Rainwater Harvesting

Lesson 2: What is Rainwater Harvesting?

INTRODUCTION

This lesson will introduce students to the basic structures used in rainwater harvesting. They will understand how rainwater harvesting functions as a system to collect, convey, store, and infiltrate stormwater. They will plan and carry out an investigation and analyze the difference between permeable and impermeable surfaces using a physical model. They will use their model to learn about Best Management Practices (BMPs) for rain and stormwater. Finally, students will learn that water can be redirected for beneficial use by using a simple system.

Teaching Strategies

Thinking questions are posed throughout this unit presentation to help students think metacognitively and to make **D**istinctions, identify **S**ystems, recognize **R**elationships, and look from different **P**erspectives. This is called Systems Thinking through DSRP.

Mental Models or "mental maps" are used throughout this unit to illustrate the Systems Thinking process. Mental maps are more than a concept map. In addition to mapping out ideas, mental maps help illustrate relationships and include perspectives. They are a simple way to model systems, visualize concepts, define relationships, and organize content to achieve a deeper level of understanding for both simple and complex subject matter.

NOTE: Keep copies of mental maps and charts from every lesson as they may be referred to throughout the unit.

OBJECTIVES

- **DISTINGUISH:** Students will **ask questions and define problems** to distinguish how a passive rainwater harvesting system functions as well as why and how it can be utilized.
- **BUILD THE SYSTEM:** Identify the physical parts of a passive rainwater harvesting system and learn the four basic processes involved in harvesting rain: Collection, Conveyance, Infiltration, and Storage.
- **RELATE:** Identify the relationships between permeable and impermeable surfaces.
- **TAKE A PERSPECTIVE:** From a **cause-and-effect** perspective, relate the parts of rainwater harvesting to one another.

MATERIALS AND EQUIPMENT

Storm Water Activity Instructions
Storm Water Best Management Practice Cards
Stormwater Worksheet

For each cooperative group you will need:

- 12 sponges (made of six standard kitchen sponges cut in half)
- 2 plastic bags filled with 4 half-sponges each
- 2 plastic bags filled with 2 half-sponges each
- 100 ml graduated cylinders
- Cup to store water

The Rainwater Harvesting Unit is adapted with permission from the Arizona Project WET, Rainwater Harvesting Aqua STEM Program.

- 1 Aluminum tray 9 x 13 with a red stripe (cut a ½-inch diameter hole where the short side meets the bottom in one end)
- 1 Aluminum tray 9 x 13 with a black stripe

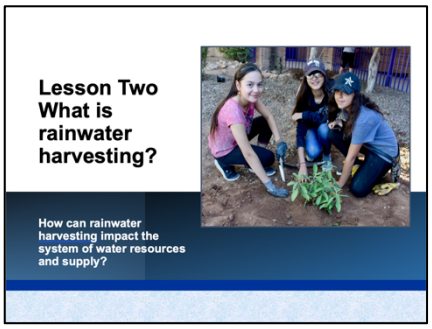
ADDITIONAL RESOURCES

Storm Water, p. 395 in *Project WET Curriculum and Activity Guide 2.0*

LESSON SUMMARY

In this lesson, students will begin to learn about rainwater harvesting and think about why it may be helpful in managing runoff on their school campus.

PRESENTATION GUIDE



Connect to the Unit

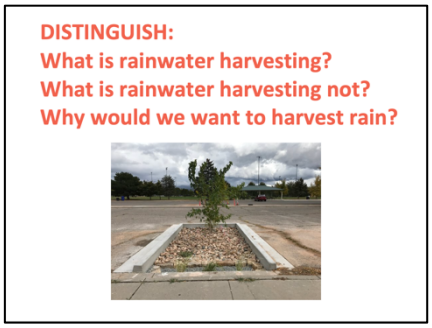
In Lesson 1, students learned the differences between weather, climate, and climate change. They developed and used a model to record weather data over a period of years to simulate climate and compared the class's climate data to student yearly data looking for trends or anomalies. Students also explored the impacts of excessive heat in urban areas and learned how passive rainwater harvesting combined with planting native or desert adapted shade trees can help reduce the heat island effect, improve soil health to assist in water retention for our groundwater system, and save water by supplementing our potable water supply.

