WATER QUALITY LESSON - Total Suspended Solids (TSS) & Turbidity



TOPIC: Total Suspended Solids (TSS) & Turbidity

AUTHOR: Beaver Water District

CLASS TIME NEEDED:

- One class period of 45 to 60 minutes for instruction about the topic
- One class period of 45 to 60 minutes for the lab
- One class period of 45 to 60 minutes for presentations.

SUBJECT/GRADE LEVEL: K-12 - Physical Science/Biology/Earth Science/ETS/Environmental Science

ARKANSAS SCIENCE STANDARDS:

Grades K-2

- Physical Science – K-PS2-1, K-PS2-2, 1-PS4-3, 1-PS4-4, 2-PS1-1, 2-PS1-2
- Biology – K-LS1-1
- Earth Science – K-ESS2-1, K-ESS3-1, K-ESS3-2, K-ESS3-3, 2-ESS1-1, 2-ESS2-1, 2-ESS2-2, 2-ESS2-3
- Engineering, Technology, & Application of Science – K-ETS1-1, K-ETS1-2, K-ETS1-3, 1-ETS1-1, 1-ETS1-2, 1-ETS1-3, 2-ETS1-1, 2-ETS1-2, 2-ETS1-3

Grades 3-4

- Physical Science – 3-PS2-1, 3-PS2-2, 4-PS3-1, 4-PS3-3
- Biology – 3-LS3-2, 3-LS4-3, 3-LS4-4
- Earth Science – 3-ESS2-1, 3-ESS2-2, 3-ESS3-1, 4-ESS2-1, 4-ESS2-2, 4-ESS3-2
- Engineering, Technology, & Application of Science – 3-ETS1-1, 3-ETS1-2, 3-ETS1-3, 4-ETS1-1, 4-ETS1-2

Grades 5-8

- Physical Science – 5-PS1-1, 5-PS1-2, 5-PS1-3, 5-PS1-4, 5-PS2-1, 6-PS3-5, 8-PS3-1, 8-PS3-2, 8-PS4-1, 8-PS4-2
- Biology – 6-LS1-5, 7-LS2-4, 7-LS2-5
- Earth Science – 5-ESS1-2, 5-ESS2-1, 5-ESS2-2, 5-ESS3-1, 6-ESS2-4, 6-ESS3-3, 6-ESS3-4, 6-ESS3-5, 7-ESS2-1, 7-ESS2-2, 7-ESS3-1,7-ESS3-2, 8-ESS1-4
- Engineering, Technology, & Application of Science – 5-ETS1-1, 5-ETS1-2, 5-ETS1-3, 6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4, 7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4, 8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4

Grades 9-12

- Physical Science - PSI-LS2-7, PSI-LS4-5, PSI-ESS2-1, PSI-ESS3-1, PSI6-ETS1-1, PSI6-ETS1-2, PSI6-ETS1-3, PSI6-ETS1-4
- Biology – BI-LS2-1, BI-LS2-2, BI-LS2-6, BI-LS2-7, BI-LS4-6, BI3-ETS1-3, BI-ESS2-2, BI-ESS2-4, BI-ESS2-5, BI-ESS3-5, BI6-ETS1-2, BI6-ETS1-3, BI-ESS3-1, BI-ESS3-2, BI-ESS3-3, BI-ESS3-4, BI-ESS3-6, BI7-ETS1-1, BI7-ETS1-4
- Earth Science - ES-ESS2-2, ES-ESS2-5, ES2-ETS1-1, ES2-ETS1-3
- Environmental Science - EVS-ESS2-2, EVS-ESS2-3, EVS-ESS2-5, EVS-ESS2-6, EVS-ESS3-5, EVS1-ETS1-1, EVS-LS2-1, EVS-LS2-2, EVS-LS2-6, EVS-LS2-8, EVS3-ETS1-3, EVS-LS2-2

LEARNING PERFORMANCE TARGET(S): (learning expectations for this lesson; combines a science practice, crosscutting concept and core idea embedded in the lesson)

Students will gain functioning knowledge and expertise equipping them to:

- Design experiments
- Measure turbidity, determine possible sources Total Suspended Solids (TSS), and assess impact to water quality in streams.
- Interpret data, graph, and present their results.

SCIENCE AND ENGINEERING PRACTICES:

Lab work, field work, acquire data, graphing, planning and carrying out investigations, analyzing and interpreting data, asking questions and defining problems.

CROSSCUTTING CONCEPTS:

Structure and Function, Stability and Change

CCSS CONNECTIONS: (include mathematical concepts and reading, writing, speaking and listening opportunities in the lesson)

All exist throughout the lesson.
ELA/Literacy
Mathematics

MATERIALS:

- Glass fiber filters
- Distilled water
- Filtering flask
- Nephelometer or Jackson turbidimeter
- Pump

Acorn Naturalists Turbidity Test Kits –

- www.acorn-naturalists.com/catalogsearch/result/?q=turbidity+test+kit

University of Arkansas Extension (UAEX) – www.uaex.edu

- Water Quality Lab - arkansas-water-center.uark.edu/water-quality-lab.php

TEACHER PREPARATION:

Collect water samples from an undisturbed location.

