THE UNIVERSITY OF ARIZONA
Cooperative Extension

ARIZONA
project WET
WATER EDUCATION TODAY

Planting for a Rainy Day Curriculum Unit, 1st ed.

Revised to assist high school teachers in meeting the 3-dimensional learning requirements of the Arizona Science Standards (adopted October 2018).

Developed by Arizona Project WET using the *Arizona Conserve Water Educator's Guide*, 1st edition, 2007, *Project WET Curriculum and Activity Guide 2.0,* 2011.

Thank you to our sponsors for supporting the development of this program.

Planting for a Rainy Day - Curriculum Unit:

INTRODUCTION

Planting for a Rainy Day (PfaRD) is a unit of study designed to help students understand the interaction between Arizona environments and rainwater. During this unit students consider the stormwater challenges in developed environments compared to "natural" ones. Students explore how rainwater may be managed in and around communities. They design rain garden basins that can address drought/flooding issues by employing STEAM skills and academic practices. The big ideas of this learning unit are:

1. Excessive heat, flooding, habitat loss, and water sustainability are concerns that exist in almost all developed/urban areas.
2. Find examples of these issues within the "watershed" of the school grounds.
3. Design a sustainable rain garden basin to mitigate excessive heat, flooding, and habitat loss.

Students identify a "hot, dry" patch of pavement in their personal watershed (home/school/community) and determine storm water drainage patterns. By calculating the amount of runoff that can be collected in the area, and then applying rainwater harvesting and smart landscaping techniques, students will design an attractive water-wise rain-garden basin habitat that can help reduce flooding, support biodiversity and create a cooler, healthier community.

UNIT GUIDING QUESTIONS:

How can we harvest rainwater to transform an impermeable plot of land into an outdoor oasis?

OBJECTIVES:

- **Define** transpiration and evaporation to explain how these water cycle processes are related to plant and animal adaptations for water conservation and temperature management.
- **Identify** native plants and animals that live in Arizona's deserts and decide which native plants are appropriate for creating a water-wise, biodiverse healthy garden.
- **Analyze** the "watershed and groundwater systems" of their school grounds, determining rainwater drainage patterns, surface porosity and temperatures, and places where water leaves the grounds or connects to groundwater.
- **Calculate** the amount of rainwater that can be collected from roofs of varying sizes to develop strategies for storing and using rainwater while also implementing strategies for natural cooling and remediating "hot pockets" on school grounds.
- **Explore** the connections between the processes of the water cycle, the urban watershed environment, and the groundwater system, in creating a rain garden basin that can also contribute to a healthy ecosystem/habitat and community.
- **Create** design drawings for a water-wise garden with supporting details and documentation (species list, water use, plant hardiness, wildlife interaction, and seasonal implications) that support a water efficient, biodiverse desert urban landscape.

ARIZONA SCIENCE STANDARDS

- **Elements of Earth and Space 8.E1U3.8** Construct and support an argument about how human consumption of limited resources impacts the biosphere.
- **Elements of Earth and Space Plus HS+E.E1U1.5** Obtain, evaluate, and communicate information on the effect of water on Earth's materials, surface processes, and groundwater systems.
- **Elements of Earth and Space Plus HS+E.E1U3.9** Construct an explanation, based on evidence, for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- **Elements of Earth and Space Plus HS+E.E1U3.10** Ask questions, define problems, and evaluate a solution to a complex problem, based on prioritized criteria and tradeoffs, that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- **Elements of Life Plus HS+B.L4U1.2** Engage in argument from evidence that changes in environmental conditions or human interventions may change species diversity in an ecosystem.

PfaRD UNIT OF STUDY AT-A-GLANCE:

Unit Guiding Question:

- How can we harvest rainwater to transform an impermeable plot into an outdoor oasis?

