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Introduction

This booklet was created to help educators teach students about the importance of water management and conservation, with a focus on rainwater harvesting. The activities included in this document can be used for students ranging from grades K-12. It can also be used for 4-H or Junior Master Gardener education. Attachments A and B include two tables showing how these activities can achieve various Texas Essential Knowledge and Skills.

This document was developed by the Texas AgriLife Extension Service through a grant provided by the Texas Water Development Board.

For more information about rainwater harvesting, please go to

http://rainwaterharvesting.tamu.edu/
Rainfall Simulator

Objective:
- Understand the movement of water through the water cycle
- Understand the concept of a watershed
- Understand the effects of land cover and management on the path of rainwater.
- Understand the practical implementation measures of rainwater harvesting for water storage in the soil, groundwater, and surface reservoirs.
- Understand the effect that increased impervious areas have on water movement in the watershed.
- Understand water and land management options that decrease runoff and promote infiltration.

Materials:
- Rainfall simulator frame
- 4 land cover trays (varying landscapes):
  - Urban landscape
  - Native grasses
  - Overgrazed land
  - Turfgrass
  - Rain garden
- 4 rain trays
- 8 catch containers
- 2 buckets for water
- Towels

Procedure:
Fill the rain trays with about 1-2 inches of water and watch to see where the rainfall goes. First explain the three reasons why Texas landscapes do not look like they did before European settlement: 1 – development; 2 – overgrazing; 3 – lack of fire. This caused a decreased in native grass prairies. Then discuss how the resulting land covers cause different patterns in water infiltration and runoff. Discuss how water movement and land management can affect water quality and what landowners can do to improve infiltration and the quality of water downstream.
After the rain has fallen for a few minutes, compare the water quantity and quality of the various catch containers. Discuss differences in water amounts between land covers and why some containers’ water is turbid while other is clear. On the tray with an urban landscape, use small cups and a sponge (picture on bottom of previous page) to simulate rainwater harvesting.

**Questions to Ask:**
- What are three reasons why there are not abundant native grassland prairies in Texas?
- Where do you think there will be the most surface runoff?
- How does overgrazing negatively affect the land?
- How does development negatively affect the land?
- How does the lack of fire negatively affect the land?
- What are ways we can improve water infiltration?
- Why does water not infiltrate into the overgrazed land cover?

For more information on how to obtain or build a rainfall simulator please see Attachment C on page 18.
Rain Drop Splash

Objective:
- Understand that a falling raindrop has energy and can detach soil particles,
- Understand how ground cover affects the energy in the raindrop

Materials:
- 1- Sprinkler can or 5 gallon bucket with holes punched in the bottom
- 1- Poster board
- 1- Ruler or measuring tape

Procedure:
Rainfall is simulated by holding a sprinkler can or 5 gallon bucket with holes punched in the bottom about 4-5 feet above the ground (pictured on right). A measured amount of water is poured out on the soil. The splash is recorded using a poster board placed next to where the rainfall strikes the soil.

Measure and compare:
- Height of the splashes
- Amount of soil splash (color of water splashed on the poster board)
- A separate test is then done on grass or vegetated area. Select 2 or 3 different soil or vegetation conditions.

Questions to Ask:
- Which surface will have the most splashing soil?
- Why is there more splashing on bare soil?
- Why is this bad for the environment and the watershed?
Soil Temperature

Objective:
- Understand the relationship between air temperature and soil temperature.
- Understand how ground cover affects the soil temperature.

Materials:
- 2 Thermometers

Procedure:
Take the soil temperature reading in the afternoon because it is usually the hottest time of the day. An inexpensive thermometer that will register up to 120-130 degrees should be sufficient. The bulb of the thermometer should be placed about ½ inch below the soil surface on both the grassed and bare areas. The ½ inch depth is suggested because this is usually the depth of most seedling grass roots. Also take the air temperature at least 4 feet above the ground to avoid soil heat radiation.

Observations and Discussion:
Have the students record the temperatures of the grassed and bare soil areas and the air. Discuss the importance that vegetation has on moderation of temperature in the soil (because it helps hold in moisture). Discuss how the temperature in the soil and earth greatly impacts the temperature of the air. Explain how the hottest years in Texas were also the driest years when there were droughts (i.e. 2011).