Total Suspended Solids (TSS)

1. Before sampling, prepare glass fiber filters by first soaking them in distilled water, drying them at 103 degrees C, and weighing and recording their weights.

2. Place the dried, weighed glass fiber filter onto a filtering flask – wrinkled side up. Shake the sample bottle first, then pour in the water and turn on the pump. (The amount of water you need to filter may change according to water conditions. Start with 100 mL. Use less volume if the filter gets clogged too quickly and more if the water filters through very fast.) Record the volume of water filtered.

3. Dry the filter at 103 to 105 degrees C, let it cool to room temperature, and weigh it. Dry it, cool it, and weigh it again. Continue until the fiber reaches a constant weight. Record the end weight.

4. The increase in weight represents TSS. Calculate TSS by using the equation below.

TSS (mg/L) = ([A-B]*1000)/C

A = End weight of the filter
B = Initial weight of the filter
C = Volume of water

Turbidity

Easiest: Acquire a turbidity test kit and follow the procedures listed.

More technical: Shake your water sample and place in a nephelometer or Jackson turbidimeter. Compare this result to a reference solution or blank. Turbidity is a measure of light scattered by particles.

BACKGROUND INFORMATION/CONTENT:

Problem Question:

What are total suspended solids (TSS) and turbidity and how do they affect the health of streams?

Background Information

Teachers: Total suspended solids (TSS) concentrations and turbidity both indicate the amount of solids suspended in the water, whether mineral (e.g., soil particles) or organic (e.g., algae). However, the TSS test measures an actual weight of material per volume of water, while turbidity measures the amount of light scattered from a sample (more suspended particles cause greater scattering). This difference becomes important when trying to calculate total quantities of material within or entering a stream. Such calculations are possible with TSS values, but not with turbidity readings. High concentrations of particulate matter can cause increased sedimentation and siltation in a stream, which in turn can ruin important habitat areas for fish and other aquatic life. Suspended particles also provide attachment places for other pollutants, such as metals and bacteria. High suspended solids or turbidity readings thus can be used as "indicators" of other potential pollutants.

TSS and turbidity values vary naturally for two main reasons – one physical, the other biological. Heavy rains and fast-moving water are erosive. They can pick up and carry enough dirt and debris to make any stream look dirty. So, heavy rainfall may cause higher TSS concentrations or turbidity, unless the additional particles are dispersed throughout large volumes of flood water.

Land use is probably the greatest factor influencing changes in TSS or turbidity in streams. As watersheds develop, there is an increase in disturbed areas (e.g., cropland or construction sites), a decrease in vegetation, and increases in the rate of runoff. These all cause increases in erosion, particulate matter, and nutrients, which in turn promote increased algal growth. For example, loss of vegetation due to urbanization exposes more soil to erosion, allows more runoff to form, and simultaneously reduces the watershed's ability to filter runoff before in reaches the stream.

Students: Prepare for this lab ahead of time by accessing and reviewing pages listed in documents at the following links, then do an online search for more, as time allows.

Beaver Lake and Its Watershed 2010 - www.bwdh2o.org/wp-content/uploads/2012/03/2010-FINAL-Beaver-Lake-Watershed-Report.pdf "Increasing Population . . . " (p. 14-15), "Land Use . . . " (p. 16-17), "Primary Water Quality Concerns . . ." (p. 26), "Water Quality Monitoring" (p. 27)
Beaver Lake Watershed Protection Strategy - www.beaverwatershedalliance.org/pdf/Beaver-Lake-Watershed-Protection-Strategy.pdf "Description of the Watershed" (p. 9-26)

Classroom of the Future - www.cotf.edu

Exploring The Environment/Water Quality Assessment: Physical

- Total Suspended Solids (TSS) - www.cotf.edu/ete/modules/waterq3/WQassess4g.html
- Turbidity - www.cotf.edu/ete/modules/waterq3/WQassess4f.html

7E'S TOTAL SUSPENDED SOLIDS (TSS) & TURBIDITY IN STREAMS

Elicit

Show images from the internet of muddy streams. Ask students what might be causing the extra sediment in the stream. Show images of polluted streams that have produced a fish kill. Ask students what could have caused wildlife death.

Engage

Form lab teams and discuss agricultural and urban sources that might affect BOD and turbidity. Locate streams on Google Earth and explain differences in what is seen in the surrounding areas of the streams, then look at the class's sample stream characteristics and list where extra sediment would be washed in.

Explore

Conduct the lab with the collected water samples. It would be best to have the students collect the sample from the stream and see the surrounding area.

Explain

Each team interprets the data, graphs results, and present findings to the class.

Elaborate

Teams should describe their stream characteristics (including the surrounding area) and list possible sources of extra sediment that has entered the stream. What nutrients might decrease the amount of oxygen present?

Evaluate

Assess lab techniques, safety, presentation, and unit test.

Extensions

Use this lesson along with other chemical tests and biological testing to determine total stream health. Form a community project to assess stream health and involve the community.