The Dirt on Clean Water

4-H SCIENCE BLAST!

Educational Elements

Key Concept:
Soil as a water filtration system

Overview:
The Dirt on Clean Water lesson plan is designed to assist leaders in teaching participants to understand that soil acts as a filter to keep pollutants out of our water supply. Participants divide into small groups to create filters to demonstrate and observe various soils as they act as water filters.

Age Level:
Ages 5 to 15 (Activities may be altered to fit a wide age span.)

Life Skills:
Critical thinking, problem solving, wise use of resources, responsible citizenship

Success Indicators:
After completing this activity, participants will be able to:

- Identify the types of soil that best filter water.
- Use scientific process to determine the best type of soil for filtration.
- Be able to understand how pollutants affect the groundwater supply.
- Suggest ways to use soil as a natural filter in the outdoor environment.

Materials & Methods

Preparation Time: 15 minutes

Lesson Time: 45 minutes

Space: Classroom or outdoor space with tables

Materials:

- ❒ 3-ounce paper cups (one for each pair or group times the number of times they will filter water with different types of soil and soil combinations)
- ❒ 5-ounce paper cups (one for each pair or group times the number of times they will filter water with different types of soil and soil combinations)
- ❒ Toothpicks (one for each pair or group times the number of times they will filter water with different soil types and soil combinations)
- ❒ Play sand (dried completely, in an oven if necessary) (It takes about ½ cup of soil or combinations of soil for each experiment run.)
- ❒ Fine soil of one type or several different soil samples (dried completely, in an oven if necessary) (You can have participants bring soil samples from various sources such as their gardens or schoolyards.)
- ❒ Water or access to water
- ❒ Pitchers or water containers that can hold 1 quart of water (one for each pair or group)
- ❒ Grape or other flavored nonsweetened drink mix (or green, red, or yellow food coloring)
- ❒ “Floaties” (water contaminants such as small pieces of paper, dried grass clippings, small pieces of foam food containers, or other material)
- ❒ “Recording Your Observations” worksheet (one for each participant) (For younger participants, recording may be done as a group.)
- ❒ Writing utensils (one for each participant)

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Vocabulary:

- **aquifer –** Areas underground where groundwater exists in sufficient quantities to supply wells or springs.
- **contaminant –** A substance added to water that makes it unfit for use.
- **filtration –** A mechanical process that involves moving water through a material, usually sand, designed to catch and remove particles.
- **groundwater –** Water found under the ground, in aquifers and between soil particles.
- **infiltration –** The gradual downward flow of water from the surface into the soil.
- **nonpoint source (NPS) pollutants –** Sediment, organic, and inorganic chemicals, and biological, radiological, and other toxic substances originating from land use activities, which are carried to lakes and streams as surface runoff and cause pollution. Nonpoint source pollution occurs when the rate of materials entering these waterbodies exceeds natural levels.
- **pollutant –** Anything which alters the physical, chemical, or biological properties of water making it harmful or undesirable for use.
- **runoff –** Precipitation that flows overland to surface streams, rivers and lakes.

