

### **Invisible Passengers**

Students perform an experiment to investigate the characteristics of sediment in water. They will also discuss the effects of various types of pollution on aquatic organisms.

**Level(s):** 6-8

**Subject(s):** Physical Science, Life Science, Earth Science

**Virginia SOLs:** 6.5 a, c, f; 6.7 a, c, f; 6.9 a, c LS.4 a, b, c; LS.10 c, LS.11 b; LS.12 e  
PS.1 l; PS.2 b, c, d

**Objectives:**

1. Students will be able to identify and describe a variety of natural and introduced materials that are found in river waters
2. Students will be able to explain some of the effects of erosion on water quality
3. Students will be able to understand that water pollution can have a harmful effect on aquatic organisms, even if the pollution is not visible.

**Materials:**

1. 25 quart-size jars (with lids)
2. water
3. clay/silt
4. sand
5. small gravel/pebbles
6. five liquids which can be identified by odor (e.g. vinegar, ammonia, vanilla extract, bleach, perfume)
7. table salt
8. measuring cups or graduated cylinders

**Estimated Time:** 45 – 60 minutes

**Background Information:** *Major Pollutants of Fresh Water*, p.103.

**Preparation:**

1. Provide containers with clay, sand and gravel
2. Provide a source of water
3. Prepare and number 5 jars with water and enough of an odorous liquid for it to be identified by smell

**Introduction:**

1. Discuss with the class how stormwater runoff can cause erosion on the land and carry silt into streams and rivers.
2. Discuss how high flows after storm events can cause erosion of stream banks and the bottom of the stream channel
3. Discuss what effects the two processes above can have on the water quality of streams, and on the aquatic life living in those streams.
4. Explain that the students will be simulating high water flows in a stream or river and investigate the properties of various substances in the water.

**Activity Procedure:**

1. Divide the class into 5 groups. Distribute 4 jars to each group. (Remind the students to use caution as the jars are breakable.)

## Water Pollution: Sediment

2. Have the students fill each of the 4 jars half full with water. Add a cup of silt or clay to the first jar, a cup of sand to the second jar, a cup of gravel to the third. In the final jar add one-third cup of each: silt, sand and gravel. Give the contents time to settle.
3. Tell the students they will be shaking the jars observing them as the contents settle. Have them record predictions regarding:
  - a. which will settle the fastest
  - b. which will settle the slowest
  - c. which will be easiest to stir up after it settles with only a slight motion
4. Advise the students to make sure that the lids are tightly fastened onto the jars. Then ask them to shake all the jars vigorously for 5 or 10 seconds. Have them set all the jars on their desks at the same time and record their observations of the three factors above.
5. Invite the students to devise a method to determine the following:
  - a. flood time or rapid flow behavior of the water (rapid motion)
  - b. low water or slow flow (gentle or no motion)
6. Discuss what behavior you have when rapid flow is followed by slow flow in each jar (silt seldom settles).
7. Have students predict if any change will occur when a teaspoon of salt is added to the mixtures in each jar, and then observe the result. (The salt dissolves and created little or no visible effect.). Discuss how salt might get into the water (natural minerals in stream beds, agricultural practices such as irrigation, road salt for snow.)
8. Ask students if they think they have a good sense of smell. Invite them to see if they can detect a difference in odor between sand silt and gravel and the mixture of all three. Invite them to describe the odors detected.
9. Tell the students that biologists believe that many fish use their sense of "smell" in different ways. Some use sensitivity to "odors" for feeding a migrating to spawning habitats. Tell the students they are going to see how many odors they can accurately detect in the water. Ask them to write the numbers 1-5 on a piece of paper.
10. Pass out one of the prepared and numbered jars to each group. Ask them to open them carefully pass the jar to everyone in the group. They are to record the jar number and the odor or "passenger in the water" they think they can detect. Once the jar has been passed among all the members of the group, trade the jar with another group. Repeat until all the jars have been sampled by all the students in the class and the lists are complete.
11. Discuss the possible effects of each of these conditions on living things in the rivers. Have them think of "invisible" substances that could be in the water, and what harmful effects these could have on aquatic organisms living in the water or on people who drink the water, swim in it or eat food taken from the water. Emphasize that the natural inhabitants of the water have adapted to the stream or river environment, but that when these conditions change, they can a harmful effect on them. Discuss how changes in land use can introduce various kinds of pollution to the stream or river environment.

