

Stream Assessment and Discharge and Channel Measurements

Objective:

Learn how to measure the velocity, discharge and cross-sectional area of small streams. You will compare **two methods** of measuring discharge ($Q = AV$): current meter and float method. Learn how to look for macroinvertebrates and how to characterize channel substrate.

Background: An understanding of how water flows is important for understanding how activities in the channel and watershed affect flow. The amount of water passing a point on the stream channel during a given time is a function of velocity and cross-sectional area of the flowing water.

$$Q = AV \quad (1)$$

where Q is stream discharge (volume/time), A is cross-sectional area, and V is flow velocity. Equation 1 is a form of a mass-balance equation typically referred to by hydrologists as the Continuity Equation.

If you change the cross-sectional area, but have to pass the same discharge, Eqn 1 shows that flow velocity must increase to maintain continuity. An increase in velocity results in an increase in the energy in the flow. This means that the flow can do more work, such as erosion and transport of sediments.

METHODS

Discharge Measurements:

1. **Float method** – inexpensive and simple. This method measures surface velocity. Average velocity is obtained using a correction factor. The basic idea is to measure the time that it takes the object to float a specified distance downstream.

$$V_{\text{surface}} = \text{travel distance} / \text{travel time} = L/t$$

Because surface velocities are typically higher than mean or average velocities

$V_{\text{mean}} = k V_{\text{surface}}$ where k is a coefficient that generally ranges from 0.8 for rough beds to 0.9 for smooth beds (0.8-0.85 are commonly used values) but values can be much lower in shallow rough streams

Step 1. Choose a suitable straight reach with minimum turbulence (ideally at least 3 channel widths long, but in the Mashel, that will be too long)

Step 2. Mark the start and end point of your reach (upstream to downstream)

Step 3. **If possible**, travel time should be at least 10-20 seconds

Step 4. Drop your object into the stream upstream of your upstream marker.

Step 5. Start the watch when the object crosses the upstream marker and stop the watch when it crosses the downstream marker.

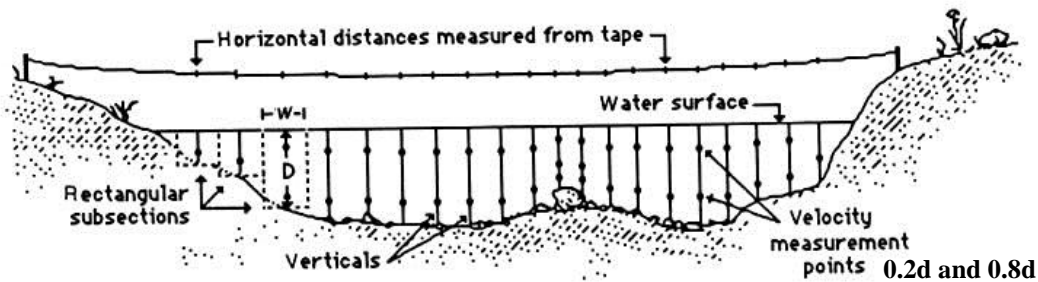
Step 6. You should repeat the measurement at least 3 times and use the average in further calculations.

Step 7. For cross-sectional area, you can use the area computed using the velocity meter method **assuming** you did your float measurements in the same general location. **If not**, you need to measure the width of the water and take 3 or 4 depth measurements to get an average depth. With an average depth and a width, you can compute an area. Correction factors to convert surface velocity to average velocity typically range from 0.8-0.9. Many times 0.85 is used. In mountain streams with lots of roughness elements, the value may be much lower e.g. ~ 0.67.

With an estimate of cross-sectional area, discharge can be computed as $Q = VA$ where V is average subsurface velocity

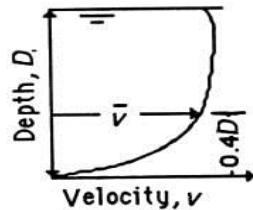
2. **Velocity meter-** Most of you will use a Swiffer meter: a propeller type meter similar to an anemometer. A few teams will use a Marsh-McBirney electromagnetic meter. When using a current meter, the stream is divided into small sections perpendicular to the streamflow and velocity and depth are measured in each section. The subsection area extends laterally from half the distance from the proceeding observation vertical to half the distance to the next (see diagram below). The width of the subsections can be variable across the cross-section. The width of each subsection is calculated by subtracting the distance to the previous vertical from the distance to the next vertical, then dividing by 2. Ideally, the stream is divided into sections so that no more than 5-10% of the discharge flows through any subsection. Think about the figures shown in lecture and in your text. In practice, depth and velocity measurements are taken at *up to* 20 points along a cross section in the field while the sub-sectional widths, areas and discharges are calculated later by hand or with a spreadsheet (See example calculation below). The number of points will vary with stream width, desired accuracy, and **available time**.

