Mud in the Water

Grades 6-12

Science, Earth and Space Science, Environmental Science

Objectives

Students will learn about soil erosion and water pollution by building a demonstration model from soda bottles and observing the movement of materials representing pollutants from soil into water.

Vocabulary

erode— wearing away material from the earth's surface by natural processes
contour—following the natural lines of uneven terrain to limit erosion of topsoil
no-till farming—method of farming in which plowing is avoided by applying chemicals to eliminate weeds
runoff—rainfall not absorbed by soil
sedimentation—the buildup of material at the bottom of a stream or river
terrace—ridges of soil built across the slope to slow the runoff of water

Background

Thousands of years ago, people began to grow crops so they had more control over their food supply. Over the years, people discovered that some farming practices were harmful to the land. Cutting down the trees, clearing away vegetation and letting animals overgraze left topsoil unprotected so winds and water could erode it away. The **runoff** water washed topsoil and rocks into streams and rivers, causing **sedimentation**. The buildup of sediment at the bottom of a stream or river creates a muddy bottom. This extra mud changes the living environment for many fish and wildlife and can restrict water flow. **Runoff** nutrients and fertilizers carried with the soil can cause rapid algae and weed growth that may harm fish and other aquatic organisms.

Early farmers learned from their mistakes and developed better farming methods. They learned to farm on the **contour** and build **terraces**— ridges of soil built across the slope to slow the **runoff** of water.

When European settlers came to the New World, they were overwhelmed by what seemed like endless resources—acres and acres of rich soil never before used for farming. Many farmers abandoned the methods their ancestors had developed for protecting the land. When one field began to produce poor crops, the farmer would simply abandon it and move deeper into the wilderness.

As more people moved in, they began farming sloping lands that washed away easily and sandy soils that blew away. In the early 20th Century, farmers began plowing up the native grasses of the Southern Plains to plant wheat. Since that land had never before been plowed, farmers had no way of knowing that their hard work would set off what we now know as the Dust Bowl. A severe drought dried up the exposed soil. With no grass roots to hold the sandy soil in place, it simply blew away with the strong summer winds.

Once farmers saw what had happened, they began thinking of different farming methods they could use that would protect the soil. One method involved using chemicals on weeds instead of turning the soil with a plow. This method, called no-till farming, keeps vegetation in place while allowing farmers to produce the food people need.

Additional reading

Bigelow, D.P. and Borchers, A., *Major Uses of Land in the United States*, U.S. Department of Agriculture, Economic Research Service, 2017

Egan, Timothy, *The Worst Hard Time: The Untold Story of Those Who Survived the Great American Dust Bowl*; Mariner Books, 2006

Freedgood, Julia, Hunter, Mitch, Dempsey, Jennifer, Sorenson, Ann, *Farms Under Threat: The State of the States*, American Farmland Trust, 2020

Low, Ann Marie, *Dust Bowl Diary*, University of Nebraska Press, 1984

Parker, Laura, *Parched: A New Dust Bowl Forms in the Heartland*, National Geographic, May 17, 2014

Spangler, Kaitlyn, Burchfield, Emily, Schumacher, Britta, *Past and Current Dynamics of U.S. Agricultural Land Use and Policy*, Frontiers in Sustainable Food Systems, July 21, 2020

Websites

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https://www.nass.usda.gov/Publications/Todays_Reports/reports/fnlo0419.pdf
https://farmland.org/project/Farms-Under-Threat/
https://www.frontiersin.org/articles/10.3389/fsufs.2020.00098/full
https://www.sare.org/wp-content/uploads/2019-2020-National-Cover-Crop-Survey.pdf
https://mccartyfamilyfarms.com/wp-content/uploads/2018/11/EP-MFF-Executive-Summary-2017-Final_Updated-11-12-18.pdf

Activity 1: Erosion Model, (Science, Earth and Space Science, Environmental Science)

1 50 minute class period

Students will learn how improved farming methods conserve and improve soil. They will observe a demonstration, then conduct their own experiments to show how various crops and covers help prevent erosion.