### **Possible Follow Up:**

1. Test various samples of water for nutrients such as nitrates or phosphates and discuss their effects on water quality.

Adapted from **Rivers at Risk**, pp. 30-31

## Major Pollutants of Fresh Water

<b>Cause of Pollution</b>	<b>Consequences of Pollution</b>
<p><b>Organic Matter and Fertilizers</b></p> <ul style="list-style-type: none"> <li>• Sewage from cities and towns</li> <li>• Livestock waste from farms</li> <li>• Pet waste</li> <li>• Fertilizers used on farms, lawns, gardens, golf courses and parks</li> </ul>	<p>Increased levels of nitrates and phosphates cause growth of algae and bacteria, which use up the dissolved oxygen in the water that fish and other creatures need for survival.</p>
<p><b>Sediments</b></p> <ul style="list-style-type: none"> <li>• Natural erosion of hills and river banks</li> <li>• Construction sites</li> <li>• Farms</li> <li>• Waste products from mines</li> </ul>	<p>Many creatures require a rocky bottom on which to lay their eggs, which becomes unavailable when covered in sediment. Fish and other creature's eggs can also be buried in silt. Food becomes harder to see and gills can become clogged with silt. Water temperature increases when the sun's heat is absorbed by darker sediment, causing oxygen levels to decrease. Sediment in water also prevents the sunlight from reaching plants on the bottom.</p>
<p><b>Toxic Waste</b></p> <ul style="list-style-type: none"> <li>• Industrial areas: petrochemical products, solvents, heavy metals and minerals</li> <li>• Cars: motor oil, coolant, brake fluid, metal particles (copper, zinc and cadmium from brake lining and tire wear)</li> <li>• Diesel exhaust: chromium, mercury, copper, zinc</li> </ul>	<p>Poisoning of fish and other water organisms. Illness in humans. Some toxic waste is associated with cancer or leukemia, which can be fatal.</p>
<p><b>Pesticides, Fungicides, Herbicides</b></p> <ul style="list-style-type: none"> <li>• Used on farms, lawns, gardens, golf courses and parks</li> </ul>	<p>Can be poisonous to aquatic organisms and to humans. Some chemicals build up over time in organisms, becoming more concentrated in the bodies of animals near the top of the food chain, such as fish, which may be consumed by humans.</p>
<p><b>Disease-Carrying Organisms</b></p> <ul style="list-style-type: none"> <li>• Bacteria found in sewage</li> <li>• Mosquitoes</li> </ul>	<p>Illness in humans caused by bacteria. Spread of diseases such as Malaria and West Nile Virus by mosquitoes.</p>

## Muddying the Waters

Students investigate the behavior of sediment in water, and discuss how sediment can affect waterways and the creatures that live in them.

**Level(s):** 6, 7

**Subject(s):** life science, earth science

**Virginia SOLs:** 6.1 h,i; 6.5 c,g; 6.7 a,f; LS4 a, b, c; LS 12 b,d,e;

### Objectives:

Students will be able to:

1. summarize the effects of sediment on water quality.
2. describe the behavior of sediment in water.
3. list methods for preventing sediment from entering waterways.

### Materials:

*For each student group:*

- one clean jar with lid
- scissors
- rulers
- white paper
- clear tape
- 50 ml of soil (from schoolyard)
- stirrer
- tap water
- graduated cylinder or measuring cup
- stopwatch or wristwatch with second hand

*For each student:*

- *Student Experiment Sheet*
- *Student Data Sheet*

**Estimated Time:** two 50-minute sessions

**Background Information:** *Water Pollution: Sediment*, p.109.

### Preparation:

1. For each jar cut a 2-inch wide strip of white paper the approximate height of the jar.
2. Divide each strip lengthwise into 3 zones of the same size and label the zones: "A" at the top, "B" in the center and "C" at the bottom.
3. Attach each strip to the jar vertically with the letters facing inward so that the students can look through the jar from one side and see the strip and its labels on the opposite side.

