Name: ___________________________________ **Period:** ___________

Where Does the Water Go?
Hydrogeology Model Experiment

Purpose/Objective: Students will learn how groundcover influences surface runoff and groundwater recharge and how pollution travels through creeks, streams, and aquifers. Students will identify potential sources of pollution and learn what they can do as individuals to help keep their water clean.

Materials:

- Maps of Texas Geology, Tectonics, and Aquifers: www.beg.utexas.edu/UTopia/resources.html
- Hydrogeology Models that show how groundcover influences surface runoff and groundwater recharge. For information about how to build or obtain a model, contact Jessica Gordon at jdgordon@mail.utexas.edu
- Red food coloring
- For each model you will need:
  - Three clear 266 mL plastic cups (write "runoff" on one, write "recharge" on another, and poke seven holes in the bottom of the third to model rain)
  - One liter (1000 mL) of water
  - Graduated cylinder or measuring cups that can measure 250 mL of water (as part of the activity, students can calibrate the clear plastic cups so they can see how much runoff and recharge there is without having to pour the water in another container)

Engagement Activity: In small groups look at maps of Texas (Aquifers, Geology, and Tectonics) and discuss patterns that you notice. What do the maps tell you about where you live?

What natural resource(s) does your town have that encouraged people to establish a town in this location?

Background Information on the Importance of Groundwater Resources: Water is an essential resource for all living things. Half of the drinking water for United States comes from **groundwater** (water stored underground in cracks and spaces in soil and rocks). An **aquifer** is a geologic formation made of a layer of rock that has large pockets of water and has openings that water can pass through. Water can enter an aquifer through faults, fractures, sinkholes, or through the soil in a process called **recharge**. How we live on our **watershed** (the area of land that drains into a body of water) can impact water quantity and quality. It is important to maintain the quantity and quality of groundwater in aquifers in order to be able to continue to use this resource.

Hydrogeology Model Experiment:
The Effect of Groundcover on Surface Runoff and Groundwater Recharge

For this lab, hydrogeology models have been built to demonstrate how concrete, soil, non-native grass, and native plants influence surface runoff and groundwater recharge. Discuss the features of the different groundcovers. Hypothesize what would happen if each groundcover received the same amount of rain. Before beginning the experiment, identify the research question, the variables, and your hypothesis.

Research Question: ____

____

Independent variable (what you will be changing): _________________________

Type of Groundcover	**Represents**
Concrete	
Soil	
Grass	
Native Plants	

Dependent variables (what will respond to the change): _____________________

Controlled variables (what must remain the same/be held constant): ____________

____

Hypothesis: ____

____

____

____

What materials will you use to test your hypothesis? _______________________

____

This experiment can either be performed as a demonstration with students taking turns "raining" on the models (four at a time: one for each model) for four trials or students can work in small groups rotating through stations and sharing their data with the class (for example, group A can do trial 1 for concrete, trial 2 for soil, etc., and the class as a whole can share data to complete the chart). For each trial, have students pour 250 milliliters (mL) of water slowly and evenly over each groundcover. Another student should be assigned to make sure the runoff and recharge containers are in the right place and have a pencil or another poking device handy in case the surface runoff drainage for soil becomes clogged. Students should document the results in the following chart.

	Concrete		**Soil**		**Grass**		**Native Plants**	
	Runoff	**Recharge**	**Runoff**	**Recharge**	**Runoff**	**Recharge**	**Runoff**	**Recharge**
Trial 1								
Trial 2	+	+	+	+	+	+	+	+
Trial 3	+	+	+	+	+	+	+	+
Trial 4	+	+	+	+	+	+	+	+
Total	=	=	=	=	=	=	=	=