Oklahoma Academic Standards

Activity 1: Erosion Model (Science, Earth and Space Science, Environmental Science)

6.ESS2.2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
7.ESS3.3	Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.
8.LS1.5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
ES.ESS2.5 EN.ESS2.5	Plan and conduct investigations of how the structure and resulting properties of water interact with the Earth's materials and surface processes.
ES.ESS3.5	Construct a scientific explanation from evidence for how geological processes cause uneven distribution of natural resources.
EN.LS2.7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

Materials:

- Activity 1 Reading Page 1 **"Preventing Soil Erosion"**
- Activity 1 Worksheet 1 **"Preventing Erosion"**
- Activity 1 Worksheet 2 "**Compare Results"**
- four 2-liter plastic soda bottles
- 1 bottle cap
- permanent marker
- topsoil (do not use commercial topsoil from the garden store - it contains pigments that will darken the water and distort results during the experiment)
- sand
- mulch (grass clippings, shredded leaves, shredded newspaper, wood chips, etc.) or sod
- fine glitter
- water
- measuring cups
- razor knife
- scissors
- push pin or ice pick (or hammer and small nail)

Procedures

1. Build an erosion model ahead of time for demonstration purposes, using the instructions included with this lesson.
2. Read and discuss background and vocabulary.
   —Write the word “erosion” on the chalkboard.
   —Students will discuss the definition of the term.
   —What causes erosion?
   —What problems can erosion cause?
   —Where have students seen examples of erosion in your community?
   —How can erosion be avoided?
3. Have students read Activity 1 Reading Page 1 **“Preventing Soil Erosion”**. Discuss how human activity and poor land management helped to create the Dust Bowl in the 1930’s.
4. Students will complete Activity 1 Worksheet 1 **“Preventing Erosion”**, after reading and discussion.
5. Show students the erosion model you have built ahead of time.
   —Follow the instructions to demonstrate the effect of erosion on the soil and on the water.
   —Repeat the demonstration, using soil with some kind of mulch on the surface or mixed in.
   —Students will note the difference in the clarity of the catch water.
   —To show how fertilizers and pesticides reach our groundwater and drinking water, add fine glitter to the soil tray.
6. Students will complete Activity 1 Worksheet 2 **“Compare Results”** and discuss answers in small groups.
7. Ask each student to bring one 2-liter plastic bottle to class.
   —Divide the class into groups of four.
   —Provide each group with a copy of the instructions for constructing the erosion model.
   —Each group will conduct one of the experiments suggested in the instructions.
   —Students will keep records so they can report observations to the class.
8. Students will locate examples of erosion in your community and photograph them.
   —As a class or in groups, students will discuss what might have caused the erosion in the photos.
   —Students will discuss what steps might be taken to prevent further erosion.
   —What might happen to the surrounding buildings, etc., if the erosion is not controlled?
9. Students will plant different kinds of seed (grass, wheat, radishes, lettuce, etc.) in the soil trays of their erosion models.
   —When the seeds have sprouted and the soil in the trays is covered with vegetation, students will test the different plants for their ability to hold the soil and protect the water.

Ag in Your Community: Invite someone from your local NRCS or Soil Conservation District to talk to your class about soil conservation methods used locally to protect the soil. Your OSU Extension Office can help you locate these resources if you need help.

