

# Water Quality in My Community

## STEM Pillars

### Informal Audience

Families with children aged 6–10 (K–5<sup>th</sup> grade).

### Content Goal

Groundwater is influenced by development in communities.

### Practice Goal

Conduct experiments and observe how groundwater changes in different community models.

### Affinity Goal

Water quality is important to me, my family, and my community.

### Driving Question

**How can we build a better world around water in our community?**

### Teaching Style

Narrative, free exploration, driving question, content, and exploration of the driving question.



Image Credit: Emily Daigle

## Water Quality in My Community: Summary

Families work together to create a simulation of an undeveloped community and to make observations about the flow of groundwater. Then they are asked to develop that simulation and make observations about run off and its effects on groundwater. Finally, they are asked to develop green alternatives to upgrade their developed community.

This workshop is for children and adults working together. The curriculum is written to be facilitated by water scientists, water conservationists, and ecologists, or other experts in water science and water conservation, in the community.



## Talk supports learning!

Look for **blue family-focused prompts** throughout this curriculum. Our team has developed questions to encourage families to talk together at their tables.

**Think-pair-share strategy:** The question format is for you to ask questions about which families can **think** together and then interact (**pair**) with each other before being asked to **share** their ideas with the group.

For example, you can begin a family prompt by saying, “**Take a moment to discuss with your family...**”

When you see these prompts, **give the families 2–3 minutes to talk**. Then, you can ask for a volunteer to share their ideas with the larger group.

If families are engaged in conversation, you are helping them **make connections to science**. This family talk time with increase learning outcomes and affinity toward water science and conservation!

# Teaching with Project-based Learning

This workshop curriculum was designed with the **project-based learning teaching strategy** for parents and children working together. This means each workshop includes teaching strategies that are NOT lecture-based. Instead, you will facilitate families to:

- ♦ engage in **free-form exploration** with scientific tools, concepts, and ideas related to water science and conservation.
- ♦ work toward answering a **driving question** that transforms their early free-form exploration into a developmentally-appropriate version of the work that a water scientist does
- ♦ collaborate in scientific work that creates a **product to share with others**.

Project-based learning is a **learner-centered** facilitation style. When you teach with the project-based learning teaching strategy, you do not deliver a lecture to the whole group; instead, you encourage the working teams to talk together. You provide less content at the start to encourage discovery. Because you are empowering small teams (families, in our case) to work, think, and talk together, you provide content after the learners have explored the tools together — rather than providing all content at the start of the workshop. By using project-based learning, we intend to give families a collaborative style of doing science together that they can continue to use in other settings, such as **museums, libraries, homes, and parks**.



# Water Quality in My Community: Overview

## Project-based Learning Phase 1: Exploration

- ◆ Tell a story about how you became interested in science and water quality.

**Family Prompt 1 :** What bodies of water exist in your community?

- ◆ Set up community model.

**Family Prompt 2:** Discuss with your family: What did the landscape look like before we built up our communities with roads and buildings? In our model what do you think the green sponges and the blue cup represent in your community?

- ◆ Experiment A: Undeveloped community model.

**Family Prompt 3:** Share your results and discuss with your family: What did you observe when the rain fell onto your community model? Where did the rain water go in your model?

## Project-based Learning Phase 2: Driving Question and Water Content

- ◆ Driving question: **How can we build a better world around water in our community?**
- ◆ Content: Explain the importance of groundwater.

## Project-based Learning Phase 3: Make Predictions and Explain Data Results

- ◆ Experiment B: Standard developed community model.

**Family Prompt 4:** With your families, predict where you think the water will go this time in your model. After you are done with your experiment, discuss what actually happened.

- ◆ Compare experiments A and B: Undeveloped and developed community models.

**Family Prompt 5:** Discuss with your family the results of experiments A and B. How do you think the water in your town is affected when the rain runs off of hard surfaces, such as roads, parking lots, and sidewalks?

- ◆ Experiment C: Green building designs model.

**Family Prompt 6:** Discuss with your family your predictions for your green community design: Will there be more runoff (in the blue cup) or more infiltration into the groundwater (in the green sponges and cups)? After you are done with your experiment, discuss what actually happened.

## Project-based Learning Phase 4: Share

- ◆ Share: Have families share their observations and recordings of their green communities.

**Family Prompt 7 :** Discuss with your family what green designs you chose and how they worked. How could these green designs be implemented in your community?

- ◆ Wrap-up: Re-address the driving question: **How can we build a better world around water in our community?**

# Water Quality in My Community: Curriculum

## Project-based Learning Phase 1: Exploration

### ✦ Start the workshop.

- Begin by introducing yourself and welcoming the families to the workshop.
- Tell a story about how you became interested in science and water quality.

### ✦ After introductions, ask:

**Family Prompt 1:** What bodies of water exist in your community?

**Facilitation Tip:** Provide a few minutes for families to talk. This may feel like a long time, but you are facilitating families making connections.