Questions:
- Which soil surface do you think will have the greatest temperature?
- Why is the temperature in the bare soil greater?
- How does vegetation help to retain water?
Soil Infiltration Measurements with Rings

Infiltration rings will be used to demonstrate how fast soils will absorb moisture. These rings may be used to show differences between soils or to show the effect of range condition on rates of infiltration on similar soils.

Objectives:
- Understand the relationship between land health and infiltration.
- Understand that if the rainfall rate exceeds the infiltration rate, runoff will occur.

Materials:
- 1- Bucket with water
- 2- 6” sections of 4” metal or PVC pipe
- 1- Large hammer

Procedure:
Select two or more different soil or vegetation conditions for measurement. Hammer the rings into the ground one to three inches so that water cannot seep out from under them.

Fill rings with water to a depth of 2 inches. Pour the water in as fast as possible without disturbing the soil surface. Record the time it takes for the water to disappear. Repeat with another container of water if time allows.

Check to see how far the water infiltrated into the soil. This can be done by digging a hole until you strike dry soil or parent material and then measuring from the surface to the dry soil or parent material. The different soil condition measurements can then be graphed or charted.

Questions:
- Which land cover will have the greatest amount of infiltration?
- Why does vegetation allow for more water to infiltrate?
Transpiration

Objectives:
• Be able to define transpiration and describe its role in the water cycle.

Materials:
• 4- gallon sized plastic bags

Procedure:
Describe to the audience what transpiration is and its role in the water cycle. Select 4 different types of plants and seal the bag over as much of the plant as possible. Leave the bags alone and check them in 30 minutes. Compare the amount of water that was transpired by each type of plant.

Discuss which plants had the most transpiration and why. Explain how introduced or invasive plants may withdraw more water than native plants, leaving less water in the soil.

Questions:
• Which plant will have the most amount of transpiration?
• Why would that plant have the most transpiration?
• What other plants would have high levels of transpiration?
• What might be bad about transpiration?
• How can we control the amount of transpiration occurring on our land?
Mist to Heavy Rain

Objectives:
• Understand that rainfall rates differ during each rainfall event.

Materials:
• 1 spraying water bottle that allows you to change the flow from a fine mist to a heavy spray.

Procedure:
Describe to the students how rainfall rates affect the environment. Demonstrate this by spraying the water bottle in front of the audience and changing the flow to demonstrate the difference between a mist to a heavy rain. Discuss how these differences can affect erosion on the soil surface. Also discuss how the rate of rainfall can change the potential of water to infiltrate or become surface runoff.

Questions:
• What rate of rainfall will cause the most amount of erosion?
• What rate of rainfall will lead to more water infiltration?
• Why might heavy rain be important?
Corrugated Roof and Gutter

Objectives:
- Identify where rainfall goes if it falls on a roof with and without gutters.
- Understand the role and purpose that gutters serve on a roof.
- Show the basic principles of rainwater harvesting.

Materials:
- Short piece of corrugated plastic/tin/wood (2’ x 2’)
- Sprinkler can to simulate rain event
- Short piece of gutter to divert water
- Bucket or container to catch the water

Procedure:
Have 2 students hold the short piece of corrugated plastic/tin in their hands (one on each side) and a third student to use the sprinkling can and sprinkle water on to the small roof to simulate a rain. Discuss where this water is going - running off the roof, splashing on the ground and running off into a ditch, drain and down the watershed.

Then slip the piece of gutter under the roof and slope it to one end and have a container there to catch the water. Discuss how much water per square foot of surface you can catch (measure your roof to determine the area and amount of water). Example: 2’ x 2’ = 4 square feet of surface. You can capture approximately 0.6 gallons of water per square foot per 1” of rainfall; 4 ft² x 0.6 = 2.4 gallons of runoff.

Questions:
- Where is the water going when there are no gutters?
- Why are having no gutters a bad thing?
- How much water can we capture from this roof with an inch of rain?
- What can you use harvested rainwater for?
Plastic Sheet Watershed Activity

Objective:
• Understand what a watershed is and how human activities impact water quality.
• Understand that everyone in a watershed is responsible for protecting water quality.
• Understand the importance of managing all of the water that falls on a landscape.

