# Rainwater Harvesting

## Lesson 6: How much water do my plants need?

### INTRODUCTION

Students will begin to understand the relationships between different types of plants and their water needs. They relate those needs to water availability on a monthly basis to begin to explore the optimum capacity of their rainwater harvesting system. Students will evaluate the use of native versus non-native plants in their designs.

**Teaching Strategies**

To design a successful rainwater harvesting system, students need to understand the concepts of supply versus demand. In an ideal system supply should be equal to demand. In this lesson, students begin to understand the demand side of rainwater harvesting which includes how much water their project landscape area needs to be sustained over the course of a year.

### OBJECTIVES

- **DISTINGUISH:** Make distinctions about different types and species of plants. (native and non-native)
- **BUILD THE SYSTEM:** Identify the parts of plant water demand.
- **RELATE:** Identify the relationships between the amount of water needed and the type, species, and size of plants.
- **RELATE:** **Analyze and interpret** a plant's watering requirements in the context of monthly rainfall amounts.
- **TAKE A PERSPECTIVE:** From the perspective of your rainwater harvesting system, **construct an explanation** of how climate will affect the plants that will be chosen.

### MATERIALS AND EQUIPMENT

- *Thirsty Plants* lesson from Project WET Activity and Curriculum Guide (white book), p. 116
- Sandwich size sealable plastic bags (one for each student)
- *Low Water Use Plants*
- *A Guide to Native Plants for the Santa Fe Landscape*
- *Recommended Trees for Santa Fe*
- Handout: *Lesson 6 Proposed Plants Worksheet.docx*
- Handout: *Lesson 6 Proposed Plants Canopy Area.docx*

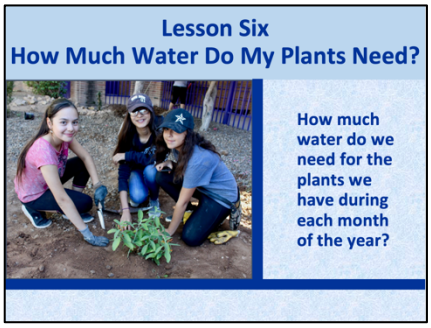
### LESSON SUMMARY

In this lesson, students will learn about the watering needs of various types of plants and relate those needs back to trends in precipitation discovered in Lesson 5. Students will understand how evaporation and transpiration impact plant water demand and will perform an outdoor experiment (*Thirsty Plants*) to observe the role plants play in the water cycle. Students will identify the specific plants on their project site and research their water needs. After evaluating the use of native versus non-native plants in their designs, students will be given time to select new plants and determine their watering needs. *NOTE:*

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

*Make sure students record the watering needs for each plant type on their project site. That information will be used to perform water demand calculations in the next lesson.*

## PRESENTATION GUIDE




### *Connect to the Unit*

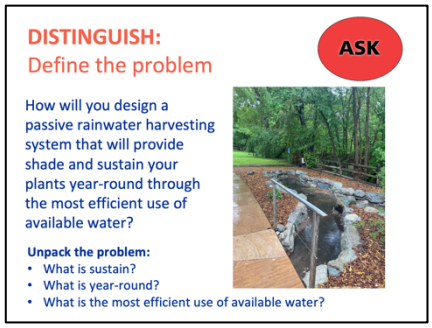
In the previous lesson, students learned what runoff coefficients are, how to use them in determining the design of rainwater harvesting basins, and how to determine the amount of rainfall (supply) that can be collected over the course of a year for their chosen rainwater harvesting collection area.

### *Launch the lesson*

In this lesson, students begin exploring the demand side of their design challenge, meeting the watering requirements of their plants. They will begin to determine the monthly watering needs of their landscape project area by accounting for watering needs using the type of plant, the number of plants, and the coverage area of the plants as a percentage of land use.

