calibration tricks and tips

pH + TURBIDITY

The Monthly Dirt
A monthly newsletter on the California Construction General Permit

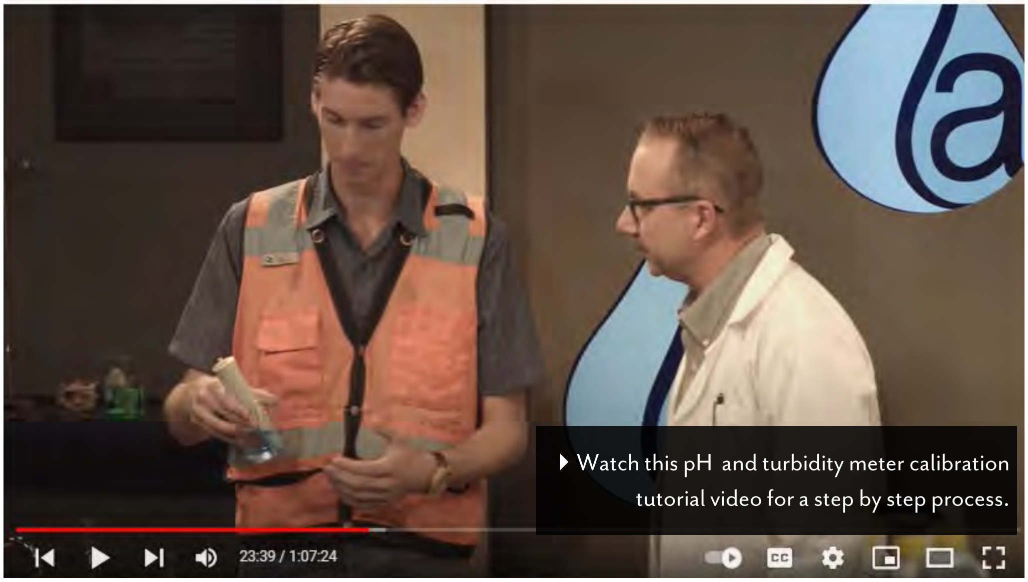
Why monitoring pH and turbidity is important, and how to make sure your meters are calibrated correctly.

If you've been around storm water for any amount of time, you will immediately recognize these two things as what most construction sites need to constantly monitor. But have you ever stopped to figure out the reason behind the sampling? Do you know why it's so important to sample for both of these? In this month's edition of **The Monthly Dirt**, we're going to take a look at why pH and turbidity are important to monitor, and do a quick refresher course on calibration methods and techniques for in-the-field pH and turbidity meters.

A pH REVIEW: While you may think pH is an element on the periodic table, it's not actually an element or substance, but a condition. pH *(literally meaning "potential of hydrogen")* is a unit of measurement for hydrogen concentration in water. pH is the negative logarithm of hydrogen ion (H+) concentration in an aqueous solution (a liquid where water is the solvent). It measures the basicity or acidity of a solution on a scale of 0 to 14, with a pH 7 being neutral. As the concentration of H+ ions in a solution increases, acidity increases and pH gets lower (dropping below 7). As H+ ions decrease, pH levels increase which makes the solution's basicity increase (also known as caustic or alkaline). The pH scale is logarithmic, which means each whole pH value below 7 is ten times more acidic than the higher value. For example, pH 5 is ten times more acidic than pH 6 and 100 times (10 times 10) more acidic than pH 7. It is also true for pH values above 7, each of which is ten times more basic than the next lower whole value. For instance, pH 9 is ten times more basic than pH 8 and 100 times (10 times 10) more basic than pH 7. Pure water is neutral, but when chemicals or pollutants are mixed with water, the water mixture can become either acidic or basic. Such is the case when storm water comes into contact with peat soils, some wood mulches, acids, lime, cement, wet or fresh concrete, and other pollutants. This mixing can happen on the ground with runoff, or can happen in the atmosphere with air pollutants, which is how we get *"acid rain"*. When acid rain or pH impacted storm water runoff collects in streams and ponds, the pH of that water body is changed. Even slight pH changes in streams harm fish, especially sensitive juvenile fish and other organisms. In storm water applications, prevention is the key. It is usually much easier to prevent pollutants from coming into contact with storm water than to try to adjust the pH of the runoff.

