

What is the Stream Velocity Rod?

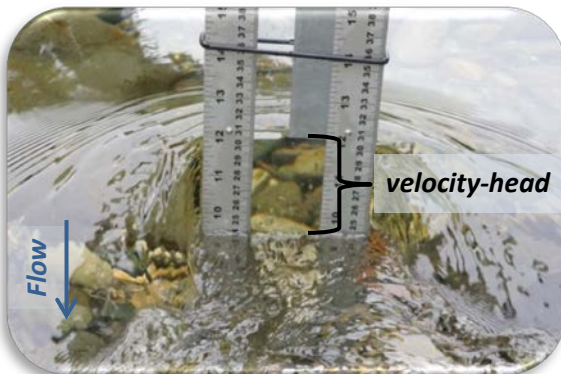
It is a clear plastic board that measures water depth and velocity in order to calculate stream discharge.

Why use it?

- It is accurate.
- It is inexpensive and simple to construct; less than \$100.
- It is easy to use with minimal operator-to-operator variability.
- It requires no stream-side calibration or batteries.
- It is rugged and easy to transport.

Who should use it?

Anyone who wants to measure stream velocity or discharge in wadeable streams and may not have access to expensive equipment.



How does it work?

It blocks streamflow to measure the difference in displaced water levels on both the upstream and downstream sides of the rod (i.e., velocity-head). Multiple measurements are taken across the stream width and then calculated into stream velocity and discharge. The Stream Velocity Rod was based on a similar instrument called the Transparent Velocity-Head Rod (Fonstad et al. 2005), but was modified for more accurate results (Pike et al. 2016).

How accurate is it?

Accuracy was rigorously tested against the Sontek FlowTracker with 2400 data pairs, at 14 sites, using 7 operators, over 3 years (Pike et al. 2016). Given ideal stream channel conditions, Stream Velocity Rod discharge results were comparable to a Sontek FlowTracker.

What are some limitations?

It has the same limitations as other discharge measurement methods:

- Proper site selection is crucial for accuracy.
- It is not meant for turbulent flows.
- Streams must be wadeable; between 5 cm and 75 cm in depth.
- Accuracy can decrease with pulsating water levels at fast velocities.
- Velocities should be less than 1 m/s (roughly 100 mm velocity-head).



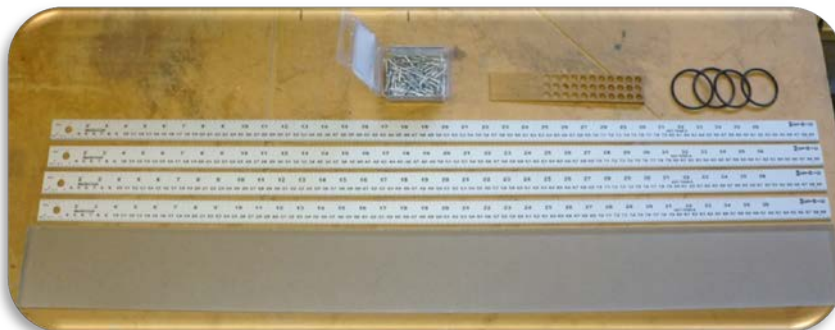
For more information: Contact Robin Pike (Robin.G.Pike@gov.bc.ca) or Emilia Young (Emilia.Young@gov.bc.ca) with the Water Protection & Sustainability Branch, BC Ministry of Environment.

Suggested citation: Young, E.L. and R.G. Pike. 2015. Stream Velocity Rod User's Guide. BC Ministry of Environment. 6pp.

Constructing a Stream Velocity Rod

The Stream Velocity Rod is easy to construct and made of commonly available and inexpensive materials:

- $\frac{1}{2}$ " thick plastic 100 cm x 9.85 cm (e.g., Plexiglas, Lexan)
- Drill with $\frac{1}{8}$ " diameter drill bit
- 4 aluminum metre sticks
- 2 or 3 clamps
- 20 – $\frac{1}{8}$ " diameter aluminum rivets and rivet gun (or screws)
- 4 – 2" o-rings
- 1 – $\frac{1}{4}$ " thick plastic wedge



1. Align a metre stick along edge of plastic board and clamp in place. Place a board behind the plastic to prevent cracking during drilling.



