Pre-Festival Lesson 2: Water Movement Between Earth Systems

Investigative Question:

- What are the relationships between plants and the water cycle?
- What are the relationships between earth materials and the water cycle?

Summary: The water cycle connects Earth systems, and this lesson explores those relationships. Students compare the movement of water through diverse substrates. Students conduct an experiment to see how water moves through plants in the process of transpiration.

Reference: adaptation of "Thirsty Plants," *Project WET Curriculum and Activity Guide*, 1st edition, 1995, pg. 116-121. "Get the Groundwater Picture" Part 2, *Project WET Curriculum & Activity Guide 2.0*, 2nd edition, 2011, pg. 143-154.

Time Frame: 50 minutes

Cross Cutting Concepts Demonstrated:

- cause and effect
- systems and system models
- structure and function
- stability and change

Science and Engineering Practices Integrated:

- develop and use models
- construct explanations and design solutions

Materials Needed:

- Clear plastic ziplock bag for each student.
- Thirsty Plants Data worksheet
- Transpiration Diagram (see below)
- Clear plastic cup for each student (could be something out of recycle bin)

☆ The Thirsty Plant activity can be set up earlier in the day. The activity works best if bags can be on plants in the sun for approx. 1 hour.

Pre-Festival Lesson 2: Water Movement Between Earth Systems

Warm Up:

Feel free to use the slides provided above to introduce this lesson. Ask students**: What are some examples of places water can go in the earth's natural system?** List the places on the board. If they do not say plants, ask students: **Where can water go from the soil?** Hopefully, this makes them think of plants. **How does water get into plants?** Most students know that it is through the roots. **How does water get out of plants?** They may not know this yet. Let them know that they will be exploring water's movement through plants today.

Go back to the list of places water can go in the Water Cycle. If they have not listed groundwater, ask students: **Where else can water go from the soil?** Hopefully, this makes them think downward and to groundwater, though they may have no prior knowledge of groundwater. **How does water get into the ground?** Let them know that they'll also be exploring groundwater's movement through earth materials today.

Lesson Sequence:

Thirsty Plant Set-up:

Thirsty Plants Activity – this activity can also be done at home using the thirsty plants data sheet.

1) Give each student an empty plastic bag. Have students examine their bag and record any observations. ☆ See above.
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 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 earth material section of the lesson while you wait for your experiment and then complete this after).

Pre-Festival Lesson 2: Water Movement Between Earth Systems

Earth Materials Modeling – Whole Body Simulation

1) Ask students: **What do we mean by earth materials?** Rocks of various sizes down in the earth.
2) Select ¼ of the students in the class to act as water molecules. The rest of the students will represent earth materials.
3) Round 1- **Water Movement through Gravel**: Students become gravel by stretching their arms out away from their bodies. Students should be able to rotate all the way around and touch only the tips of other students' fingers. Students should then drop their hands to their sides. The students representing water molecules will start on one side and move (flow) all the way through students representing gravel to the other side (see page 145 in PW 2.0 book). The water molecules are moving down due to gravity through the earth materials. Say **"on your mark, get set, go"** and time how long it takes the water molecule students to move through the gravel. Record the time.
4) Round 2- **Water Movement through Sand**: Choose a different ¼ of the students to act as water molecules. Students become sand by putting their hands on their hips and rotating all the way around so that only the tips of other students' elbows touch. Students should then drop their hands to their sides. The goal of the students representing water molecules is to move (flow) all the way through students representing sand from one side to the other (see page 145 in PW 2.0 book). Say **"on your mark, get set, go"** and time how long it takes the water molecule students to move through the sand. Record the time.
5) Round 3- **Water Movement through Clay**: Choose a different ¼ of the students to act as water molecules. Students become clay by keeping their arms at their sides and standing shoulder to shoulder. The goal of the students representing water molecules is to move (flow) through students representing clay (see page 145 in PW 2.0 book). But there are not many pathways. This simulates water trying to move into clay. Tell them the clay may keep the water from going through at all. Over a long period of time water can soak in between the fine plates of clay. But in normal time frames, clay acts as an impermeable layer. Stop the simulation there.

Earth Materials Video:

Show students the video of water moving through different earth materials https://youtu.be/_KEjB-u4dQo. The first part of the video demonstrates capillary action in transpiration. At **3:30** minutes the percolation experiment starts. You can also use this online simulation - https://has.concord.org/groundwater-movement.html. Have students discuss or write about how water moved through each earth material and what that means in regard to transpiration and percolation.

Pre-Festival Lesson 2: Water Movement Between Earth Systems

Earth Materials Experiment:

1) Have each student find a cup that will allow for holes to be poked on the bottom. A clear plastic cup is preferable.
2) Students should make holes in the bottom of their cup, about a dozen of them. Tip: a thumbtack/push pin makes a great tool to make the initial hole then using the tip of a pen to enlarge the hole, but students may need assistance from an adult if they need to use a sharper object
3) Students should identify and fill the cup with any earth material from an outdoor area (examples - gravel for a tank or landscape, sand for a sandbox, etc.). They should collect it from only one area or one type of material.
4) If students will do the experiment in the classroom, have containers to catch the draining water, as well as a container of water and a towel in case of spills. Otherwise conduct the experiment outside.
5) Have students discuss what their earth material looks like, the size, observations, etc. Have students pour their water in their cup. You can have them count all together and then report after the experiment how many seconds it took for the water to go through.
6) Create a data table to record the type of material and how long it took the water to move through it as you do the experiment with students. Discuss with students where the water was as it moved through (in the pore spaces) and compare their observations. Did the size of the earth material make a difference for how fast the water moved through?

