Stream Velocity Board

USER'S GUIDE

What is the Stream Velocity Board?

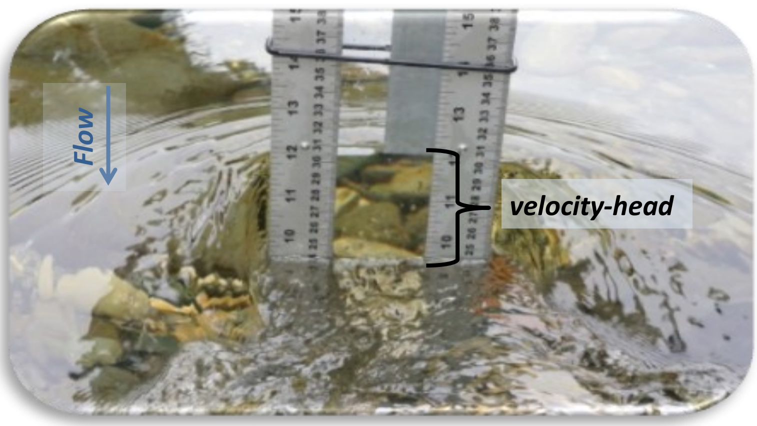
A clear plastic board that measures water depth and velocity-head which are then used to calculate stream velocity and discharge.

Why use it?

- Accurate.
- Simple and inexpensive to construct (less than $100 CAD).
- Easy to use with minimal operator-to-operator variability.
- Requires no stream-side calibration or batteries.
- 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?

The board displaces streamflow and measures the difference between the upstream and downstream water depths (i.e., velocity-head). Measurements are taken across a stream's cross-section and then used to calculate stream velocity and total discharge. The basic design and measurement principles were based on the Transparent Velocity-Head Rod (Fonstad et al. 2005) but were modified slightly to increase accuracy (Pike et al. 2016).

How was it calibrated?

Accuracy was rigorously tested against the Sontek FlowTracker over 3 years with 2400 data pairs, at 14 sites, using 7 operators (Pike et al. 2016).

What are some measurement conditions?

- Sites must be suited to measurement by the mid-section method (RISC 2018).
- Streams must be wadeable, with maximum depth of 75 cm and maximum velocity of 1 m/s.
- A few low velocities per cross-section are acceptable but most should be greater than 0.20 m/s.
- Pulsating water levels at fast velocities make estimating velocity-head more difficult, requiring averaging, and potentially increasing measurement uncertainty.

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 and Climate Change Strategy.

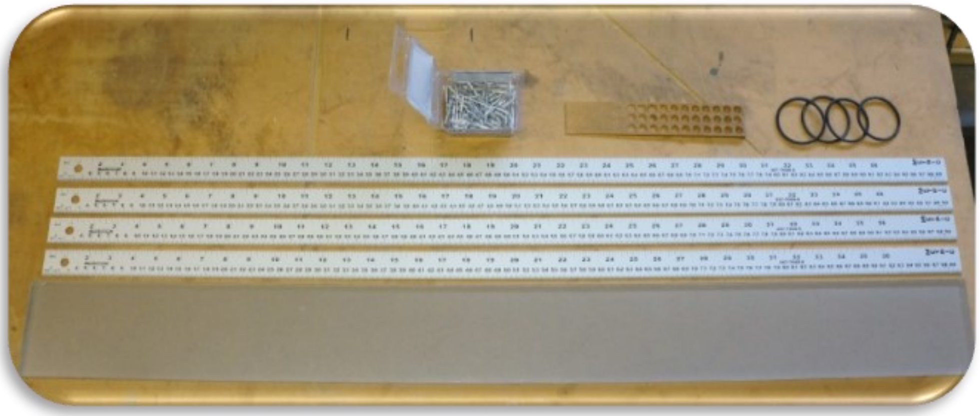
Suggested citation: Young, E.L., R.G. Pike and J.D. Goetz. 2021. Stream Velocity Board User's Guide. BC Ministry of Environment and Climate Change Strategy. 5pp.

*This guide is also available in French with translation provided by Jérôme Le Coz, Hydraulique des Rivières, France.

