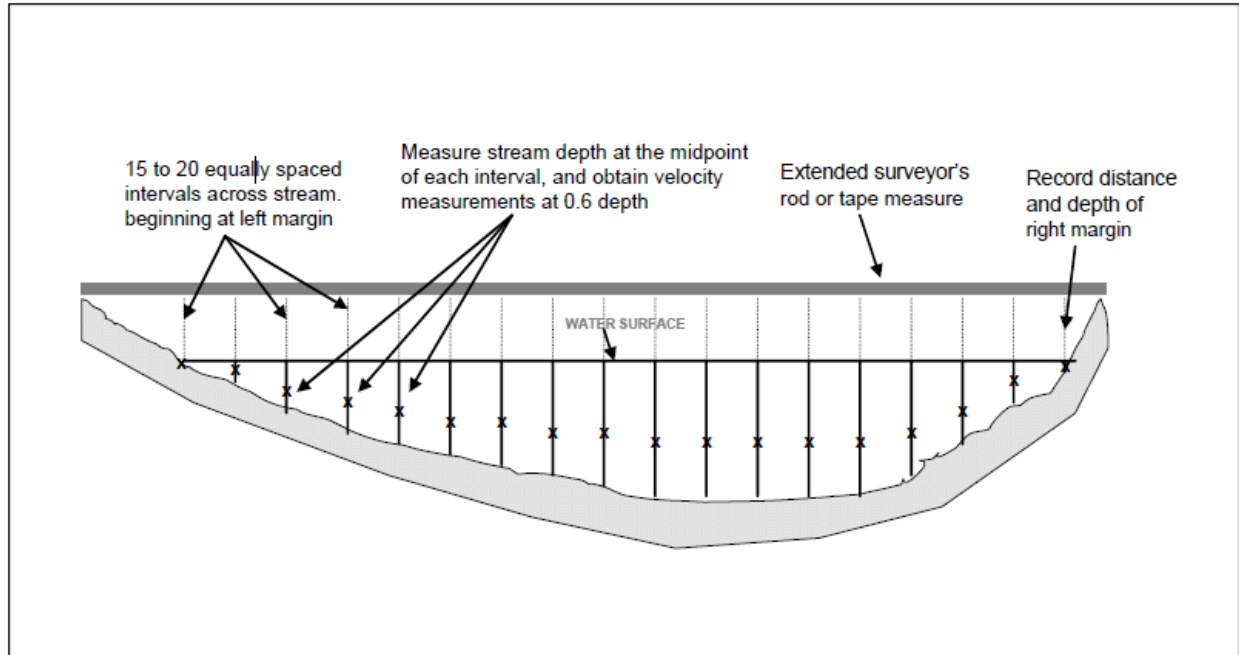


Figure 1. Layout of Channel Cross-Section for Obtaining Discharge Data by the Velocity-Area Procedure (same as Figure 8.20 U.S. EPA 2013).

Procedure: Determining Stream Discharge – Velocity-Area

- Locate a cross-section of the stream channel for discharge determination that has most of the following qualities (based on Rantz et al. 1982):
- Segment of stream above and below cross-section is straight
- Depths mostly greater than 15 centimeters, and velocities mostly greater than 0.15 meters/second. Do not measure discharge in a pool.
- “U” shaped, with a uniform streambed free of large boulders, woody debris or brush, and dense aquatic vegetation.
- Flow is relatively uniform, with no eddies, backwaters, or excessive turbulence.
- Lay the surveyor’s rod (or stretch a measuring tape) across the stream perpendicular to its flow, with the “zero” end of the rod or tape on the left bank, as viewed when looking downstream. Leave the tape tightly suspended across the stream, approximately one foot above water level.
- Attach the velocity meter probe to the calibrated wading rod. Check to ensure the meter is functioning properly and the correct calibration value is displayed. Calibrate (or check the calibration) the velocity meter and probe as directed in the meter’s operating manual. Darken in the “VELOCITY AREA” bubble on the Stream Discharge Form.
- Divide the total wetted stream width into 15 to 20 equal sized intervals. To determine interval width, divide the width by 20 and round up to a convenient number. Intervals should not be less than 10 cm wide, even if this results in less than 15 intervals. The first interval is located at the left margin of the stream (left when looking downstream), and the last interval is located at the right margin of the stream (right when looking downstream).
- Stand downstream of the rod or tape and to the side of the first interval point (closest to the left bank if looking downstream).
- Place the wading rod in the stream at the interval point and adjust the probe so that it is at the water surface. Darken in the appropriate bubbles for “Distance Units” and “Depth Units” on the Stream Discharge Form. Record the distance from the left bank and the depth indicated on the wading rod on the Stream Discharge Form.
- Note: For the first interval, distance equals 0 cm, and in many cases depth may also equal 0 cm. For the last interval, distance will equal the wetted width (in cm) and depth may again equal 0 cm.
- Stand downstream of the probe to avoid disrupting the stream flow. Adjust the position of the probe on the wading rod so it is at 0.6 of the measured depth below the surface of the water.

