

9/18/09

Rain Drop Journey

Activity Description

This demonstration shows students how water moves through a small model aquifer and flows into a well. It shows that water moves quickly through the pores between the sand and gravel. An aquifer can be easily contaminated by pollution that spills on the surface of the ground.

Take Home Message

It only takes a tiny amount of pollution to contaminate a lot of drinking water and a long time to remove it.

Massachusetts Frameworks

Earth Science

Earth Material #1 and #4

Supplies

- Plastic specimen bags, filled with two inches of filtered pool sand for each student
- A pipette for each student
- Plastic cups, one cup for dirty and one for clean water per every 2-3 students (label the outsides of the cups so they don't get them mixed up)
- **Packets of unsweetened grape kool-aid <<<<<DO NOT ACCEPT SUBSTITUTES>>>>>**
- a pipette (with the tip cut at an angle) to dispense the powder
- One pitcher filled with water to top off clean cups
- Bucket for all dirty water after each demonstration
- Twist ties
- Dry sponge and bucket
- Plastic tray for filled baggies
- Bucket of filter sand* SEE NOTE ON FILTER SAND and funnel
- TARP UNDER THE TABLE. TAPE IT DOWN CAREFULLY WITH DUCK TAPE.

Set-Up

Before the start of each festival, you should fill as many specimen bags as the number of students expected. First, fold down the top of each bag about 1" to make a collar before filling. Using the funnel will speed up the job of getting the sand (about 2 ") in the bag. Place the filled baggies together in the plastic tray. Set up the table so that you have the clean and dirty cups next to each other, a pair for each student if possible (or they can share), have pipettes and filled baggies on the side. Have a bucket and dry sponge ready. Place a packet of koolaide with the top opened in a clean dry cup. Have the tip of a pipette cut lengthwise to use as a scoop. Have a filled pitcher of clean water, and pail to empty dirty water nearby on the floor.



Activity Procedure/Script

Introduce yourself and ask their names.

- **Ask the kids what an aquifer is**, if they know, good, otherwise explain. If anyone has done edible aquifer, ask them what they remember.
 - An *aquifer* is the sand and gravel underground that is saturated with water. It supplies the drinking water to people here on Cape Cod. The water gets into the aquifer from rain. The water table makes up the upper boundary of the aquifer and bedrock or sometimes salt-water make up the lower boundary. The water in the aquifer is called groundwater.
- **Demonstrate the concept of saturation with a sponge.**
 - The dry sponge has pores in it, and the pores are filled with air. This is just like the spaces between each grain of sand and gravel underneath the ground.
 - Place the sponge in a pail of water and squeeze. The pores fill up with water instead of air.
 - When groundwater is saturated, the spaces between the grains of sand become filled with water (groundwater).
 - Remind the students, this is where our drinking water comes from and its called an aquifer
- **Tell them they are going to create an aquifer today**
 - Give them a baggie of sand and pipette.
 - Explain that the bag of sand is just like the sandy soil that we have on Cape Cod. Have them pretend that the surface of the sand in the bag is like the students backyard, a very, very dry backyard.
 - Tell them that they must take very good care of their backyard, and to hold the bag very carefully, and not to squeeze it or they will cause an earthquake.
- **Ask students if they can know how to use a pipette.** Practice sucking up and ejecting water from a pipette. Do this several times till everyone is good at using the pipette.
- **Tell the students that the pipette is first going to be a rain cloud.** Remind the students that all of our water supply comes from the rain.
- **Have them start to rain (put water on the sand). Ask the students to observe the side of the baggie and describe what is happening.** Talk about the term percolate.
 - Percolate is the downward movement of water through porous materials. The rain travels down into the sand and it becomes groundwater. Have them describe how it fills up the air spaces between the sand grains, just like the sponge demonstration. The bag will start to fill up, from the bottom. This is just like the aquifer, the water table starts out below the land surface, and as it rains more, the water table rises. The area in the baggie that is full of water is called the saturated zone.
 - Have them keep raining, and fill the aquifer (the water table rises) till there is water above the sand. Have them stop filling the aquifer and observe the water.
- **Ask what this looks like in the real world.** Lakes and ponds work the same way as this water above the sand. The top of the saturated zone is the top of the water table. So when you look at a pond or lake you are looking at the top of the local water table.
- **Ask, “ Do you know how we get water out of the ground to use for drinking, cooking washing, etc?”** Next ask the kids if they know what a well is? The pipette is now going to be a well, We need to have wells to extract groundwater from the ground.
 - Squeeze the pipette bulb shut. Push the tip into the sand as far down as possible and let go of the bulb on the pipette. The water will be sucked up from the bottom. Explain, how that is the way that a well work. It pulls up water (groundwater) from the ground. When the bulb is full, remove the pipette from the bag and eject the water.
 - Have the students try pumping the “well”.