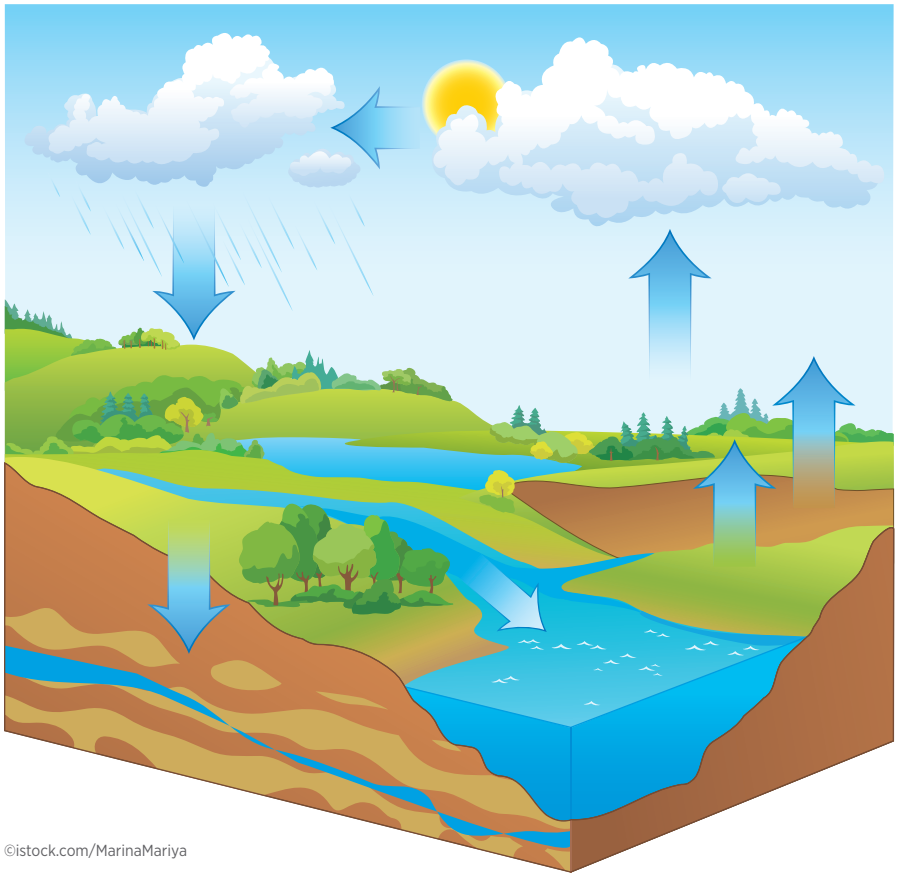
(Farrell-Poe, 1997)

Background Information:

Filtering water is one of soil's most important functions. Soil can naturally filter out pollutants, such as fertilizers, gasoline, leaks from sewer pipes, and harmful bacteria from water. Through this process of naturally filtering many harmful toxins, the water is then safe as it enters our groundwater supply.

Most of our drinking water comes from aquifers. These are underground water sources that are "tapped," which means wells are drilled through the soil and rock, and the water is pumped to the surface. Some communities store water in water towers once it is pumped up from the ground. People that do not live near a community water source drill private wells.

Gasoline, lawn care products, household cleaners, or other pollutants can contaminate the groundwater. These are known as nonpoint source pollutants, or NPS pollutants. These pollutants often enter the groundwater as runoff. Runoff usually happens when rainwater falls on impermeable surfaces such as roads, parking lots, or compacted soil. The runoff water picks up pollutants from these surfaces, and the pollutants enter the groundwater supply through rivers and streams. When water has the opportunity to move slowly through the soil, especially where there are plant roots, the toxins are filtered out of the water by binding to soil particles. The water is then naturally filtered and usable for drinking and other household purposes.



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Instructions:

Before the Meeting:

Review the lesson and gather any supplies you will need. Make copies of the "Recording Your Observations" worksheet – one per participant.

During the Meeting:

1. Introductory discussion:
   - a. *Where does our water come from?*
     - i. Faucet, well, city
   - b. *Is it important to have clean water?* (yes)
     - i. *Why?* (Living things get sick form dirty water.)
   - c. *How does water get dirty?* (As water flows across the land after a rain, it picks up contaminants from:
     - i. People who dump oil, gas, and other contaminants on their yards, driveways, and roads.
     - ii. The products we use to wash cars, bikes, and boats
     - iii. The products we use to keep our yards green.
     - iv. Animal waste from pets, farm animals, and other animals.)
   - d. *How do you think water gets clean?* (Answers will vary.)

2. (Read aloud or paraphrase the following):

