THE WATER CYCLE GAME

DESCRIPTION

Students play the roles of reservoirs and hydrologic processes to illustrate the movement of water in the water cycle.

PHENOMENON

How is climate change impacting the cycling of water through Earth's reservoirs?

GRADE LEVEL
6 – 12

OBJECTIVES

Students will:
- Interpret a diagram of the water cycle
- Plan the movement of water from one reservoir to another
- Describe water cycle processes

TIME
30 – 50 MINUTES

COMMON CORE STATE STANDARDS

English Language Arts Standards » Science & Technical Subjects » Grade 6-8

CCSS.ELA-LITERACY.RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.ELA-LITERACY.RST.6-8.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

CCSS.ELA-LITERACY.RST.6-8.7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

English Language Arts Standards » Science & Technical Subjects » Grade 9-10

CCSS.ELA-LITERACY.RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS.ELA-LITERACY.RST.9-10.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

CCSS.ELA-LITERACY.RST.9-10.7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

English Language Arts Standards » Science & Technical Subjects » Grade 11-12

CCSS.ELA-LITERACY.RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CCSS.ELA-LITERACY.RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

NEXT GENERATION SCIENCE STANDARDS

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models (MS)	ESS2.A Earth Materials and Systems (MS, HS) ESS2.C The Roles of Water in Earth's Surface Processes (MS, HS)	Systems and System Models (MS, HS) Energy and Matter (MS, HS)

BACKGROUND

As climate change intensifies, climate scientists predict that many areas of the world, including the southwestern United States, will experience more frequent and prolonged periods of drought. As water becomes scarcer, it becomes increasingly important. Knowledge of the water cycle is necessary to understand how climate change impacts our water resources.
Water continuously moves around through the living and non-living parts of

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Earth. The **water cycle** is the movement of water on, in, and above Earth. During the cycle, water changes state between liquid, vapor, and ice. The processes by which water moves through the water cycle are defined below.

GLOSSARY

- **Evaporation**: process by which water changes from a liquid to a gas or vapor, most often driven by heat from the sun
- **Groundwater Flow**: flow of groundwater towards streams, the ocean, or deeper into the ground
- **Infiltration**: process of water seeping through soil and rock
- **Precipitation**: water released from clouds, can be in the form of rain, freezing rain, hail, snow, or sleet
- **Plant Uptake**: process by which the roots of plants take up water from the soil and move it to their leaves
- **Reservoir**: place that water is stored for some period of time
- **Snowmelt Runoff**: movement of water from melted snow and ice
- **Streamflow**: amount of water flowing in a river or stream channel
- **Transpiration**: process by which plants release water to the atmosphere

MATERIALS

- *Water Cycle diagram* [1 per every 2-4 students]
  - Optional: extra set of black and white *Water Cycle* diagrams [1 per student]
- *Bin labels* [1 set]
- *PowerPoint presentation*
- Computer and projector
- Six clean medium storage bins (approximately 16" h x 20" l x 17" w or similar size) or small trash cans (Figure 1)
- 72 wadded-up pieces of scrap paper wrapped with masking tape (masking tape is optional; it is best to wrap masking tape around the paper wads for durability if the game will be played multiple times, and it gives them a bit more weight for tossing)
- *Water Cycle Game instructional video*, optional introduction to the game for the educator

Figure 1. Reservoir bin example, storage bin with bin label attached

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PREPARATION

1. If possible, watch the *Water Cycle Game instructional video* for an introduction of how to play the game.
2. Make six reservoir bins by taping the bin labels to the outside of the storage bins or trash cans (Figure 1).
3. Plan to divide students into six groups. Plan to spread the groups around the space as much as possible. Clear a small space on the floor next to each group for the reservoir bin.
4. Place 12 paper wads into each reservoir bin.
   a. The paper wads represent water. For simplicity the game is started with equal amounts of water in each reservoir. In reality, Earth's reservoirs do not contain the same amounts of water (Table 1). For accuracy, you may want to plan to explain the relative distribution of water among Earth's reservoirs before you play the game.

