Name: _____ Date: _____

CHALLENGE! 22.1

22.1 Groundwater and Wells Project

READ CPO Science

When it rains, some of the water that falls on Earth seeps into the ground, while some water flows over the surface into local streams or lakes. Some water is absorbed by plants and some evaporates back into the atmosphere. The water that seeps into the ground flows downward, moving through empty spaces between soil, sand, or rocks. It continues its journey until it reaches rock through which it cannot easily move. Then, it starts to fill the spaces between the rock and soil above. The top of this wedge of water is called the *water table*.

The water that fills the empty spaces is called *groundwater*. Areas that groundwater easily moves through are called *aquifers*. *Aquitards* are bodies of rock where water can move through—but very slowly. If the aquitard does not allow any water to pass, it is called an *aquiclude*. Groundwater comes from precipitation (rain and snow melt), from lakes or rivers that leak water, and even from extra water not used by agricultural crops when they are irrigated.

Groundwater is a very important source of drinking water. According to the US Geological Survey, 51% of Americans get their drinking water from groundwater. 99% of the rural population in the US uses groundwater for drinking. 37% of agricultural water, which is mostly used for irrigation comes from groundwater. Groundwater is obtained by digging wells. The water fills the well underground and a pump inside pumps it up to the surface where it travels through pipes to bring it to our homes and businesses.

This project will help you learn more about groundwater movement and wells.

Materials:

• GeoBox	• ½”to ¾” white stone; rounded is better (approximately 1,800 mL total)	• ¼” plastic foam; one piece 7 ¾” x 13 ¾”; second piece 7 ¾” x 9"	• Caulk or plumbers putty (something that can be molded around the PVC wells for waterproofing)
• Plastic wrap	• Food dye - dark colors	• 8-10 cotton swabs	• Tape
• Wooden skewer or dowel with diameter less than ½”	• 3 wells (½” inside diameter PVC pipe with caps; 4 well holes near cap drilled with 13/64 drill bit)	• Watering can or beaker	

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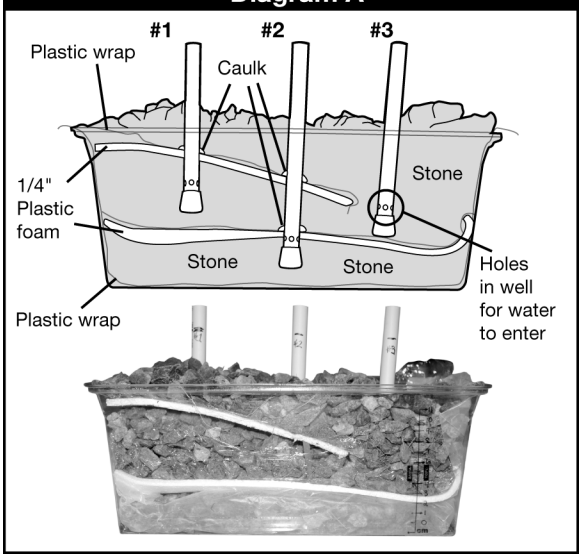
Constructing the model:

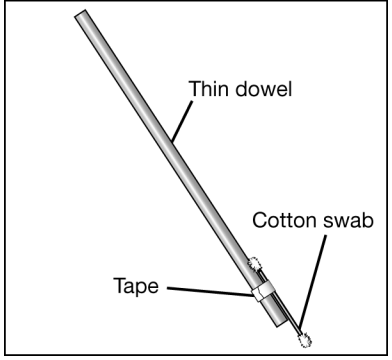
1. Line the inside of the GeoBox with plastic wrap so that it comes up and over the edges of the box.
2. Hold well #2 in the middle of the GeoBox, with the cap end sitting directly on the bottom of the GeoBox. Add approximately 1,800 mL of the rock, surrounding the well. The rock should just cover the holes of the well and the well should stand on its own.
3. The larger plastic foam sheet will be layered next on top of the rock. In order to put it down, carefully poke the well through it so it fits over the well. Now place on top of it the plastic wrap that will come up and over the edges. Because you need to also make a hole in the plastic wrap through which to fit the well, use the caulk or putty to mold around the well and onto the plastic wrap to keep it water proof.
4. Once this is set, hold well #3 in place on the right side (diagram A) and add approximately 2,000 mL of stone down on the surface, so that it surrounds well #3 and holds it upright.
5. Now add approximately 1,300 mL of stone to the left side of the GeoBox to create a diagonal plane of stone that runs highest from the left edge to level just right of well #2.
6. Place well #1 in the built up area of stone on the left side of the GeoBox, just above, but not touching the first plastic foam layer (as well #3 is). Make sure that the stone is covering the holes in the well.
7. Place the smaller plastic foam sheet over well #1 and well #2, again poking holes in the plastic foam so that the sheet can sit on the rock layers below. This sheet will be slanted down towards the middle.

Diagram A



8. Again you will cover just the sheet with plastic wrap which will come up and over the edge on three sides. Caulk the two wells that poke through this sheet.
9. Use the remaining 3,000 mL of stone to fill the tray up to the top so that what is visible is just stone and three well tops. See photo at right.
10. Tape one cotton swab to the end of the skewer or wooden rod so that the cotton swab reaches out from the end of the wood. See diagram B at right.
11. Dye the water that you will be using for precipitation a dark color, such as blue, red, or green.

Diagram B



Making predictions:

a. Which well/s would you expect to collect water when it rains?

b. If contamination entered from the surface, what well would you expect to first show contaminated water?

c. Will well #2 get contaminated from surface contamination? Why?

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Testing the model:

1. Watch the water flow closely as you do this experiment.
2. Sprinkle or pour the dyed water into the top layer of rock to simulate precipitation, without allowing the water to precipitate into the wells. The dye will make it easier to see the water as it travels.
3. Regularly check the wells with the cotton swab/dowel rods to see if water has entered the wells. In this way, you can also see which well collected water the quickest.
4. For a demonstration of the movement of surface pollution—dye water another color and allow this contaminated water to percolate through the layers. Use new cotton swabs attached to the wooden rods to visualize if and when the wells will get contaminated. The cotton swab should change color as the two dyes mix.

Thinking about what you observed:

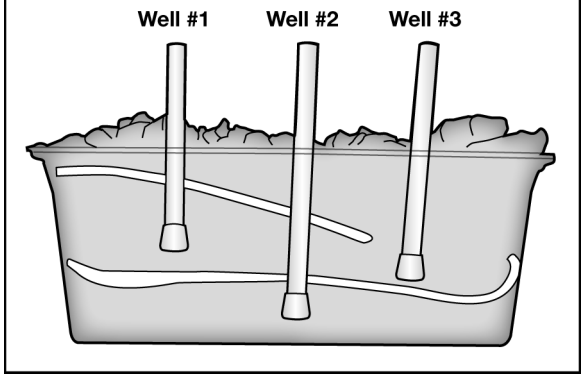
a. Which wells collected water when it rained? Was your hypothesis correct?

b. Which well was first to be contaminated? Was your hypothesis correct?

c. What does the plastic wrap/plastic foam layer represent? Label diagram C appropriately.

d. What do the rock layers represent? Label diagram C appropriately.

Diagram C



e. Did well #2 get contaminated from surface contamination? Why? Was your hypothesis correct?

f. What effect would pumping from well #1 have on movement of surface contamination? Pumping from well #2?

g. What would happen if there was a dry spell and the water table and thus the groundwater was lowered to below well #1? Would any well be able to pump water?

h. If well #3 were located near the coast, what effect might pumping freshwater too quickly have on the water in the well?

i. When you dig a well, how might you decide how deep to dig it?