Launch the lesson

This lesson introduces students to the idea of rainwater harvesting by using basic DSRP questions used to deepen thinking on any topic. Begin a *"Rainwater Harvesting"* mental map.

DISTINGUISH

- **What is rainwater harvesting?**



Write student ideas under the question. They may or may not come up with: collecting water; storing water; infiltrating water for plants; moving water to where it is needed. If necessary, distinguish the two words one by one, e.g., What does it mean to harvest something?

- **What is rainwater harvesting not?**

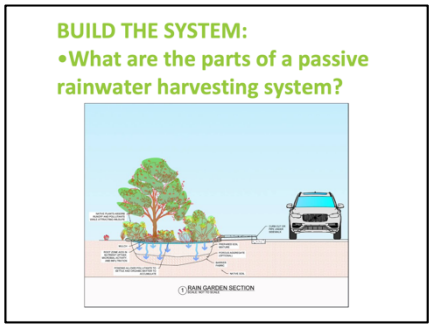
Again, record student ideas. They may or may not include thoughts like: just collecting water alone; collecting water from any other source except for the rain; difficult.

- **Why would we want to harvest rain?**

Discuss why it might be beneficial to harvest rain in our area. How can we increase shade in a sustainable manner? How can we save water

through green stormwater infrastructure?

Ask students if they can define what a system is. A system is a set of connected parts that work together to make a complex whole. Lead students through a "roof to soil" discussion of where water might flow during a rainstorm. Where might they be able to capture flowing water?

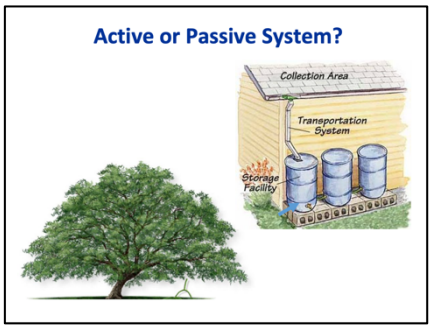


BUILD THE SYSTEM

- **What are the parts of a passive rainwater harvesting system?**

Write student ideas under the question. At this point they will be listing words like the ones in parentheses below. We will revisit these later in the unit to group them in these 4 categories:

- Collection areas (roof, street, parking lot, patio, etc.),
- Conveyance equipment (gutters, downspout, piping, curb cuts, swales),
- Infiltration areas (basin, berms, overflow),
- Storage (plants: grasses, shrubs, trees, tanks, or directly into the groundwater system).

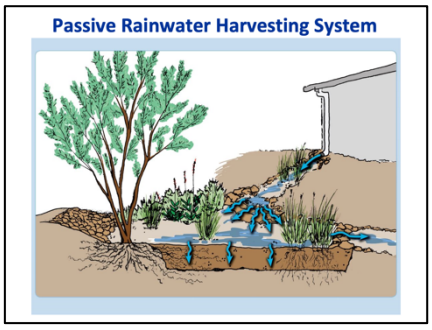


There are two main types of rainwater harvesting systems. One is called an "Active" system, and one is called a "Passive" system.

Ask students what type of system they think is depicted on the slide and why they think so. Ask them, "What structures do you see and what are the structures' functions?" Go through all components depicted on the slide.

An active rainwater harvesting system requires a person, switch, or valve to actively turn it on or off. It requires energy to operate it. For example, getting the water from the storage containers to the tree may require a pump to move the water to the tree or manually turning a valve or spigot if the system is set up to run by gravity. Thus, it's called an active system.