Table 1. The hydrologic cycle by the numbers, an estimate of the amount of water in selected reservoirs

RESERVOIR	AMOUNT (KM^3)
OCEAN	1,338,000,000
ICE CAPS, GLACIERS, AND PERMANENT SNOW	24,064,000
GROUNDWATER	23,400,000
LAKES	176,400
ATMOSPHERE	12,900

Source: water.usgs.gov/edu/earthwherewater.html

PROCEDURES

1. Give an introduction to the water cycle using the PowerPoint presentation.
   a. **Slide 2**: small amounts of water are lost and gained through geologic processes and space, but basically we have a fixed amount of water on Earth. This water is continuously moved around through the living and non-living parts of Earth in the water cycle. The water cycle is the movement of water on, in, and above Earth. During the cycle, water changes state between liquid, vapor, and solid (ice and snow).
   b. **Slide 3**: this diagram shows the water cycle. The arrows show the movement of water from one location to another. For example, because of heat from the sun, water evaporates from the ocean and condenses to form clouds in the sky; then it falls from the clouds as precipitation. Places that water is stored for some period of time are called reservoirs, and flows or pathways (denoted by arrows) are the routes that water takes between reservoirs.
2. Divide students into six groups
3. Pass out copies of the *Water Cycle* diagram and show it using the PowerPoint presentation (**slide 4**). Give a quick overview of the diagram, showing how the arrows indicate the movement of water from one location to another. Point out that the arrows are labeled with the processes by which water moves. Explain that the thickness of the arrows indicates the relative amount of water. In other words, the thicker the arrow, the more water that is moving to that location.
4. Assign each of the six groups a water cycle reservoir: atmosphere, groundwater, lakes and streams, land ice and snow, ocean, or plants.
5. Explain that each group is a reservoir for water, and they will move water to another reservoir by using one of the processes indicated on the diagram.
6. Tell students that they will be given an allotment of water in the form of 12 paper wads, and each group will receive a reservoir bin.
   a. You might want to take a moment to explain that water is not actually evenly distributed among Earth's reservoirs. The large majority of water is in the oceans. A large amount is also found in ice/glaciers/snow and ground water (Table 1).
7. Explain that as a group, students must plan where they could move their water, and water will be moved by tossing paper wads into a reservoir bin in at least one correct location.
8. Explain that they must determine the number of water drops that they could move to each reservoir based on the thickness of the arrows in the diagram.
   a. Students can move **two water drops into reservoirs connected to their own reservoir with thin arrows and five water drops into reservoirs connected to their own reservoir with thick arrows.**
   b. Students must state the process by which water is moving from their reservoir to the other.
   c. You may want to write these rules on the board as you discuss them.
      i. Thin lines = 2 water drops (paper wads)
      ii. Thick lines = 5 water drops (paper wads)
      iii. State process by which water is moving
9. Have students look at their *Water Cycle* diagrams and have a discussion in their group to decide where they could move their water.
10. Optional: on the extra black and white set of *Water Cycle* diagrams, direct students to write the number of water drops they can move to each reservoir next to the

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arrows.

11. These are the possibilities for the movement of water.
    a. The ocean can give five water drops to the atmosphere through evaporation.
    b. The atmosphere can give five water drops to the ocean through precipitation and two water drops each through precipitation to land ice and snow, lakes and streams, and groundwater.
    c. Land ice and snow can give two water drops to lakes and streams through snowmelt runoff.
    d. Lakes and streams can give two water drops to the ocean through streamflow, two water drops to groundwater through infiltration, and two water drops to the atmosphere through evaporation.
    e. Groundwater can give two water drops to the ocean through groundwater flow and two drops to plants through plant uptake.
    f. Plants can give two water drops to the atmosphere through transpiration.
12. Once students have come up with a plan for the movement of their water, you can begin the game. Spread the groups around the space as much as possible. Clear a small space on the floor next to each group for the reservoir bin.
13. Give each group a reservoir bin with 12 paper wads inside. Place the reservoir bin on the floor near the group.
14. Instruct students to pick **one** reservoir on their diagram where they can move their water.
15. Have each group take a turn to send members of their group over the **one** reservoir where they have chosen to move their water. Instruct students to state the process by which the water is moving from their reservoir to this one.
16. Tell the whole class that if it is not their group's turn to move water, their job is to ensure that water is being moved correctly. They must check the other groups by consulting their *Water Cycle* diagram. If the current group tries to incorrectly move water to the wrong reservoir or with the incorrect number of water drops, the other groups must "buzz" them by making a buzzer noise.
17. Choose *one* group to go first, and direct that group to remove the number of water drops they will need from their reservoir bin to move their water drops to their one chosen reservoir.
18. To move water, students must first state by which process the water is moving from their reservoir to this one. Then students stand 3-5 feet away from the reservoir bin and shoot each of the allotted water drops into the reservoir bin. For management purposes, they should not stand further away.
19. After each group moves their water drops, discuss the process that led to that movement with the whole class and be sure that students understand how and why the group moved their water drops to that reservoir.
20. Next, choose a second group to move their water drops to **one** reservoir on the *Water Cycle* diagram.
21. The second group then moves their water to their chosen reservoir's bin after stating the process by which the water is moving.
22. Continue by choosing groups to move their water until each group has had a turn.
23. Complete as many rounds of the game as time allows or until water has been moved by each process shown on the diagram.
24. If there is time remaining, quiz students on the processes that result in the movement of water from one reservoir to another. Instruct students to turn over their diagrams on the desk (or collect them). Go through the *Water Cycle* diagram, and ask them by which process water moves for every arrow on the diagram.