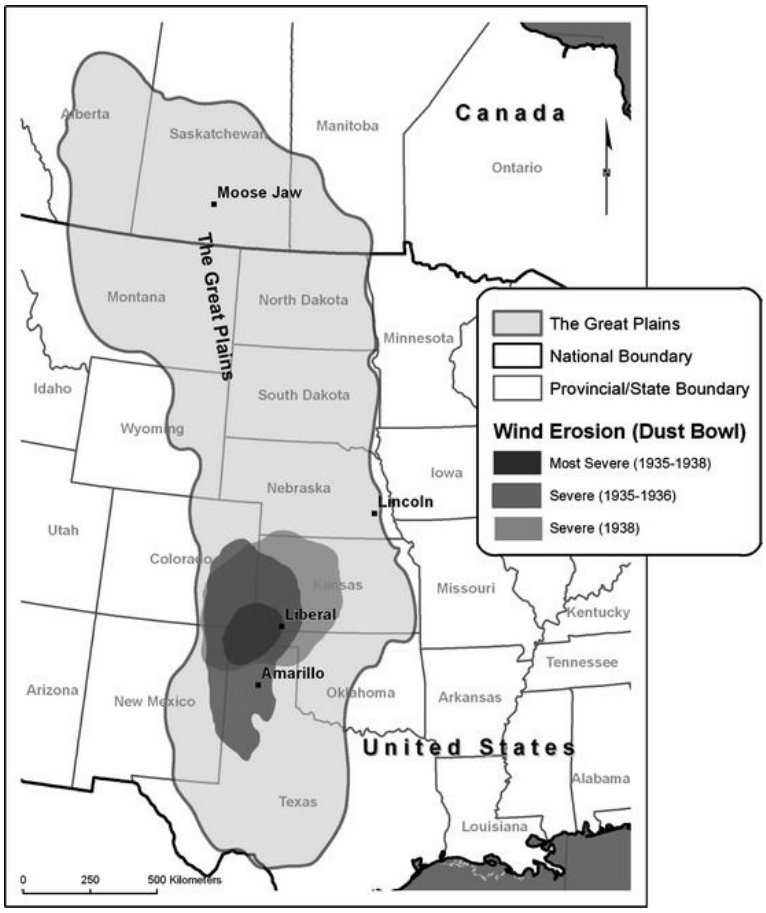
Around the world, soil is being broken down faster than it is being replenished. The activities listed below contribute to those changes:

- Clearing land for construction of homes, business and roads leaves it vulnerable to wind and water erosion.
- Cutting down forests to plant annual crops can cause erosion without the trees' roots to hold the soil in place
- Unsustainable farming practices like plowing the land to control weeds and planting crops on former prairies causes a loss of topsoil soil, soil moisture and nutrients.
- Overgrazing grasslands makes land vulnerable to erosion when grass is pulled out by the roots during grazing and when animals' hooves break up the surface.

Extreme Erosion

The period in the 1930's commonly called the "Dust Bowl" is an example of wind erosion brought on by extreme drought. According to the 1936 Great Plains Committee, weather patterns and unsustainable farming practices led to severe crop failure and loss of topsoil. While weather was the primary cause, the following activities played a part as well:

- Overstocking grassland with livestock
- Inefficient use of water resources
- Lack of farm improvement/long-term planning
- Expansion of farming into marginal areas
- Over-cultivation of small landholdings
- Failure to recognize diversity of soil conditions across the region



To prevent further soil loss, the Soil Conservation Service took aerial photos and made detailed soil maps to identify the areas needing the most attention.

Researchers and scientists with the US Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) and the Cooperative Extension Service (OSU Extension) used research trials to learn the best ways to prevent wind and water erosion of farmland. At the county level, these agencies do educational programs and work directly with farmers to encourage adoption of farming and land management practices that protect natural resources.

Today many farms use herbicides and cover crops instead of plowing several times a year to control weeds. No-till farming protects the land and the air and cover crops add nutrients back to the soil while they help prevent erosion. Because of the changes made in farming and livestock management practices, recent droughts in the US (1989-90; 2012-14) have caused crop failures, but have not caused the level of soil loss that occurred during the 1930's.

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Activity 1 Worksheet 2: Preventing Erosion

Name: _____ Date: _____

Use information from **Protecting Agricultural Land** to answer the following questions

List three human activities that have negative impacts on soil conservation:

1. _____
2. _____
3. _____

Why was the 1930's drought in the Great Plains called the "Dust Bowl"?

_____

_____

_____

List two government agencies who work with farmers to encourage good land management practices.

1. _____
2. _____

Name at least two farming techniques that help conserve and protect soil.

_____

_____

_____

_____

Mud in the Water

Activity 1 Worksheet 2: Preventing Erosion

ANSWER KEY

Name: _____ Date: _____

Use information from **Protecting Agricultural Land** to answer the following questions

List three human activities that have negative impacts on soil and the environment

1. Clearing land for construction of roads, businesses and homes
2. Cutting down forests and native trees to grow crops on the land
3. Unsustainable farming practices and overgrazing pasture land

Why was the 1930's drought in the Great Plains called the "Dust Bowl"?

The dust bowl describes a period of time when extreme drought in the Great Plains combined with unsustainable farming methods caused severe crop failure and loss of topsoil through wind erosion. Huge dust storms made it impossible to see very far, the the name the "Dust Bowl"

List two government agencies who work with farmers to encourage good land management practices.