According to the Construction General Permit's Fact Sheet, *"the chosen limits [for pH NALs] were established by calculating one standard deviation above and below the mean pH of runoff from highway construction sites in California. Proper implementation of BMPs should result in discharges that are within the range of* ***6.5 to 8.5 pH Units."*** Due to the narrow window of acceptable pH results, using the correct tool to measure pH is very important—which, according to the Permit, is a calibrated pH meter that can be used in the field. It should be noted that these pH readings should be taken either directly in the flow of water (for best results) or within 15 minutes of collecting the sample.

TURBIDITY IN A NUTSHELL: Turbidity isn't the measurement of solids suspended in water, rather, it's the measurement of water clarity. Turbidity is determined by shining light through a sample and measuring the amount of light that was scattered (or, conversely, the amount of light that passed through the sample). The more particles present in the sample, the more the beam of light will be scattered. Turbidity and Total Suspended Solids (TSS) are similar since they are both used to measure the clarity of an aqueous solution. However, they aren't actually measuring the same thing. Turbidity is a quick test which allows you to have instant results, while TSS is something that has to be measured by a laboratory. Generally, the laboratory will evaluate for TSS by measuring the weight the of solids in a sample. But, the problem with this test is that it will only detect solids down to 2 microns in size. Colloidal clay suspensions have particles so small that these particles will pass



right through the filter paper the laboratory uses to capture, weigh, and quantify the solids. This is most likely the reason why turbidity is now the testing standard according to the CGP as opposed to Total Suspended Solids—since turbidity results can be obtained quicker and are more accurate. The NAL for turbidity is **250 NTUs** (Nephelometric Turbidity Units).

Turbidity presents several problems to a water body. First, elevated turbidity is caused by suspended particles that eventually settle out in slower flows. These particles can bury and kill benthic organisms (clams, worms, oysters, shrimp-like crustaceans and mussels) or fish eggs. Second, particles that stay in suspension can cause other negative conditions such as blocking sunlight from reaching aquatic plants that rely on the sun for photosynthesis. Plants release dissolved oxygen into the water body which is important for the health and survival of fish and other aquatic organisms. When these plants die, they not only stop generating dissolved oxygen, but actually consume it while decomposing. Furthermore, the decomposition releases more particles into the water which in turn increases the turbidity. Third, turbidity can cause water temperatures to rise - since suspended particles absorb more of the sun's energy than clear water, heat is transferred by conduction to the water. Warmer water contains less dissolved oxygen than colder water and certain species of fish and organisms dependent upon higher dissolved oxygen concentrations will no longer be able to survive in that water body. Finally, water quality is threatened due to pesticides, heavy metals, oils and greases, and pathogens that cling to suspended sediment particles.