EXTENSIONS

1. Challenge students to create their own model of the water cycle.
2. Have students research the water cycle and add missing processes to the *Water Cycle* diagram. Instruct students to describe the added processes in their own words.
3. Ask students to research and write a paragraph about how the water cycle is driven by energy from the sun and the force of gravity.

ADDITIONAL RESOURCES

Websites with background information about the water cycle:

United States Geological Survey. The Water Cycle – UGSC Water Science School. Modified 18 Mar. 2014. Web. Accessed 30 Apr. 2015. <http://water.usgs.gov/edu/watercycle.html>.

University Corporation for Atmospheric Research (UCAR), Center for Science Education. The Water Cycle. Published 2011. Web. Accessed 28 Apr. 2015. <http://scied.ucar.edu/longcontent/water-cycle>.

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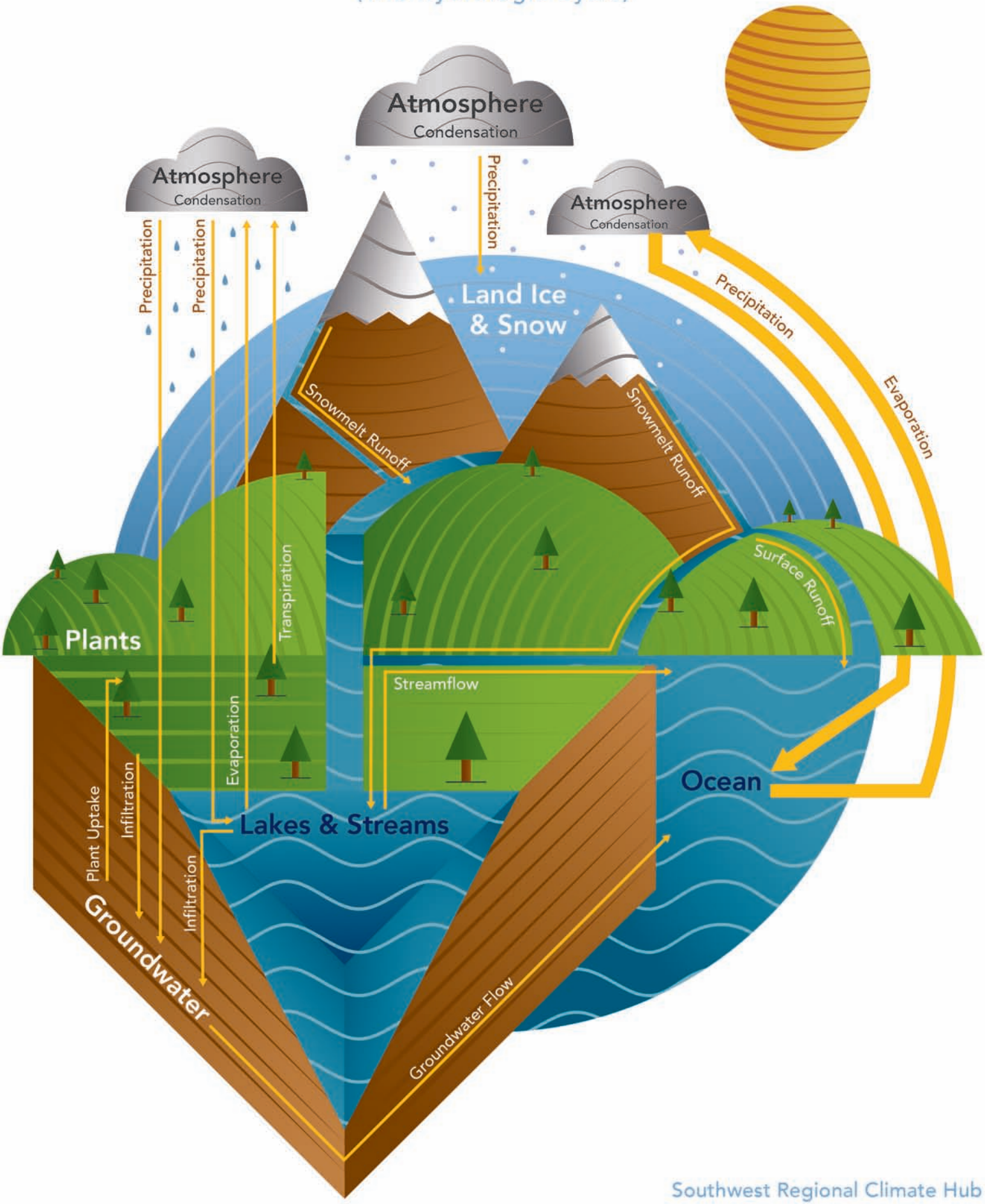
THE WATER CYCLE
(The Hydrologic Cycle)