Teacher Professional Development Workshop

- 2.5-hour workshop led by APW staff

APW Staff Drops of Class Materials:

- Plant & Animal Adaptation Card Game
- Spiralbound Student Handbook
- Roof Demo Kit (aluminum pan, soil/sand, clay, plastic house)
- Faux Plant Exhibit

Lessons for teachers to do:

- **Lesson 1: Estivation, Xerophytes, and Ephemerals (1 class period)**
  - Thirsty Plant Activity
  - Discuss plant and animal adaptations & play game
  - Define watershed and students identify where they live and climate using maps
- **Lesson 2: Smart Landscapes – Part A (1 class period)**
  - Discuss low-water use landscaping and show students before and after photos
  - Can utilize Student Handbook and materials from APW staff
  - Do soil activity and watershed tour of school grounds
- **Lesson 2: Smart Landscapes – Part B (1-2 class periods)**
  - In small groups students design their own landscape garden – working through copy pages and calculations and including all four design requirements.
- **Lesson 2: Smart Landscapes – Wrap-up & Sustainability (1 class period)**
  - Groups present their landscape design and class votes
  - Could they apply what they have learned to other areas in the community?

STUDENT PRE-ASSESSMENT – Click Here

Before: Please administer the survey before students start any of the lessons. It is not a test and please feel free to facilitate reading the questions as a class.

ATTEND PROFESSTIONAL DEVELOPMENT TEACHER WORKSHOP:

Teachers will get a 2.5-hour workshop that introduces them to the unit of study and best practices for teaching the lessons/activities in fun, engaging ways. At the workshop APW Staff will go over slides, lessons, resources and hands-on models that are available for this unit.

APW STAFF BRING MATERIALS FOR SCHOOL

Before you start the lessons, you can schedule Arizona Project WET staff to come deliver some materials to your school. This will consist of a class set of:

- Plant and Animal Adaptation Card Game
- Spiralbound Student Handbooks (one per group)
- Roof Demo Kit (aluminum pan, soil, clay and plastic house)
- Faux Plant Exhibit

INTRODUCTION & LAYOUT OF THE UNIT

Teachers will receive the Unit of Study during the Professional Development Workshop that they attend. A pdf copy of the Student Handbook can be found in your resources folder if you want to throw it up on a big screen in front of the class while your students review the hard copies.

In this unit, students will take on the role of eco-designers, learning how to work with nature, and not against it to solve some of today's most pressing environmental challenges. As climate change increases, the intensity of storms and urban development alters natural landscapes. The ability to manage rainwater wisely has never been more important. This project asks students to think deeply about how we capture, absorb rainwater, and how the thoughtful use of native plants can help reduce flooding, support biodiversity, and create cooler, healthier communities.

As you move through the lessons you may want to have the students create a driving questions board… where you can continuously add new ideas and vocabulary to the discussions:

Some leading questions that might help with this are:

- How do you know when you wake up in the morning that you are in Arizona and not in Florida?
- What are some desert plants that have special adaptations to live here?
- What are some animals that have special adaptations to live here?
- Why are these adaptations important here in Arizona?

DO THE LESSONS

We then suggest doing the 2 lessons below with your students. There are some notes/observations pages for you to use here for the students to write down ideas or evidence that they think might help them design the best rainwater garden as they learn more information in each lesson.

WATER CYCLE & WATERSHEDS - AMAZING ADAPTATIONS

LESSON 1: ESTIVATION, XEROPHYTES, AND EPHERMALS

Investigative Question: How have the animals and plants living in Arizona adapted so that they can survive here? How does transpiration and evaporation relate to plants' and animals' adaptations for water conservation and temperature management when living in Arizona? What is a watershed and which watershed do you live in within Arizona?

Activate: Students brainstorm desert plants and animals with special adaptations for their environments. Students define the terms transpiration and evaporation and then explain the advantages and disadvantages of those terms in plants and animals that are trying to conserve water and stay cool. Students define what a watershed is and then use maps to identify where they live in Arizona, and use multiple maps to compare water availability, temperature and rainfall in different areas to discuss ways the climate of a place influences the types of ecosystems and habitats that are found there.

Check: Students play a matching game to identify Arizona animals and plants and their water conservation strategies by analyzing clues that describe various species' adaptations for the arid climate.

WATERSHEDS, GROUNDWATER & SUSTAINABILITY

LESSON 2: SMART LANDSCAPES (PART A, PART B & WRAP UP)

Investigative Questions: What does water-efficient landscapes or xeriscaping mean? How can you transform your school grounds into a water-efficient oasis?

Activate: Students explore the "watershed" of their school grounds to determine rainwater drainage patterns, calculate the amount of rainwater that can be collected from roofs of varying sizes, and then apply rainwater harvesting and smart landscaping techniques in the design of an attractive, water-efficient section of a school's grounds.

