3. Infiltration Investigation

Anticipated timeframe: 1 class period

3 Pilot	Actual numb class periods

LESSON OVERVIEW

In this lesson students will learn about infiltration, head outdoors to observe a demonstration of an infiltration pit, and record some notes.

KEY CONCEPTS AND PRACTICES

1. Infiltration

KEY VOCABULARY

1. **Infiltration:** when water sinks in from the land surface into the soil.
2. **Infiltration rate:** the rate at which water infiltrates soil, expressed as a depth over time, often inches per hour
3. **Surface water:** water above the surface of the land, including lakes, rivers, streams, ponds, floodwater, and runoff.
4. **Groundwater**: water stored in the ground; the saturated zone where all of the [pores,] cracks and spaces between rock particles are saturated with water. *This water is still moving, being pulled by gravity, though sometimes very slowly. It is part of the water cycle. Groundwater is "recharged" when water infiltrates, raising the level of groundwater (also called the water table). Without groundwater recharge, the level of groundwater generally continues to drop as water leaves the system by seeping into surface water or oceans, or being withdrawn through wells.*
5. **Water table:** indicates the level below which soil and rock are saturated with water; the top of the saturation zone.

Some definitions taken from http://www.groundwater.org/get-informed/basics/glossary.html#item4033365

MATERIALS AND PREPARATION

FOR TEACHER

- Whiteboard/PowerPoint
- Internet connection and monitor or projector on which students can watch and hear streaming video
- Three clear plastic cups with a hole in the bottom
- Various substrates (soil, sand, gravel)
- Container of water
- Empty container to catch water
- Note taking graphic key
- Shovel
- Jug of water
- Toothpick or nail
- Ruler or tape measure

- Stopwatch

FOR EACH INDIVIDUAL
- Journal/Notebook
- Lab packet
- Water Cycle image from previous lesson
- Blank note taking graphic

BACKGROUND

The video in this lesson shows how to dig an infiltration pit for the purpose of preparing to build a rain garden. A rain garden is one of many options students have available to them when they do their engineering design solutions, though their possibilities are endless, so it is important that they do not get rain-garden-tunnel-vision. For a PDF of a PowerPoint with information about the need for, function of, and building of rain gardens, visit: http://water.epa.gov/learn/training/wacademy/upload/raingardens_dec10_2slides-2.pdf
A resource you might make available to students, "Follow a Drop Through the Water Cycle" as review or to learn more about possibilities we are not focusing on: http://ga.water.usgs.gov/edu/followadrip.html More information on groundwater: http://ga.water.usgs.gov/edu/earthgw.html and http://www.groundwater.org/get-informed/basics/groundwater.html

#	Misconception or alternate conception	Correct conception
6	Groundwater is water held in underground rivers or caverns	Groundwater is just water in the soil/substrate – below the water table the soil/substrate is saturated, but water is suspended between and around soil/substrate particles and from there it seeps down due to gravity (and pressure)

LESSON DETAILS

INTRODUCTION - DEMONSTRATION

1. In view of the document camera, or in another visible-to-students location, set up the three cups with a hole at the bottom, each filled with a different substrate (likely soil, sand, and gravel)
   a. Ask students to predict what will happen if you pour water on each one
   b. Ask students if there will be differences between the cups, and if so, which will drain faster
   c. Pour a consistent amount water into each of the cups, starting the timer – options include:
      i. Pour and time the samples one at a time
      ii. With student help, pour all at once and use one timer
      iii. On your own pour them one after another, waiting 10 seconds between pours so that you will be able to calculate the correct length of time

d. Record the times for each sample, ideally in a table to role model good habits of science (3.1)
    i. Note: students may notice that the amount of water that drains from the samples is not necessarily equivalent – unfortunately we do not have time to discuss the properties of water
e. Ask students why they think there were differences in time
    i. Hopefully get at pore space (no need to use the term) – the idea that water fits between the particles, and that gravel has the largest spaces, followed by sand, making it easier for water to find a path down into the cup, and drain out (3.2)
        1. Reiterate that gravity is what pulls the water downward
    ii. Explain that what you demonstrated was **infiltration**, and that with the known volume of water and time it took to drain, you are able to calculate the **infiltration rate** for that material in that set up by dividing the volume by the time (3.2)