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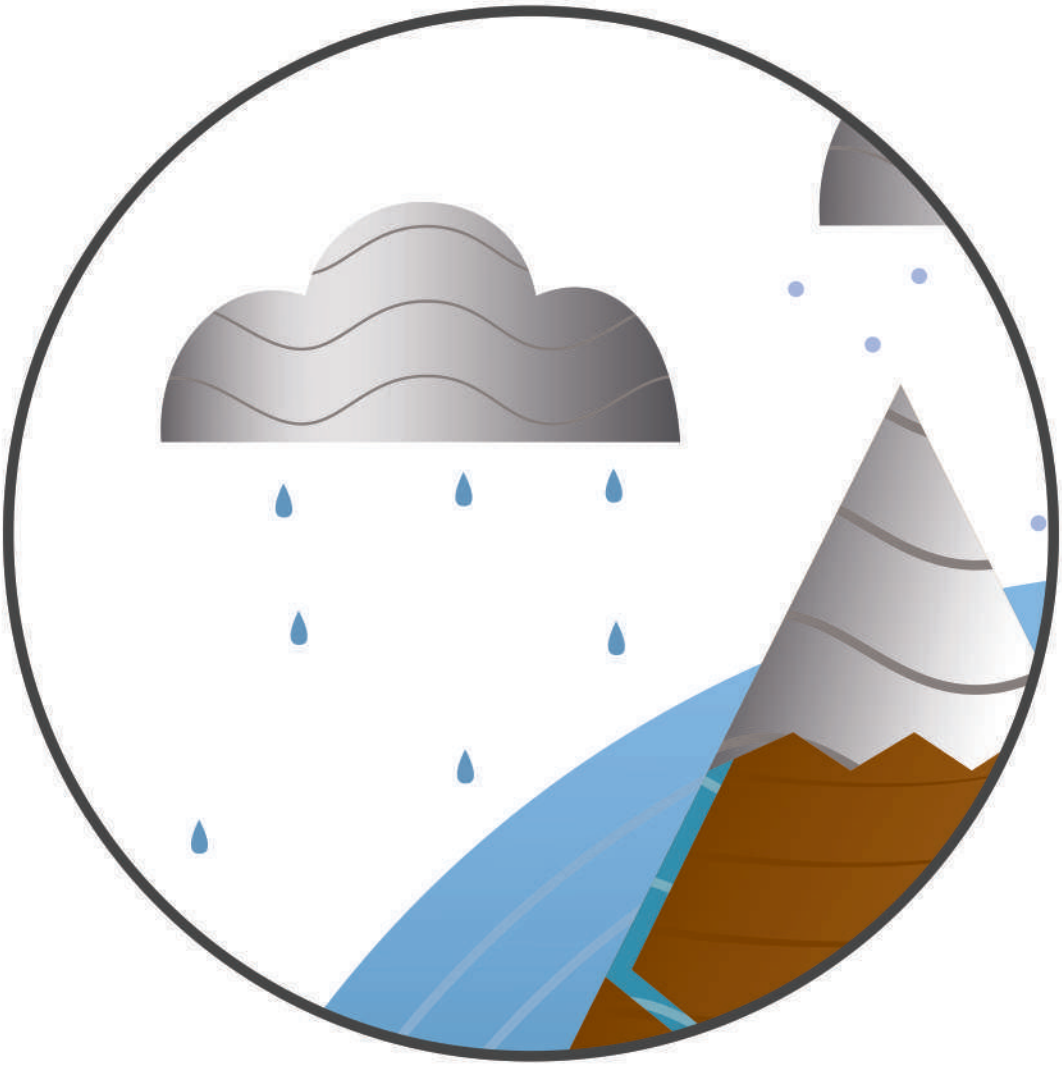
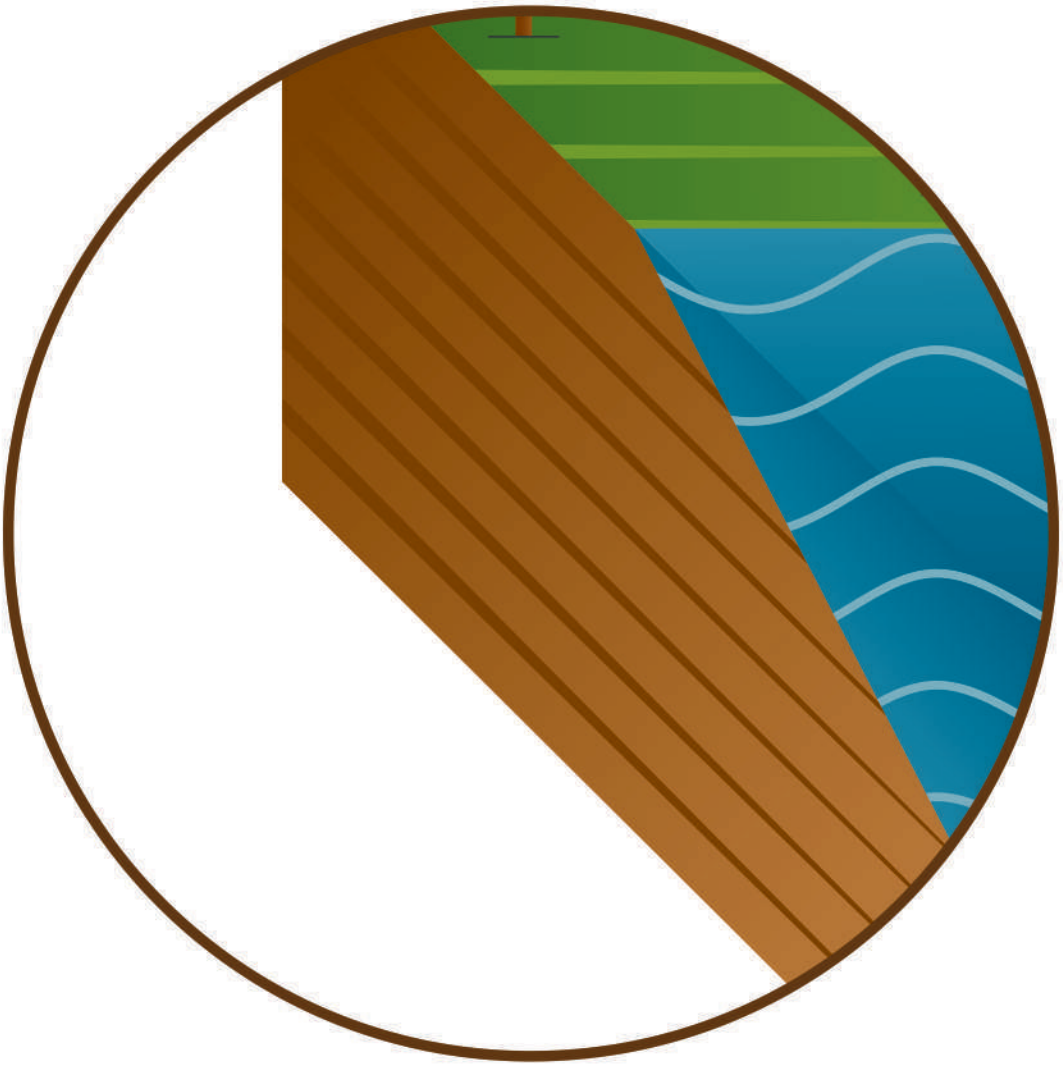