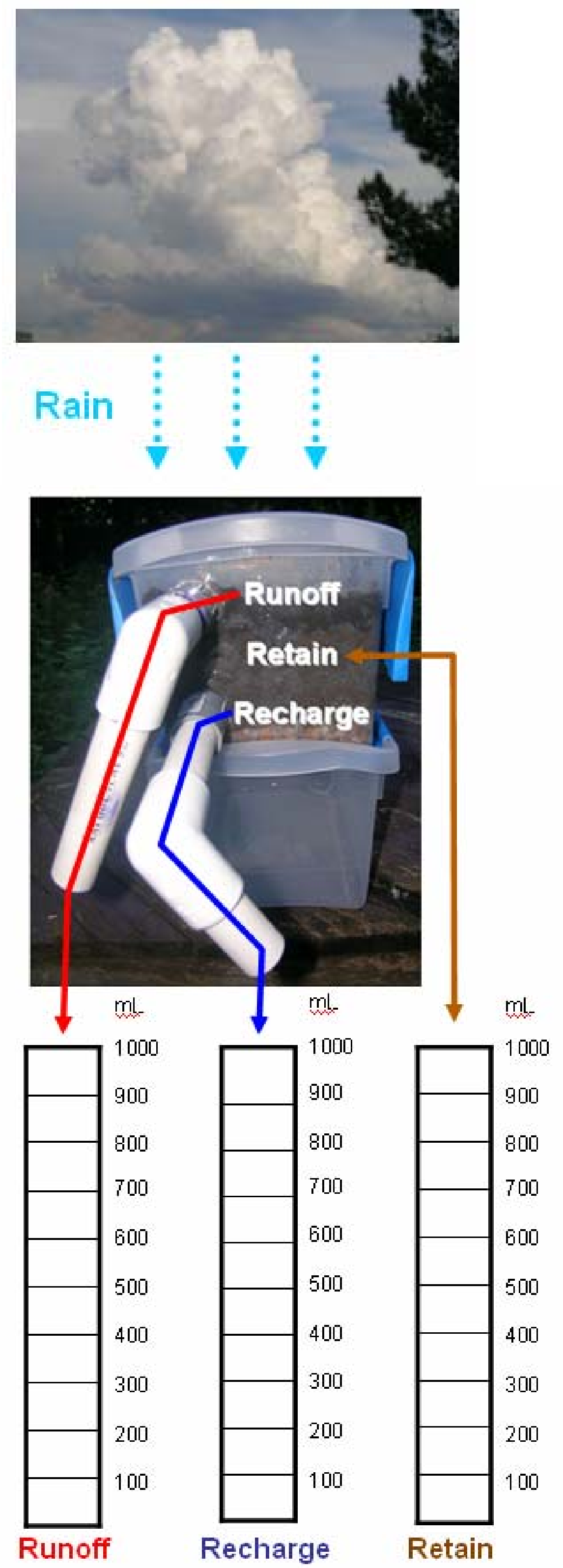
You may notice that the amount of runoff and recharge may not be equal to the amount of "rain" that was poured on the models. Where did the water go? It may have been **retained** (held) within the soil. In the following charts, calculate the amount of water retained by adding the amount of runoff and recharge, then subtract the total runoff + recharge from the total amount of "rain" (1000 mL).

	Concrete	**Soil**	**Grass**	**Native Plants**
Total Runoff				
Total Recharge	+	+	+	+
Total Runoff + Recharge	=	=	=	=

