Earth's Filter

Become an Environmental Engineer and solve a water-contamination problem

*Adapted version of the "Engineering a Model of the Earth as a Water Filter" From NSTA's Engineering Encounters

Objectives:

At the end of this activity, youth should be able to:

- Apply how layers of soil are used to filter and clean ground water
- Analyze various methods to engineer a water filtering system

Time to complete activity: 45 minutes

Skill level: Beginner to Intermediate (3rd through 6th grade)

Background/Setting the Stage:

Students will complete an activity to explore the work that environmental engineers do. They will design a filtration system that models the Earth's natural process to produce clean ground water by removing the particles from water. Students will determine the effectiveness of their filtration system by observing the clarity of the water before and after filtration.

The process of evaporations, condensation and precipitation is mostly used to describe the water cycle. However, this simple definition does not include one of the most important processes, infiltrations. In the water cycle, water infiltrates or enter through penetrable surfaces such as soils. The process of water infiltration of soil is vital for human survival because as water filters through the soil layers, it cleans and stores the groundwater. The Earth is a natural water filtering system. As rain falls on to the Earth's surface, it seeps into the ground. Different soil types varies in soil particle size and supports different vegetation. These differences in soil particles sizes and vegetation influences infiltration rates. Water is able to infiltrate soil due to soil pores, which are air pockets found between soil particles. Water filters through all the layers of soil: humus (organic debris/vegetation), topsoil, subsoil (made up of various about of sand, clay, silk, and larger particles such as gravel) creating a macropore filtration system and collecting once it hits the impermeable bedrock storing the ground water. This area of stored ground water is called an aquifer and is an important resource for human drinking water. About half of all the drinking water in the United States comes from groundwater (EPA 2016).

Materials:

Lists of materials per group (Groups of 3-4)

1. (4) 12 oz plastic cups
2. (4) Pushpins (To make holes in the bottom of cups)
3. (2) Coffee filters
4. Handful of cotton balls
5. (2) Plastic spoons
6. Small sandwich bag of sand
7. Small sandwich bag of gravel
8. (Optional) Small sandwich bag of crushed charcoal
9. (4) Rubber bands
10. (Optional) 100 mL Graduated cylinder

11. 1 pitcher of dirty water (water mixed with dirt and other debris)

Methods

1. Have materials spread out on a table, show the students the pitcher of dirty water, and ask them to descript what they think about it.
2. Explain that it is their job to design and build their own system to clean this water.
3. Before they get started, ask them to think about other inventions that were inspired by nature. Have them share their thoughts.
4. Ask, is there a natural process that filters water you could look to help you build your filter?
5. Ask, participants where the water in their house come from?
6. Explain that water found in wells come from groundwater. That Earth has its own way of filtering water by allowing water to infiltration down through its layers of soil.
7. Show a diagram of the soil layers and describe them: **https://www.asec.purdue.edu/soilhealth/soil-basics.html**
8. Allow participants to gather their materials and ask them to align them with the layers of soil to develop their own model of how the Earth filters water.
9. Afterwards, have all group go around to see each other's models to see the different designs and how effective they were in "cleaning" the water.
10. Explain, even though the water looks clean, there are much smaller things we cannot see that could still be in this water; such as bacteria or other chemicals. Therefore, it is not safe for us to drink here because it could make you sick. Our filters were able to filter out some of the large particles we could see, but to remove what we cannot would require additional processing, such as boiling to kill any harmful organisms.

Reflection Questions (Journal or Discussion)

- What methods/systems worked the best for removing sediment? What didn't work?
- Do spills happen in the real world?
- When contaminants move in groundwater, what are some things that might cause them to move in one direction versus another?
- How did your model align to how Earth filters water?

Supplemental Information:

Indiana 4-H Soil and Water Science manuals: https://www.edustore.purdue.edu/item.asp?Item_Number=4-H-1027-W

Vocabulary:

Aquafer- a body of water found underground

Containment- The presence of a substance that has potentially harmful effects

Groundwater- Water held underground in pores of soil and crevices in rocks

Impermeable- a solid that does not allow water to move through it or infiltrate it

Infiltration- the ability of water to be absorbed into a solid surface

Permeability- the ability of water to move through a solid