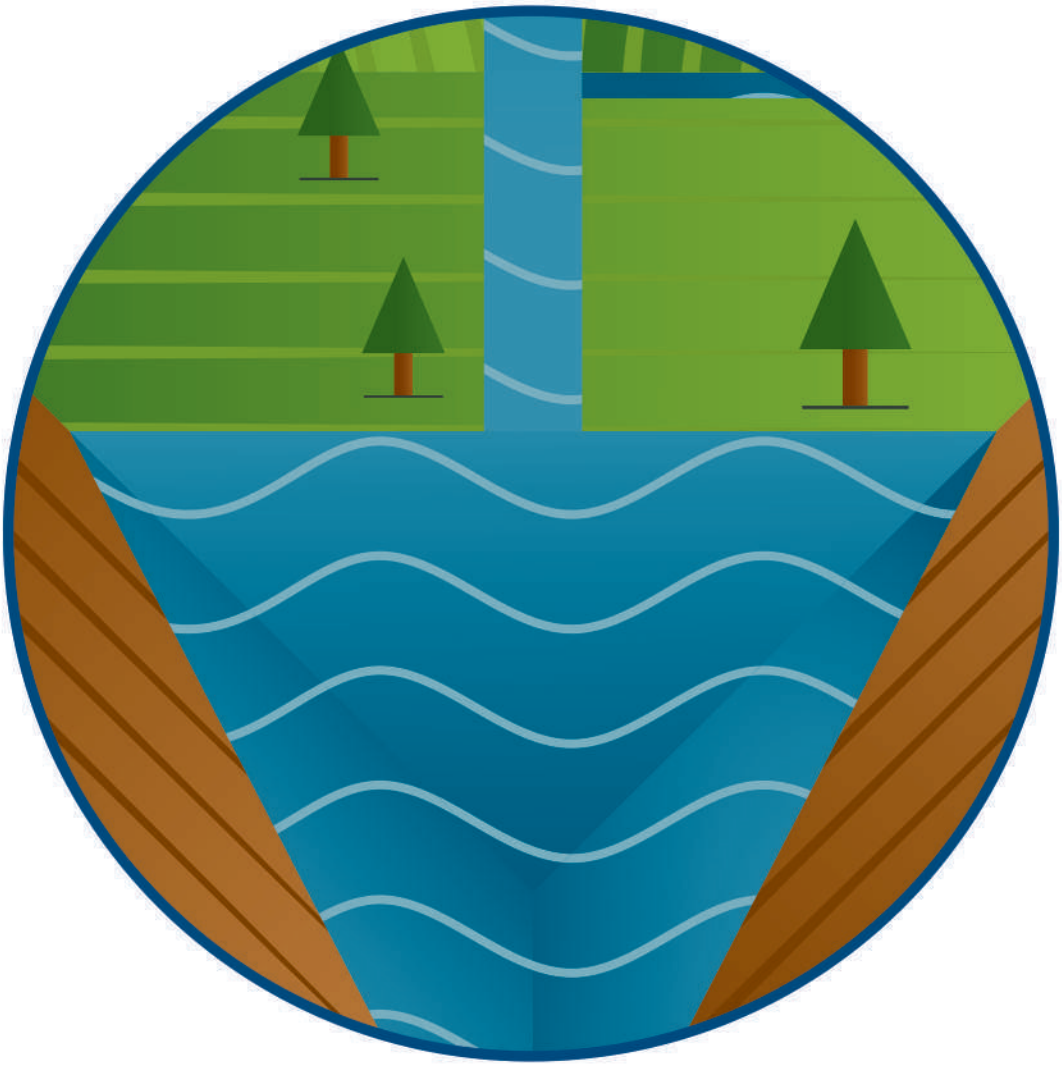
ATMOSPHERE