Materials:
1. Clear plastic sheeting – heaver gage – 4 mil thickness or thicker (square or rectangle). Sizes can range from 8’ x 8’ to 10’ by 20’.
   a. Cut a 4” diameter hole in the very center
2. Water hose with spray nozzle on the end if possible.
3. Water holding container like a 1 – 5 gallon container or bucket.
4. Open space, preferably outside.

Procedure:
1. Have students open up the sheeting and stretch it out at waist level and spread out uniformly or evenly spaced all the way around the sheeting (see picture above).
2. Discuss with the students that the sheeting represents their watershed and water flows from the highest point to the lowest. The sheet could represent their watershed, which includes their school and community and drains into the nearest creek, river, lake or ocean
3. Place about 2 gallons of water onto the sheeting and instruct students to move the water in a circle all the way around the sheeting without it going to the center and being lost in the center hole (leaving their watershed). Students learn to raise and lower their section to get it to move around. Instruct them to work slowly at first.
4. Once they have moved it in a circle 2-3 times (or after about 5 tries), let that water drain into the center hole to remove it.
5. Select a taller student and have him or her get into the center and raise it up as high as possible. Instruct all other students that it is going to rain on their
new home and they can either be underneath it or on the outside.

6. Spray water up high over the sheeting to create a rainfall event (previous page on bottom).

7. Once you have allowed it to rain for a few minutes, ask the students where the water went.

8. Have the student in the center bring the sheet low. Select another student to hold the bucket under the center hole of the sheet.

9. Spray water up high for a minute and wave the nozzle from end to end (picture on right).

10. Explain that all the water went into the bucket and this is the process of rainfall capture. Discuss that we can capture and save that water for dry days and use it for all types of purposes outside their home. With proper treatment, it can also be used inside the home.

11. Next repeat step 3 and have the students move the water than before.

12. Once they are successful (3-10 circles depending on time available) stop and discuss:
   
   a. Water is precious. World-wide children only have about 5 gallons of water per day to bathe, drink, cook and use. In the USA, there is abundant and safe water to use and play with.

   b. We want our children and their children to be able to have the same privileges and fun playing and using water as we have the fortune of doing. But it will take teamwork – just as it did to move the water around in a circle – for us to give that luxury to their children. We all live and play in our watershed and if we can work together to protect and conserve that water in our watershed we can continue to have the fun we do today.

13. Finally allow the students to shake the sheet dry. Have the students fold up the sheet or lay it out for the next group.
One Gallon Jug Watering Device

Objective:
- Understand the importance of water to wildlife.

Materials Needed:
1. 1 gallon water or milk jug
2. An adjustable drip emitter
3. A drill and 3/16” drill bit or punch to make hole for emitter
4. Spray paint for plastic
5. Markers or other paint
6. String or bungee cord to hang watering device

Procedure:
Making the watering jug:
1. Clean out 1 gallon jug
2. Spray a base coat of paint over the jug to prevent UV degradation
3. Drill or punch a small in the bottom and opposite corner as the jug would hang
4. Have students paint or decorate the jug as desired
5. Insert the drip emitter into the hole
6. Attach a string or cord to the handle so it can hang in a tree or other support

Steps to making the concrete base (Two methods)
Method 1
1. Mix concrete according to directions on bag
2. Pour the concrete in the plastic pie container or mold and spread it out (either use spackle tool or protective gloves)
3. Put a bowl in the middle and push down until it is about an inch away from the bottom
4. Let it sit for about 5 minutes
5. Decorate the concrete around the bowl with shells or other items (be sure that they are firmly in the concrete)
6. Take out the bowl and see if there is an indention there; if not keep the bowl in there a few more minutes.
7. Remove the bowl and decorate the center indentation
8. Let it dry for approximately 24 hours or until completely set
9. Remove the concrete base from the mold or pie pan
10. Place under watering jug

Method 2
1. Mix cement according to directions – fast setting concrete is preferred
2. Lay a plastic sheet over the top of a table and cover with one inch of sand
3. Find a larger leaf – 2 to 4 inches in diameter and lay it on the sand
4. With a finger draw an outline of the leaf in the sand down to the plastic sheet
5. Place about 1 inch of cement over the leaf and into the trench outlining the leaf created by the child’s finger
6. Have the students – *with protective gloves on – pat the cement until it is smooth over the top and beaten into the trench
7. Allow the cement to dry – about 1 hour
8. Have students roll the cement over and dig out the leaf
9. The imprint can be left the color of concrete or painted
10. Place under watering jug
Water Conservation Pledge

I promise to do my best to save water in my home.
I also promise to help others by telling them about ways to conserve water.
I will do my best to be a water conservation citizen.