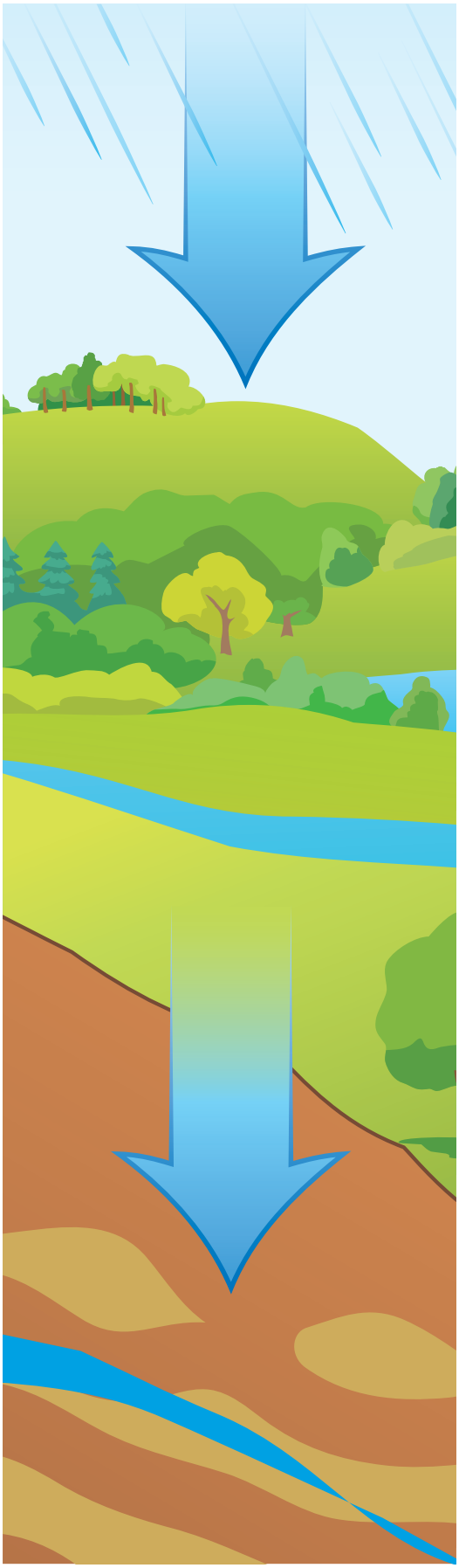
   The water on Earth has been here for millions of years and has been used over and over again. We use the same water as the dinosaurs used. Thousands of years from now people will be using the same water that rains down on us and that is in our lakes, streams, and home faucets.

   Water is naturally filtered through layers of dirt, sand, and gravel. When the water travels through the layers it is cleaned of "contaminants," or substances that pollute our water. These are also called "pollutants."

   To help understand how soil can filter out pollutants from our water, think about how a magnet works. What happens when you hold two magnets together? (Allow time for answers.) They stick together. This is called an attraction. Soil acts like a magnet. Most soils have a negative charge. Many contaminants in water have a positive charge. The soil works like a magnet to attract the contaminants. These contaminants get trapped in the soil or stuck to the soil particles as the water moves down through the soil.

   Today we are going to demonstrate how soil can filter out pollutants from our water. We are going to make water filters and to filter contaminated water through them.

3. Divide the participants in pairs or small groups. Hand out supplies to each pair or group, enough for each pair or group to make a filter(s). Hand out a writing utensil and a worksheet to each participant.



4. Demonstrate to the participants how to build a filter as you read aloud or paraphrase the steps for Experiment 1 below:
   a. *With the toothpick, punch a few holes in the bottom of a 5-ounce cup, and fill the cup 1/2 full of sand or other soil.* (They can also layer with different types of soils as well.)
   b. *Put the 5-ounce cup inside the 3-ounce cup.*
   c. *Put a toothpick between the cups vertically so air can escape from the bottom cup.*
   d. *Mix the packet of flavored drink mix in 1 quart of water.* (Do not add sugar.)
   e. *Add floaties to the flavored drink mix.*
   f. *Pour some of the mix into the top cup.*