Check: In groups, students will create and then present their water-efficient landscape designs, and the class will vote on which one should win according to the rubric for smart landscape design.

STUDENT POST-ASSESSMENT- Click Here

After: Please administer the same survey again after completing the unit. Ideally, no more than four weeks after the water festival event.

Lesson 1 – Estivation, Xerophytes, and Ephemerals

Investigative Questions:

- How have the animals and plants living in Arizona adapted so that they can survive here?
- How does transpiration and evaporation relate to plants' and animals' adaptations for water conservation and temperature management when living in Arizona?
- What is a watershed and which watershed do you live in within Arizona?

Slides: **Lesson 1 Slides PowerPoint**
Lesson 1 Slides PDF
Lesson 1 Slides Google

Materials Needed:

- Water Cycle Diagram (optional as refresher)
- Water Cycle Teacher Answers
- Thirsty Plant Worksheet
- Plastic zip lock bag per student
- Teacher Page – Arizona Adaptations & Species Matches
- APW Materials left for class to utilize: Game & Student Handbook
  - **Adaptation Game** laminated & ready: (Set of Arizona Adaptations Cards & Set of Arizona Species Cards included)
  - **Student Handbook per group which includes:**
    - Copies of Arizona Maps
    - Background Info on Arizona Plant and Animal Adaptations
    - Arizona Biomes
- Entire PDF of Estivation, Xerophytes and Ephemerals Lesson (optional)

Materials Needed for optional Watershed Activity:

- Instructional Video Link
- Spray bottles
- 2 pieces of 8-1/2 by 11 white paper per student or two pieces of large poster paper/butcher paper per group (scrap paper can be used if blank on one side)
- Water soluble markers (green, blue, brown, red, purple)
- Scotch Tape

Lesson 1 – Estivation, Xerophytes, and Ephemerals

Warm Up:

Understanding Transpiration and Evaporation:

1. Set-up Thirsty Plant Experiment: can be done at home as well

1) Give each student an empty plastic bag. Have students examine their bag and record any observations on their worksheet.

2) Take students outside to an area with several plants (a variety of types is nice, and **sunny areas work best**). Have students carefully place the bag over several leaves of their plant (try for 2 or 3). (You may want to have a few larger plastic bags on hand for some groups who choose large trees or plants with large leaves.) Each student should count and record the number of leaves in their bag, record the time, and then take a moment to estimate the total number of leaves on the plant.
3) Back in the classroom, have students predict what they think will happen and write down their predictions.
4) Wait to collect the bags for approx. 60 minutes, or whatever time frame works for your class. (This is a good time to move on with the rest of the lesson while you wait for your experiment).

2. Ask students this question: "How do you know when you wake up in the morning that you are in Arizona and not in Florida?" To initiate a discussion of climate and the environment and how it varies from place to place. How does living in Arizona's climate (vs. someplace like Oregon) influence their behaviors and lifestyle (e.g. the clothing they wear, the types of plants growing in their yard)? What about the plants and animals that are adapted for their area of Arizona – could a Gila monster survive in Alaska? Could a walrus survive in the Sonoran Desert? Why don't we see saguaro cacti anywhere other than the Sonoran Desert? Many desert organisms have adapted in ways that allow them to survive and thrive in hot, arid environments.

3. Ask students to brainstorm desert plants and animals with special adaptations for their environments. Remind them that plants, as well as animals, have evolved mechanisms and structures for conserving water and for staying cool (a very important element of conserving water in the desert). Make sure you cover the adaptations and species on the Adaptations and Species cards. You can have students read the Background Info on Arizona Plant and Animal Adaptations to assist in this discussion.

Investigations Activity:

1. Define the terms ***transpiration*** and ***evaporation***. **Ask students** how having the following characteristics would enable plants to conserve water and stay cool: few or no leaves; waxy coating on leaves; shallow radial roots; deep tap roots; water storage capacity. **Ask students** to explain the advantages and disadvantages of evaporation and transpiration in plants and animals that are trying to conserve water and stay cool.