Signed                  Date
## Attachment A. Texas Essential Knowledge and Skills (TEKS) for Science

<table>
<thead>
<tr>
<th>Activity</th>
<th>TEKS for Science Addressed by Activity</th>
</tr>
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<tbody>
<tr>
<td>Rainfall Simulator</td>
<td>Grade K, TEK 7 B; Grade K, TEK 9 B; Grade 1, TEK 7 B; Grade 2, TEK 7 B; Grade 2, TEK 8 C; Grade 3, TEK 9 C; Grade 3, TEK 10 A; Grade 4, TEK 3 C; Grade 4, TEK 7 A,B,C; Grade 4, TEK 8 B; Grade 5, TEK 8 B; Grade 7, TEK 8 A,B,C; Grade 7, TEK 10 B; Grade 8, TEK 10 B; HS Aquatic Science, TEK 7 A,B,C; HS Aquatic Science, TEK 11 A, B; HS Biology, TEK 12 F; HS Earth and Space Science, TEK 11 A,E; HS Earth and Space Science, TEK 12 A; HS Earth and Space Science, TEK 15 C; HS Environmental Sciences, TEK 4 B; HS Environmental Sciences, TEK 5 A,B,E; HS Environmental Sciences, TEK 9 A,E,F</td>
</tr>
<tr>
<td>Rain Drop Splash</td>
<td>Grade K, TEK 7 B; Grade 3, TEK 7 B; Grade 4, TEK 7 B; Grade 7, TEK 8 A,B,C; HS Earth and Space Science, TEK 11 A; HS Environmental Sciences, TEK 9 A; HS Physics, TEK 6 B</td>
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<tr>
<td>Soil Temperature</td>
<td>Grade 3, TEK 2 A; Grade 4, TEK 2 A; Grade 4, TEK 7 A</td>
</tr>
<tr>
<td>Soil Infiltration Measurements with Rings</td>
<td>Grade 3, TEK 2 A; Grade 4, TEK 2 A; Grade 4, TEK 7 A; Grade 5, TEK 2 D; Grade 7, TEK 8 C; HS Aquatic Science, TEK 7 B; HS Earth and Space Science, TEK 15 C</td>
</tr>
<tr>
<td>Transpiration</td>
<td>Grade K, TEK 9 B; Grade 1, TEK 10 B; Grade 2 TEK 10 B</td>
</tr>
<tr>
<td>Mist to Heavy Rain</td>
<td>Grade K, TEK 7 B</td>
</tr>
<tr>
<td>Corrugated Roof and Gutter</td>
<td>Grade K, TEK 7 C; Grade 1, TEK 7 C; HS Environmental Sciences, TEK 5 B</td>
</tr>
<tr>
<td>Plastic Sheet Watershed Activity</td>
<td>Grade 1, TEK 7 B; Grade 2, TEK 7 B; Grade 2, TEK 8 C; Grade 4, TEK 3 C; Grade 4, TEK 7 C; Grade 5, TEK 8 B; Grade 7, TEK 8 A,B,C; HS Aquatic Science, TEK 7 A,B,C; HS Earth and Space Science, TEK 15 C; HS Environmental Sciences, TEK 5 B; HS Environmental Sciences, TEK 9 A</td>
</tr>
<tr>
<td>One Gallon Jug Watering Device</td>
<td>Grade K, TEK 9 B; Grade 7, TEK 10 A</td>
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**Attachment B. Texas Essential Knowledge and Skills (TEKS) for Agriculture, Food, and Natural Resources**