Construction

The instrument is easy to construct and made of commonly available and inexpensive materials. Supplies include:

- 1 — piece of $^{1}/_{2}$" thick plastic 100 cm x 9.85 cm (e.g., Plexiglas, Lexan). Thickness and width must be exact.
- 1 — drill with $^{1}/_{8}$" diameter drill bit
- 4 — aluminum metre sticks
- 3 — clamps
- 1 — rivet gun
- 20 — $^{1}/_{8}$" diameter aluminum rivets (or screws)
- 4 — 2" O-rings
- 1 — $^{1}/_{4}$" plastic levelling wedge



1. Align a metre stick along edge of plastic board and clamp in place. A backing board can prevent plastic from 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. Repeat steps 1-3 with a 2nd metre stick (running in same direction as 1st one). Sand rough edges if necessary.

4. Slide four O-rings over the board, spacing them out evenly.
5. Slide two metre sticks under the O-rings; one on the front and one on the back.

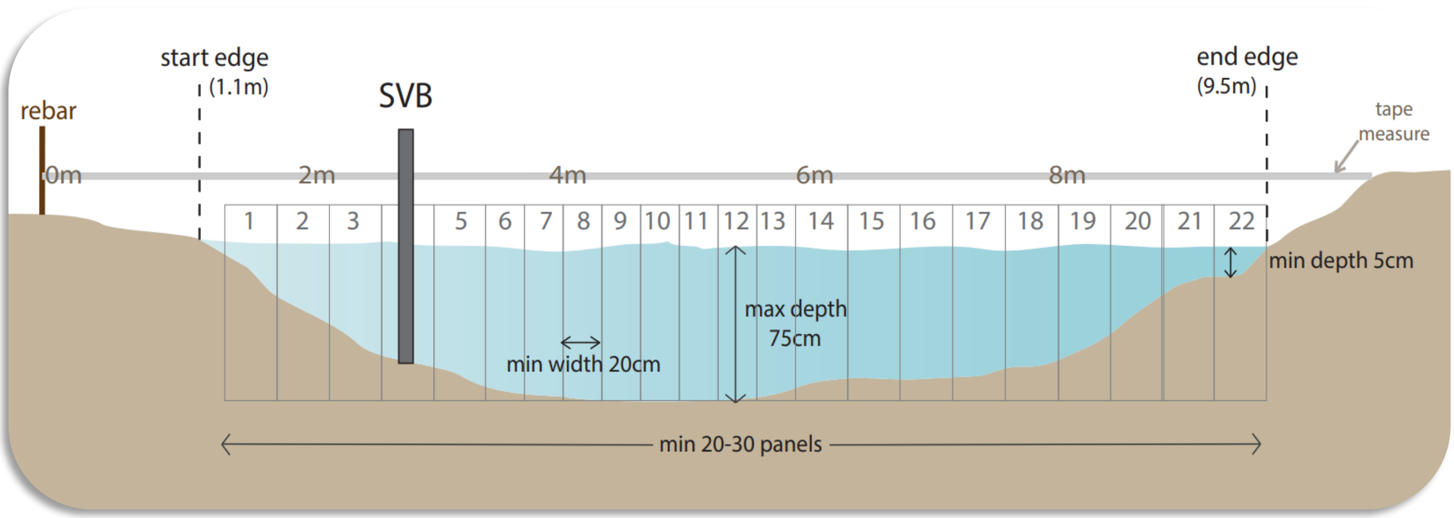
6. Slide levelling wedge under topmost O-ring to provide tension for front sliding ruler.

Site preparation for stream discharge measurement

1. String a tape measure across the stream, perpendicular to streamflow.
   - If stream cross-sections will be repeatedly measured, it is recommended to hammer rebar into the bank to ensure that consistent start/end points are used each time.

2. Divide the stream into 20-30 sampling locations with:
   - the recommended minimum spacing of 20cm, and
   - the first location as close the stream edge as possible (see Mid-section Method, RISC 2018).

3. Record the start edge of the stream (refer to the cross-section diagram below).



Preparing your field book

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

- Date and time
- Operator(s)
- Site being measured
- Start edge (i.e., wetted edge of stream).
- Sampling measurements:
  - Location (m)
  - Depth (m)
  - Velocity-head (mm)
- End edge (i.e., wetted edge of stream).

