Lesson: Land's Wonders and Worries: Pollution Solution

*Arlington Echo works to continuously improve our lessons. This lesson may be modified over the course of the school year.

Environmental Literacy Question: How have humans affected the Chesapeake Bay and its watershed?

Topic/Essential Question: How do weathering and erosion change the Earth?

Unit/Lesson Sequence: This lesson is one of two in the "Land's Wonders and Worries" module based at Arlington Echo Outdoor Education Center.

Content Standards:

- **Environmental Literacy**
  5.A.1. Analyze the effects on human activities on earth's natural processes.
  1. A.5.f. Make recommendations supported by data to help address or resolve the issue.
  8.F.1.b. Identify actions that can be taken as individuals and those that require the involvement of other people, organizations and government.
- **Science**
  MSDE 3.0 Life Science The student will use scientific skills and processes to explain the dynamic nature of living things, their interactions, and the results from the interactions that occur over time.
- **Social Studies**
  3.D.1.b Describe ways and reasons people in Maryland and the U.S. modify the natural environment and the consequences of modifications.

Length of Lesson:
Overnight program: 60 minutes
Day program: 45 minutes

Student Learning Outcome: The student will explain the impacts of runoff from different land uses and identify the best land surfaces for minimizing runoff.

Knowledge of the Learner:

- Prerequisite knowledge, skills and processes: runoff causes sedimentation problems in waterways. Students should be able to listen to instruction and follow directions.
- Student needs, interests and previous learning: These will be identified in the pre-assessment.
- Conceptual difficulties: relating pollution and sedimentation to ecological problems; building self-efficacy to help solve the problems
- Differentiated: Students are in 4th grade, with a diversity of backgrounds and skill levels. In this lesson, students will use a variety of learning styles. The auditory learner's needs will be met through the presentation, the kinesthetic learner will have the hands-on aspect with the models, and the visual learner will have the opportunity to see what happens to pollution as water runs over different surfaces. There is an opportunity for social learning by working in partners for each model and as a group for the whole lesson. Students that need more guidance can use the information on the back of the cards.

Knowledge of Content:

Students will be investigating how water flows over and through different surfaces. They will see the differences in the water that pours out of the models. Students will be following a simplified scientific method for discovery. Content knowledge for the activity leader is provided in lessons and supplements.

Vocabulary:

Characteristics	Habitat	Organism	Adaptation	Storm water
Watershed	Ecosystem	Runoff	Aquatic	

Resources and Materials:

Watershed Simulation Materials

Poly spots	Cones	Laminated pollution cards

Pollution Solution Materials:

Runoff model cheat sheets	Buckets (2)	Cups (12)
Chesapeake Bay watershed poster	Water	Pollution Solution felt board
Dead zone poster	Large erosion models	Watering can

Picture Sequences:

Hurricane Sediment in Bay	Step Pool Reconstruction	Sediment in Severn River

Runoff Models (2 liter bottle models) and Pollutants (dropper bottles):

Construction site- clay and excavator	Impervious surface/road- roof shingle and car
Forest- Leaves, sticks, dirt	Shoreline- sand with shells and beach grasses
Farm- bare topsoil with farm animals	Lawn- turf grass with teeter totter and slide
Pesticide- red food dye	Road Salt- baking soda
Animal waste- instant coffee	Fertilizer- green food dye
Oil and Gas- vegetable oil and instant coffee	

Supplements:

A. Background on Pollution
B. Hurricane Sediment in Bay sequence and picture of sediment in the Severn River
C. Step Pool Reconstruction sequence
D. Felt board poster
E. Watershed Simulation
F. Watershed Dance

Lesson Setup:

<u>Watershed Simulation:</u>

Create a large rectangle to represent the Chesapeake Bay watershed with cones on each “sideline” and poly spots for the starting (“raincloud”) and ending (“Chesapeake Bay”) lines. Use blue poly spots to create a “river” through the watershed.

<u>Models:</u>

Assemble the runoff models by inserting the 2-liter bottle with the simulated land surface into the bottle with the hole cut into the middle and a bag of stones in the base to weigh it down, at a downward angle. The cut-off top of the bottle should be turned upside down and placed in the top of the model to create a funnel. Place an empty cup under the spout of each model and a half-full cup of water next to it. Place the "Forest" model at the end of the table so it is the last demonstration.

Instructional Delivery

Engage:

Introduce yourself and the lesson. Ask students about storm water and watersheds to start a discussion about water movement.

