Nature's Water Filter
Soil Infiltration Investigation

Objective

Students will be able to understand:

▪the difference between water cycling through an urban environment versus a natural environment.

▪that water is naturally filtered through particles in the soil.

▪that different sized soil particles have different infiltration rates.

▪that impervious surfaces contribute to pollution in our urban watershed.

Author:

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Time:

50 min. class period

Grade Level:

4-8

Standards:

AZ Science Strands and Concepts
Science as Inquiry, Science in Personal and Social Perspectives, Earth Science
NGSS-Core Ideas
Earth Materials and Systems, The role of Water in Earth›s Surface Processes
Human Impacts on Earth Systems

Specific AZ, Common Core, and NGSS Standards on page 3

Background:
The water on Earth has been here for millions of years and must be used over and over again. Thousands of years from now people will be using the same water that rains down on us, occupies our lakes and rivers, and runs through our faucets. How is the water that we pollute going to be clean enough for later generations to use?

Water is naturally filtered through layers of dirt, gravel, and sand. When the water travels through the layers it is cleaned. When rainfall lands on natural areas like forests, desserts, and wetlands, the water soaks into the ground. When it soaks into the ground it is cleaned through the layers of the soil (soil horizons).

However, in a city or town, much of the water lands on roofs or roads so it does not soak into the ground. From there the water flows into a gutter or drain and then into the local waterway. When it rains in the city, the rain water picks up pollutants from the ground, including but not limited to:

- Fertilizers
- Detergent
- Sediment
- Paint
- Motor Oil
- Pesticides
- Pet waste

These pollutants then get washed into the nearby streams (or washes), where they pollute the watershed.

Vocabulary:
infiltration - to pass into or through something

soil horizon - any of the series of distinctive layers found in a vertical cross section of any well-developed soil.

aquifer- any geological formation containing or conducting ground water, especially one that supplies the water for wells, springs, etc.

permeable/impermeable surfaces: the ability of water to pass through a surface, typically dependent on the porosity and connectivity of open space within the surface material

Advanced Preparation:
All particle sizes can be obtained from backyard soil and sifted into three categories, or they can be purchased from a hardware or gardening store.

Pre-measure approximate amounts of the soil, sand and gravel and provide them to students in separate plastic cups. Arrange the cups, spray bottle and funnels on a tray with paper towels for clean up.

Mix the glasses of dirty water by pouring approx. 1 teaspoon (5 mL) fine-grained soil into 1 cup (240 mL) tap water. Stir the mixture immediately before use. Break the students into groups of four or five.

Materials:

For each group:

- 1/4 c (60 mL) soil or silt
- 1/2 c (120 mL) sand or small gravel
- 1 c (240 mL) large gravel
- 3 large funnels
- 3 drainage beakers/cups
- 1 spray bottle with 1/2 c (120 mL) clean tap water
- 1 glass of dirty water
- 1 timer (or use classroom clock)
- Worksheet for each student

Recommended Procedure:

Engagement

1) Review concepts of water cycle, watershed and urban watersheds.

2) Introduce the idea of pervious versus impervious surfaces. Which kind of surface would they expect to see more of in an urban setting? In the natural environment? How does that impact water quality?

3) Show a glass of sludge water to the class (water mixed with dirt).

4) Ask the class if they would like to drink that water, why or why not? Ask the class to brainstorm how to clean the water.

Briefly introduce infiltration, soil horizon and soil particle size to help aid the problem solving/design process—more detail can be provided as follow-up to the activity.

Introduce scientific questions: What is the role of soil in a watershed?

Can soil help clean water?

Exploration:

5) Pass out a cup of dirty water for each group and the student worksheets. Ask students to rate the initial clarity of the water using the 1-5 scale.

6) Explain that the students will be given sand, small gravel, large gravel and 3 funnels. With these tools, in their teams of four or five, they must design a plan to clean the sludge water.

Show the students the funnels and the bag of sand. Ask them to think of what they could do to prevent the sand from going right through the funnel.

Note: If they do not understand what you are asking them, demonstrate. Hold the funnel over a bucket and poor the sand in. The sand will immediately drop through the bottom of the funnel. The students will need to put one large piece of gravel at the bottom of the funnel in order to prevent the sand from just washing through.