2. Drill 10 holes through metre stick and plastic board. Insert rivets as holes are drilled to prevent metre stick from sliding during drilling.



3. Secure rivets with rivet gun. Repeat steps 1-3 with second metre stick (running in same direction). Sand rough edges.



4. Slide four o-rings over the board, spacing them out evenly.



5. Slide metre sticks under the o-rings on the front and the back. Scratches that develop over time can be removed with a buffing wheel.

6. Slide levelling wedge under the top-most o-ring to provide tension for front sliding ruler.

Selecting the right site

Site selection is crucial for measurement accuracy. Stream sites should meet 5 basic criteria:

1. Laminar/semi-laminar flow.



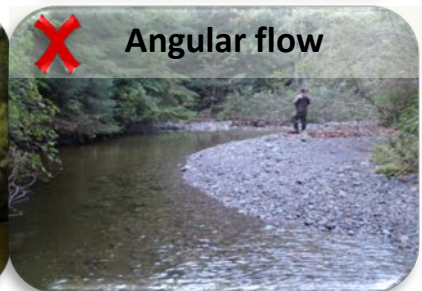
2. Depths between 5 cm and 75 cm with velocity-head between 2 mm and 100 mm.



3. Smooth/even channel bed with no white water.



4. Relatively straight upstream channel reach with no angular flow.

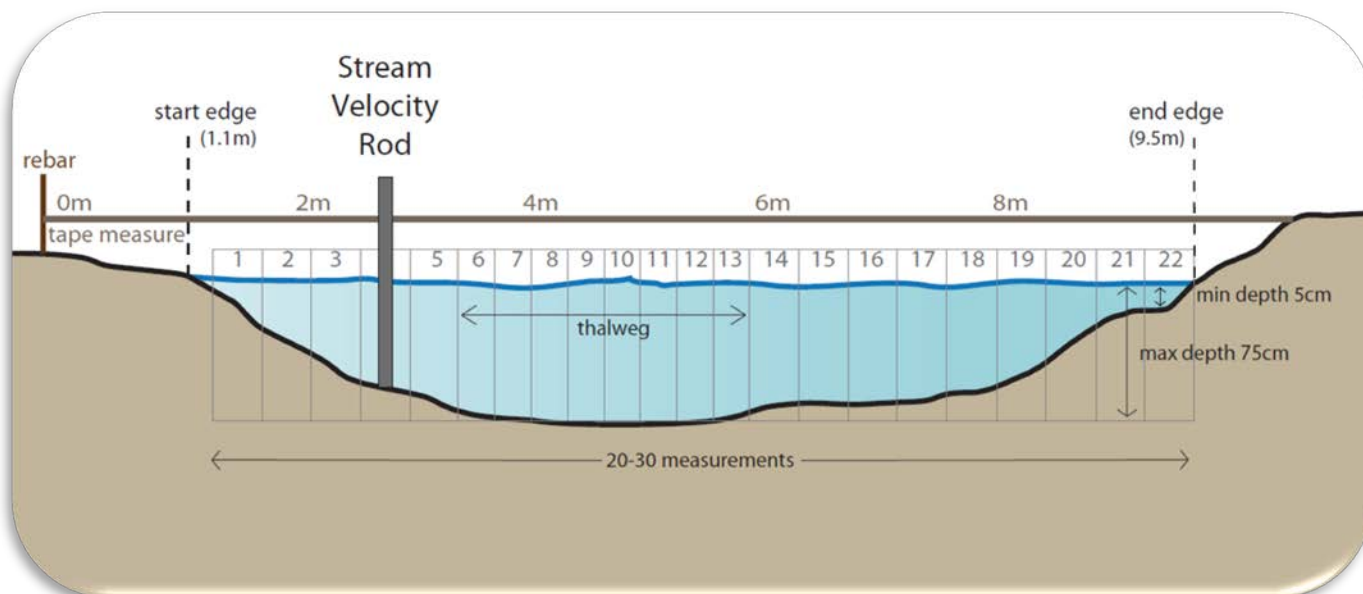


5. Accessible stream banks with no obstacles.



Preparing the site

1. String a tape measure across the stream, perpendicular to streamflow.
 - Where stream cross-sections will be repeatedly measured, it is recommended to hammer rebar into the bank to ensure that consistent sampling locations are used each time.