5. Read aloud or paraphrase the following.

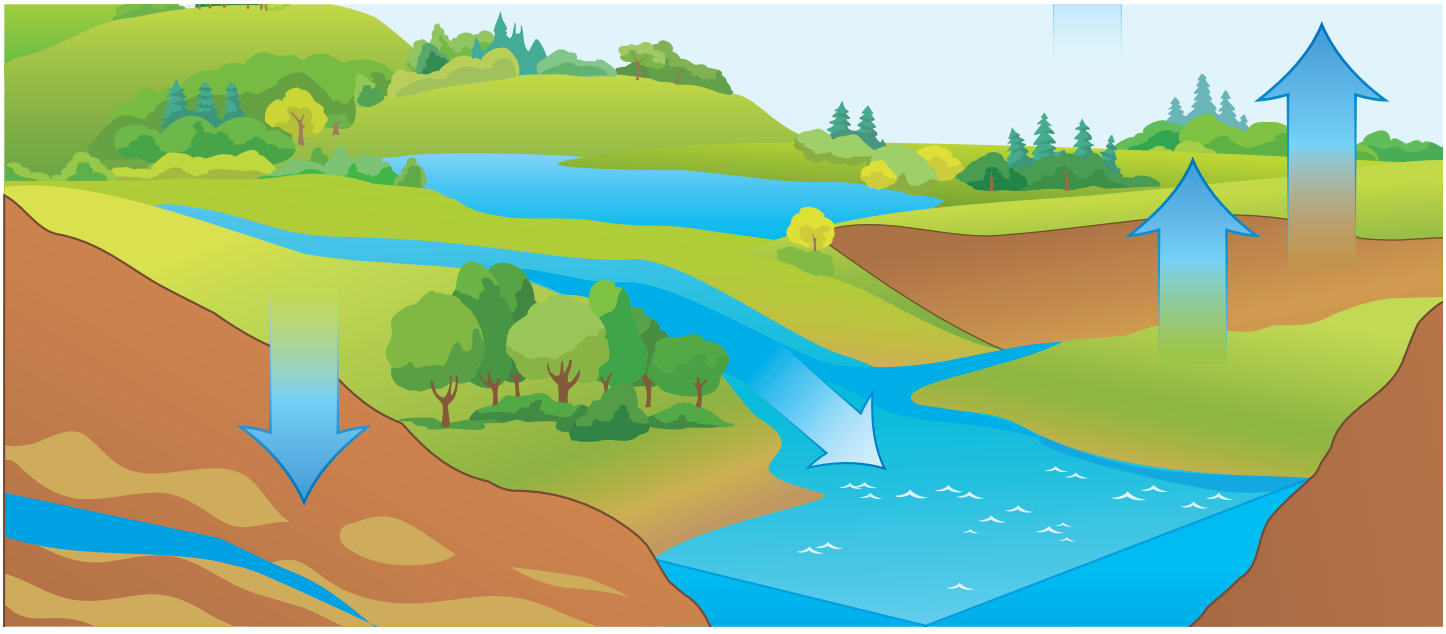
   Now it's time to observe what happened and record your observations. Look on your worksheet. In the first section, you'll see the following questions:

   - *What happened to the floating things in the water?* (They stay on top of the soil.)
   - *What color is the flavored drink that goes into the cup?* (It depends on what color is used.)
   - *What color is the water that collects in the bottom cup?* (It depends on the type of soil used for the filter.)

   Record your answers.

6. Participants should record their observations on the worksheet, using the questions as a guide. Allow some time for this.

7. After observations are recorded, ask participants to share their answers with the group.



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8. Continue on to Experiment 2. Participants can label the observation sheet with the type of soil they used. Examples: "½ sand, ½ loam," or where the soil came from, "school garden bed #3."

9. Read aloud or paraphrase the following:

   Next, we are going to add the soil of your choice to your filters. Follow along as I demonstrate these steps:

   a. *Put a ½-inch layer of sand in the bottom of the 5-ounce cup (with holes in the bottom).*
   b. *Put the 5-ounce cup into the 3-ounce cup.*
   c. *Put a toothpick vertically between the cups so air can escape from the bottom cup.*
   d. *Add the other soil until the cup is full.*
   e. *Pour some of the grape-flavored drink into the top cup.*

10. Read aloud or paraphrase the following.

    Now it's time to observe what happened and record your observations. Look on your worksheet. In the second section, you'll see the following questions:

    - *What color is the flavored drink that goes into the cup?* (It depends on what color is used.)
    - *What color is the water that collects in the bottom of the cup?* (It depends on the type of soil used for the filter.)
    - *Is the water in the bottom cup the same for both soils?* (It should not be the same color.)

    Record your answers.

11. Participants should record their observations on the worksheet, using the questions as a guide. Allow some time for this.