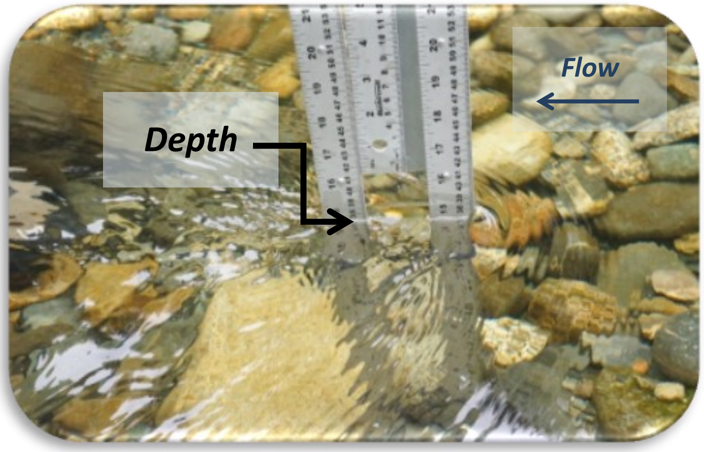
Aug 29, 2015. 10:15am PST			
Operator: John Smith			
Cowichan River near Boys Rd trailer park			
Staff gauge measurement (if available): 0.22m			
Start edge: 1.1 m		End edge: 9.5 m	
Panel	Location (m)	Depth (m)	Velocity-head (mm)
1	1.5	0.05	0
2	1.9	0.15	9
3	2.3	0.18	15
4	2.7	0.32	18
5	3.1	0.33	20
6	3.5	0.32	25
7	3.7	0.32	38
...	...	...	...

Collecting measurements

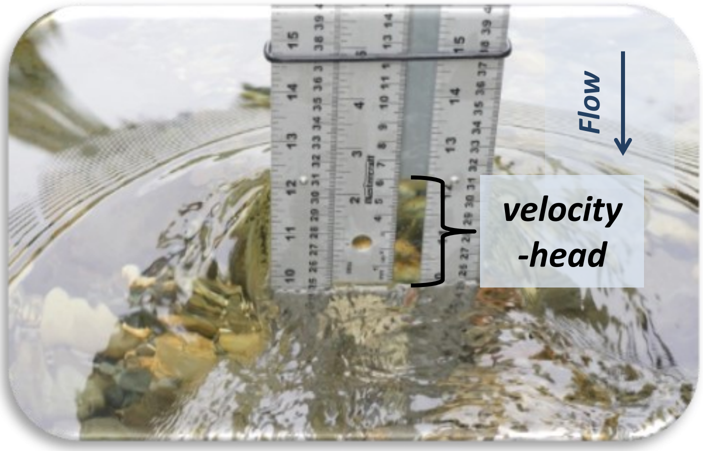
1. Record the start edge of the stream (refer to the cross-section diagram on the previous page).

2. Record measurement location as indicated by distance on tape measure.

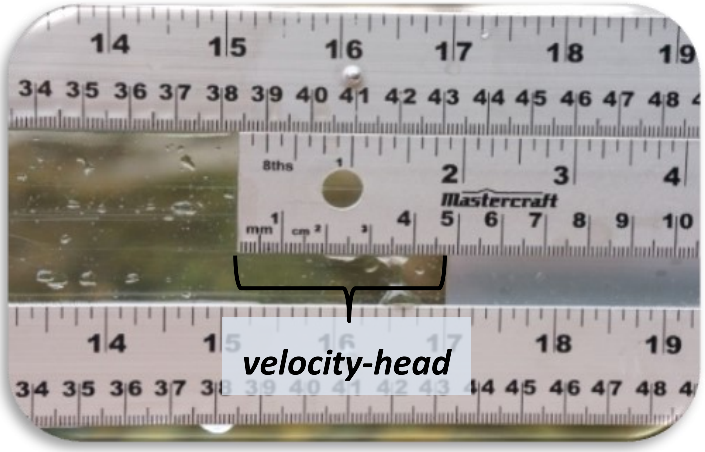
3. Measure panel depth:
   - Position the board parallel with streamflow
   - Record the depth measurement from the downstream side ruler. NOTE: If water level is pulsating, average the depth over 40 secs.