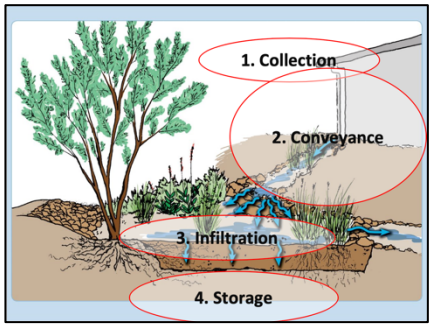
A passive rainwater harvesting system is a system that freely works without the need of any person, switch, or valve. The more passive a system is, the less energy it requires.



In this image, the landscape has been contoured to create a basin or depression for water to soak into the ground as a form of infiltration for plants to store water. Such applications are called "earthworks" which function to help speed up infiltration and augment soil moisture.

Native plants are especially well adapted to finding water in the ground and can benefit greatly from this simple technique.

Tell students that in this unit, we are going to focus on passive rainwater harvesting systems.



BUILD THE SYSTEM:

- **What are the four main processes involved in rainwater harvesting?**

Have students group the parts of rainwater harvesting that they identified earlier into categories. They should begin to identify these four main categories.

- Impermeable or less permeable collection surfaces (roof, street, parking lot, patio, etc.),
- Conveyance equipment (gutters, downspout, piping, curb cuts, swales),
- Infiltration areas (basin, infiltration berm, overflow),
- Storage (plants: grasses, shrubs, trees, or tanks).

They may not yet think of the storage in the ground as part of the system yet, but we'll come back to it.

DISTINGUISH:

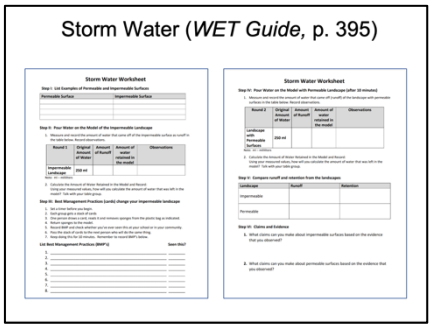
- **What is stormwater runoff?**

Students are likely to be familiar with stormwater but may not know that water managers consider it a valuable source of water for reuse. In the next exercise, they will learn about Best Management Practices or BMPs to keep stormwater from flowing down our streets and into storm drains and arroyos, but rather to put it to use.

The ***Storm Water*** lesson in the Project WET Curriculum Guide 2.0 will demonstrate and quantify the effect different surfaces have on the flow of water. *Distribute the materials and demonstrate how to set it up.*

Have the students look at their model. If the sponges represent the natural land, ask them what they think the plastic bags represent?

Be sure they notice where the storm drain is located inside the top pan. The top pan will be nested into the second pan with one side propped onto the edge of the second pan so that it slopes down inside the pan. The storm drain should be on the lowest side.



Ask the students, "Do the sponges in the bag represent an impermeable surface or permeable surface?" Have them write examples in Step I and explore more in the investigation.

The goal of this experiment is to discover and explore ways to manage rainwater by experimenting with runoff.

Have the students work through the worksheet. First, they pour 250 mL of water on the top portion of the tray. Let the pan drain and collect into the second tray for one minute and then measure and record

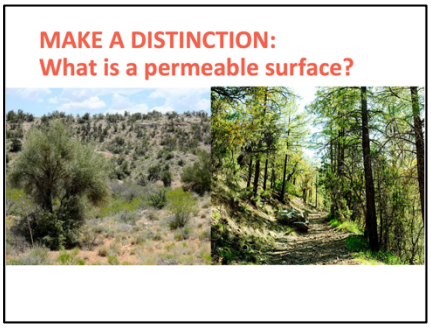
amount (Step II). This is runoff.

Some ways of managing stormwater are better than others. During the next part of this activity, they're going to learn about Best Management Practices (BMPs) for managing stormwater. Each student group gets a stack of cards which describe different Best Management Practices (BMPs). Each card will describe the practice and then tell them to remove a certain number of sponges from the bag and place it back in the tray. Once a plastic bag is empty, they can take it out of the tray.