Students will:

- Learn about differences in watering needs for Very Low, Low, Moderate, High, and Very High water use plants.
- Select appropriate plants for their project which meet the criteria of:
    - Provide shade
    - Watering requirements met
    - Integrated design/stacking functions




### DISTINGUISH

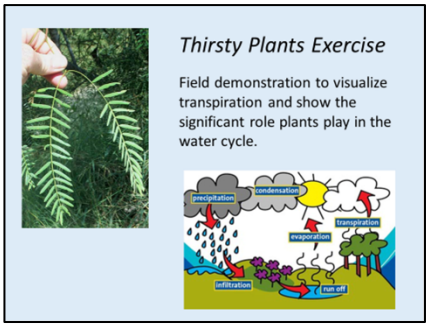
Remind the students of the driving question and orient them to where they are in the process of answering that question:

**• What do we know?**

Ask students what they learned during Lesson 4, the school yard exploration. They should know the number and types of existing plants in their selected area and how water moves through their chosen area.

From Lesson 5, they should know the amount of rainfall that can be collected and stored.

**• What don't we know?**

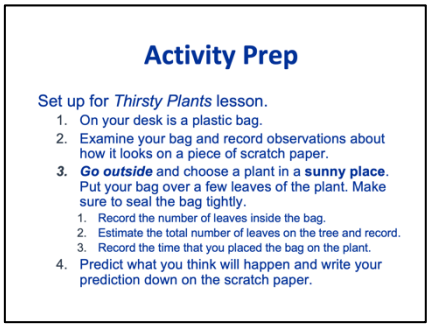



If they are designing their system to support new plants, they need time to research the types of trees, shrubs, and plants that will support the driving question.

Engage students in supply vs demand thinking. They know how much water they potentially have to work with. Now they need to know what the specific water needs of their project area is throughout the year.

The following activity uses the *Thirsty Plants* lesson from Project WET Activity and Curriculum Guide (white book), p. 116.

Students will be going outside and placing a small, sandwich size sealable plastic bag over a set of leaves on a plant that are in the sun to demonstrate transpiration. Bags should be left on plants and collected later in the lesson.




Set up for the *Thirsty Plants* lesson.

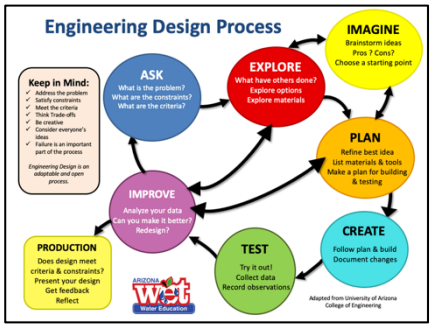
1. On your desk is a plastic bag.
2. Examine your bag and record observations about how it looks on a piece of scratch paper.
3. Go outside and choose a plant in a sunny place. Put your bag over a few leaves of the plant. Make sure to seal the bag tightly.

    ✓ Record the number of leaves inside the bag.

    ✓ Estimate the total number of leaves on the tree and record.

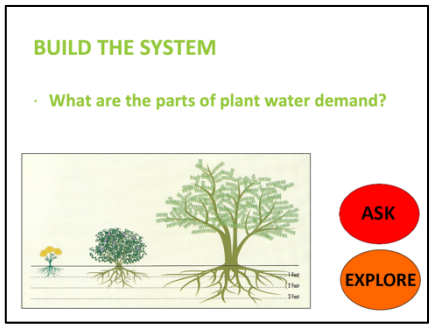
    ✓ Record the time that you placed the bag on the plant.

Predict what you think will happen and write your prediction down on the scratch paper.




### *Where are we in the engineering design process?*

We are still asking questions, but we're also exploring, imagining and planning as we proceed in our effort to find the best solution as defined by our criteria and constraints.




**BUILD THE SYSTEM**

- **What are the parts of plant water demand?**

Kind of plant, size of plant, monthly or seasonal climate (rainfall), evapotranspiration. (They might not know about evapotranspiration now, but they will by the end of the lesson.)