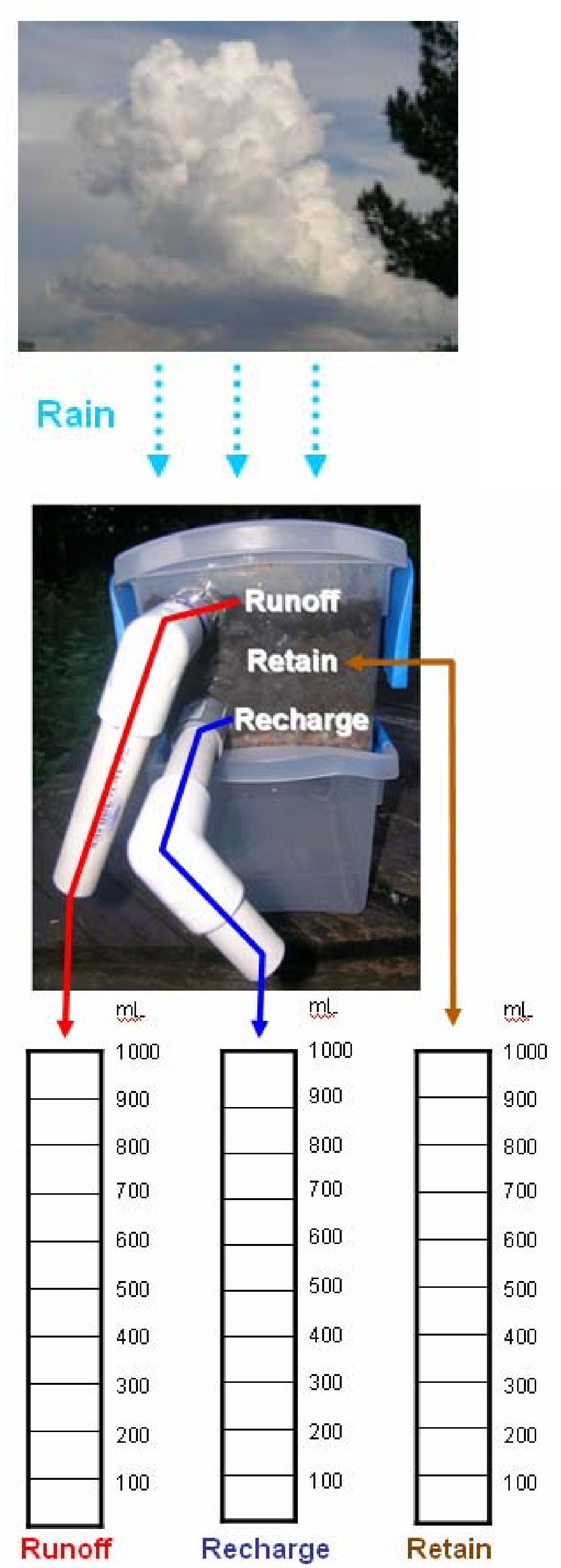
	Concrete	**Soil**	**Grass**	**Native Plants**
Total Amount of "Rain"	1000 mL	1000 mL	1000 mL	1000 mL
Total Runoff + Recharge	-	-	-	-
Total Amount of Water Retained	=	=	=	=

On the following pages graph the results for the total amount of runoff, recharge, and water retained for each groundcover.

