Measuring Stream Banks: Height and Slope

Stream bank heights and slopes are of interest because they yield information relevant to bank erosion and stability. A high, steep bank is likely to be unstable and often indicates susceptibility to erosion, sloughing or collapse. In this activity students will measure the height and slope of a streambank.

Pre-Activity Discussion (Answers can be found in the Background Information section below)

Before beginning the activity, ask students:
1) Why are the height and slope of streambanks monitored? How can the results of the measurements be used?
2) Do these streambanks seem stable? What evidence do you see to support your view?
3) Are there conditions present in the area that could affect the streambanks?

The Activity

Equipment needed

-marked staff with a protractor and weight to allow the students to orient the staff in a vertical position; for measuring bank height. (photos below of staff and slopometer)
-protractor/level combination for measuring streambank slopes—a slopometer
-hip boots or waders
-data forms or data notebook and clipboard
-pencils
-display board

Site Selection

The students will be working in and alongside the stream, so safety is a consideration. Suitable sites should have the following characteristics:

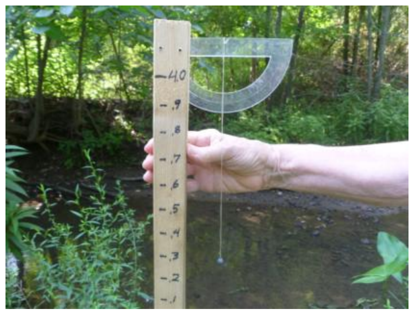
1. At the site selected, the stream should be easily accessible so students can get to the place where measurements will be taken without accidents.
2. The water must not be too deep or too fast. The students will be wading back and forth across the stream in the course of making their measurements.
3. The stream bottom should not be so muddy that it is difficult to walk on.
4. There should not be excessive quantities of woody debris or thick vegetation in the stream.
5. Select a spot free of poison ivy, wild roses, blackberries, or stinging nettles.
6. If possible, select sites having reasonably well defined bank heights and bank slopes. This will make the task of taking measurements easier.

Measuring Streambank Heights

The students will have several sites (typically three) at which they are to make height measurements using a procedure described below. At each site two measurements will be taken: one of the right bank and one of the left bank. Right and left are determined when facing downstream.

Make sure each set of measurements is identified with the correct site. Have students sketch a map of the study section of the stream and label and number the sites. This will help to avoid errors while recording data that could invalidate the results of the activity.

Simple measurements of streambank heights can be made with a marked staff or a surveyor's rod, both of which are just over-sized rulers calibrated in tenths and hundredths of a foot. In this activity a homemade marked staff will be used. When the staff is held exactly vertically, the string with the weight will hang at 90º on the protractor as in the picture below.



Begin by measuring the height of the left bank first. Remember: It is on your left while facing downstream. One student- the staff holder- places the marked staff at the water's edge on the left bank with 0.0 at the bottom and holds it in a vertical position.

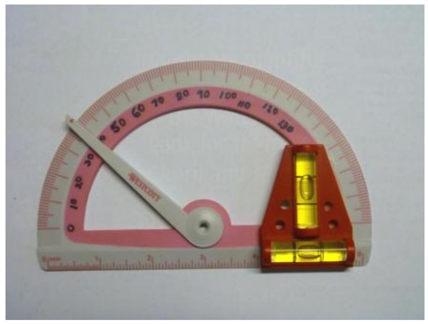
If the bank is no higher than the length of the staff, a second student- the reader- will stand close to the staff and move his head up or down until it is level with the top of the bank (generally defined by a marked decrease in slope as you go up). This student reads the corresponding number on the staff and calls it out to the student who is serving as the data recorder. The data recorder writes down the measurement on the data sheet in the proper place and repeats it back to the reader to make sure there's no error.

The procedure above is then repeated for the right bank with the measurement recorded in the proper place on the data sheet. Try to involve all of the students as much as possible as you take measurements at different sites.

Sometimes bank heights are greater than the length of the staff. If so, the staff holder holds the staff vertically at the edge of the stream on the side being measured and the reader moves to the other side of the stream. The reader will look carefully at the staff and the stream bank behind it and estimate the height of the bank by comparing it to the length of the staff. Thus, if the staff is 5.0 feet long and the bank appears to be about one and a half times higher than the length of the staff, the bank height is about 7.5 feet. If the bank appears to be about two times higher than the length of the staff, the bank height is about 10 feet. Usually such estimates are close enough for practical purposes.