Discuss the results. **Ask students to describe how water moves through the earth materials. Does it move through the pieces of gravel themselves?** No, it moves through the spaces. **Which earth materials did water move through the fastest?** Gravel **Why?** The spaces were bigger. We call these spaces between earth materials pore spaces. When water moves through spaces in rocks, we say they are permeable. **What do you think permeable means?** Water can move through it. **When we think of water moving into the clay what happens?** It cannot get through. **What do you think we call this clay layer?** Impermeable. **Can you summarize what we know from the simulation?** Water moves through some earth materials and not through others.

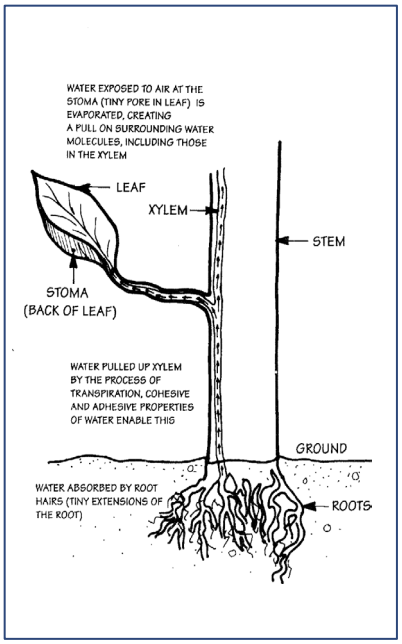
Thirsty Plants – Finish activity:

5) Have students carefully remove the bag from the plant, leaving the leaves in place. Have students take one leaf from the plant/tree they had their bag on for identification. Make observations about how much water is in the bag. Have students hold up their bags showing how much water was collected in each bag.
6) Have students do a gallery walk, comparing how much water is in each bag and the plant type and leaf size**. What claims can they make based on evidence?** Ask students: **Where did the water come from and how did it get there?** Show the diagram below.

Pre-Festival Lesson 2: Water Movement Between Earth Systems

7) Ask students: **What form of water goes into the roots?** Liquid. **What form of water is in a plant?** Liquid. **During the day, increased heat energy will cause water to move into a pore in the stoma**. **What causes the heat energy?** The sun. It is the driver of water moving through a plant. **So, what is not in this diagram that is needed?** The sun. **When the water molecule leaves the pore, what form do you think the water is in?** Gas or vapor. **Would you be able to see it?** No, it's invisible to the eye now. Explain that during this process, water molecules change form from liquid to gas or vapor when the molecules leave a plant. **Do you know what this process is called?** Transpiration. When the Sun heats up the water molecule on the plant's surface and changes it to a gas it also pulls the next molecules up through the plant. This is called capillary action and happens because water sticks to itself and to other things. This is an important property of water. Show students the Capillary Action section of the earth material video as an example of what it looks like- https://youtu.be/_KEjB-u4dQo.

8) Have students answer these questions: **How many leaves were in your bag? How many leaves did you estimate were on your tree? How much water do you think would come from the entire tree in that same time? How about all the trees in your neighborhood? Do you think transpiration plays an important role in the water cycle?**



Wrap-Up:
Summarize today's learning by having students explain how plants transpire and groundwater moves through earth materials. Ask them to include all the details that they remember. Have students return to their water cycle diagram and fill in any missing places and processes that they learned about in this lesson. They should add **groundwater** and **transpiration** and give an example of how the **sun is the energy driver** to the water cycle.

*Students should complete the Lesson 2 section of their AWF Water Notes handout to record evidence and construct explanations based on that evidence. Students will also look at the lesson from the perspective of structure and function - Structure is how something is formed or organized. Function is something the structure does or is meant to do.

Other Resources:
Water Science School - https://www.usgs.gov/special-topics/water-science-school

Thirsty Plants Data Sheet

Use your science notebook to create a table like below to record your data as you work through the experiment. Alternatively, if you would like you can print this worksheet and record your data.

Today's Date:	
Get an empty plastic baggie, examine your bag, and record any observations:	

Go outside and find a sunny place with plants or trees. Choose a plant or tree and place your bag over a few of the leaves. Close your bag as much as possible without hurting the plant/tree.

Time bag is placed on plant/tree:	
Temperature:	
Weather observations:	
Type of plant/tree (if known):	
Number of leaves in bag:	
Estimate of number of leaves on entire plant/tree:	

Leave the bag on the plant or tree for an hour or so.

Make a prediction of what will happen when the bag is left on the plant/tree:	

Remove your bag carefully and take one leaf for identification. Make any observations including if there is any water in the bag and how much. Bring your bag to class.

Time bag is removed from plant/tree:	
Observations:	

Transpiration Diagram