
5.5 Turbidity

What is turbidity and why is it important?

Turbidity is a measure of water clarity—how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. These materials are typically in the size range of 0.004 mm (clay) to 1.0 mm (sand). Turbidity can affect the color of the water.

Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates. Sources of turbidity include:

- Soil erosion
- Waste discharge
- Urban runoff
- Eroding stream banks
- Large numbers of bottom feeders (such as carp), which stir up bottom sediments
- Excessive algal growth.

Sampling and equipment considerations

Turbidity can be useful as an indicator of the effects of runoff from construction, agricultural practices, logging activity, discharges, and other sources. Turbidity often increases sharply during a rainfall, especially in developed watersheds, which typically have relatively high proportions of impervious surfaces. The flow of stormwater runoff from impervious surfaces rapidly increases stream velocity, which increases the erosion rates of streambanks and channels. Turbidity can also rise sharply during dry weather if earth-disturbing activities are occurring in or near a stream without erosion control practices in place.

Regular monitoring of turbidity can help detect trends that might indicate increasing erosion in developing watersheds. However, turbidity is closely related to stream flow and velocity and should be correlated with these factors. Comparisons of the change in turbidity over time, therefore, should be made at the same point at the same flow.

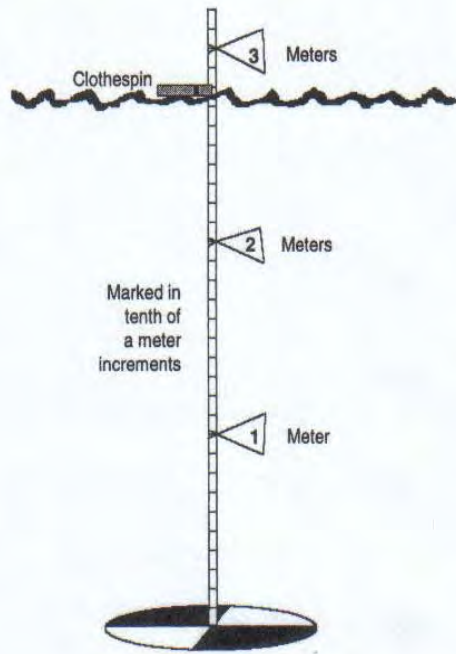
Turbidity is not a measurement of the amount of suspended solids present or the rate of sedimentation of a stream since it measures only the amount of light that is scattered by suspended particles. Measurement of total solids is a more direct measure of the amount of material suspended and dissolved in water (see section 5.9).

Turbidity is generally measured by using a turbidity meter. Volunteer programs may also take samples to a lab for analysis. Another approach is to measure transparency (an integrated measure of light scattering and absorption) instead of turbidity. Water clarity/transparency can be measured using a Secchi disk or transparency tube. The Secchi disk can only be used in deep, slow moving rivers; the transparency tube, a comparatively new development, is gaining acceptance in

Figure 5.10

Using a Secchi disk to measure transparency.

The disk is lowered until it is no longer visible. That point is the Secchi disk depth.



programs around the country but is not yet in wide use (see *Using a Secchi Disk or Transparency Tube*).

A turbidity meter consists of a light source that illuminates a water sample and a photoelectric cell that measures the intensity of light scattered at a 90° angle by the particles in the sample. It measures turbidity in nephelometric turbidity units or NTUs. Meters can measure turbidity over a wide range—from 0 to 1000 NTUs. A clear mountain stream might have a turbidity of around 1 NTU, whereas a large river like the Mississippi might have a dry-weather turbidity of around 10 NTUs. These values can jump into hundreds of NTU during runoff events. Therefore, the turbidity meter to be used should be reliable over the range in which you will be working. Meters of this quality cost about \$800. Many meters in this price range are designed for field or lab use.

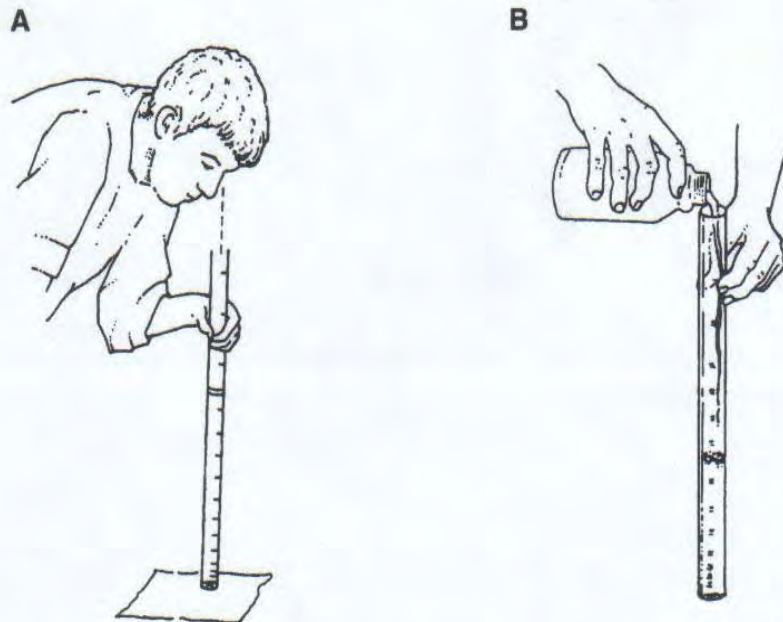
Although turbidity meters can be used in the field, volunteers might want to collect samples and take them to a central

Figure 5.11

Using a transparency tube.

(A) Prepare the transparency tube to take a reading. Place the tube on a white surface and look vertically down the tube to see the wave pattern at the bottom.