2. Determine the ideal number and spacing of measurements (20-30 measurements with a minimum of 20 cm spacing is recommended). Spacing between measurements should be approximately even, except where stream velocities change significantly (i.e., in the thalweg where narrower spacing can be used) (see Mid-Section Method, page 96, RISC 2009).



Preparing your field book

Clear field notes are important for quality control. Here are the recommended notes and a sample field book:

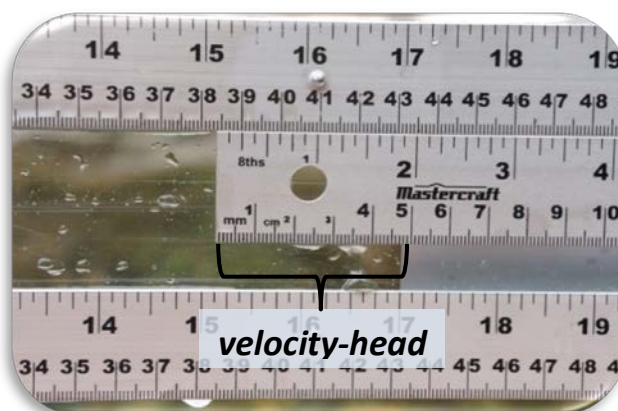
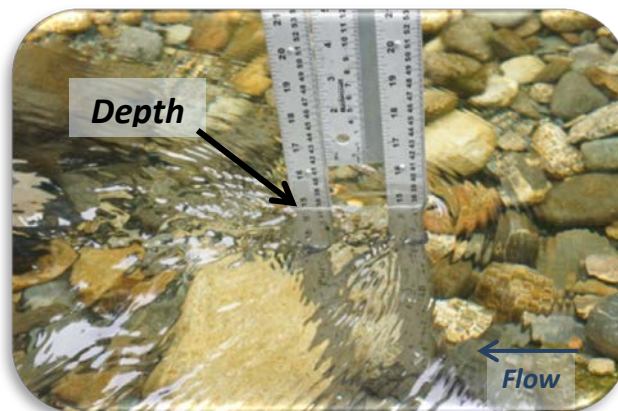
- Date and time
- Operator(s)
- Site being measured
- Staff gauge measurement (if available)
- Start & end edge (i.e., wetted edge of stream)
- Measurement number
- Field measurements:
 - o location (m)
 - o depth (m)
 - o velocity-head (mm)

Aug 29, 2015. 10:15 am PST			
Operator: John Smith			
Cowichan River near Boys Rd trailer park			
Staff gauge measurement: 0.220 m			
Start edge: 1.1 m		End edge: 9.5 m	
Measurement number	Location (m)	Depth (m)	Velocity-head (mm)
1	1.5	0.050	0
2	1.9	0.150	9
3	2.3	0.180	15
4	2.7	0.320	18
5	3.1	0.330	20
6	3.5	0.320	25
7	3.7	0.320	38
...	...	...	...