12. After observations are recorded, ask participants to share their answers with the group.

13. Read aloud or paraphrase the following.

    Now let's compare what happened by asking this question:

    - *Is the water in the bottom cup the same for both soils?* (Answers will vary.)

14. Participants should record their observations on the worksheet, using the question as a guide. Allow some time for this.

15. After observations are recorded, ask participants to share their answers with the group, Make sure that you stress the meaning of their results. (Answers will vary depending on the types of soils and amount used; however, the basic meaning is that soil is a natural filter for water. In general, the finer the soil, the slower the water moves through the soil, therefore filtering out more contaminants.)

Check for Understanding:

What did you notice? (Water moved faster through some soil than through others. Some soil filtered better than others.)

What type of soil filtered the water better? (Answers will vary.)

Why do you think some soils filtered better than others? (Soil particles were smaller and it took longer for the water to move through the soil. The smaller the size of the soil particles the slower the water moves through the soil, therefore filtering out more contaminants.)

Where does water go once it falls on the ground? (It goes into the groundwater supply.)

Where do the contaminants such as gas, oil, or pet waste go that mix into the water? (They go into the groundwater supply.)

What steps could be taken to avoid contamination of the groundwater? (We can be careful of the methods we use to dispose of contaminants. We should use pesticides and herbicides safely to eliminate excess going into the groundwater supply. We can also build rain gardens as filtering systems for runoff.)

Ways to Extend:

Investigate how water is filtered in countries in the world that have little or no access to clean water.

Alignment to Science and Engineering Practices

How does 4-H increase science literacy?

4-H has a long-standing reputation of engaging youth in experiential, inquiry, hands-on activities. These activities enhance formal (public school) science education through their alignment to the eight Science and Engineering Practices identified by the National Research Council on page 42 in their report *A Framework for K-12 Science Education* (*http://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts*). Alignment to the practices was determined by Tracy D'Augustino, Michigan State University Extension educator.

Alignment to the National Research Council Science and Engineering Practices

Science & Engineering Practice	Action	Activity Step Number
1. Asking questions and defining problems	Youth define the problem – decontaminate or clean the water. Youth discuss – ways to reduce contaminates.	(1) (Check for Understanding)
2. Developing and using models	Youth build and use a soil filter.	(4–12)
3. Planning and carrying out investigations	Youth test their filters – decontaminating the water.	(4–12)
4. Analyzing and interpreting data	Youth look at and discuss how the different soils cleaned the water.	(Check for Understanding)
5. Using mathematics and computational thinking	Youth show they understand basic fractions when filling the cups with soil.	(3 & 8)
6. Constructing explanations and designing solutions	Youth explain how well different types of soil filter the water.	(8)
7. Engaging in argument from evidence		
8. Obtaining, evaluating, and communicating information	Youth gathered evidence using the model and additional resources and determined which soils clean the water better, sharing that information.	(whole lesson)

References & Resources:

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Robinson, C. (n.d.). *Soil Is a filter*. (Dr. Dirt K-12 Teaching Resources). Madison, WI: Alliance of Crop, Soil, and Environmental Science Societies. Retrieved from http://www.doctordirt.org/teachingresources/soilfilter

Acknowledgments:

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This lesson is adapted with permission from "Soil Is a Filter" from the Dr. Dirt K-12 Teaching Resources, ACSESS: The Alliance of Crop, Soil, and Environmental Science Societies. Retrieved from http://www.doctordirt.org/teachingresources/soilfilter

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THE DIRT ON CLEAN WATER WORKSHEET:

Recording Your Observations

Experiment 1

Soil type or description (include particle size):

Observe the results and record your answers below each question.

- **Observe:** *What happened to the floating things in the water?*
  Record:

- **Observe:** *What color is the flavored drink that goes into the cup?*
  Record:

- **Observe:** *What color is the water that collects in the bottom cup?*
  Record:

Experiment 2

Soil type or description (include particle size):

Soil particle size compared to the soil in experiment 1 (smaller or larger?):

Observe the results and record your answers below each question.

- **Observe:** *What color is the flavored drink that goes into the cup?*
  Record:

- **Observe:** *What color is the water that collects in the bottom of the cup?*
  Record:

- **Compare:** *Is the water in the bottom cup the same for both soils?*
  Record: