

CHAPTER 10. RELATIVE BED STABILITY/SUBSTRATE CHARACTERIZATION PROTOCOLS (INCLUDING GRADIENT)

Materials and Supplies

1. 100-meter Measuring Tape – used to delineate the length of the substrate characterization reach and to demarcate the data points along this reach.
2. Flagging Tape – used to mark the eleven data point intervals in the substrate transect.
3. Survey Extension Pole – used to determine stream width and data points along each transect. It is also used in conjunction with the clear plastic tubing to measure the rise in the stream between the two ends of the reach.
4. Thalweg Pole – used to measure the Thalweg and to determine the substrate character at each transect data point. It is also used in conjunction with the clear plastic tubing to measure the rise in the stream between the two ends of the reach.
5. Handheld Eye Level – used as an alternative method to measure the rise in the stream between the two ends of the reach.
6. Water Level– made of clear plastic tubing with valves on each end; used to measure the rise in the stream between the two ends of the reach.
7. Relative Bed Stability Form – Forms for substrate characterization are a not a normal component of the WAB habitat sheet and are documented on appendix sheets (**See CHAPTER 2. Section C. APPENDIX #5 – Relative Bed Stability (Pebble Count) including Gradient on page 2-129**)

Section A. Procedures

Part 1. Establishing Reach and Transects

1. Determine the substrate characterization reach by multiplying the average stream width (as determined during the Rapid Bioassessment Protocol survey) by 40. The minimum and maximum widths are 100 and 500 meters, respectively. Record the reach length on the Habitat Assessment Form (**See CHAPTER 2. Section C. APPENDIX #5 – Relative Bed Stability (Pebble Count) including Gradient on page 2-129**).
2. Determine the transect intervals by dividing the total reach length by 10. Measurements are taken at each of these transects including the upstream and downstream endpoints for a total of 11 transects. Each transect is assigned a letter, with the first (downstream) transect identified as Transect A and the upstream terminus being Transect K.

Part 2. Substrate Measurement (AKA Pebble Count), Thalweg Profile, and Bankfull Height

1. Begin at Transect A and work upstream. Mark the measurer and recorder of the data.
2. Using the survey extension pole, determine the wetted stream width. Divide the stream width by four to determine the measurement points. Measurements will be taken at the right descending bank (0% of the wetted-width), right-center (25% of the wetted-width), center (50% of the wetted-width), left-center (75% of the wetted-width), and at the left descending bank (100% of the wetted-width). **Note: If a split channel is encountered one of two things can occur:**
 - A) If the split channel features a bar (bar definition: a channel feature below the bankfull height that is dry during baseflow conditions) then conduct the measurements at that transect as if there was only one channel and note the presence of the bar. Any measurements that fall on the bar should be treated just as if it was inundated with water but noted as being taken on a bar.**
 - B) If the split channel features an island (island definition: a channel feature even with the surrounding flood plain or above the bankfull height that remains dry even at bankfull flow) then conduct a separate transect in each channel for the length of the island. The situation should be documented and the second transect information is recorded continuing the transect letters down the alphabet starting with J.**
3. To take a substrate measurement, hold the Thalweg pole vertically at the transect point and lower it straight down to the bottom. Pick up the particle at the tip of the pole (if it is not a boulder or bedrock). Using the markings on the Thalweg pole, measure the particle at its median diameter. Each particle will have three dimensions: width, depth, and height. Measure the "middle" dimension, i.e., the dimension that is neither the largest nor smallest. Record the size class the particle falls into based on the following table (*see Table 10-1 on the next page*).

NOTE: In cases where there is a deposit of fine material (silt or sand) on top of another substrate type, you must use the THUNK test to determine which layer to count. The THUNK test consists of slowly lowering your Thalweg pole straight down to the bottom as normal. If your pole hits the particle abruptly and makes a sort of "THUNK" sound, then the deposit of fine material is not considered, and you count the underlying material. If your pole hits the bottom and can continue down to some degree with minimal resistance, then you record the fine material on top. Much of this determination relies upon experience and best professional judgment. Be sure to confer with your team partner and if in doubt, write notes.