2. **Distribute copies of the** AZ maps found in **Student Handbook** and have students identify where they live on the Arizona Reference map. What is a ***watershed*** and **which watershed do they live in**? What plants and animals live in their area? What adaptations have they made to survive? Then have students identify other areas on the Arizona map and compare water availability, temperature, and rainfall in these areas, using the appropriate maps. Discuss the ways that the climate of a place influences the types of

Lesson 1 – Estivation, Xerophytes, and Ephemerals

ecosystems and habitats that are found there. What kinds of plants and animals live in these different habitats and how have they adapted?

- Feel free to use the slides provided above. Ask students: **What is a watershed?** Split the word in two and ask, **what is water?** (we are just looking for a simple definition here).
- **What is a shed?** They will likely know that sheds store something. **What does a watershed store?** Water. Then, think about shed as a verb. **What does it mean to shed?** They will likely be able to relate the word to a pet. A pet sheds hair. **What do you think watersheds shed?** Water. We relate this to water running off the land. **Do you think a watershed looks like a toolshed?** No.
- ***A watershed is a land area that drains to the low points.*** What marks the **edge or boundary** of a watershed? The high points or mountains. What are the **low points**? The rivers or valleys that may become rivers when it rains. When managing a watershed, we are managing both the **land and water** … everything within the boundaries.

3. Tell students they are going to **play a matching game** in which they must match a species to its adaptations, using clues about how it has learned to survive in the arid climates of Arizona.

4. Distribute Arizona Adaptations Cards and **Arizona Species Cards** to the class, taking care to ensure that every card has a match. If there are more students than cards, have students pair up. Answer key can be found here on Teacher Page – Arizona Adaptations & Species Matches.

5. Explain that some cards list characteristics, mechanisms, or behaviors that a specific plant or animal has adopted for survival in Arizona, and that other cards have pictures of specific plants and animals in Arizona. Based on the clues, students find their match. If they have an Adaptations card, they find the Species picture card that it describes. If they have a Species card, they find the person that has the adaptation card that matches it. Encourage all students to move around the room and talk to each other until they find their match.

6. When students have found their match, they must pair up and sit down together.
Grades 7 through 12: Tell students not to show their cards to anyone after they have found their match. After playing the game, each pair of students come to the front of the room individually and begin reading the Adaptation Card clues for their plant or animal one at a time, without revealing the answer. The rest of the class should try to give the species' name correctly after as few clues as possible. ("Knowledge Bowl" style).

Wrap Up:

Discuss how adaptations enable species to live in their environment. Ask students to summarize water- and heat-related adaptations included in the game by categorizing types of adaptations (avoiding heat, storing water, dissipating heat, etc.).

Lesson 1 – Estivation, Xerophytes, and Ephemerals

Optional Investigation Activity (Watershed Model):

We are going to make a model of a land area.

1. Put a piece of (8 ½ by 11 or poster size white paper) down on the table in front of you (blank side up if using scrap paper).
2. Crumple the second piece of (8 ½ by 11 or poster size white paper) blank side facing out if using scrap paper.
3. Un-crumple the paper until you can find all four corners, it should **not** be perfectly flat.
4. Tape all four corners of the crumpled paper onto the flat piece of paper in front of you. Leave the crumpled paper as high as you want. It should now look like mountains or a raised relief map.
5. Using **water soluble** markers, draw symbols that represent different features on your relief map using the following key:
   a. **Green** marker to draw a line along all the ridges (the up folded areas).
   b. **Blue** marker to draw a line along all the valleys (the down folded areas).
   c. **Red** marker to indicate any abandoned mines with a * symbol.
   d. **Purple** marker to indicate cities with a # symbol.
   e. **Brown** marker to indicate a farm with a colored-in area.
   f. Add additional colors as wanted to represent applicable things that you are studying.
6. You have made a model of the land surface or a raised relief model.
7. Predict how water is going to flow on your model when we spray them with water. **What direction will water flow? Why?**
8. Are there areas on your model that have no outlet and will store water?
9. Have students take their models outside where they will spray their model with a spray bottle, in other words they are going to make it rain!

While Outside:

Have students form a circle and place their models in front of them toward the middle of the circle. Share spray bottles and give all students time to make it rain on their models. After students have sprayed their models, ask students to recall the definition of a watershed. **What is the edge or boundary of a watershed?** The high points. **What color are the high points on the model or map that you made?** Green.