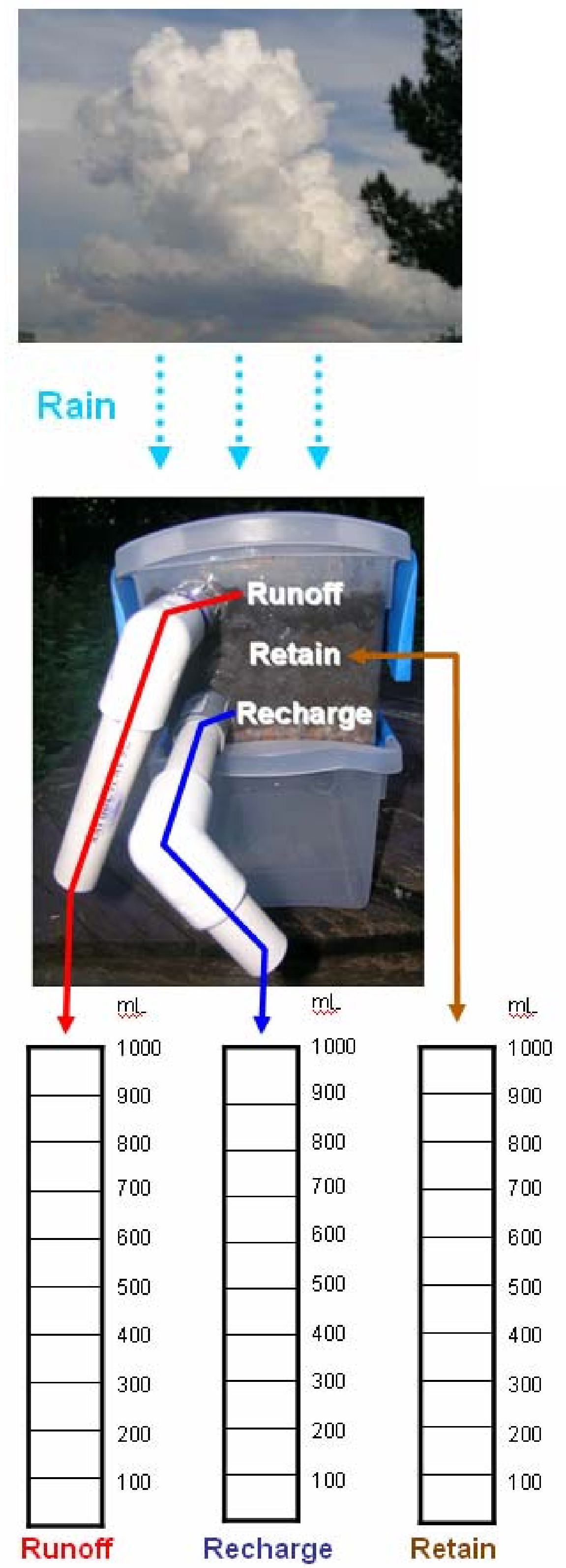
Type of Groundcover: Concrete



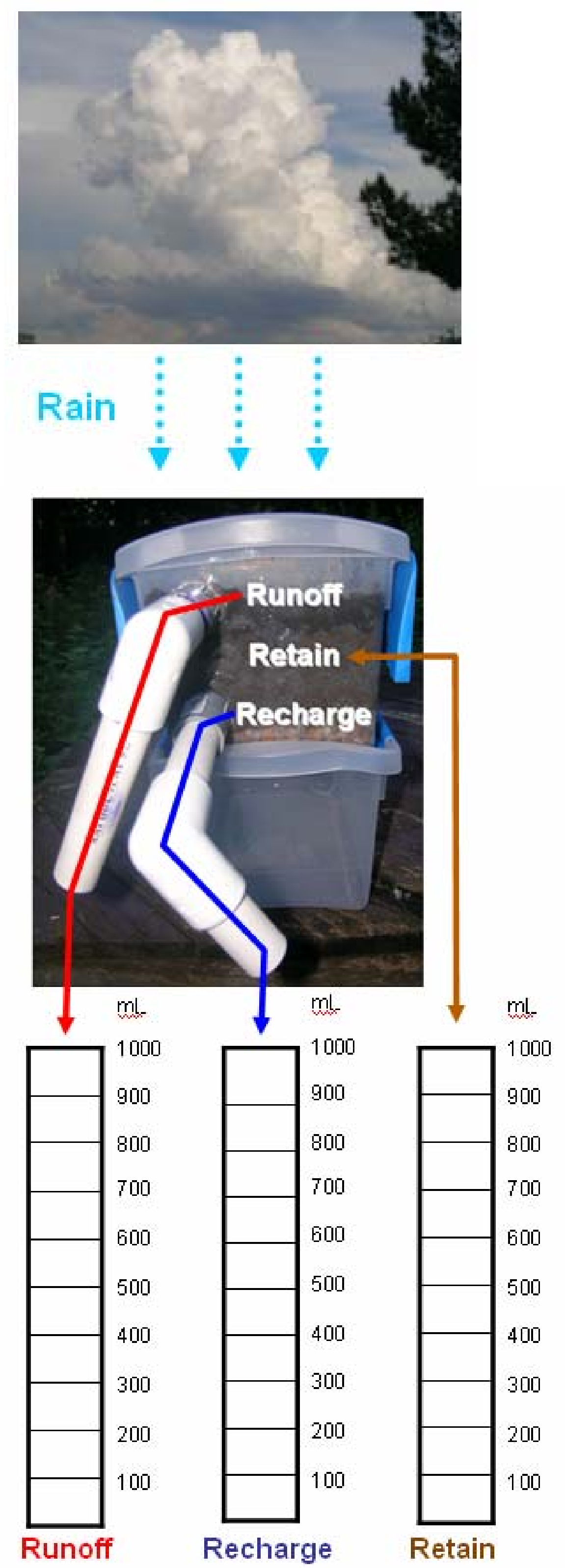
Type of Groundcover: Soil



Type of Groundcover: Grass



Type of Groundcover: Native Plants



Conclusions (1. Restate the research question; 2. What did you learn? Which ground cover had the most recharge? Which one had the most runoff? Which one retained the most water? Provide important data from your charts (such as amount of runoff) as supporting evidence; 3. State any problems that you encountered). Be prepared to present your findings.

What is the importance of doing multiple trials?

Do you think that four trials were enough or should more trials be conducted? Why?

We have examined how groundcover influences surface water runoff and groundwater recharge, but how do our actions affect water quality? What are potential sources of pollution for each groundcover?