**DISTINGUISH**

**• What kinds of plants are there?**

Trees, Shrubs, Grasses, Turf, Vegetables, Fruit trees, Native, Non-native, Desert-adapted

**• What kinds of plants best provide shade?**

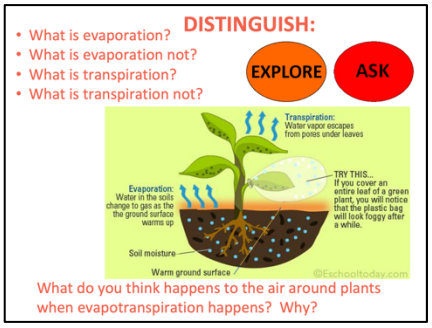
Trees, large shrubs

**• What is meant by "*integrated design*" in our design statement?**

Each element in the design should serve more than one function. Every function is supported by many elements.

**• What other kinds of plants might you consider in your design?**

Grasses to clean water and increase infiltration. Flowering shrubs can provide habitat, beauty, attract pollinators.




**DISTINGUISH**

**• What is evaporation?**

Ask a student to define evaporation. (It is water changing from a liquid to gas due to the absorption of heat energy.)

What is it part of? (It's part of the water cycle.)

**• What is it not?**

It's not condensation, precipitation, respiration, or perspiration. It's not gas changing to liquid.

**DISTINGUISH**

**• What is transpiration?**

Transpiration is water leaving the leaf surface, changing from a liquid to gas due to the absorption of heat energy.

**• What is transpiration not?**

It's not evaporation, condensation, precipitation, respiration, or perspiration. It is water moving up through a plant from the roots in liquid form and leaving the plant in vapor form at the leaves.

Inform the students that to calculate water needs for their landscape areas, they're going to combine these two ideas into a single measure called **evapotranspiration.** The reason one value is used in place of two is because it's too difficult for scientists to measure evaporation and transpiration separately.

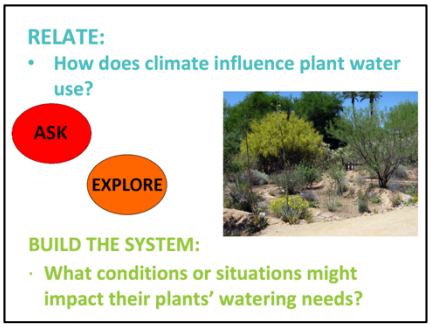
Ask students what they think happens to the air around plants as evapotranspiration occurs? If they have trouble imaging that, ask them how it feels when they are in a wooded area. (The air is cooler.)

Why does the air become cooler? (When changing from liquid to vapor, the water molecules absorb heat energy from the air, and that leaves less heat energy in the air.)

**So, trees and plants not only cool us by creating shade they also cool the air around us by transpiration.**

**Evapotranspiration** is the combined loss of water due to evaporation from the soil and transpiration from the plants.

To put it another way, **evapotranspiration** is the process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration from plants.




**RELATE:**

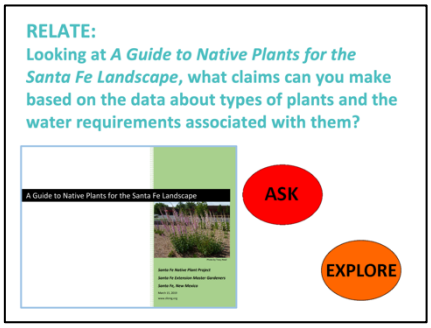
**• How does climate influence plant water use?**

Hotter, drier climates have a higher evapotranspiration rate.

**BUILD THE SYSTEM:**

**• What conditions or situations might impact their plants' watering needs?**

Remind students that a system is a collection of parts working together as a whole. To create their rainwater harvesting systems they need to understand how much water their plants need to help determine the size of their system.