- **What are the parts of your watershed?** Have them point out their answers on their maps. The water, the city, the farm, high points, low points, etc. **What is the white area?** If they don't know, ask: **What is the definition of a watershed?** Give them time to think about this. The white is the land area. **What could be on the land area other than cities, old mines, and farms?** Forests, deserts etc.
- Do a circular gallery walk so that students can view other students' models. **How are they the same? How are they different?**
- Discuss each of the following questions with your students. Did any of your cities flood? If there was pollution on your city streets, could it get into your farm field? Could excess pesticides or fertilizers from your farms go into your cities? Could old mines affect water coming into cities or farms?
- **What is a watershed again? Do you think you live in a watershed?** Yes, we all live in a watershed.
- **What is a watershed a part of?** Give them time to think about this, talking with the person next to them. A landscape or bigger land area, our community, our water supply. It can also be a part of another watershed.

Lesson 2 – Smart Landscapes – Part A

Investigative Question:

- What does water-efficient landscapes or xeriscaping mean?
- How can you harvest rainwater to transform an impermeable plot of land on your school grounds into a water-efficient oasis?

Slides: **Lesson 2 Part A Slides PowerPoint**
Lesson 2 Part A Slides PDFs
Lesson 2 Part A Google Slides

Materials Needed:

- Spray Bottle
- Colored pencils – 1 per group
- Rulers
- Student notes/observations pages - one per student/or group
- APW Materials left for class to utilize – Fake plants & Student Handbook
  - **Roof Demo Kit:** (aluminum pan, soil, clay, miniature house)
  - **Student Handbook per group which includes:**
    - Background Info on Water Efficient Landscapes
    - Rubric for Smart Landscape Design
    - Images of Landscapes before and After
    - Native Plants for Water-Efficient Landscapes Student Copy Pages
- Storm to Shade Video of xeriscape garden - play at beginning of lesson
- Storm to Shade Green Infrastructure – play at end of lesson
- Storm to Shade Infographic for Green Infrastructure

Warm Up:

1. **Discuss what is meant by the terms low-water use landscaping, Xeriscape** (pronounced zeer-ih-scape), **and water-efficient landscaping.** These terms are often used interchangeably to refer to landscapes that need little water to maintain them. Briefly discuss the Rubric for Smart Landscape Design or "smart" landscaping and see Background Info on Water Efficient Landscapes in the student handbook.

2. **Use slides above or the student handbook to show students the "before and after" photographs of different landscapes.** Students can also spend time exploring the materials APW staff dropped off (the student handbook, and fake plants) to think about what is important for a water efficient garden. When a homeowner, business owner, or institution is deciding what type of landscaping to maintain, the choices are endless. However, in the hot and dry climates found in much of Arizona, outdoor water use for landscaping can consume tremendous amounts of water. Choosing landscaping that requires less water can conserve significant amounts of water, as well as requiring less time to maintain. Water efficient landscapes center around the use of plants that are adapted for arid conditions, often native species that evolved in the local environment.

Lesson 2 – Smart Landscapes – Part A

Investigations Activity:

1. **Review with students, "what is a watershed?"** Remind them of the definition learned the day before "a land area that drains or flows to a low point". This should be kept in mind as you proceed with today's activities.
   - Use the slides provided above to introduce or review with your students some urban watershed topics.
     - Have students define what a **permeable landscape** is and how water behaves on a permeable surface - water soaks or infiltrates into the soil. Once in the soil, it can go into plants or keep traveling further to reach groundwater. Some water also evaporates. Have students write down examples of permeable landscapes in their notebooks.
     - Have students define what an **impermeable landscape** is and how water behaves on an impermeable surface - water stays on the surface or runs off. Water can also evaporate.
     - Have students define what the **urban heat island effect** is and how water behaves in this landscape – there may be less rain overall because of the heat dome or if there is rain there is more runoff that can't soak in. Water can also evaporate faster. Have students write down examples of things that might increase heat (pavement, buildings, AC units, cars) or suggest things that might cool down the urban environment (trees).

2. **Ask students if they have ever tried to capture and store rainwater from their roof or water from a stream or arroyo.** Discuss some of the benefits of using rainwater; it is free; using it saves tap water; it doesn't contain salts, so plants love it; if it is captured, it doesn't flood the streets. When a yard or ground is designed to make maximum use of rainwater by having topography that slows its flow across the ground (berms, swales, etc.), more water can seep into the soil and help sustain soil moisture levels between rain events. This process of slowing down and spreading out water also helps more rainwater reach our **groundwater** system.