### Activity Procedure:

*Session One*

1. Define and discuss *sediment*, if you have not already done so in previous activities. Explain that when soil and other particles are eroded from the land, they are often carried into waterways.

## Water Pollution: Sediment

2. Distribute the *Student Experiment Sheet* and *Student Data Sheet* to each student. Explain how the sheets are to be used, and ensure that the students understand the experiment procedures.
3. Have students complete the “hypothesis” section of the *Student Experiment Sheet*. When they are done, ask students to share their predictions with the class.
4. Divide the class into groups of 3-4 and give each group the materials for the experiment (i.e. jar, soil, stirrer, measuring cup and stopwatch). Instruct students to perform the experiment procedures, and explain that each group member should complete his or her own Student Data Sheet (with help from group members).

### *Session Two*

1. Direct students to consult their completed *Student Data Sheets* and complete the “Conclusions” section of the *Student Experiment Sheet*.
2. When students have completed the *Student Experiment Sheet*, discuss the experiment, and ask students to share their results. Ask students to share their “Conclusions” from the *Student Experiment Sheet*. In addition, discuss the following questions:
  - What are some ways that people can help reduce the amount of sediment entering waterways?
  - What can we do to educate others in our school and community about the effects of sediment on the water quality and aquatic life of local waterways?

### **Assessment Opportunities:**

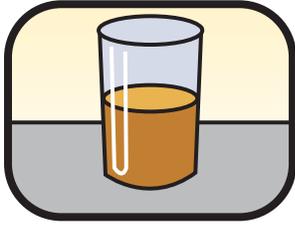
Have students:

1. summarize the effects of sediment on water quality
2. describe the behavior of sediment in water
3. list methods for preventing sediment from entering waterways

### **Extensions:**

1. Have students design experiments comparing how long various types or mixtures of soil remain in suspension, including different mixtures of clay, sand and organic debris. What conclusions can they draw from the results?
2. Have the class participate in the planting of a riparian buffer.

Adapted from **Lessons from the Bay**



**Muddying the Waters**  
**Student Experiment Sheet**

Name \_\_\_\_\_

**Question:** How does sediment affect water quality?

**Prediction:**

I predict the sediment will

- sink to the bottom.
- float on the top.
- completely dissolve.
- be suspended in the water.

I predict the sediment will

- not change the clarity of the water.
- change the clarity of the water. In what way?

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**Procedures:**

1. Fill your jar with 500ml of tap water.
2. Add 50 ml of soil.
3. Use your stirrer to mix the contents of the jar completely.
4. Put the lid back on the jar.
5. Shake the jar well.
6. After 1 minute, 5 minutes, and 10 minutes:
  - a. Observe the clarity of the water in each zone. Record the level of clarity (*clear*, *somewhat clear*, *somewhat cloudy*, *cloudy*, or *very cloudy*) on the data sheet.
  - b. Draw a detailed picture of the jar in the boxes on the data sheet.

**Conclusions:**

1. Were your predictions correct or incorrect? Explain.

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2. What actually happened? Did the sediment sink, float, dissolve, or suspend in the water? Describe what happened.

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3. How did time affect the clarity of the water in each zone?

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4. How do you think sediment might affect fish and other aquatic life? Will the impact be different depending on where the organisms live?

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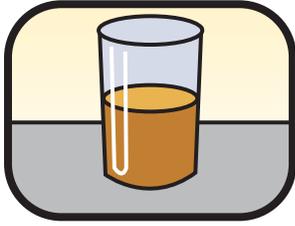
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5. Based on what you have observed, could sediment in the Bay eventually change it physically? If so, explain how.