(B) Slowly pour water sample into the tube stopping intermittently to see if the wave pattern has disappeared.



Using a Secchi Disk or Transparency Tube

Secchi Disk

A Secchi disk is a black and white disk that is lowered by hand into the water to the depth at which it vanishes from sight (Figure 5.10). The distance to vanishing is then recorded. The clearer the water, the greater the distance. Secchi disks are simple to use and inexpensive. For river monitoring they have limited use, however, because in most cases the river bottom will be visible and the disk will not reach a vanishing point. Deeper, slower moving rivers are the most appropriate places for Secchi disk measurement although the current might require that the disk be extra-weighted so it does not sway and make measurement difficult. Secchi disks cost about \$50 and can be homemade.

The line attached to the Secchi disk must be marked according to units designated by the volunteer program, in waterproof ink. Many programs require volunteers to measure to the nearest 1/10 meter. Meter intervals can be tagged (e.g., with duct tape) for ease of use.

To measure water clarity with a Secchi disk:

- Check to make sure that the Secchi disk is securely attached to the measured line.
- Lean over the side of the boat and lower the Secchi disk into the water, keeping your back toward the sun to block glare.
- Lower the disk until it disappears from view. Lower it one third of a meter and then slowly raise the disk until it just reappears. Move the disk up and down until the exact vanishing point is found.
- Attach a clothespin to the line at the point where the line enters the water. Record the measurement on your data sheet. Repeating the measurement will provide you with a quality control check.

The key to consistent results is to train volunteers to follow standard sampling procedures and, if possible, have the same individual take the reading at the same site throughout the season.

Transparency Tube

Pioneered by Australia's Department of Conservation, the transparency tube is a clear, narrow plastic tube marked in units with a dark pattern painted on the bottom. Water is poured into the tube until the pattern disappears (Figure 5.11). Some U.S. volunteer monitoring programs (e.g., the Tennessee Valley Authority (TVA) Clean Water Initiative and the Minnesota Pollution Control Agency (MPCA)) are testing the transparency tube in streams and rivers. MPCA uses tubes marked in centimeters, and has found tube readings to relate fairly well to lab measurements of turbidity and total suspended solids (although they do not recommend the transparency tube for applications where precise and accurate measurement is required or in highly colored waters).

The TVA and MPCA recommend the following sampling considerations:

- Collect the sample in a bottle or bucket in mid-stream and mid-depth if possible. Avoid stagnant water and sample as far from the shoreline as is safe. Avoid collecting sediment from the bottom of the stream.
- Face upstream as you fill the bottle or bucket.
- Take readings in open but shaded conditions. Avoid direct sunlight by turning your back to the sun.
- Carefully stir or swish the water in the bucket or bottle until it is homogeneous, taking care not to produce air bubbles (these will scatter light and affect the measurement). Then pour the water slowly in the tube while looking down the tube. Measure the depth of the water column in the tube when the symbol just disappears.

For more information on using a transparency tube, see the references at the end of this section. Many programs have begun making their own tubes. They now may also be purchased in the U.S. (see Appendix B—Scientific Supply Houses).

point for turbidity measurements. This is because of the expense of the meter (most programs can afford only one and would have to pass it along from site to site, complicating logistics and increasing the risk of damage to the meter) and because the meter includes glass cells that must remain optically clear and free of scratches.

Volunteers can also take turbidity samples to a lab for meter analysis at a reasonable cost.

How to sample

The procedures for collecting samples and analyzing turbidity consist of the following tasks:

TASK 1 Prepare the sample containers

If factory-sealed, disposable Whirl-pak® bags are used to sample, no preparation is needed. Reused sample containers (and all glassware used in this procedure) must be cleaned before the first run and after each sampling run by following Method A described on page 128.

TASK 2 Prepare before leaving for the sampling site

Refer to pages 19-21 for details on confirming sampling date and time, safety consideration, checking supplies, and checking weather and directions. In addition to the standard sampling equipment and apparel, when sampling for turbidity, include the following equipment:

- Turbidity meter
- Turbidity standards
- Lint-free cloth to wipe the cells of the meter
- Data sheet for turbidity to record results

Be sure to let someone know where you are going and when you expect to return.

TASK 3 Collect the sample

Refer to page 128 for details on how to collect water samples using screw-cap bottles or Whirl-pak® bags.

TASK 4 Analyze the sample

The following procedure applies to field or lab use of the turbidity meter.

1. Prepare the turbidity meter for use according to the manufacturer's directions.
2. Use the turbidity standards provided with the meter to calibrate it. Make sure it is reading accurately in the range in which you will be working.
3. Shake the sample vigorously and wait until the bubbles have disappeared. You might want to tap the sides of the bottle gently to accelerate the process.
4. Use a lint-free cloth to wipe the outside of the tube into which the sample will be poured. Be sure not to handle the tube below the line where the light will pass when the tube is placed in the meter.
5. Pour the sample water into the tube. Wipe off any drops on the outside of the tube.
6. Set the meter for the appropriate turbidity range. Place the tube in the meter and read the turbidity measurement directly from the meter display.
7. Record the result on the field or lab sheet.
8. Repeat steps 3-7 for each sample.

TASK 5 Return the samples and the field data sheets to the lab/drop-off point.

If you are sending your samples to a lab for analysis, they must be tested within 24 hours of collection. Keep samples in the dark and on ice or refrigerated.

References and Further Reading

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- Mississippi Headwaters River Watch. 1991. Water quality procedures. Mississippi Headwaters Board. March.
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