pH METER CALIBRATION: Before starting, be sure you are working with devices that are in good working condition – if you need to buy a new device entirely, check out our favorite meters (Hanna or Oakton). PS – we highly recommend that those who will be measuring pH in the field, be properly trained on how to calibrate pH meters, how to keep accurate records, and how to properly sample for pH. Calibration for pH meters should occur before the first use of the day (you don't have to re-calibrate between uses, once a day is fine). Calibrating pH meters is a fairly simple process which only takes a couple minutes. *Be sure to wear gloves when calibrating your device since you don't know where it was used last and what type of pollutants it came in contact with.* Before calibrating your pH meter, give the electrode (glass bulb) a quick rinse in deionized water (if you have it, but we have found tap water doesn't adversely affect the instrument). Shake the meter to remove excess water, press the calibration button and place device into the first of the three buffers and give it a little stir and let it sit in the buffer for 1-2 minutes – typically it is best to start with the 4 and 10 buffers and end with the 7. You may notice the reading fluctuating for the first several minutes, but once the reading has stabilized after a couple minutes, go ahead and press "enter" to calibrate the device to that buffer (or follow the manufacturer instructions for your particular device). After the device is calibrated to the first buffer, give the meter a quick rinse before repeating the same steps with the remaining two buffers. Be sure to rinse the meter between buffers and to properly document the calibration readings in the pH calibration log *(if you need a form for calibration logging, you can find the one we use and recommend, attached at the end of the newsletter)*. NOTE: Buffer can be re-used and is fairly stable, but change it when it looks cloudy or contaminated. We like using smaller disposable cups to calibrate our devices. These use less buffer solution while still allowing the electrode to be completely covered by the buffer. To store the device between uses, we recommend keeping the electrode from drying out by dampening a small piece of paper towel with tap water and placing that it inside the device cap before putting the cap back on the device. This will help extend the life of your pH meter.

TURBITIY METER CALIBRATION: Finding a good and reliable turbidity meter is a great starting place – the Oakton Meter is our recommended brand (check it out HERE). It's reliable, easy to use, and moderately priced. Since these meters are measuring the cloudiness of the water, be careful to not move the device around a lot while taking a reading, because it will jostle the water and give a false reading. Check out this video for an interesting case study we did on the potential for getting false turbidity readings due to meter limitations, and why it is a good idea to let your turbidity sample "rest" for a bit before taking a reading. However, don't let it sit too long otherwise the solids will settle out and result in an unrepresentative reading. Most field turbidity meters have an upper limit of 1,000 NTUs, but the NAL and Receiving Water sampling triggers are far below this level. Follow the manufacturer's directions for calibration which can vary from one make to another.

TRICKS AND TIPS:

- Keep the unit dry, moisture will condense on cold vials and cause a higher reading.
- Have a clean microfiber rag to clean off smudges on the outside of the vials which could elevate the reading over the NAL.
- Color doesn't always mean high turbidity. Coffee will have a fairly low turbidity as do natural tannins and lignins.
- Turbidity meters are light sensitive, so be sure to put the cap on when taking a reading or calibrating to keep light from leaking through and affecting the sample.

Please contact us if you have any questions …

The Monthly Dirt

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pH Meter Calibration Log

Date	Time	Name of Person Calibrating	Initials	Meter ID	Measurement pH 4.01 Buffer	Measurement pH 7 Buffer	Measurement pH 10 Buffer	Comments:

Turbidity Meter Calibration Log

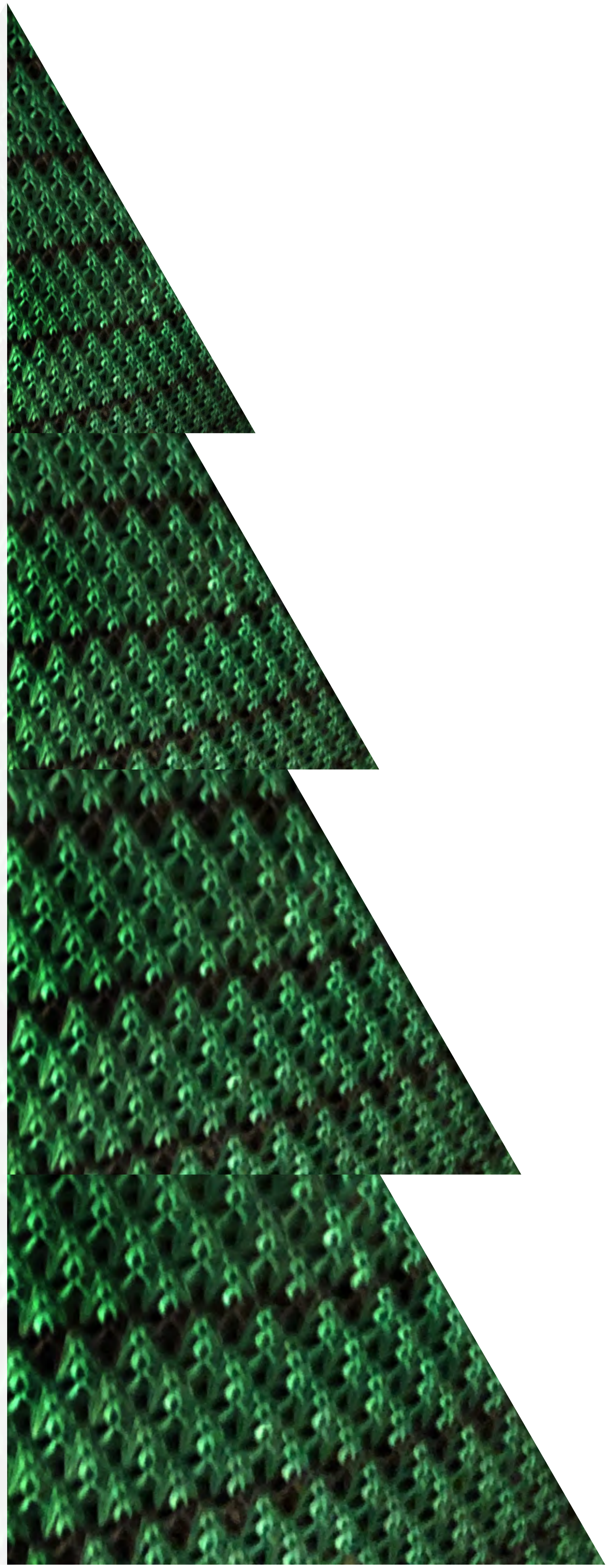
Date	Time	Name of Person Calibrating	Initials	Meter ID	Measurement ____ NTU Turbidity Buffer	Measurement ____ NTU Turbidity Buffer	Measurement ____ NTU Turbidity Buffer	Comments


ALL IS CALM
& all is bright
wishing you the merriest christmas & a happy
new year! may your holiday season
be filled with peace and light.
isaiah 9:2

LET IT
RAIN

LET IT RAIN, LET IT RAIN.

Deck your site with festive and effective BMPs for the holiday season!