Type of Groundcover	Type of Pollution	Potential Sources of Pollution
Concrete		
Soil		
Grass		
Native Plants		

Students can add one to four drops of red food coloring to each groundcover to represent pollution before "raining" on the model. The amount of pollution can either be held constant to test if the four groundcovers filter the pollution differently, or the amount can vary depending on how much pollution is expected on each type of groundcover (one drop where the least pollution is expected to four drops where the most pollution is expected). Then, other students can "rain" on the model. Document observations in the following chart.

Type of Groundcover	Runoff	Recharge
Concrete		
Soil		
Grass		
Native Plants		

Describe what happened to the pollution. Provide examples of pollution and how it could enter the aquifer.

Has this activity changed the way you think about surface runoff, groundwater recharge, and how decisions you make can influence water quantity and quality? If so, how?

What is the most interesting thing that you learned? Did anything surprise you?

What are the benefits and limitations of this model?   What would you change to make the model better?

What can you do to help keep our creeks, rivers, and aquifers clean?

Extension Activities:

- Have students do an experiment of their choice keeping the type of groundcover constant, but changing the slope or amount or rate of rain.
- Experiment with additional groundcovers, including gravel, sand, mulch, and different types of soils and/or plants.
- Have students time how long it takes for recharge and runoff.
- Look at aerial photographs of your town and/or school. Identify the amount of different types of groundcover, potential sources of pollution, and what kind of impact each type of groundcover has on the water cycle. How has this changed overtime?
- Have students select one of the extension activities described above or design a different experiment that they would be interested in investigating. Ask them to identify their research question, the variables, their hypothesis, and materials and tools they would need to conduct the experiment. When appropriate, ask them to include illustrations and cite references.

Additional Resources:

Aerial Photographs: www.googlemaps.com

Aquifer Model in a Tank, An Earth Science Experiment:
www.beg.utexas.edu/education/aquitank/tank01.htm#purpose

Digital Library for Earth Science Education: www.dlese.org/library/index.jsp

Educational sites on groundwater and caves that includes videos, lesson plans, maps and graphics, games, and additional resources: www.esi.utexas.edu

The Edwards Aquifer website: www.edwardsaquifer.net/

Geologic Wonders of Texas: Maps of Texas Geology, Tectonics, Physiography, River Basins, Land Resources, Vegetation/Cover Types, Aquifers, Oil and Gas:
www.beg.utexas.edu/UTopia/resources.html

Online Workbook on *Water*, *Water Conservation & The Edwards Aquifer*:
www.eardc.txstate.edu/aquabook/wwcbook.htm

PowerPoint Presentation with slide notes on "The Edwards Aquifer: Will There Be Water For Texas?" by Dr. John M. Sharp: www.esi.utexas.edu/outreach/lectures.html

Virtual Tour of the Edwards Aquifer and El Paso:
www.beg.utexas.edu/education/advnvr/vrfrnt.htm

Webcast and PowerPoint Presentation with slide notes on "What's in the Water? The History and Future of Barton Springs" by Dr. Barbara Mahler:
www.esi.utexas.edu/outreach/lectures.html

Appendix. Correlations with the Texas Essential Knowledge and Skills (TEKS).

4th Grade TEKS

(1A) demonstrate safe practices during field and laboratory investigations;

(1B) make wise choices in the use and conservation of resources and the disposal or recycling of materials;

(2A) plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology;

(2B) collect information by observing and measuring;

(2C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence;

(2D) communicate valid conclusions;

(2E) construct simple graphs, tables, maps, and charts to organize, examine, and evaluate information;

(3C) represent the natural world using models and identify their limitations;

(4A) collect and analyze information using tools including calculators, safety goggles, microscopes, cameras, sound recorders, computers, hand lenses, rulers, thermometers, meter sticks, timing devices, balances, and compasses;

(4B) demonstrate that repeated investigations may increase the reliability of results;

(5A) identify and describe the roles of some organisms in living systems such as plants in a schoolyard, and parts in nonliving systems such as a light bulb in a circuit;

(5B) predict and draw conclusions about what happens when part of a system is removed.

(10A) identify and observe effects of events that require time for changes to be noticeable including growth, erosion, dissolving, weathering, and flow; and

(11A) test properties of soils including texture, capacity to retain water, and ability to support life.