1. Natural Resources Conservation Service (NRCS) USDA would also be correct
2. Cooperative Extension Service (OSU Extension)

Name at least two farming techniques that help conserve and protect soil.

No-till or low-till farming

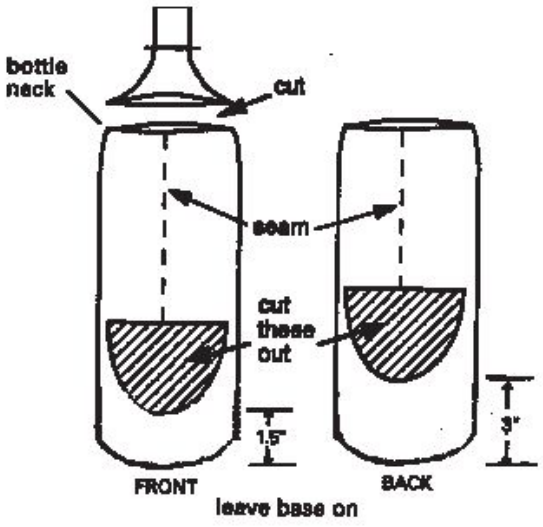
Planting cover crops on fields between harvest and the next planting season

Mud in the Water

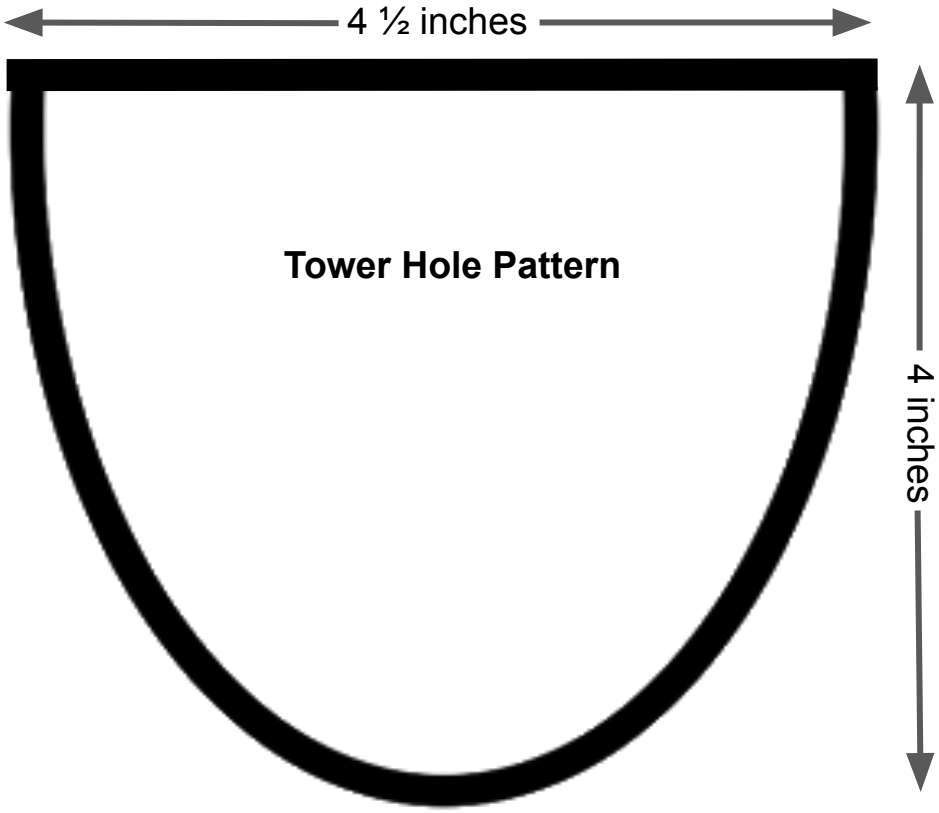
Activity 1 Worksheet 1: Erosion Model

Name: _____ Date: _____

BOTTLE 1: THE SUPPORT TOWER



1. Cut out the tower pattern on the back page.
2. Cut the top off the bottle with a knife or scissors. (See diagram 1.)
3. Choose a front and back on the tower, and mark these locations with a marker or pen at the base of the bottle.
4. Measure 1 1/2 inches (4cm) up from the “front” mark on the bottle. Make another mark.
5. Take the tower pattern and trace it on the front side of the bottle. The rounded edge or bottom of the pattern should be on the 1 1/2 inch mark. See diagram 1.
6. Turn the bottle around to the back mark.
7. Measure three inches (7.5 cm) up from the mark on the back of the bottle.
8. Using the tower pattern, trace it onto the back side of the bottle. The rounded edge of the pattern should be on the 3-inch mark. See diagram 1.
9. Cut out the front and back holes.