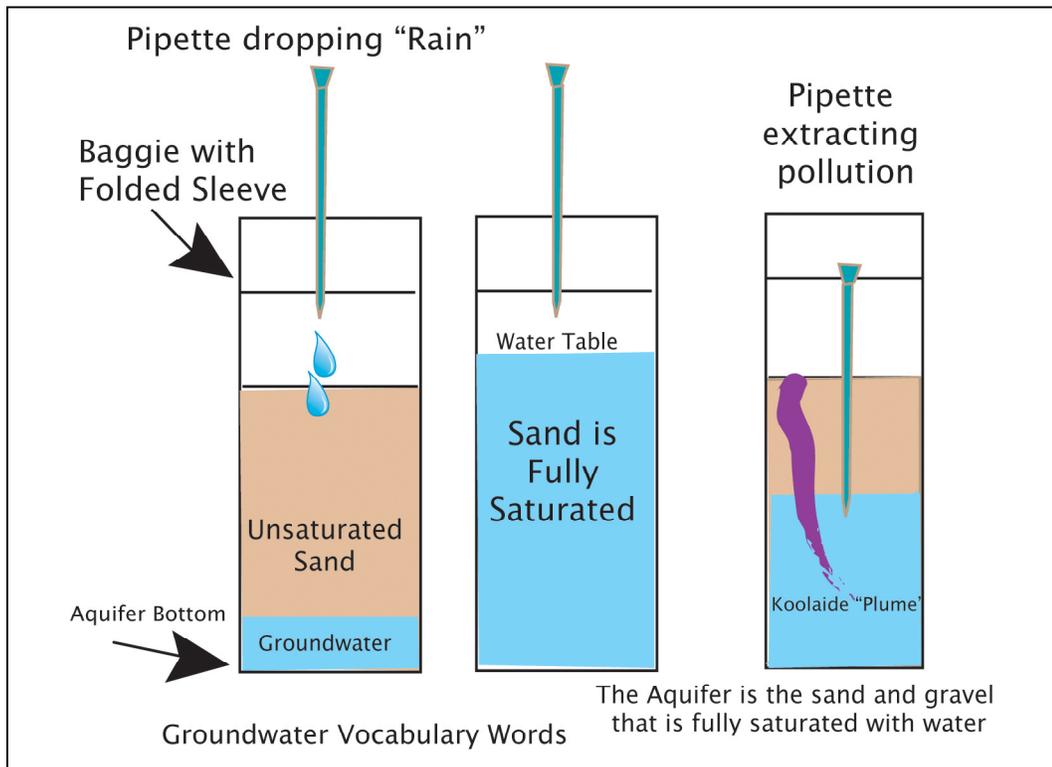
- **Now ask them, what would happen if it didn't rain for a long time?** You are looking for any of the following: the water table would get lower, the sand would get dry or the well will run out of water.
 - Now have them pretend there is a drought, and have them get as much water as possible from the sand. (This is one time its ok to put the tip of the pipette into the corners of the baggie to get all of the water out. The have them tap the bottom of the bags just a little to even out the sand and fill in the holes...
 - Remind the students that anytime they remove water or pump it out, they should put it into the "dirty water" cup...this keeps things easier as the demonstration continues.

- Once the students have pumped out all the water, **ask if they know what a contaminant is.**
 - A contaminant is an unnaturally occurring substance that affects the quality of the water in the aquifer. An example would be motor oil.
- **Ask the students if they can think of any other contaminants?**
 - Some examples the students may give could include fertilizer, chemicals, gasoline, etc.

- Now you will put a small amount of kool-aid which represents a contaminant on the ground. Use the tip of the pipette to sprinkle a tiny amount- just a few grains, onto the top of the damp sand.
 - Have the student rain on the contaminant very slowly and gently and have them observe what is happening. The contaminant is carried through the sand by transport of water.
 - Explain to the students that the area of the contamination is called a "plume" of contamination because it sort of looks like a long feather.
 - Once they have put several pipettes of water on the aquifer have them insert the pipette and pump out water. The students will see that contamination has gotten into their wells.

- **Ask what they see after each pump. Eventually they will get purple in the pipette. Ask if they would like to drink the contaminant Ask the students what they think will happen to the plume overtime?**
 - Have the students continue to alternate between raining and pumping until they can see what may happen to a plume over time.
 - The students should see that the plume gets bigger, turns the whole aquifer purple, and moves up the well.
 - Remind the students that if it was left to mother nature, it would take 100's of years to clean up water contaminated by a plume, but today, engineers can help with the clean up through advanced systems.

- **Challenge the students to see who can be the best engineer.**
 - See what student can best clean up their plume by simply raining and pumping.
 - To compare, you can look at the coloring before and after a round of pumping and raining. It also helps if you hold the pipette up to a white background to detect lighter shades of purple. It's pretty rare to have a student actually be successful at this.
 - Once the students have given up or time is almost up, have the students pull out as much water as possible and then stick the pipette back in the sand. Wrap the baggie around the pipette and tie it off with a twist tie. (The aquifer "to-go" is the prize in this activity)
 - Tell the students they can continue at home if they didn't get rid of their whole plume.



- **To wrap up, ask the students to compare the plume in their “backyards” to those caused by the Massachusetts Military Reservation here on the Cape.**
 - Or you can talk about other famous places where groundwater has been contaminated by underground movement.
 - Remind the students about an aquifer, water table, and plumes.

Clean-Up

During the festival

- Make sure the kids tie their pouches tightly.
- Clean-up all water and sand spilled after each student.
- Keep making up new baggies if you didn't get enough filled in the morning

After the festival

- Dump all water out
- Clean up all Kool-aid and pipettes. If it will be a while before the next festival, throw out partially used packages of kool-aid, moisture will ruin it.
- Tie off unused sand in baggies if any are left for use in the next festival
- Dry everything and pack up the materials.
- Make sure to check your inventory list and always warn the supervisor if you are low on pipettes or baggies, these take several weeks to order.

***NOTE: FILTER SAND IS HARD TO GET OUT OF SEASON. PURCHASE IT IN THE SPRING FOR THE FOLLOWING YEAR AT A POOL SUPPLY STORE OR A HARDWARE STORE. PLAYGROUND SAND WILL NOT WORK AND CANNOT BE SUBSTITUTED FOR FILTER SAND.**