GROUNDWATER

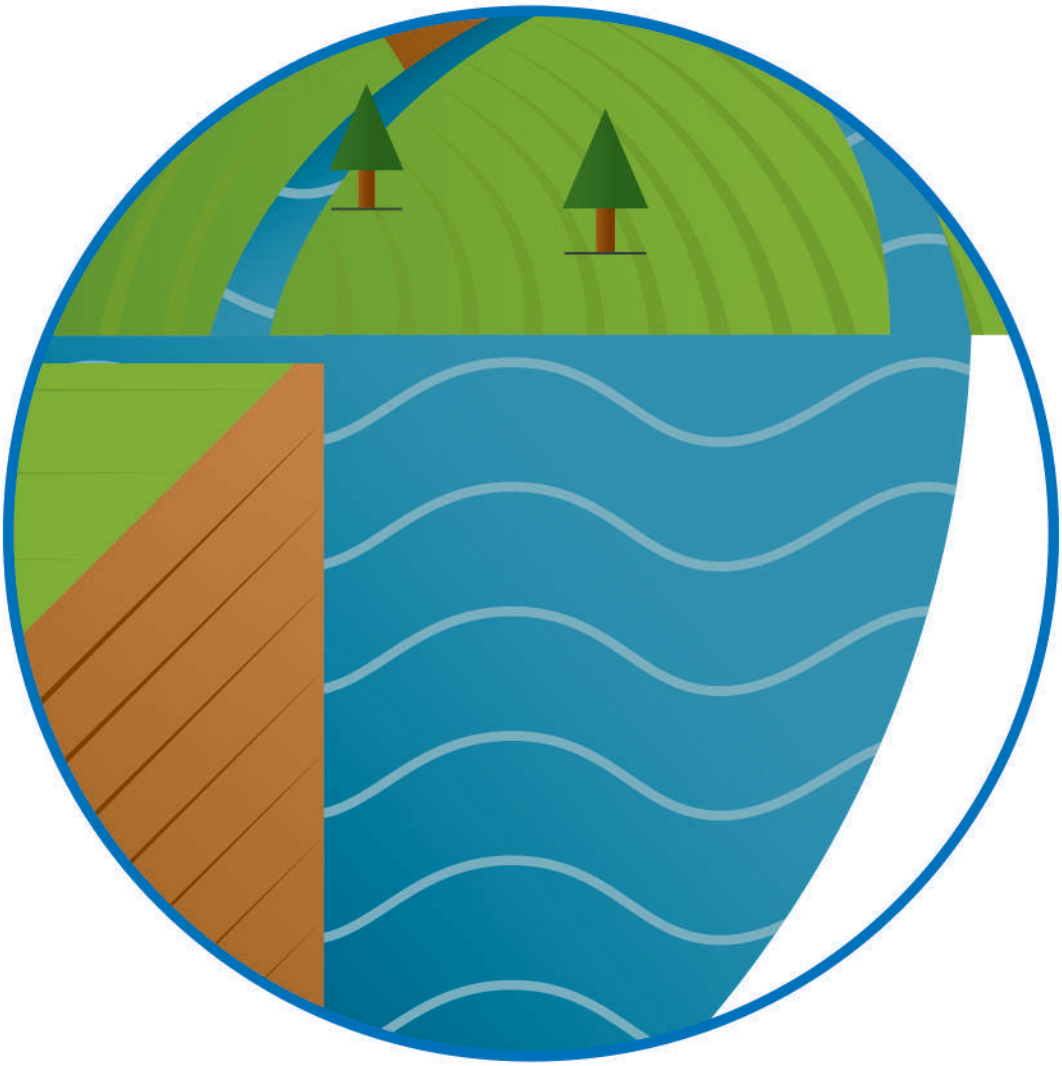


LAKES & STREAMS



LAND ICE & SNOW

OCEAN



PLANTS