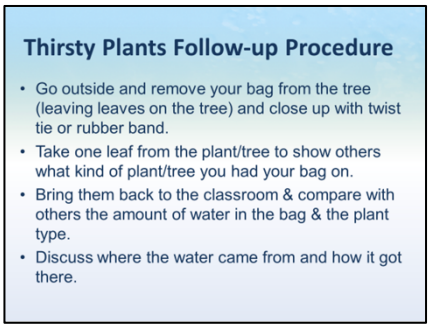

Ask students, "What conditions or situations might impact their watering needs?" (type of plants, size of plants, climate, rainfall patterns, evapotranspiration)

**RELATE**

**• Looking at *A Guide to Native Plants for the Santa Fe Landscape*, what claims can you make based on the data about**

**types of plants and the water requirements associated with them?**

Plants and grasses that are native to the area generally have Very Low and Low water usage. Trees that are native and don't live near bodies of water or higher elevations that receive more snow, generally have Moderate and Low water usage.

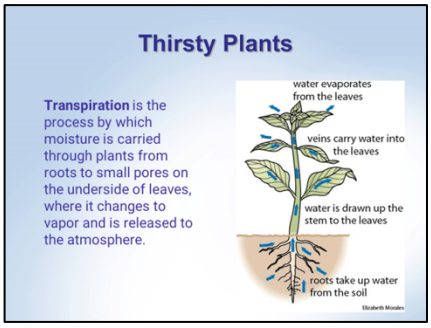



(If they can't get there, have them think about what kinds of plants they see in the natural landscape around them. Do we get a lot of precipitation locally? Do those plants use a lot of water?)

We will use the plant water rate category (Very Low, Low, Moderate, High, Very High) to help us calculate how much water our plants need.

Ten minutes before the end of class, have the students go and retrieve their plastic bag. Look at the plant bags together.

Have them analyze the phenomenon and interpret what they observe. They should also know how many leaves were in the bag and have an estimate of how many leaves are on the tree.




### *Transpiration as a phenomenon:*

Ask them how the water cycle works with plants.

- How does water get into plants? What form is it in?
- How does water get out of plants? What form is it in?
- How does water get from the bottom of a plant to the top?
- What enables water to move up the plant against the force of gravity?

### *Plant Palette*

Allow students time to explore plant types using the suggested guides below. To address the criteria of meeting all plant watering requirements, they should consider using native plants and trees which have very low and/or low watering needs.

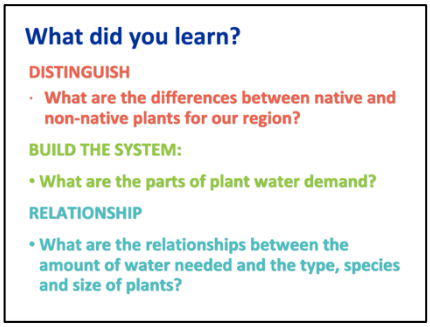
Information on plants types and watering needs can be found in the following guides:

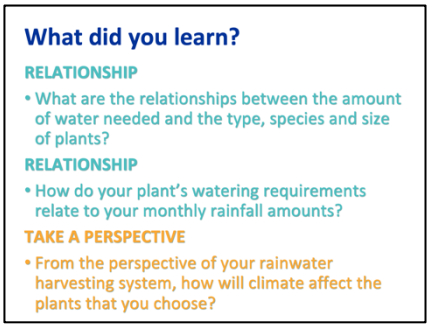
- *Low Water Use Plants*
- *A Guide to Native Plants for the Santa Fe Landscape*
- *Recommended Trees for Santa Fe*

Have students record their plant selections using:

- Handout: *Lesson 6 Proposed Plants Worksheet.docx*
- Handout: *Lesson 6 Proposed Plants Canopy Area.docx*

Using the handouts, students will calculate how big their plants will grow, and the total area plants will take up. They will use these calculations in the next lesson. Have students add their plant selections to their site sketch from lesson 4.




## *Conclusion*

**DISTINGUISH:**

- **What are the differences between native and non-native plants for our region?**

**BUILD THE SYSTEM:**

- **What are the parts of plant water demand?**

**RELATE**

- **What are the relationships between the amount of water needed and the type, species and size of plants?**
- **What are the relationships between the amount of water needed and the type, species, and size of plants?**
- **How do your plant's watering requirements relate to your monthly rainfall amounts?**

**TAKE A PERSPECTIVE**

- **From the perspective of your rainwater harvesting system, how will climate affect the plants that you choose?**