Turbidity and Sediment Engineering

4th Grade MWEE driving question: How can I, along with my family and community, positively affect our watershed?

Engineering Problem:

- How can we design a way to remove contaminants from our water so that it doesn't flow downstream?

End-of-activity reflection question (SOL big idea reflection):
What are some things that we can do to improve the health of our water natural resources?

Goal: Students gain an understanding of how much effort it takes to remove sediment before it impacts the health of the Chesapeake Bay and its tributary streams and rivers.

Objectives:

Knowledge: Sediment is detrimental to organism health, and thus Chesapeake Bay system health. Turbidity is the measure of the amount of sediment in the water.
Skills: Students design and engineer a filtering system, compare results, and make careful observations of sediment and turbidity.
Values: Students develop an appreciation for the Chesapeake Bay system and the impacts of sediment/deposition on Bay health.

Grade(s): 4th

Special Safety: Watch for water spills; caution students to walk carefully.

VA Standards addressed:

Science (2018) = Science and Engineering Practices (SEP)

4.1 The student will demonstrate an understanding of scientific and engineering practices by

a) asking questions and defining problems
- define a simple design problem that can be solved through the development of an object, tool, process, or system

b) planning and carrying out investigations
- collaboratively plan and conduct investigations
- use tools and/or materials to design and/or build a device that solves a specific problem
- take metric measurements using appropriate tools

c) interpreting, analyzing, and evaluating data
- analyze data from tests of an object or tool to determine whether it works as intended

d) constructing and critiquing conclusions and explanations
- use evidence (i.e., measurements, observations, patterns) to construct or support explanations and to make inferences

e) developing and using models
- develop and/or use models to explain natural phenomena
- identify limitations of models

f) obtaining, evaluating, and communicating information
- communicate scientific information, design ideas, and/or solutions with others

4.8 The student will investigate and understand that Virginia has important natural resources. Key resources include

a) watersheds and water

d) forests, soils, and land

4.8 Big Idea (central idea): Virginia has many natural resources including watersheds, minerals, rocks, ores, soil, land & forests.
This activity helps students understand that they can develop solutions to improve the health of our watershed resources.

This activity helps develop skill in SEP 4.1b Planning and carrying out investigations: collaboratively plan and conduct investigations & use tools and/or materials to design and/or build a device that solves a specific problem

Enduring Understandings	**Essential Knowledge and Practices**
Natural resources are necessary or useful to humans. Many natural resources are distributed unevenly around the planet. · Virginia has many natural resources. Some examples of Virginia's natural resources include minerals, plants, animals, water, soil, and land (4.8 a, b, c, d). · A watershed is an area of land over which surface water flows to a single collection place. The materials from the watershed, including pollutants, add to the water flow and impact organisms that may serve as a natural resource for humans. The Chesapeake Bay watershed covers approximately half of Virginia's land area. The other two major watershed systems in Virginia are the Gulf of Mexico and the North Carolina sounds (4.8 a). *Students do not need to identify all the major watersheds in Virginia; however, they should be able to identify the watershed in which they live.*	In order to meet this standard, it is expected that students will create and interpret a model of a watershed (4.8 a) use evidence to explain the statement, "We all live downstream." (4.8 a) investigate the school yard or local ecosystem to identify questions, problems, or issues that affect a natural resource in that area and determine a possible solution to an identified problem (4.8 a, b, c, d).

Time: 40 minutes

Materials:
- Soil erosion runoff water (about one gallon per class) - preferably produced during the erosion model activity
- Per Group:
    - One filter holder with three holes for funnels
    - 3 funnels
    - Small Beakers-250 mL (four per student group)
    - Turbidity Secchi disks (taped to outside bottom of beakers)
    - Stirring sticks- bamboo chopstick or paint stick (2 per student group)
- Two tables with Filtration materials, examples include:

Sand, Cotton Balls, cellulous sponges, Coffee filters, cheesecloth (if possible: compostable materials)

- **Water Filter Procedure** (one for each student or small group of students)
- **Water Filter Lab Datasheet** (one for each student)
- POSSIBLE- Vernier labquest for precise turbidity measurements