String a tape across the stream perpendicular to streamflow. Note that the zero end of the tape does NOT need to be at the water's edge. It's much easier to tie it off to a twig or branch. No one needs to hold either end.



Definition of terms used in computing discharge from current meter measurements (see text). Note variable spacing of verticals

The mean velocity is assumed to be 0.4 d from the bottom (or 0.6d from the water surface). In deeper streams (> 2.5 feet) you should take a velocity reading at 0.2d and 0.8d and then average those to get mean velocity in a section. For this lab, just take the one measurement at 0.6 d at each section across the stream.



Q = stream discharge (Volume/time)

V = stream velocity

A = cross-sectional area

W = top width

Example calculations for the flow meter discharge method: You enter data in columns 2 (initial distance), 3 (depth) and 5 (velocity). Set up formulas in the spreadsheet to fill in Interval width, area, Q interval and % total flow.

Site:	Goblin Creek		Gage Height/Time	11/26/00 13:00			
Date:	11/26/00		Stage:	0.243 feet or (74 mm)			
Method:	Six-tenths						
	Tape reading	Width of Interval	Depth	Area	Velocity @ 0.6D	Q interval	% total flow
Left Edge of Water	9.000	1.500	0.000	0.000	0.000	0.000	0%
	12.000	2.000	0.900	1.800	0.290	0.360	2%
	13.000	1.000	1.200	1.200	0.400	0.492	3%
	14.000	1.000	1.400	1.400	0.770	1.064	7%
	15.000	1.000	1.400	1.400	0.810	1.134	7%
	16.000	1.000	0.500	0.500	0.810	0.405	3%
	17.000	1.000	0.600	0.600	0.770	0.462	3%
	18.000	1.000	1.600	1.600	0.810	1.296	8%
	19.000	1.000	1.700	1.700	0.620	1.054	7%
	20.000	1.000	1.450	1.450	1.120	1.624	10%
	21.000	1.000	1.500	1.500	1.350	2.025	13%
	22.000	1.000	1.200	1.200	1.470	1.764	11%
	23.000	1.000	0.700	0.700	1.290	0.903	6%
	24.000	1.000	0.600	0.600	1.350	0.810	5%
	25.000	0.750	1.000	0.750	0.880	0.660	4%
	25.500	0.750	1.100	0.825	1.270	1.048	7%
	26.500	1.000	0.000	0.000	0.000	0.000	0%
	27.500	1.250	0.700	0.875	0.820	0.718	5%
Right Edge of Water	29.000	0.750	0.000	0.000	0.000	0.000	0%
					Q total =	15.818	

Enter data for X Y and V – excel will do the rest

Substrate

At the site where you take your velocity-area discharge measurement, estimate the substrate coverage by category for the stream area extending 1 m upstream from your cross-section. If you have chosen a good site for discharge measurement this should be a riffle. Estimate the area of a near-by pool and estimate the substrate coverage by category for the pool. Substrate size categories

Substrate Categories

- Sand, silt, clay (smaller than pea) < 0.25", < 0.8 cm
- Small Gravel (pea to golf-ball) 0.25 – 1" or 0.81-2.5 cm
- Large Gravel (golf-ball to baseball) > 1-3" or > 2.5-7.5 cm
- Small Cobble (baseball to cantaloupe) < 3 – 6" or > 7.5-15 cm
- Large Cobble (cantaloupe to basketball) >6"-12" or >15-30 cm
- Small Boulders (basketball to car tire) > 12 -40" or > 0.30 to 1m
- Large Boulders (bigger than car tire) > 40" or > 1 m
- Bedrock

Benthic Invertebrates

We will use a kitchen sieve to collect insects. One can also pick up cobbles (medium sized rocks) from the stream and look for invertebrates. Caddis flies will be in little rock tunnels. Mayflies and stoneflies will scurry across the rock. A field guide has been posted to the web site. There will a couple available in the field.