3. **Have students gather around the soil pan. Make sure you start with level, evenly deep soil.** Prop one end of the pan on a book with a one-inch spine to create a slope.
   - Use the spray bottle to simulate rainfall on the "roof" of the house
   - Observe the way the water runs off the roof, where it causes indentations to form in the soil, what runoff and erosion patterns result, etc.
   - Experiment with building small berms to slow the flow of runoff. Ask the students to brainstorm ways they could control the runoff and capture it to store it for future use.
   - Talk about using gutters to direct rainwater, cisterns or rain barrels to store it, and using the topography of the land to control where water runs.
   - Ask them to think about how water flows off the flat roof of their school. Have they observed this happening? How is it directed to the ground and where does it flow after that?

4. **Take the class outside for a "watershed tour" of your school grounds.** Have each student bring Student notes/observations pages to record their observations, and the **student handbook** so they can reference the questions below and their Native Plants for Water-Efficient Landscapes copy pages (they will be looking at the photos of native plants later in the tour).

Lesson 2 – Smart Landscapes – Part A

5. **Focus on the area around the building first.**
   - Look for places where water drains off the roof, and follow the paths water would take, noticing where it leaves the school grounds. Where are high and low areas?
   - Does the rainwater get used to water landscaping, or does it get directed off the school grounds as quickly as possible?
   - Are there design features in the parking lots where water can flow into low, vegetated areas, or is it curbed? Is most of the ground surface permeable or impermeable to water?

6. **After you have explored the rainwater drainage patterns of your school grounds and identified high and low areas, areas of high runoff, and areas where water can soak in, ask the students to brainstorm ways to keep the water on the grounds where it can be used to water landscaping and recharge the ground water.**
   - How could the rainwater be stored so that it can be used when needed?
   - Ask them to think about where they would place rainwater holding tanks, and how they would get the water from the tanks to the landscaping.
   - How big would the tanks need to be? Calculating the size of holding tanks will be practiced in *Part II* of this activity.
   - Can they think of ways to restore more natural topography to the school grounds to keep water from running off?
   - Are there places where concrete and asphalt could be replaced with more permeable surfaces such as sand or gravel to allow more water to soak into the ground?

7. **Now ask students to focus on the vegetation.**
   - How many different species of plants do they notice? Are there trees, shrubs, cacti, etc.? How much of the grounds are covered with turf grass? Are the places that have grass used for play areas and eating areas, or are they just to be looked at?
   - Have the students look at the photos of native plants in their packets. Do they see any of the native plants that are included in their packets growing on the school grounds?
   - Ask them to think about where they would incorporate native species in the landscaping and whether or not the turf grass (which uses high volumes of water) is necessary in all the places it is currently growing. Replacing turf grass with native vegetation (in decorative areas) or artificial turf (in playing areas) can conserve a lot of water.

Additional Resources:

- City of Tucson Storm to Shade
  - Green Stormwater Infrastructure – animated design example
  - Storm to Shade video by Tucson Water
- https://www.weather.gov/wrh/climate?wfo=twc
- https://storymaps.arcgis.com/stories/b9c35f205ea14015a23b446ff75eeeb4
- Rain Log - https://rainlog.org/map#6.3/34.234/-111.93
- Green Stormwater Infrastructure for Residents – City of Phoenix
- Landscape Plants for the Arizona Desert – Low-Water-Use Plants
- Landscaping with Style
- Low Water Use & Drought Tolerant Plant List – Tucson AMA Area

Lesson 2 – Smart Landscapes – Part A

- Passive Water Harvesting
- When It Rains It Runs Off
- RainScapes Brochure
- Rainwater Storage System
- Harvesting Rainwater
- Welcome Wildlife to Your Garden
- Tucson Water Rainwater Harvesting Maintenance Tips Video
- https://wateruseitwisely.com/saving-water-outdoors/rainwater-harvesting/
- H is for Habitat
- Landscape for Wildlife
- Backyard Habitat
- Guide to Water-Efficient Landscaping – Tucson Water
- Plants for the Arizona Desert
- Build a Rain Garden
- Arizona Groundwater Videos
- **Optional Investigation Activity:** HS Worksheet Runoff & Heat Investigation

Lesson 2 – Smart Landscapes – Part B

Investigative Question:

- How can you harvest rainwater to transform an impermeable plot of land on your school grounds into a water-efficient oasis?

