Turbidity Engineering: Removing Sediment

Grade	4th & 5th
Time	45 minutes
Overview	Students build understanding about how much effort it takes to remove sediment before it impacts the health of the Chesapeake Bay and its tributary streams and rivers.
Objectives	Understanding: 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 & Processes: Students design and conduct an experiment, compare results, and make careful observations of sediment and turbidity. Student use models to infer how sediment filtration works. Values: Students develop an appreciation for the Chesapeake Bay system and the impacts of sediment/deposition on Bay health.
Essential Question	How can we design a way to remove sediment and contaminants from our water so that it does not flow downstream?
Primary VA SOL	Science (2018): 4.1, 5.1
Related VA SOL	Science (2018): 4.8, 5.8d

Materials	**Special Safety**
• Soil erosion runoff water (about one gallon per class) - preferably produced during the erosion model activity • Per Group: o One filter holder with three holes for funnels o 3 funnels o Small Beakers-250 mL (four) o 1000 mL beakers (1) o Turbidity Secchi disks (laminated) o Turbidity scoring card (laminated) o Stirring sticks- bamboo chopstick or paint stick • Bins of Filtration materials (one per table): Napkins, Gravel, Sand, Cotton Balls, Sponges, Coffee filters (if possible: compostable) • Water Filter Procedure (one per group) • Water Filter Engineering Datasheet (one for each student)	*Watch for water spills; caution students to walk carefully.*

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• CLEAN UP STATION o Compost bucket o Rinse bucket o Towels for clean-up	

Set Up

1. 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.
2. Set up tables with Funnels, funnel holders, beakers, and turbidity cards.
3. Place filtering materials either in bins (one per table) or in an area accessible to all students.

Instructional Strategy	
Recommended Grouping/Instructional style	Small groups (not more than 4 per group) Hands-on Modeling Activity
Steps	1. **Engage:** Show students a clear container of water and a cloudy container of water. a) Ask: what is the difference? Eventually introduce the word "turbidity" The clear container is clear, then muddy one is "turbidity" Ask: What does turbidity mean? b) 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. c) 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? The goal with this activity is for your team to design, create/engineer, and test 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. a) Record data on Water Filter Engineering Analysis datasheet and/or on the classroom whiteboard. Demonstrate how to use the Turbidity Scoring Card. 4. **Student Filter Design:** Working in small groups, students will review the Water Filter Procedure and then begin a discussion on how they can create a filter to remove sediment from the

	water. Instruct students to use the Water Filter Engineering Data Sheet in their journal. **5. Record Data:** Students follow the procedure outlined in Water Filter Procedure, record data and answer the questions in the Water Filter Engineering Data Sheet and Water Filter Engineering Summary and Analysis Table. a) Teachers take pictures of each group's setup. Teachers fill out their data sheet for each of their groups. 6. **Wrap Up:** Water Filter Design Discussion a) 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? b) 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? c) 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)? d) Use evidence from this engineering design activity to support the statement "We all live downstream". 7. **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.

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Image of turbidity models setup.

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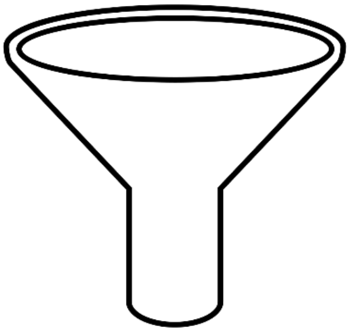
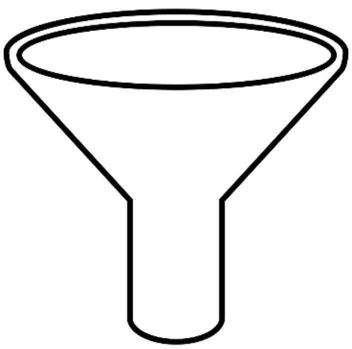
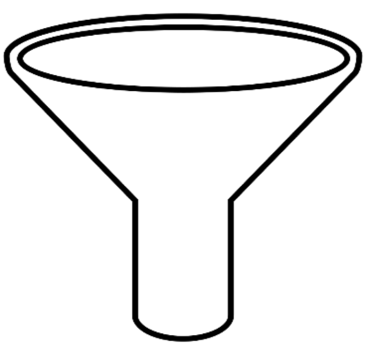
Water Filter Engineering Datasheet 1

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

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Water Filter Engineering Datasheet 2

Water Filter Engineering Summary & Analysis Table
Observe and Compare: Look at your Water Filter Engineering 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:

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Turbidity Observation Disks

Turbidity Comparison Scoring Card

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

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The NGSS are included for reference and for sharing this activity with a broader education community.

Next Generation Science Standards Addressed:

- **MS-LS2-5**. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- **MS-ESS2-4.** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
- **MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

From Virginia Standards of Learning Curriculum Framework (2018)

The Engineering Design Process:

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 the question
6. Test: Test the device/model in a series of trials
    1. Does the design meet the criteria and constraints defined in the problem?
        1. Yes? Go to Share (#8)
        2. 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