Collecting measurements

1. Record the start edge of the stream as indicated by the tape measure (refer to the cross-section diagram on the previous page).
2. Record the first sampling location as indicated by the tape measure.
3. Record depth:
 - a. Position the rod parallel with streamflow.
 - b. Record the depth measurement as indicated by the downstream ruler. NOTE: If water level is pulsating, average the depth over 40 secs.
4. Measure velocity-head:
 - a. Turn the rod 90° so the back of the rod is facing upstream. Water level will be elevated on the back of the rod and depressed on the front.
 - b. Slide the back ruler down to touch the water surface, and then slide the front ruler down to touch the water surface.
5. Record velocity-head:
 - a. Lift the rod horizontally to eye level to read the rod squarely; this eliminates refraction and ensures all measurements are viewed at 90°.
 - b. Record the velocity-head measurement as indicated by the inner sliding rulers (i.e., the difference between the two sliding rulers).
6. Repeat steps 2 – 5 at each sampling location across the stream width until the end edge is reached.
7. Record the end edge of the stream as indicated by the tape measure.
8. Before leaving the site, inspect the data for any inconsistencies and take new measurements where required.

TIP: Be sure to hold the rod at a distance so as not to impede water flow.



TIP: If water levels are above 75 cm, it is helpful to substitute the sliding metre sticks for shorter 30 cm rulers to improve stability.

Calculating velocity and discharge

If interested in only stream velocity (not discharge), use this look-up table as a quick reference.

VH (mm)	2	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Velocity (m/s)	0.108	0.182	0.265	0.329	0.382	0.43	0.473	0.512	0.549	0.583	0.616	0.647	0.676	0.705	0.732	0.758	0.784	0.808	0.832	0.856	0.878

It is recommended to build a spreadsheet to calculate discharge. First, enter the field measurements (location, depth, VH) (Columns B, C, D in the figure), and then enter the following equations:

$$1. \text{ Velocity-Head in Metres (Column E) } = \frac{\text{VH (mm)}}{1000}$$

$$2. \text{ Panel Velocity (Column F) } = [0.641 \times (2 \times 9.8 \times \text{VH(m)})^{0.5}] - 0.019$$

NOTE: If velocity-head is zero, manually set panel velocity to zero (as shown below in cell F3).

$$3. \text{ Panel Width (Column G) } = \frac{\text{'Next' Location} - \text{'Preceding' Location}}{2}$$

$$4. \text{ Panel Area (Column H) } = \text{Panel Depth} \times \text{Panel Width}$$

$$5. \text{ Panel Discharge (Column I) } = \text{Panel Velocity} \times \text{Panel Area}$$

$$6. \text{ Total Discharge } = \text{SUM (all Panel Discharge calculations)}$$

Field measurements					Formula calculations				
	A	B	C	D	E	F	G	H	I
1	Measurement	Location (m)	Depth (m)	VH (mm)	VH (m)	Panel Velocity	Panel Width	Panel Area	Panel Discharge
2	Start edge	1.1							
3	1	1.5	0.050	0	0.000	0	0.400	0.020	0.000
4	2	1.9	0.150	9	0.009	0.250	0.400	0.060	0.015
5	3	2.3	0.180	15	0.015	0.329	0.400	0.072	0.024
6	4	2.7	0.320	18	0.018	0.362	0.400	0.128	0.045
7	5	3.1	0.33	20	0.020	0.382	0.400	0.132	0.050
8	6	3.5	0.420	25	0.025	0.430	0.300	0.096	0.042
9	7	3.7	0.320	38		...	...	...	...
10	...		...	...					
11	End edge	4.5							
12								Total Discharge	

=F3*H3

=C3*G3

=(B4-B2)/2

=D3/1000

=(0.641*((2*9.8*E3)^0.5))-0.019

=SUM(I3:I11)

References

- Fonstad, M.A., J.P. Reichling, and J.W. Van de Grift. 2005. The Transparent Velocity-Head Rod for Inexpensive and Accurate Measurement of Stream Velocities. *Journal of Geoscience Education* 53(1): 44-52.
- Pike, R.G., T.E. Redding, and C.J. Schwarz. 2016. Development and Testing of a Modified Transparent Velocity-Head Rod for Stream Discharge Measurements. *Canadian Water Resources Association Journal*. DOI 10.1080/07011784.2015.1127776.
- Resources Information Standards Committee. 2009. *Manual of British Columbia Hydrometric Standards*. Version 1.0, March 12, 2009. Resources Information Standards Committee. Victoria: British Columbia Ministry of Environment, 222 p.