Slides: **Lesson 2 Part B PowerPoint**
Lesson 2 Part B Google
Lesson 2 Part B PDF

Materials Needed:

- Colored pencils – 1 per group
- Rulers
- **Student Handbook per group which includes:**
  - Background Info on Water Efficient Landscapes
  - Rubric for Smart Landscape Design
  - Images of Landscapes before and After
  - AZ Climate Data
  - Arizona Physiographic Provinces Map per group
  - Steps for Designing Your Water Efficient Landscape Student Copy Pages
  - Sample Landscape Design: Step 1 and 2
  - Rainwater Harvesting Calculations Student Pages
  - Native Plants for Water-Efficient Landscapes Student Copy Pages
- Entire PDF of Smart Landscapes Lesson (optional)

Investigations Activity:

1. **Tell students that they will be designing their own landscaping for a portion of a school's grounds, with systems for capturing and using their rainwater as well as native plants that are adapted for desert environments.** Refer back to notes from the activity on plant adaptations for arid environments, "Estivation, Ephemerals, and Xerophytes," for information about why these species are able to survive with little water.

2. **Direct the class to work through the calculations on the** Rainwater Harvesting Calculations Student Pages**.** Provide the AZ Climate Data for students to use as they calculate their roofs' water yields.

3. **Hand out the Sample Landscape Design: Step 1 and 2 Student Copy Pages and emphasize that this is only an example to help them visualize what their completed project may look like (this is all in the Student Handbook).** Share the Rubric for Smart Landscape Design with them and remind them to focus on

Lesson 2 – Smart Landscapes – Part B

efficient use of rainwater (keeping rainwater on the grounds), temperature control, and use of native plants.

4. **Hand out the Steps for Designing Your Water Efficient Landscape Student Copy Pages and review the steps as a class.** Encourage students to think about the shade the building provides and which plants like full sun and which like partial sun when they are deciding where to place them. Ask them to think about ways to naturally cool the school building as they design their landscapes.

5. **Have students work in groups designing their Water-Efficient Landscape Garden:**
   - Students may use their notes from their watershed tour of the school grounds (*Part I* of the activity) to shape their landscape design, or they may create a hypothetical school yard.
   - Allow students to work in groups as they design their group landscapes and complete the calculations.
   - Remind them to refer to the *Native Plants* pages you handed out to them earlier in the activity. (You may want to develop an additional, more detailed assessment rubric for the project that specifies, for example, the number of plants required, a gutter, cistern, etc.)

You can decide to let your students have one to two class periods to create their Water-Efficient Landscape Design (completely up to you), but we then expect the wrap-up to take another class.

Lesson 2 – Smart Landscapes – Wrap Up & Sustainability

Investigative Question:

- How can you harvest rainwater to transform an impermeable plot of land on your school grounds into a water-efficient oasis?

Slides: **Lesson 2 Wrap Up & Sustainability PowerPoint**
Lesson 2 Wrap Up & Sustainability Google
Lesson 2 Wrap Up & Sustainability PDF

Materials Needed:

- Rubric for Smart Landscape Design
- Student Sustainability Worksheets (optional)
- Sustainability Worksheets Answers for Teachers

Wrap Up: (expected to take a class period)

1. After each group has finished their landscape designs, discuss the answers to the calculations on the Rainwater Harvesting worksheet (answers below).
2. Have each group share their landscape design and have the class vote on who should win, focusing on items in the rubric. Please feel free to send pictures of the final designs.
3. Discuss the activity. What were the challenges presented by the different areas they chose around the school? Are there concepts that they learned through doing the activity that they could apply at home?

Rainwater Harvesting Calculations
Answer Key

Roof Square Footage:
SCHOOL #1 = 36,800 square feet
SCHOOL #2 = 154,400 square feet
SCHOOL #3 = 85,950 square feet

You can also wrap up the unit with sustainability and stewardship slides provided here:
This will help students understand their **water footprint** and what is meant by **direct** and **indirect water use**. This all contributes to being a member of our greater community and what kind of future we want to build.