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**Muddying the Waters**  
**Student Data Sheet**

Name \_\_\_\_\_

		<b>Zone A</b>	<b>Zone B</b>	<b>Zone C</b>
1 minute	Clarity			
	Picture			
5 minutes	Clarity			
	Picture			
10 minutes	Clarity			
	Picture			

## **Water Pollution: Sediment**

Sediment, small particles of soil and other materials, is one of the most damaging pollution of waterways and bodies of water such as the Chesapeake Bay. When stormwater runoff causes soil erosion, it carries sediment into the water. Natural erosion may be increased 4 to 8 times by agricultural development and 10 to 50 times by careless construction.

Sediment fills stream channels, harbors and reservoirs. When suspended in the water, sediment prevents sunlight from reaching underwater vegetation. Suspended sediment can also clog the gills of fish. And makes it harder for them to find food. As sediment settles to the bottom, it can smother the organisms that live there. It can also cover the rocks on the bottom of waterways, which is where many aquatic creatures lay their eggs.

Sediment can best be reduced by erosion-control measures. Hay bales and filter cloths can be used to keep exposed soil from reaching nearby waterways. Seeding and mulching can establish vegetation that will hold soil in place. Vegetated buffer zones along waterways filter sediment from runoff before it reaches the water.

## **Erosion: Rubbing the Earth the Wrong Way**

Students perform an experiment to determine how water volume and velocity affect soil erosion.

**Level(s):** 6-8

**Subject(s):** Life Science, Earth Science

**Virginia SOLs:** 6.5 c,g; 6.7 a,f; 6.9 a,c; LS4 a,b,c; PS1 b,k,m

### **Objectives:**

Students will be able to explain how

1. water volume and velocity affect the erosion of soil.
2. sediment in water affects aquatic organisms.
3. erosion can be prevented.

### **Materials:**

*For all students.*

1. Copies of the article *Water Pollution: Sediment*
2. Copies of the handout *Erosion: Student Data Sheet*
3. (optional) clipboards

*For each group*

1. enough sand or sandy soil to build a mound 2 feet high
2. enough clay soil to build a mound 2 feet high
3. eye dropper
4. graduated cylinder
5. step ladder (or other means of pouring water from a height of 6 feet)

**Estimated Time:** 50 minutes

**Background Information:** *Water Pollution: Sediment*, p.109.

**Preparation:** Arrange for materials and a suitable outdoor location

### **Activity Procedure:**

1. Have students discuss what they know of erosion and its effect on water quality.
2. Describe the experiment that you will be having the students perform. Ask them to predict what they think the results will be.
3. Divide the students into groups of 4 or 5.
4. Have each group build two mounds of soil – each 2 feet high – one from sandy soil and one from clay soil.
5. Drop 10 drops of water from an eye dropper from a height of one foot onto both mounds of soil. Have students observe and record any marks made by the water, taking notes on their data sheet.
6. Repeat the process from six feet.

## Water Pollution: Sediment

7. Pour 4 oz. of water onto each mound from one foot and then six feet, taking notes and sketching any changes to each mound.
8. Pour 16 oz. of water onto each mound from the two heights, recording the results.
9. Discuss and compare results back in class. Have students compare their results to their initial predictions. Ask students to suggest conclusions about soil erosion as it relates to type of soil and volume and velocity of rainfall, based on their observations.
10. Hand out *Water Pollution: Sediment* for homework or to read in class and discuss the article afterwards.

### **Assessment Opportunities:**

Ask students

1. What three factors account for the amount and rate of soil erosion?
2. What are three ways soil erosion can be controlled?
3. What are three ways in which sediment is harmful to aquatic organisms?

### **Extensions:**

1. Have students locate places around the school (or in their own neighborhood) where erosion has occurred. They should sketch the erosion and suggest ways the erosion at each location could be prevented. If digital cameras are available, have students take photographs.
2. Have students suggest ways that the previous experiment could be improved to make it more accurate or informative. (each test should use a dry mound, the rate at which water is poured should be standardized)

Adapted from **Action for a Cleaner Tomorrow**, pp.153-154.