Measuring Streambank Slopes

Again, begin by measuring the left bank. Hold the slopometer protractor vertically, with the ruler (flat) edge down and horizontal. Use the lower bubble level to be sure the bottom is held level to the ground. The bubble will be between the two black lines when the ruler is horizontal. (See below)



Keep the protractor in this level position while you adjust the movable arm until its slope is equal to the slope of the bank. The arm should be parallel to the bank. For irregular banks, use the slope of an imaginary straight line between the foot of the slope and the top of the slope. The reading on the scale at the triangle on the movable arm is the slope of the bank in degrees. Repeat the procedure for the right bank.

Engineers use a measurement known as percent grade. This involves a higher-level calculation. It is explained below in Background Information

Post-activity discussion questions:

1) To make the measurements meaningful, what else do we need to know about the banks and surrounding area?
2) Does this area need human intervention? What would you suggest?
3) What are some other methods that could be used to stabilize stream banks?

Background Information

Streambank heights and slopes are of interest because they give us information relevant to bank erosion and stability. But there is far more to the issue of streambanks than just height and slope. A bank that is high and steep is not necessarily at risk, nor is a bank that is low and with little slope necessarily stable. One must observe the condition of the bank itself, its composition, and the condition of the riparian buffer zone and nearby areas.

It is this combination of measurements and careful observations that yields the most useful information. Begin by looking for existing signs of erosion. Gullies and sloughing of portions of the bank are clear indications that the bank is not stable.

Next observe the composition of the bank and note what you see: crumbly soil, tight clay, sand, rock, etc. Look at the vegetation on and near the bank and note whether you see lots of mixed vegetation including woody shrubs and trees; grass, flowers and weeds; sparse vegetation; bare soil.

Finally, the observer should note the conditions of nearby terrain. If a farm field slopes down towards the bank there should be more concern than if the riparian streamside zone is in a natural state with a variety of vegetation. Look for grassy areas, parking lots, roadways, and other things that could direct water runoff to the banks of the stream.

When areas near a stream have a lot of impervious surfaces or farm fields that permit water to reach a stream quickly after a rain, there is greater risk of flash flooding. This can seriously damage banks. If the streambed has been straightened or altered, this, too, could increase the “flashiness” of the stream. If downed trees and other vegetation have been removed from the stream the flow of water increases as does the tendency for the stream to experience flash flooding.

All of this information together allows for a more accurate assessment of the stability of a stream bank and its tendency to erode. It is also needed in selecting and designing remedial measures to correct streambank problems. Such measures may include both “hard engineering” and “soft engineering” or bioengineering techniques.

Hard engineering methods include riprapping with concrete rubble or stone, re-grading of the slope, installation of a concrete or metal seawall, etc. Soft engineering methods include the use of coir (coconut husk fiber) logs; cedar tree revetments (cut cedar trees anchored firmly to the bank that dissipate the energy of water flowing past the bank); planting live willow stakes which grow to produce a willow thicket along the stream; and planting a number of different flowers, shrubs, and trees. Soft engineering is generally both cheaper and more environmentally friendly than hard engineering, which is used only on difficult, tough sites at which soft engineering would not be likely to be effective.

Engineers could also take pains to contain or slow water runoff to reduce damage caused by high water levels. Protecting banks can at times be an expensive proposition but if it prevents a road from collapsing into a stream, it is money well spent.

One last note about measurements: The numbers yielded from a single measurement of a streambank’s height and slope are not by themselves all that useful. But measurements over time can be quite useful for they may indicate stability or changes in the bank due to erosive influences. A series of measurements taken in combination with careful observations of the condition of the bank, the riparian buffer zone and the watershed in general can alert stream managers to potential problems.

<u>Determining Grade</u>

If you want to use slope (S) to determine the percent grade G used by engineers, this is the formula:

$$G = 100 \cdot \tan S$$

In doing this calculation, make sure your calculator is set for degrees, not radians. Check: if the slope is 45 deg, G is 100%. If the slope is 30 deg, G is 57.7%. If the slope is 60 deg, G is 173%.

For this and all other units, advanced level information is available if desired. Contact the HRWC and request an electronic version of the unabridged manual.

Stream bank data sheet

	Bank height in feet	Bank slope in degrees
First cross-section Right bank		
First cross-section Left bank		
Second cross-section Right bank		
Second cross-section Left bank		
Third cross-section Right bank		
Third cross-section Left bank		

Comments on flood plain (wide/narrow, state of vegetation, structures, etc.)

1. **Do these stream banks seem stable?**

2. **What problems do you see here?**

3. **Does this area need human intervention? What would you suggest?**