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Activity 1 Worksheet 1: Erosion Model

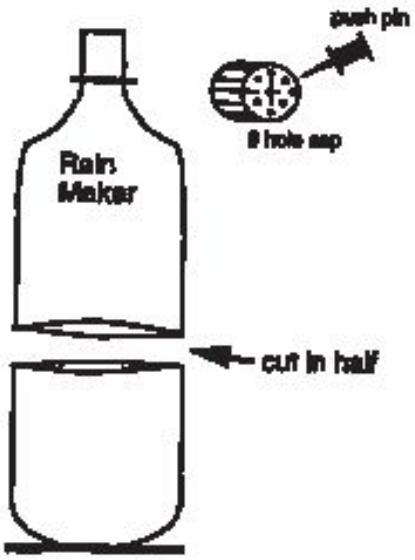
Name: _____ Date: _____

BOTTLES 2 AND 3: SOIL TRAY (You need at least two of these.)

1. Use a permanent marker to draw a line (baseline) around the base of the bottle about 2 inches from the bottom of the bottle.
2. Lay the bottle on its side.
3. Find the seams that run the length of the bottle. You can use these seams as a guide.
4. Use the marker to draw a line along each seam from the baseline to the neck of the bottle.
5. At the neck of the bottle, draw a line from one seam line to the other seam line.
6. Cut along lines, and remove the side of the soil tray. The soil tray is ready to be filled with soil.
7. Repeat steps 1-7 for the second soil tray.

FILLING THE SOIL TRAY

1. With the bottle on its side, Fill one bottle with about 1/2 inch of sand. This is the subsoil. Level the subsoil and gently press it down to make it firm.
2. Put 1/4 inch of moist topsoil over the sand. remove or break up any soil clumps. The layers of soil should be easy to see through the side of the bottle.
3. 3. Repeat steps 1 and 2 for the second soil tray.
4. 4. In the second tray, press mulch (grass clippings, newspaper, wood chips) into the moist topsoil so most of the surface is covered. You may also use a piece of sod from your yard or plant alfalfa, ryegrass, lettuce, radish or some other fast-growing seed in the tray.
5. 5. Sprinkle about 1/2 a bottle cap full of glitter evenly over the surface of both trays. The glitter represents some kind of fertilizer, herbicide or pollution.



BOTTLE 4: RAINMAKER

1. Cut the next bottle in half to form a funnel and a water container. See diagram at left.
2. The funnel or top portion is the rainmaker.
3. Poke holes in the bottle cap by using a push pin or ice pick. Make nine holes with the push pin.
4. Screw the cap tightly on the rain maker, and fill the rainmaker about halfway with water to test whether all holes are free-flowing. If the water is only dribbling out, enlarge the holes by wiggling the push pin back and forth a bit more.
5. The bottom half of the bottle can be used to hold the water added to the rain maker.

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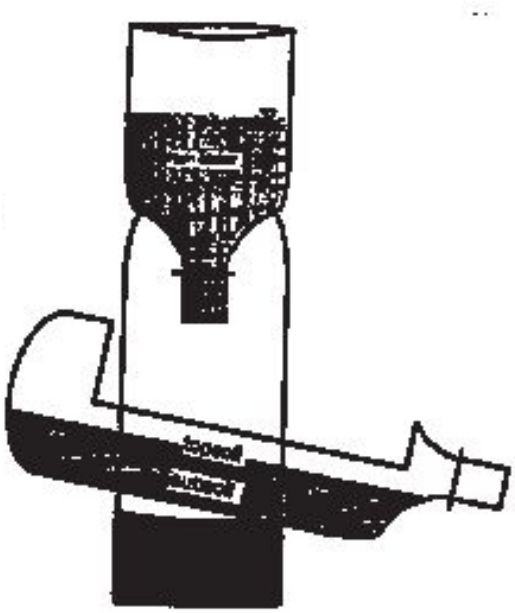
Activity 1 Worksheet 1: Erosion Model