Table 10-1. Substrate Size Classes for Substrate Characterization (Pebble Counts)

Class	Code	Size	Description
Bedrock	BR	>4000 mm	Bigger than car
Boulder	BL	>250-4000 mm	Basketball to car
Cobble	CB	>64-250 mm	Tennis ball to Basketball
Coarse Gravel	CG	>16-64 mm	Marble to Tennis ball
Fine Gravel	FG	>2-16 mm	Ladybug to marble
Sand	SA	>0.06-2 mm	Gritty between fingers
Silt & Fines	ST	<0.06 mm	Smooth, not gritty (silt & muck)
Clay	CL	>4000 mm	Slick/ hard clay or hard-pan clay bottom
Leaves	LD	Regardless of size	Leaf packs
Wood	WD	Regardless of size	Root wads, snags, logs, sticks

4. Repeat this step for each of the five measurement points.
5. Determine the Thalweg of the transect. The Thalweg is the deepest part of the stream channel at the transect. Use the Thalweg pole to determine water depth at the Thalweg.

IMPORTANT: Read the depth on the side of the Thalweg pole to avoid the wave produced by turbulence.

6. The bankfull height is defined as the channel height that is filled by moderate-sized flood events that occur every one or two years. Look for a variety of bank characteristics to determine the bankfull height. First, determine the location of the active floodplain. Next, look for an obvious slope break in the banks that differentiates the channel from a flat floodplain higher than the channel. A transition zone often exists between exposed substrate and vegetation, which marks the bankfull height. Look for a change from water-loving and scour-tolerant vegetation to more drought-tolerant vegetation. Also, it may be determined by moss or vegetation growing on rocks along the banks. A change from well-sorted stream sediments to unsorted soil materials is also a good indicator. In addition, indicators from the previous season's flooding are may be used if there have been no recent large floods or prolonged droughts: the presence of drift material (e.g., leaves, trash) along the bank or on overhanging branches from the previous seasons flooding, the level where deciduous leaf-fall is absent on the ground because it was swept into the stream by flooding since the last leaf-fall, and unvegetated sand, gravel or mud deposits from previous seasonal flooding. In cases where the channel is cutting a valley side slope and has over steepened and destabilized that slope, the bare "cut-bank" against the steep hillside is not necessarily an indication of recent incision. In such a case, the opposite bank may be lower and a more obvious indicator of bankfull and channel heights and widths.

In streams in deep V-shaped valleys, the difference between the bankfull and channel depth may be indistinguishable due to a lack of stream incision.

7. **Be sure to record a minimum of three bankfull height measurements throughout the sample reach. These measurements can occur anywhere along the reach but should be spaced out along the reach.**
8. Repeat these steps for Transects B through K. The next transect can be located by moving upstream the transect interval as calculated above using the 100m tape measure as a guide. Be sure the data from each transect is recorded in the appropriate space on the data sheet.

Part 3. Gradient Measurement

IMPORTANT: Gradient measurements must be taken along the full length of the reach. If the full reach is not measured with the tape measure, the gradient calculation will be incorrect, and the time taken to record this data will be wasted.

There are two options for devices to measure slope: The Handheld Eye Level and the Water Level. Each device has its positives and negatives, and each should be considered when selecting a device.

The Handheld Eye Level is much smaller than the Water Level in both weight and volume, so it may be more ideal in situations where a lengthy hike is necessary. It also is possible to measure longer distances with the Handheld Eye Level if the stream is straight enough and there are not major line-of-sight issues (e.g., overhanging vegetation, houses, bends, etc.). Larger reaches (e.g., >250 m) may benefit from the use of the Handheld Eye Level in both ease of use and reduction in the amount of time to obtain the Gradient Measured. On the negative side, the Handheld Eye Level is less accurate than the water level. It can also be problematic in raining conditions as the lenses can fog up. In addition, if two shorter people are working together, it may become necessary to use shorter distances between readings so that the person at the downstream end can point out with a stick or even read the level mark.

The Water Level is more accurate, but the distance between readings is limited (usually to 20 m) by the length of tubing. In addition, high gradient streams may require one to shorten the length of the tube to capture the reading on the downstream end. The Water Level is ideal for situations with dense overhanging vegetation that prevent the use of the Handheld Eye Level. Because of its weight (the tubing and water inside the tubing) may be more useful when the sample site is immediately near the roadside and jeep.

Measurement Methodology

The primary method is to use a handheld eye level. In the Handheld Eye Level Method, the slope is measured by “backsiting” or “backshooting” downstream between the two reach ends. If a situation occurs where using the handheld eye level is not feasible (e.g., the stream is too sinuous or there is too much overhanging vegetation) then the Water Level Method may be used instead to cover that distance.