CLEAN UP STATION with:

- Compost bucket
- Rinse bucket
- Towels for clean-up

Set-up:

Erosion Runoff Water: To obtain water containing sediment: Pour water over one of the bare soil erosion models. Collect the runoff. Repeat to obtain almost a gallon of erosion runoff per class. This will need to be prepared in advance for the first rotation, all other rotations can bring it from the erosion station.
Filter Materials Common Stations (2): Place filtering materials in an area accessible to all students.
Filter Materials Student Stations: Each group should have:

- one filter holder with three holes (labeled A, B, C)
- Four 250 mL beakers (3 with laminated secchi discs taped to the bottom inside)
- two large beakers (1000 mL)
- Turbidity comparison Scoring Card
- laminated **Water Filter Procedure**

Instructional Strategy:

1. Engage. Show students a clear container of water and a cloudy container of water. Ask: what is the difference? If students have not yet done the erosion model experiment, what are some ideas on how this was caused? Students may respond with dirt, sediment, soil that washed away. Based on responses, come to a class understanding of erosion.
   If students have done the erosion model experiment, ask: What were the results of the erosion model experiment? Describe what your water looked like from the bare soil model? What did your water look like for the model with the plants? Clear or polluted (muddy)?
2. Engineer. Inquire: Does anyone have an idea of what sediment is? What can we do to remove sediment and improve the water quality? Each of your teams is to experiment to design and create/engineer a process to remove sediment from water.
3. Measure Turbidity. To know if we have created a solution, we collect information on the cloudiness of the water before we begin. Each of your groups will measure how clear or how cloudy (scientists call this turbidity) their bare soil water sample from their erosion model experiment. Record data on **Water Filter Lab Analysis datasheet** and/or on the classroom whiteboard.
4. Teachers: Ask teachers to take photos of each groups' filter designs to facilitate discussion back in the classroom. Teachers take pictures of each group's setup. Teachers fill out their data sheet for each of their groups.

5. Student Water Filter Experiment. Working in small groups, students will review the **Water Filter Procedure** and then begin a discussion on how they can design and create a filter to remove sediment from the water. Instruct students to use the **Water Filter Lab Data Sheet** in their journals to draw their filter designs and record their test data.
6. Record Data. Students follow the procedure outlined in **Water Filter Procedure,** record data and answer the questions in the **Water Filter Lab Data Sheet** and **Water Filter Lab Summary and Analysis Table.**
7. Wrap Up. Water Filter Design Discussion- What worked well for filtering sediment OUT of water? What didn't work? What material/supplies do you wish you had to improve your filter? Do you think your process could be used on a bigger scale (i.e., to filter large amounts of water)? Is your filter a natural filter or a built filter? What can we do to prevent stream bank erosion and sedimentation? Is building and taking care of a filter more or less effective (labor and cost) than cleaning the water after it is polluted (muddy)? Did we design a way to remove contaminants from our water so that it doesn't flow downstream?
8. Clean up. Be sure to have students put all materials back where they found them, discard or compost those that can't be reused, and wipe any water from the tables.

Water Filter Engineering (Page 1 of 2)

Water Filter Procedure

Make your filter

1. Place the funnels into the holder. Place beakers under each of the funnels; they will hold the **filtered water**.

Since you are testing the same polluted (muddy) water sample with three different filters, use **different materials** to make different filter types. Test **one filter at a time**!

Predict:

2. Stir the water. Use the **Turbidity Comparison Scoring Card** to record the turbidity of the water from the erosion model investigation. Then, **predict** what will happen to the polluted (muddy) water when it goes through the filter. Record.

Test your filter:

3. Choose **filter materials** and **layer them** into a funnel. Draw/describe your filter design on the **Water Filter Lab Data Sheet**.