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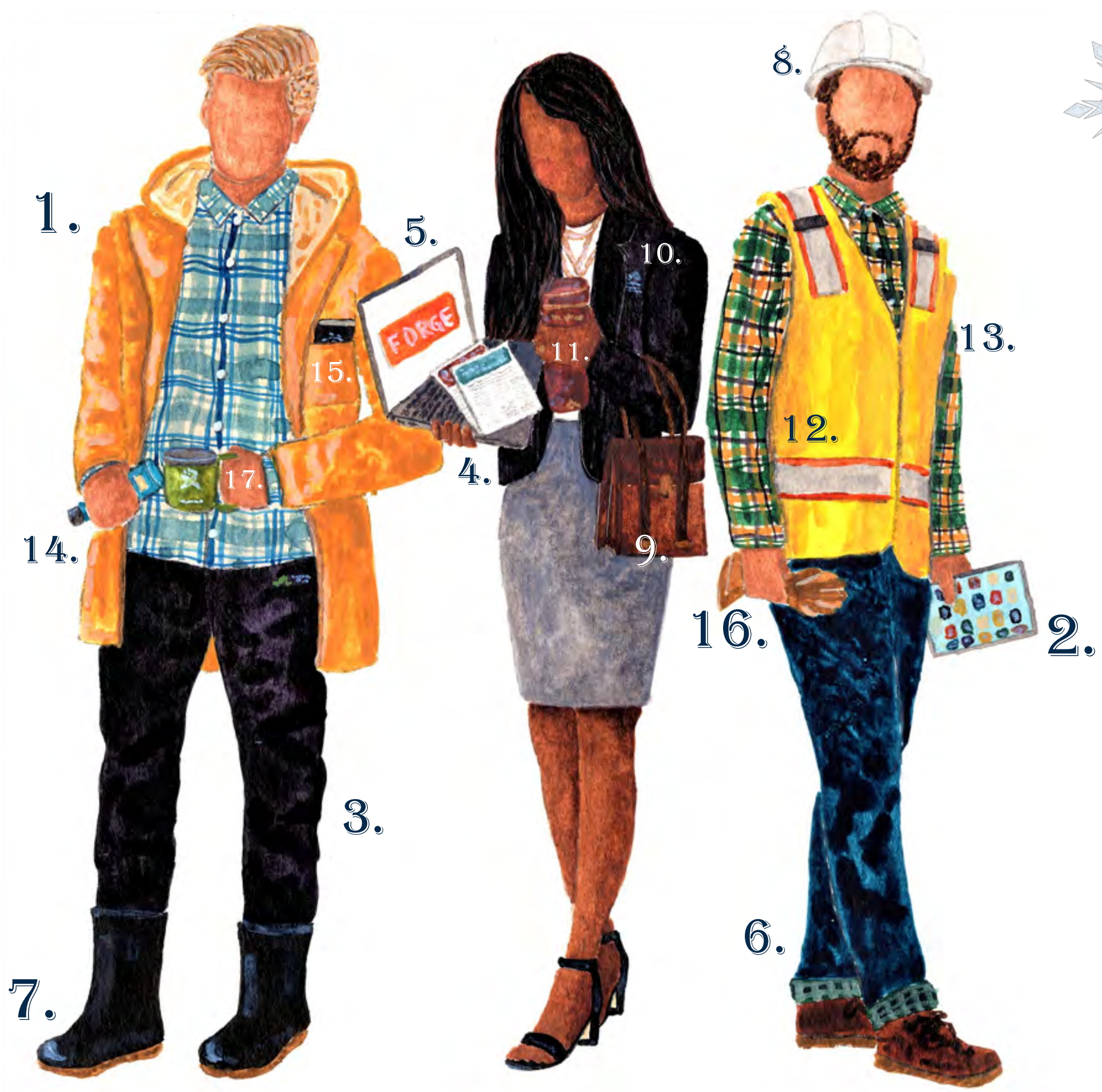

Need Christmas shopping ideas? Check out these awesome finds!

1. Waterproof Rainslicker Jacket - HIS & HERS
2. WGR's Customizable Storm Water Inspection App (contact jteravskis@wgr-sw.com for more information)
3. Frogg Toggs Water-Resistant Pants - HIS & HERS
4. Free Storm Water Newsletter Subscriptions
5. FORGE - Online Learning Subscription
6. Flannel Lined Work Jeans - HIS & HERS
7. Rain Boots - HIS & HERS
8. Bullard 4 Point Pinlock Suspension Hard Hat
9. Leather Briefcase - HIS & HERS
10. Company Logo Blazer - HIS & HERS
11. Water/Tea/Cold Brew Coffee Insulated Infuser Bottle
12. Safety Vest
13. Fleece Lined Flannel Shirt - HIS & HERS
14. pH Meter
15. Rite In The Rain Waterproof Notebook and Pen
16. Deerskin Work Gloves
17. HydroFlask Insulated Coffee Mug

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ONLINE QSP/QSD TRAINING

JOIN US FOR OUR NEXT ONLINE COURSE JANUARY 25-27, 2022

QSP TRAINING (2-DAY): $375 | QSP/QSD TRAINING (3-DAY): $550
QSD-ONLY (1-DAY): $250

The first 12 people to register will receive a $25 gift card to Chipotle to enjoy during the course.

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.

For factsheets on other water quality parameters, visit: epa.gov/awma/factsheets-water-quality-parameters.

For more information about the CWA Section 106 Grants Program, visit: epa.gov/water-pollution-control-section-106-grants.

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