<table>
<thead>
<tr>
<th>Activity</th>
<th>TEKS for Agriculture, Food, and Natural Resources Addressed by Activity</th>
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<td>Rain Drop Splash</td>
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<td>Soil Temperature</td>
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<td>Soil Infiltration Measurements</td>
<td>Mathematical Applications in Agriculture, Food, and Natural Resources, TEK 4 A; Rangeland Ecology and Management, TEK 3 B</td>
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<td>with Rings</td>
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<td>Transpiration</td>
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<td>Mist to Heavy Rain</td>
<td>Principles of Agriculture, Food and Natural Resources, TEK 15 E; Mathematical Applications in Agriculture, Food, and Natural Resources, TEK 1 F; Mathematical Applications in Agriculture, Food, and Natural Resources, TEK 4 A; Energy and Natural Resources Technology, TEK 8 A,F; Advanced Plant and Soil Science, TEK 8 B; Agricultural Mechanics and Metal Technologies, TEK 5 A,B,C</td>
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<td>Corrugated Roof and Gutter</td>
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<tr>
<td>Plastic Sheet Watershed Activity</td>
<td>Energy and Natural Resources Technology, TEK 8 C,D,E,F; Advanced Environmental Technology, TEK 5 A,D,E; Wildlife, Fisheries, and Ecology Management, TEK 5 G; Forestry and Woodland Ecosystems, TEK 2 H; Advanced Plant and Soil Science, TEK 9 A,B,C,D; Advanced Plant and Soil Science, TEK 11 A,B</td>
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<tr>
<td>One Gallon Jug Watering Device</td>
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Attachment C. Obtaining or Building a Rainfall Simulator

The rainfall simulator as shown on page 2 is available for use for educational purposes from several AgriLife Extension offices throughout Texas. To find contact information for a local Extension office, go to http://agrilifeextension.tamu.edu/. Contact the county’s Extension Agent to find out if they have a simulator available or where to find one. For more detailed teaching instruction, there are leader guides available for purchase online at agrilifebookstore.org. The title of the series is, “What is the Fate of Your Rainfall?”

The rainfall simulator can also be built with proper tools and supplies. Below are drawings and pictures for the currently-used rainfall simulator by the Texas AgriLife Extension Service. The construction of the frame requires welding. Be sure to follow all safety precautions when welding the simulator or hire a trained professional.

![Drawing of the rainfall simulator frame.](attachment://attachment-c obtains or builds rainfall simulator.jpg)
The plant tray for the simulator is made from a 15"×11"×6" plastic storage (15 quart volume) container.

There are two drains in the tray: one for groundwater and one for surface water runoff. The groundwater drain is made from ½” PVC pipe. As show above, the pipe extends along the bottom of the tray to maximize the capture of groundwater. The surface water hole drilled into the tray is 1 ½” in diameter and the hole for the groundwater pipe is 7/8” in diameter.
Above are the groundwater pipe components which include ½” sizes of the following (starting at the bottom left and moving up and to the right): 90° elbow, 2” long pipe, male adapter, two rubber washers, threaded 90° elbow and slip, 7” long pipe, end cap. Also, there are four holes drilled in the section of pipe that will be in the container. The hole is 3/16”. The rubber washers go on both sides of the plant tray when the groundwater pipe is assembled.

Above are the surface water pipe components which include 1” sizes of the following (starting at the bottom left and moving up and to the right): 4” long pipe, 90° elbow, 2 ¾” long pipe, male adapter. The male adapter threads into the surface water hole at the top of the tray.
Once the trays and piping have been assembled, they can be filled with “land uses.” In this picture, there are (from left to right) land uses of native grasses, over-grazed land, turf grass, and urban landscape. Note that the water pipes in this example use 45° elbows, which is a viable option.

On the urban landscape tray, a small model house (i.e. birdhouse) can be used to represent roof surface. The impervious ground is a piece of plastic glued to the tray. Small containers can be used to simulate rainbarrels and a sponge can be used to simulate a rain garden. The gutters are made from ½” pipe cut in half.
The containers to collect the groundwater and surface runoff should be clear plastic containers. It is also important to label them (as seen above).

The rain trays are the same sized containers as the plant trays. They are drilled with 35 small holes (1/16”) across the bottom for the water to simulate rainfall.