ACTIVITY

1. Tell students that they are going to see infiltration in action
2. Watch the video http://vimeo.com/47118692 starting at the 1:54 mark and play until the 3:03 mark (trimmed to avoid confusion about what/why rain gardens)
3. Get ready to head outside to dig an infiltration pit, calculate infiltration rates – be sure to take shovels, toothpicks, stopwatch, tape measure and water
4. Head outside as a class to model the infiltration activity
    i. Find an area that is close enough to get to quickly and out of the way of footpaths or other sensitive areas
    ii. Dig a hole one shovel-head deep, keeping the soil and turf in one clump like a cork to be easily replaced into the ground
    iii. Pour water into a pit as shown in the video; (3.2) provides a materials list and procedure for students to follow later on
        1. Fill about half full
        2. Mark the high water line with a toothpick
        3. Start the timer
        4. Let students know you will be coming back in about 30 minutes to see how it has changed
            a. Keep in mind that one inch in 30 minutes is not necessarily equivalent to two inches in an hour as rates change as soils saturate
5. Head back inside
6. Have students get out their water cycle graphics
7. Pass out note taking graphic – we will focus on the left side, so fold it so that showing is the entire left side and the middle/creek area; the rest will be filled in during the next lesson

8. Using the water cycle graphic, begin by looking at the cloud, reviewing information from weather unit getting at precipitation [underlined words have a place for students to record them on their note taking graphic]
9. Begin by labeling the source, the precipitation
10. Why does rain fall down rather than float up? Gravity
11. Ask if anyone knows the fancy word for water soaking into soil – **infiltration**
12. There are a few things that could happen to water that lands on the soil
    a. It could land on the ground and evaporate back into the air – point out on water cycle graphic [near creek]
    b. It could be used by trees and other plants and return to the air via transpiration – point out on water cycle graphic [tree]
    c. It can infiltrate by sinking in and recharge **groundwater** – point out on water cycle graphic [drop dissolving into ground cross section]
        i. From there it could get stored as groundwater, raising the water table – point out on water cycle graphic [line beneath the tree]
        ii. Explain that the groundwater is saturated soil, held in the tiny spaces between soil particles, NOT in the often misconceived underground caverns or rivers [misconception #6], despite the somewhat misleading image on the water cycle graphic [this will be reinforced by a box in the bottom left]
        iii. Gravity causes groundwater seep[s] slowly into surface water, i.e. streams, creeks, rivers, lakes, etc. – point out on water cycle graphic [arrow to the left of "creek", and "creek"]
        iv. The creek constantly continues on to the lake, in our local watershed
            1. The idea that groundwater is constantly feeding the creek as the creek flows away is a difficult concept. For lack of an adequate and reasonable visual demo, ask students to picture digging a hole at the beach – ask a student to share what happens when you dig a deep hole in the sand near the ocean
                a. You get to the point where the bottom of the pit keeps filling with water faster than you can bail it out
                b. This happens because you have dug deep enough to have passed from the unsaturated sand to the saturated sand, or the **water table**
                c. When you make that pit, the sides and bottom of the pit, which are saturated (soaked), keep seeping water into the

hole, leveling out the water table – essentially creating a well (drier sand is higher in elevation than wetter sand, so it makes sense that you would need to dig deeper to get to the water table)

d. The same thing happens in a creek, etc. – as water flows away, groundwater from the banks seeps in to replace it

FOLLOW UP

1. Head back outside to the infiltration pit and demonstrate how to record the depth of how far the water had infiltrated
2. Show students how to carefully-to-avoid-splashes return the plug to its home and pat it into place
3. Ask students to think about reasons a person would want to either know their infiltration rate or have a good infiltration rate
4. Return to the classroom and pack up

TEACHING SUGGESTIONS

ACTIVITY: If required by building policy, remember to call the office and let them know where you will be so that they can locate you and your students if needed.