Turbidity

Turbidity is a measure of water clarity. High turbidity makes water appear cloudy or muddy.

Why do we measure turbidity?

Turbidity and total suspended solids (TSS) are different ways to measure similar water quality characteristics. TSS is the concentration of suspended particles, which include soil particles (clay, silt, organic matter), algae, and microscopic organisms.

An increase in turbidity (Figure 1) or suspended solids can also negatively affect aquatic health by:

- Clogging fish gills or the filter-feeding systems of other aquatic animals.
- Hindering visibility, making it difficult for predators to find prey.
- Decreasing light penetration into water and thereby the ability of submerged aquatic plants to photosynthesize, reducing biomass and growth rates of aquatic plants.
- Reducing fish resistance to disease.
- Altering egg and larval development.

Changes in turbidity can also affect other water quality parameters; increased turbidity is likely to be accompanied by the following:

- Higher temperature and reduced dissolved oxygen due to increased heat absorption of the water.
- Reduced dissolved oxygen due to decreased light penetration into the water and an associated decrease in photosynthesis by aquatic plants.
- Increased nutrient concentrations and chlorophyll *a* if the turbidity is caused by excess algal growth.

Figure 1. Fish in turbid water (left), and fish in clear water (right). Credit: Photo courtesy of Credit Valley Conservation

The suspended solids contributing to turbidity can affect water chemistry and microbiology. The particles can adsorb (take up on their surfaces) pollutants, including nutrients, metals, and organic compounds. If the particles settle on the bottom of the waterbody, then the pollutants settle with them. If bottom sediments are subsequently disturbed and resuspended, the aquatic community can be exposed to any adsorbed toxins or nutrients.

In drinking water, particles can interfere with disinfection by physically blocking UV rays from reaching microorganisms. Some microorganisms can make people sick if they occur in drinking water.

What affects turbidity?

Natural factors that increase turbidity include:

- Runoff caused by precipitation and/or severe weather.
- Disruption of bottom sediments (resuspension) due to water turbulence from windstorms or rain events.
- Bottom-feeding animals moving sediments around.
- Small floating organisms suspended in the water column (plankton, algae, cyanobacteria).
- Dead organic matter in the water column.
- Wood ash from wildfires that reaches surface water.
- Spring snowmelt and precipitation.
- Summer algal growth in lakes and slower moving rivers.

Human-induced factors that increase turbidity include:

- Stream bank erosion contributing soil to water (Figure 2).
- Erosion in other areas of the watershed caused by changes in land use (construction, farming, forestry, and urban development) that cause soil to be carried in runoff to surface water.
- Urban runoff carrying particles from impervious surfaces to surface water.
- Untreated wastewater discharges.
- Disturbance and resuspension of bottom sediments during dredging or boating activity.
- Algal growth due to fertilizer use and resulting increases in nutrients in the water, especially in lakes or slower moving rivers.

Figure 2. Example of streambank erosion. Credit: Photo courtesy of Cuyahoga SWCD

What are EPA's recommended criteria for turbidity?

EPA's *Quality Criteria for Water* (1986) contains the following general narrative criterion for turbidity: "Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life."

States and tribes have the discretion to set quantitative or qualitative water quality criteria for turbidity. For example, narrative criteria may require no increases above naturally occurring conditions.

How do we measure turbidity?

Turbidity is measured directly using a turbidity meter or sensor (nephelometry). Turbidity can also be measured indirectly through water clarity, which is measured in deeper rivers or lakes using a Secchi disk.

Figure 3. Water sample taken to assess turbidity. Credit: Photo courtesy of USEPA

Turbidity is reported in nephelometric turbidity units (NTUs) or Secchi depths (in meters) depending on the method used for measurement. Figure 3 shows a water sample that was taken to assess turbidity in murky water.

Turbidity can vary both horizontally and vertically in a waterbody. Water samples should, therefore, be taken at regular increments across a waterbody and at various depths (or depth integrated, which is a sample that represents the entire water column).

Basic field data collected by a water quality monitoring program should include turbidity along with other parameters that may influence turbidity, such as temperature, streamflow, dissolved oxygen, specific conductance, and pH.

What are the challenges of using turbidity as a water quality parameter?

Turbidity is an optical property of water rather than a chemical or biological measurement. Caution should be exercised when using turbidity as a water quality parameter because high turbidity levels do not necessarily indicate poor water quality, and low turbidity levels do not necessarily indicate good water quality. Values should, therefore, be evaluated alongside other parameters. Measurements made using a Secchi disk as shown in Figure 4 are qualitative and subject to the accuracy of the measurer. A related parameter, total suspended solids (TSS), is the concentration of particles suspended in the water column that are larger than two microns in size. Although turbidity is not a direct measure of TSS, changes in turbidity often correspond with changes in TSS. In general, higher turbidity values and greater TSS concentrations are both observed at higher flows. TSS is reported in units of mg/L.

Figure 4. Secchi disk measuring the Secchi depth in water with extensive algal growth. Credit: Photo courtesy of USGS

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