Does anyone know what storm water is?

Any precipitation from a major storm event.

Can anyone tell me what a watershed is?

The area of land where all the rivers and streams flow into a body of water.

***Reinforce the concept of a watershed using the watershed dance. (**Supplement F**)

Visualization activity: Tell students to imagine the area where they are standing as it was 400 years ago. Were the buildings here? The road they drove in on? Was their school here? What was here instead? *Trees!* How about the river? Did it look brown and cloudy, or blue and clear? *Blue and clear*. Do the students think that the trees had anything to do with the river being so clear? *Yes!*

Explore:

1. **Watershed Simulation**
   i. Divide students into two groups, "trees" and "rain", and explain that they will help act out a living simulation of a watershed. They will start by acting out the watershed as it was 400 years ago, as they just discussed in their visualization activity.
   ii. "Trees" pick a spot in the rectangle representing the watershed. They may not stand on the blue dots representing the river. Explain that they will want to spread out to reach as many "rain" students as possible. Once they have chosen a spot, they are now rooted to the ground and may not move their feet. However, they may move their arms to tag "rain".
   iii. "Rain" lines up at the top of the rectangle. They will move through the watershed to the Chesapeake Bay. When they get tagged, they have to walk around the tree 3 times saying "slow it down, soak it in." They must stay in the bounds of the rectangle. Once tagged, they enter the "river" leading to the Chesapeake Bay and cannot be tagged again.
   iv. Before students begin to move through the watershed, ask them if being tagged is a good thing or a bad thing. Do we want the water to be slowed down? What happens if the water moves too fast?
   v. When the "rain" students finish, ask the students if they moved quickly or slowly. They moved slowly because there were a lot of trees in the watershed to tag them. The trees slowed down the water, and did something else. Ask students if they have seen a filter before, for example in a pool, in a Brita pitcher, in a fish tank, etc. What do those filters do to the water? They clean the water. Trees are natural filters, cleaning water as it passes through their roots.
   vi. Switch the groups. Have the "tree" students go to the starting line and have the "rain" students become the trees standing on either side of the river.
   vii. Place the pollution cards on the ground in front of the "rain" students. Ask the students to

listen carefully because the game has changed. We are now going to think about the last 400 years. In that time, what have we, as humans, done to change the environment in the Chesapeake Bay Watershed? Cut down trees, paved roads, built homes, schools and other buildings, added pollution like erosion, fertilizer and pet waste.

viii. Have most or all the "tree" students sit or kneel. They are now stumps and cannot tag "rain" students.

ix. Ask students what they see on the ground: the pollution cards. Rain picks up and carries pollutants, so as "rain" students move through the watershed, they will pick up the pollution cards.

x. Ask students if they could move fast or slowly on their way to the Bay. They could move fast because there were no trees to slow down and soak in the rain water. How does the water of the Bay look? Polluted, because most or all the raindrops picked up a pollutant.

xi. Collect the pollution cards and have students sit at the picnic tables for the next activity.

2. Chesapeake Bay Watershed

i. Have the students try to name the six states (Virginia, West Virginia, Maryland, Pennsylvania, Delaware, New York) and one large district (Washington DC) within the Chesapeake Bay Watershed. Once they have named all the states and district, have the students look at the watershed map of the Chesapeake Bay. Ask the students what kinds of pollution water can carry within our watershed.

ii. Discuss with the students about how our watershed covers a lot of different land types. Explain that water moving through a forest probably moves differently than water through a farm or parking lot. (**Supplement A**)

3. Runoff models:

i. Explain to students that these surfaces collect pollutants. Have students determine which pollutants occur at their model. To apply the pollutants, use a pipette to squirt liquid pollutants (2 pipettes full), or add a shake of the "salt" onto the surface **directly**. To use the pipette, squeeze the top, insert into bottle of pollutant, then release to fill the pipette. DO NOT POUR POLLUTION THROUGH THE FUNNEL TOP. Ask a student to apply each type of pollution.

ii. Have each group make a hypothesis about what will happen when it rains on their surface. Ask each group to place their card on the felt board to rank how polluted they think their water will be after it rains.

iii. Make sure that the students hold their empty cups below the mouth of the downward-facing bottle. Starting with the model closest to the end of the table, have the students make it rain by pouring the cup of water into the funnel-like top. Discuss the results, then move onto the next model and repeat. The forest model should be the last one tested.

iv. After the water has run through their model, students should analyze the water in their cups and share the results with the other students.