The secondary method is to use a water level in the form of clear plastic tubing with some sort of length measuring device on each end (e.g., the Thalweg and Survey Extension Poles). If a situation occurs where using the water level is not feasible (e.g., the stream goes under a road or culvert) then the handheld eye level may be used instead to cover that distance.

Handheld Eye Level

IMPORTANT: Everyone should determine and remember their eye level height (the point on the survey pole that their eye is level with) before doing any slope measurements using the handheld eye level. Also, keep in mind that this point can change when wearing different wading boots or footwear.

- 1) One individual stands at the water surface along the bank with the handheld eye level while the other holds the survey extension pole at the water surface downstream (as far as the individual can see accurately with the handheld eye level).
- 2) Looking through the eye level, the upstream individual determines where along the vertical surface of the survey extension pole their eye is level. The upstream individual will instruct the downstream individual to move a horizontal marker (e.g., finger, stick, pencil, Thalweg pole) up or down to the same spot. The upstream individual's eye level height is then subtracted from the measured height to determine the rise of the stream for that distance. This value is recorded on the field form.
- 3) The upstream individual must now move to the position of the downstream individual (which can be marked by stacking rocks or with placement of an object or flagging) and the downstream individual moves down as far as the upstream individual can see accurately with the handheld eye level). Repeat the measurements as described until the downstream end has been reached.

Water Level Method

1. Fill the tubing by holding both ends level and pouring stream water collected in a cubitainer into the tubing until full. An alternative method to fill the tubing is to put stretch the tubing along the stream and submerge the upstream end under the water surface while siphoning the downstream end until enough of a draw is created to fill the tube.
2. Each partner secures an end by placing a rubber stopper or thumb into the end of the tubing, and then stretching the tubing to length along the contour of the stream starting at the upstream end of the reach.
3. Place the surveyor pole at water level at the downstream end. Stretch the tubing along the surveyor pole with the end of the tube at least to the 1 m mark (or higher if

necessary). To help hold the tube against the pole, you may use your foot to help hold the tube at water level. Perform the same steps at the upstream end apart from using the Thalweg pole.

4. When both ends are in position, the upstream individual must remove the stopper or thumb from the end of the tubing, followed by the downstream individual. The water level will oscillate until equilibrium is reached. Once the water level in the tube is stable, record the approximate location of the meniscus on each end, then subtract the upstream from the downstream measurement. Record this as the change in elevation or rise of that stream segment.
5. The upstream individual must now move to the position of the downstream individual (which can be marked by stacking rocks or with placement of an object or flagging). The tubing is again stretched to length and the method is repeated. Repeat the measurements as described until the downstream end has been reached.

IMPORTANT: If you encounter a high waterfall in the reach, measure the rise of the waterfall from the edge (if safe) of the fall to the splash-zone below using the surveyor pole and record it in one of the extra blanks on the field form (See CHAPTER 2. Section C. APPENDIX #5 – Relative Bed Stability (Pebble Count) including Gradient starting on page 2-129). Also, describe the reading and include what it is (i.e. waterfall) and where in the reach the waterfall was located (transect location). Then continue measurements past the waterfall as normal.

The final gradient measurement (% Gradient) is calculated after data entry via a query calculation:

Equation 7. Calculation of Percent Gradient

$$\% \text{ Gradient} = \frac{\text{Sum of Rises}}{\text{Reach Length}} \times 100$$

Where:

Sum of Rises = the summation of all the measured rises within the reach in meters

Reach Length = the total length of the reach in meters

Section B. Substrate Characterization Data Analysis

All this data (Pebble Count, Thalweg Profile, Bankfull Height, and Gradient) are entered into the WAB database and numerous values and statistics are calculated via a series of queries. These values define the approximate characteristics of the stream's substrate (D_{50} or average particle size) and the relative extent of impairment by sedimentation that is occurring (D_{84} or bankfull particle size).

Substrate Characterization Quality Assurance/Quality Control

Once a year, all field participants in the WAB attend mandatory training sessions. The purpose of these sessions is to ensure that all field personnel are familiar with sampling protocols and calibrated to sampling standards. A hands-on session concerning the collection and recording of Substrate Characterization data is included. Individual training will occur simultaneously on the same stream, so the results can be compared to the group average. Readings that deviate exceptionally from the norm will be examined for errors. In the field, Substrate Characterization teams will consist of two people. Individuals who are more experienced in measuring Substrate Characterization data will be teamed up with the less experienced to ensure reinforcement of training and accurate results. This document is also provided to all program personnel for review and use in the field.

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