Explanation

7) Next, student groups will draw or describe three possible plans for filtering the sludge on the worksheet provided. Remind them to time infiltration and measure the total amount of water filtered for each design. Remind them that there is no right or wrong method. Their challenge is that they need to use all the components and try to get their water the cleanest. (Students may try to simply dilute the dirty water with the clean water in the spray bottle, emphasize that this is just for rinsing equipment and sediments.)

8) Once the student groups have agreed upon their plans, pass out the materials. Make a prediction about which design will be fastest and which will make the water cleanest. (Each group may test all three designs, or they may agree on one for the sake of time.)

9) After each group has finished, look at the resulting water. Which group has the cleanest water? Which group filtered the water in the quickest amount of time? What different methods were used? Why did some work better than others?

Elaboration

10) Review the concept of infiltration rates and how particle size impacts infiltration rates. Ask the students which of the three materials has the longest infiltration rate? [The smaller the particle, the less space is available for water to move around it. A mixture of sediments fills the pores and provides the most thorough filtering, which takes longer.]

11) Conclude by relating back to urban and natural environments. Students discovered that the combination

of particles with the longest infiltration rate filtered the water the best (produced the cleanest water). Now think about pavement, where there is zero infiltration. How does that impact water quality? Do they think there is a difference in the water quality between urban and natural environments? Is there anything that can be done to improve the water quality in urban environments?

Evaluation:
Students will participate in the group design and investigation. Students will complete the worksheet and questions.

Extensions:
- Journal activity—describe all the roles of soil in a watershed. … in an ecosystem. Illustrate with a drawing or diagram.
- Design a field investigation to observe what happens to a known volume of water when pored on various surface types (i.e. grass, sand, asphalt, concrete). Where does it flow? How long does it take to soak in or travel a measured distance?
- Introduce the concept of porous pavement. Why might porous pavement be more sustainable than the conventional pavement through which water can not infiltrate? Obtain a sample for students to observe or research the industrial development and uses of porous pavement on the internet.
- Based on initial observations from this lesson, establish a specific hypothesis about the relationship between particle size and infiltration rate. Design a replicated experiment to test the hypothesis in which students compare particle sizes in isolation or two different soil horizons they create.

Standards
AZ Science Standards
S1-C2-GR4-8-PO1
S1-C2-GR6-8-PO4, PO5
S1-C3-GR4-8-PO1
S1-C3-GR4-PO2
S3-C1-GR7-PO3
S3-C1-GR8-PO2
S3-C1-GR5-PO3
S3-C2-GR4-PO3
S3-C2-GR6-8-PO1, PO2, PO3
S6-C2-GR6-PO1
S6-C3-GR4-PO1

NGSS Core:
ESS2AEarth Materials and Systems,
ESS2C The role of Water in Earth›s Surface Processes
ESS3C Human Impacts on Earth Systems

NGSS Practices
Analyzing and Intrepreting Data
PLanning and Carrying Out Investigations
Constructing Explanations and Designing Sollutions

NGSS Crosscutting
Cause and Effect
Scale Proportion and Quantity

Common Core/Literacy
RST7: Integrate content from diverse formats
WHTS1: Write to support claims
WTS2: Write to convey ideas and information
SL1: Participate in collaborations and conversations
SL2: Integrate oral information
SL4: Present effectively to listeners

Common Core/Mathematics
Domains:
Number and Quantity
Measurement and Data

Student Worksheet
Soil Infiltration Investigation

Question: What is the role of soil in a watershed? Can soil help clean water?

Initial Observation: Water Clarity (circle one)

very dirty   somewhat dirty   slightly dirty   mostly clean   very clean

Challenge: Filter the dirty water suing gravel, sand and silt/soil. You will have three funnels and three cups to hold each funnel and catch the water after infiltration.

Design:

Funnel One-

Funnel Two-

Funnel Three-

Prediction: Which design do you think will filter water the fastest? Why?

Which design do you think will clean the water the best? Why?

End Results: Water Clarity (circle one)

very dirty   somewhat dirty   slightly dirty   mostly clean   very clean

Time to filter (in minutes): _____________

Water volume (ml) ______________

Conclusion (answer on back)

1) Which soil type or combination filtered water the best? Why?

2) Where would this water go next in a real watershed?

3) What does this tell you about urban watersheds?