Start all the student groups at the same time. Students take turns drawing a card randomly from the stack and read the card. Have them discuss the card and record the BMP type in the appropriate section of their worksheet (Step III). Then, have them follow the directions for removing sponges. Do NOT let them move on to Step IV until the timer goes off after 10 minutes.

Then, have students move on to Step IV: Pour 250 mL of water on the top portion of the tray. Let the pan drain and collect into the second tray for one minute and then measure and record amount. Students subtract that amount from the amount they poured on the model (250 mL) to calculate the amount of water retained in the model.

In Step V, students compare the runoff and retention for the permeable and impermeable surfaces. Discuss their data.



DISTINGUISH

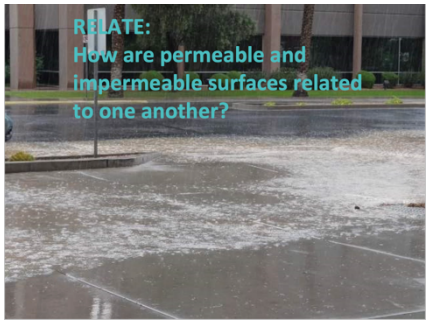
- **What is a permeable surface?**

Have students go back to their list of permeable surfaces on the data collection sheet. Ask them if there are other permeable landscapes they can add to their list. Were any mentioned in the BMP exercise?

DISTINGUISH

- **What is an impermeable surface?**

Have students also add to their lists of impermeable surfaces on the data collection sheet. Ask them if there are other impermeable landscapes they can add to their list. For example, what impermeable surface might be a good one to harvest rain from? (roof) Why the roof?



RELATE:

- **How are permeable and impermeable surfaces related to one another?**

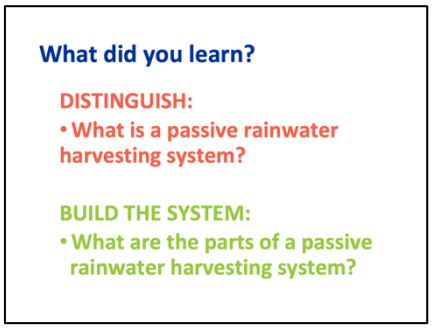
Connect their observations back to the ***Storm Water*** experiment and the BMPs. What did they learn from the experiment? What might be some better ways to handle this excess of water?

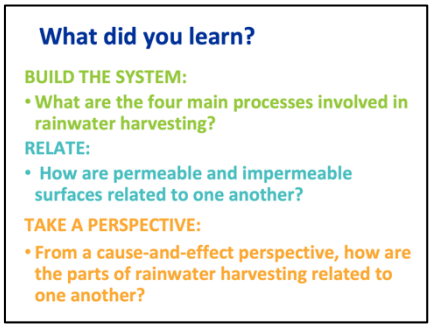
Engage the students in a discussion of how water moves through our

city. Why does water pool in some areas? Where does it end up? (low lying areas, water flows to it by gravity) Ask them if this is a good thing or a bad thing? (it could be both) Have they seen this happen in their neighborhood or at the school? Are there places in your school/community where it floods?

Discuss where this water goes after it "disappears." What do they think happens to it? (depends – it could evaporate, go into a storm drain or arroyo, infiltrate through cracks in pavement)

Ask students to explain where water flows during a storm on their school grounds. Get them to think about: Where does water collect? Where is water conveyed? Where can water infiltrate? Where is water stored? What does their schoolyard watershed look like?





Conclusion

Discuss with students or have them write in their science notebooks answers to these questions:

DISTINGUISH: What is a "passive" rainwater harvesting system?

BUILD THE SYSTEM: What are the parts of a passive rainwater harvesting system?

BUILD THE SYSTEM: What are the four main processes involved in rainwater harvesting?

RELATE: How are permeable and impermeable surfaces related to one another?

TAKE A PERSPECTIVE: From a cause-and-effect perspective, how are the parts of rainwater harvesting related to one another?