1. What does the water look like?
2. Is there evidence of pollutants?
3. Which cup has the clearest water?
4. Do they think their hypotheses on the felt board were accurate?

v. Collect all runoff into a bucket. Show the students that this is what the Chesapeake Bay looks like after a real rainstorm. In a watershed, all the water will lead to one place, and our "one place" is the Chesapeake Bay.

Explain:

4. Cedar Tree Root Demonstration:

i. To further reinforce the idea that trees and plants help slow down storm water and prevent pollution, especially sediment, from reaching bodies of water, show the students a potted Atlantic White Cedar. When removed from the pot, the tree's roots will take the soil with them, leaving an empty pot.

5. **Sedimentation Discussion (Supplement B):**
   i. **Construction pictures:** Together, look at the aerial photographs of silt in the Severn River from a construction site. Have the students figure out the point source of the sediment. Discuss the effects of sediment and sedimentation in the river, and work with the students to come up with management practices to reduce the effects of construction on the river.
   ii. **Hurricane pictures:** Together, look at the pre-and post-hurricane Irene pictures. Discuss the effects of sediment and sedimentation on the Bay, and work with students to come up with management practices to reduce the effects of runoff into the Chesapeake Bay.
6. **Erosion Discussion (Supplement C):**
   i. Share the image of an eroded outfall area. Explain where storm water comes from and where it goes.
   ii. Show students an image of the erosion effects of a poorly built outfall. Explain the effects erosion has on the land and its living things.
   iii. Show students the sequence of images of step pool construction. Explain how step pools work to create a natural environment that allows water to slow down and be soaked into the ground.
   iv. Show students the picture of the same step pools a few years later, planted with native plants by AACPS students.
7. **Large Erosion Model:**
   i. Bring students over to the large erosion model and have them identify the three different surfaces (sand/beach, step pools, and forest).
   ii. Students will test the effect of rain on the first two surfaces (sand and step pools) by pouring water on them with the watering can. Students will count to see how long it will take the water to flow down to the bin below.
   iii. Ask what is different about the third model, and if they think it will slow down water more or less than the first two. Test their hypothesis.
   iv. Talk about the importance of trees and their roots, the effects of erosion on the land and sediment caused by erosion in the water. Discuss the advantages of combining step pools and forests.
      1. What can we do to stop erosion?
8. **Step Pool Model (OVERNIGHT PROGRAM ONLY!)**
   i. Explain that students will be building their own miniature step pools based on the images and demonstration they have just seen, using the second large model. The two "hillsides" should be filled and leveled with sand.
   ii. Split students into two groups to work on their step pools.
   iii. Give each group an empty bucket, a bucket with rocks and gravel, and a small trowel. Students will use the empty bucket for any sand they remove from the bin, and will use the rocks and gravel to create their own step pools. Once they are finished, students may test their model using the watering can to see if they have slowed down the water.
9. **Algae Bloom Activity**:
   i. Have one student hold the Chesapeake Bay model and describe the contents of the bowl.
   ii. Have a second student hold the sun model (flashlight) pointed down toward the grasses in the Bay. Discuss the importance of sunlight in the photosynthesis process- plants use sunlight

to make their own food. Without sunlight, plants will die. Ask the students if sunlight can reach the plants in the model. Discuss the problem excess nutrients from sources such as pet waste, fertilizer, septic tank seepage, and sewage overflow has on the Bay, and how it causes algae blooms.

iii. Have a student float the algae bloom model in the bowl. Discuss what has happened to the sunlight, and how that affects the plants in the Bay along with the photosynthesis process.

iv. Have a student push the algae bloom model down into the grasses. Discuss what happens when the algae bloom dies. The decomposing organic material uses up dissolved oxygen from the water, causing dead zones.

v. Discuss dead zones using the poster of dead zones in the Chesapeake Bay. Discuss what we can do to prevent algae blooms from occurring in the Bay (use compost instead of fertilizer, fertilize less frequently, clean up pet waste).

Elaborate:

Show the students the Chesapeake Bay fish bowl with all the storm water with pollution. Ask them if they think it looks clean. Ask students what ways they think they can help prevent the Chesapeake Bay from looking like this, e.g. what they can do to help prevent erosion (plant trees, install a rain barrel, cover exposed sediment with mulch or rocks). Have them focus specifically on things around their houses, neighborhoods and schools.