Face the probe upstream at a right angle to the cross-section, even if local flow eddies hit at oblique angles to the cross-section.

- Wait 20 seconds to allow the meter to equilibrate, then measure the velocity. Darken the appropriate “Velocity Units” bubble on the Stream Discharge Form. Record the value on the Stream Discharge Form. Note for the first interval, velocity may equal 0 because depth will equal 0.
- For the electromagnetic current meter (e.g., Flo-Mate by Marsh-McBirney), use the lowest time constant scale setting on the meter that provides stable readings.
- Move to the next interval point and repeat Steps 6 through 8. Continue until depth and velocity measurements have been recorded for all intervals. Note for the last interval (right margin), depth and velocity values may equal 0.
- At the last interval (right margin), record a “Z” flag on the field form to denote the last interval sampled.

NRSA 2013/14 DISCHARGE - WADEABLE ONLY					Reviewed by (initial):
Site ID: _____		Date: ____ / ____ / ____			
Velocity Area					
Distance Units ☐ ft ☐ cm		Depth Units ☐ ft ☐ cm		Velocity Units ☐ ft/s XX.X ☐ m/s X.XX	
	Dist. from Bank	Depth	Velocity	Flag	
1	0				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Timed Filling					
	Repeat	Volume (L)	Time (s)	Flag	
1					
2					
3					
4					
5					
Neutral Buoyant Object					
		Float 1	Float 2	Float 3	
Float Dist.	☐ ft ☐ m				
Float Time (s)					
Flag					
Cross Sections on Float Reach					
		Upper Section	Middle Section	Lower Section	
Width	☐ ft ☐ m				
Depth 1	☐ ft ☐ cm				
Depth 2					
Depth 3					
Depth 4					
Depth 5					
Q Value		If discharge is determined directly in field, record value here: Q = _____ ☐ cfs ☐ m ³ /s FLAG			
Flag	Comments				
04/08/2013 2013 Discharge		8103048936			

Figure 2. Discharge Form, showing data recorded for All Discharge Measurement Procedures (from Figure 8.21 U.S. EPA 2013).

Literature Cited

- Rantz, S. E., et al., 1982. Measurement and Computation of Streamflow, Vols. 1 and 2. U.S. Geological Survey Water-Supply Paper 2175.
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- Thornbrugh, D. J., I. W. Ashton, A. R. Jarding, J. S. Mills, and K. Paintner-Green. 2019. Protocol implementation plan for stream channel monitoring in the Northern Great Plains Network: narrative version 1.0. Natural Resource Report NPS/NGPN/NRR—2019/1918. National Park Service, Fort Collins, Colorado.
- U.S. EPA. 2013. National Rivers and Streams Assessment 2013-2014: Field Operations Manual – Wadeable. EPA-841-B-12-009b. U.S. Environmental Protection Agency, Office of Water Washington, DC. Available at: https://www.epa.gov/sites/production/files/2016-04/documents/nrsa1314_fom_wadeable_version1_20130501.pdf