4. Stir the polluted (muddy) water sample with a stir stick, then measure 100mL of this water into a small beaker.

5. Pour this 100 mL onto filter design "A". **Observe** what the filtered water looks like and record this on your **Water Filter Lab Data Sheet.**

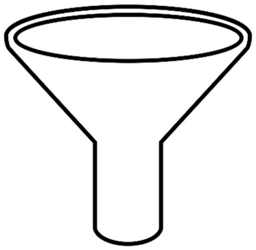
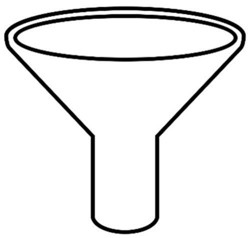
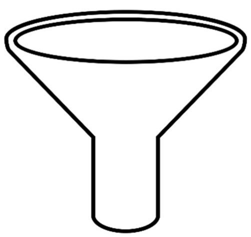
6. **Adjust design**: What could be done to improve your filter? You can create a new filter design and test it again or you can try the same filter design three times. Your choice!

7. Repeat steps 3-7 with filter design "B" and again with filter design "C". Record all data on the **Water Filter Lab Data Sheet**.

8. Complete and summarize your observations on the **Water Filter Lab Summary & Analysis Table**. Use the **Turbidity Comparison Scoring Card** to estimate the turbidity of the filtered water.

The water filter investigation was adapted by Blandy Experimental Farm from "Water Filter," pbskids.org/zoom, 2008. Modified Feb 2019 & Jan 2022.

Water Filter Engineering (Page 2 of 2)

	Make Your Water Filter: Draw and label the filter you built on the image.	**Predict:** What will the filter do to the polluted (muddy) water?	**Observe & refine:** Was sediment filtered out? How can you get cleaner water?
A		Prediction:	
B		Prediction:	
C		Prediction:	

Water Filter Lab Summary & Analysis Table
Observe and Compare: Look at your data and the beakers of filtered water.

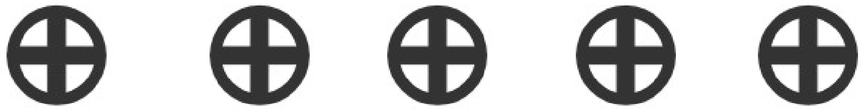
	Color	Describe Turbidity Using the **Turbidity Comparison Scoring Card**
polluted (muddy) Water (before filtering)		
Filter A		
Filter B		
Filter C		

Were your predictions about your filters supported? Why or why not?

What filtering design was most effective? Explain below:

Commented [1]: What filtering design was most effective? Group discussion.

Turbidity Observation Disks

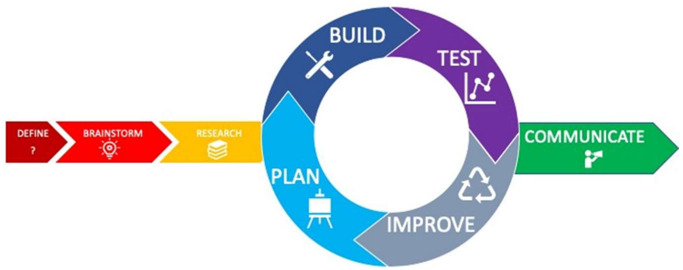


Turbidity Comparison Scoring Card

1= Little Filtering/ Highly turbid	3=Some filtering/ Less turbid	5=High filtering/ Not turbid

The water filter investigation was adapted by Blandy Experimental Farm from “Water Filter,” pbskids.org/zoom, 2008. Modified Feb 2019 & Jan 2022.

The Engineering Design Process from the 2018 Science Curriculum Framework



1. Define: Define the problem; ask a question
2. Imagine: Brainstorm possible solutions
3. Research: Research the problem to determine the feasibility of possible solutions
4. Plan: Plan a device/model to address the problem or answer the question
5. Build: Build a device/model to address the problem or answer question
6. Test: Test the device/model in a series of trials
    a) Does the design meet the criteria and constraints defined in the problem?
        i. Yes? Go to Share (#8)
        ii. No? Go to Improve (#7)
7. Improve: Using the results of the test, brainstorm improvements to the device/model; return to #3
8. Share: Communicate your results to stakeholders and the public