Evaluate: Invite students to think about their homes and schools. What kinds of surfaces do they primarily see? Can they identify any places where pervious surfaces have been installed?

Notes for inclement weather:

Arlington Echo encourages keeping students outdoors whenever possible—even in the rain—but in the case of severe weather (thunder, extreme cold, etc.), the rain location for this activity will be under the overhang at the lower Resource Lab.

Notes for clean-up:

Please organize and return the lesson folder, with all the supplements, and the pollutants, to the tray. All models should be taken apart and put back in their pans. All the pans and the tray should be loaded onto the black cart. Once the black cart is loaded, the black cart and the easel should be taken back into the Resource lab. Remember to inform the Arlington Echo Staff if you need assistance or if any materials are damaged or missing.

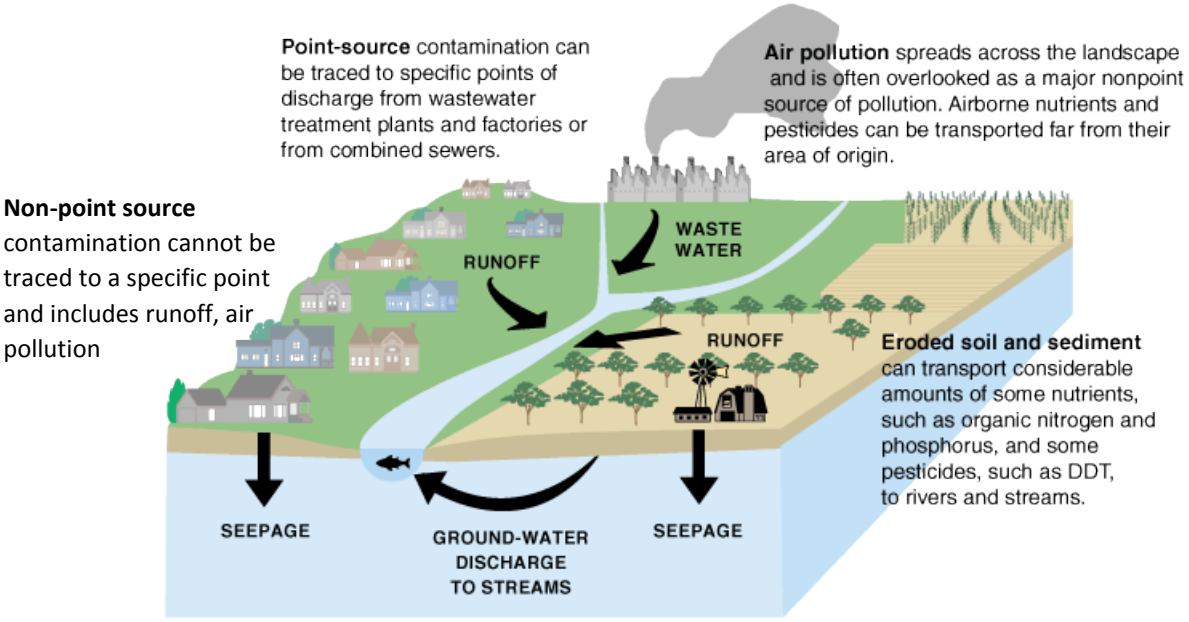
Supplement A: Background Information

Background Information for Activity Leaders

Pollution is the presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects. Pollution can be either point source or non-point source. Point source pollution is a pollution that has a localized identifiable source that is regulated by the government, e.g. chemical plant runoff, sewer system outfall, storm water outfall etc. Non-point source pollution is a pollution that does not have a localized identifiable source and is hard to be regulated by the government, e.g. road salt runoff, irrigation runoff from farms, car exhaust etc.

Pollution can be carried by storm water runoff during heavy rain and storm events. Pervious surfaces can infiltrate some of the polluted water where the trees and plants or man-made materials help to clean, cool, and hold the water so it does not overflow storm drains. These pervious areas include wetlands and forests, as well as some man-made surfaces like bio-retention areas, which allow water to infiltrate the soil quickly. Impervious surfaces, which are those that do not allow water to soak into the soil (or, allow it to soak in only very slowly) include roads, parking lots, construction sites, lawns, playing fields, or barren landscapes. If storm water flows over impervious surfaces, it does not infiltrate into the ground and can instead carry pollutants from the land directly into waterways.

Sources of contamination:



From the U.S. Geological Survey, http://ga.water.usgs.gov/edu/waterquality.html