4. Measure panel velocity-head:
   - Turn the board 90° so the backside is facing upstream. Water level will be elevated on the upstream side of the board and lowered on the downstream side.
   - Slide both rulers down to touch the water surface (on both the front/downstream side and the back/upstream side). NOTE: If water level is pulsating, average it over 40 secs.



5. Record panel velocity-head:
   - Lift the instrument horizontally to eye level. It is important to read the velocity-head measurement squarely at 90° to eliminate any refraction through the board.
   - Read the velocity-head measurement from the inner sliding rulers, in mm (i.e., the difference between the two sliding rulers).



6. Repeat steps 2 – 5 at the centre of each panel across the stream's cross-section until the ending edge is reached.

7. Record the end edge of the stream (refer to the cross-section diagram on the previous page).

8. Before leaving the site, inspect the data for any inconsistencies and take new measurements where required.

Look-up Table: Velocity-head (mm) to Velocity (m/s)

Example: velocity-head of 24mm, can be quickly be converted to velocity of 0.421 m/s.

mm	0	1	2	3	4	5	6	7	8	9
0	-0.019	0.071	0.108	0.136	0.160	0.182	0.201	0.218	0.235	0.250
10	0.265	0.279	0.292	0.305	0.317	0.329	0.340	0.351	0.362	0.372
20	0.382	0.392	0.402	0.411	0.421	0.430	0.439	0.447	0.456	0.464
30	0.473	0.481	0.489	0.497	0.504	0.512	0.519	0.527	0.534	0.541
40	0.549	0.556	0.563	0.569	0.576	0.583	0.590	0.596	0.603	0.609
50	0.616	0.622	0.628	0.634	0.640	0.647	0.653	0.659	0.664	0.670
60	0.676	0.682	0.688	0.693	0.699	0.705	0.710	0.716	0.721	0.726
70	0.732	0.737	0.742	0.748	0.753	0.758	0.763	0.768	0.774	0.779
80	0.784	0.789	0.794	0.799	0.803	0.808	0.813	0.818	0.823	0.828
90	0.832	0.837	0.842	0.846	0.851	0.856	0.860	0.865	0.869	0.874
100	0.878	0.883	0.887	0.892	0.896	0.901	0.905	0.909	0.914	0.918
110	0.922	0.926	0.931	0.935	0.939	0.943	0.948	0.952	0.956	0.960
120	0.964	0.968	0.972	0.976	0.980	0.984	0.988	0.992	0.996	1.000

Calculating velocity and discharge

1. Panel width (Column F) = $\frac{\text{'Next' Location} - \text{'Preceding' Location}}{2}$

2. Panel area (Column G) = **Panel Width x Panel Depth**

3. Panel velocity (Column H) = $\left[0.641 \times \left(2 \times 9.8 \times VH(m) \right)^{0.5} \right] - 0.019$
   *if result is negative manually change to zero

4. Panel discharge (Column I) = **Panel Area x Panel Velocity**

5. Total stream discharge = **SUM (all Panel Discharge calculations)**

Here is a sample spreadsheet for calculating the above equations (*bold red indicates the excel formulas)

	A	B	C	D	E	F	G	H	I
1	**Field Measurements**				**Formula Calculations**				
2	**Panel**	**Location (m)**	**Depth (m)**	**VH (mm)**	**VH (m)**	**Panel Width**	**Panel Area**	**Panel Velocity**	**Panel Discharge**
3	**Start edge**	1.1			**=D4/1000**	**=(B5-B3)/2**	**=C4*F4**	**=(0.641*((2*9.8*E4)^0.5))-0.019**	**=G4*H4**
4	**1**	1.5	0.05	0	0.000	0.400	0.020	-0.019	0.000
5	**2**	1.9	0.15	9	0.009	0.400	0.060	0.250	0.015
6	**3**	2.3	0.18	15	0.015	0.400	0.072	0.329	0.024
7	**4**	2.7	0.32	18	0.018	0.700	0.224	0.362	0.081
8	**5**	3.7	0.32	38	0.038	...	...	...	...
9	**...**	...	...	...	...	...	...	...	...
10	**End edge**	9.5						Total Discharge	**=SUM(I4:I12)**

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.