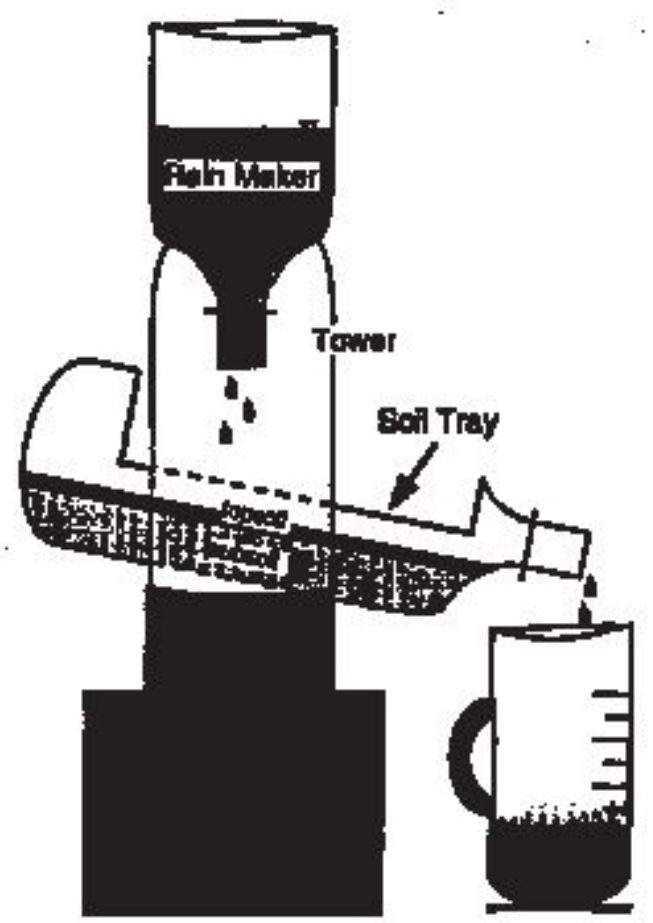
Name: _____ Date: _____

PUTTING THE MODEL TOGETHER

1. Pour sand into the tower (Bottle 1) to make it stable.
2. Push the bare soil tray through the holes in the tower. The neck of the soil tray should be lower than the base of the soil tray. (See diagram at right.)
3. Place the model on an empty coffee can, block of wood or some other platform so the mouth (bottle cap end) of the soil tray is high enough to place a measuring cup beneath it.
4. Insert the empty rainmaker into the top of the tower.



How to do the Demonstration



1. Use a two-cup measuring cup to collect runoff. Make sure you use the same size collection container when comparing runoff between demonstrations.
2. Pour water into two separate containers so each container has two cups of water This water will be added to the rain maker. Place the measuring cup below the soil tray to collect runoff. (See diagram at left.)
3. Dump the water from one container into the rainmaker.
4. Observe the amount of glitter and soil being “eroded” into the measuring cup.
5. When all of the runoff water has flowed into the measuring cup, set it aside. You will need to use it to compare runoff with the next soil tray.
6. Remove the first soil tray from the tower and replace it with the second soil tray (mulch tray).
7. Repeat demonstration steps 2-4, but this time use the mulch tray and the second container of water.

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Activity 1 Worksheet 2: Compare Results

Name: _____ Date: _____

After repeating the simulation with each bottle, compare the results

Which measuring cup has the most water? _____

What do you think caused the difference? _____

_____

Which measuring cup has the most glitter? _____

Since the glitter represents fertilizer or chemicals, how would it impact water quality and aquatic life?

_____

_____

_____

Was the mulch helpful in reducing the amount of runoff? _____

If it made a difference, tell why it reduced runoff _____

_____

Was the mulch helpful in reducing erosion? _____

If it was helpful, tell why mulch reduced erosion. _____

_____

Was the topsoil washed away directly beneath the rainmaker? _____

Are the techniques that could help keep topsoil in place during heavy rains? If so, list them.

_____

_____