### ✦ Set up community model.

- Distribute the Rain to Drain kits and workbook, one kit and one workbook per family.
- Tell families that they can start setting up their community model while watching you demonstrate the set up.

**Facilitation Tip:** Instructions are provided on pp. 11–13 for the community model set up and all experiments. The workbook pages are provided on pp. 14–21.

- Describe the components of the model as follows:
  - Muffin pan: “This is the base of your community model. The five plain cups will each represent a land property and the blue cup will represent a body of water.”
  - Sponges: “Place a sponge in each of the muffin cups, leaving only the blue cup open. The five sponges will act as the natural surfaces at each of these five properties.”

**Family Prompt 2:** Discuss with your family: What did the landscape look like before we built up our communities with roads and buildings? In our model what do you think the green sponges and the blue cup represent in your community?

- After families talk for a few minutes, engage them in a whole-group discussion so the families can share what they discussed.

**Facilitation Tip:** As you call on adults and children to talk, use names from their name tags to create a nice community feel during the workshop.

- Explain how to set up the basic model:

1. “On the tray, place the muffin pan on top of six plastic cups so that the muffin cups each fit into the top of one of the six plastic cups. Match the blue cup to the blue muffin cup.”
2. “Gently lift the plastic cup that is located in the corner opposite the blue cup, and place the roll of tape underneath it. This will create a hill in your community with the water body at the bottom of that hill.”
3. “You will create rain with a rainmaker, or a 16-ounce plastic soda bottle with holes poked into the cap. This will represent rain, and other types of precipitation, falling in your community.”

♦ **Introduce Experiment A: An undeveloped community model.**

- Once families have completed setting up their community models, talk about its undeveloped state.
- Say, “No homes or business have been built here yet. The five parcels of land are in the most natural condition they can be. This is represented by the green sponges.”
- Ask families to create rain for their undeveloped community models. Say:
  1. “Please pour 250 milliliters of water into your measuring cup. We will each use 250 mL of water every time we make it rain in our community. This is what we call a control variable in our experiment. The control variable stays the same throughout an experiment.”
  2. “Have an adult hold your rainmaker over your community model (~8–10 inches above) while you carefully pour the water from your measuring cup into the rainmaker. Move your rainmaker over your entire community but make sure that the rain is not falling outside the tray.”
  3. “Observe where the rainwater ended up after the storm in your community by looking at the plastic cups under the muffin pan.”
- Ask families to collect data about the underground and aboveground water after rainfall. Say:
  1. “Carefully slide the blue plastic cup out from under the muffin pan and use the measuring cup to measure how many milliliters of water were captured there. This represents the amount of stormwater that rained directly into the body of water in your community, and also the stormwater that drained from your community into that body of water. When stormwater moves across the land and drains into a nearby body of water, we call that **runoff**.”
  2. “Fill in this runoff volume in the appropriate beaker in your booklet, then put the water back into the blue cup.”
  3. “The water in the other five cups, along with the water soaked up by the sponges, represents stormwater that **infiltrated** into the soil to become groundwater. To measure the

groundwater, first squeeze each sponge into the empty measuring cup. Now lift the muffin pan off of the five plain plastic cups and empty each into the measuring cup as well.”

4. Fill in the infiltration volume in the appropriate beaker in your booklet.”
  5. Circle which received more water: your local body of the water (the blue cup) or your groundwater (plain cups combined with the green sponges).
- Note that stormwater lost (or water that spilled outside of the tray) should be 25% or less of the total stormwater. If you lost a large amount of water this way, be careful to direct your rain onto your community model for future experiments.
  - Explain that small amounts of lost water could represent water that evaporated or was used by plants and animals in the community.

**Family Prompt 3:** Share your results and discuss with your family: What did you observe when the rain fell onto your community model? Where did the rain water go in your model?

**Facilitation Tip:** You may need to use an attention-getting technique to get the families focused on you after the experiment. Examples include saying loudly, “One-two-three, eyes on me!,” or ringing a bell.

- After families talk for a few minutes, engage in a whole-group discussion to allow families the chance to share their results.

## Project-based Learning Phase 2: Driving Question and Water Content

- ◆ **Introduce the driving question: How can we build a better world around water in our community?**

**Facilitation Tip:** Make sure that the driving question poster is clearly visible to all families. You may want to refer back to this poster and driving question throughout the workshop.

- ◆ **Briefly present content on water quality.**

- Say, “You may get your water from a well, from your town, or from a local body of water acting as a reservoir. The quality of water from those sources is important for the health of you, your family, and your community.”

- ◆ **Explain the importance of groundwater.**

- Say, “It’s important for water to move through the ground because it acts as a natural filter of many pollutants that may be found in the water.”
- Say, “Does anyone get their water from a well? Your well is being filled by groundwater. Without rain or water moving through the ground, your well might run dry for a little while, or sometimes longer. This is similar for a natural spring you might see coming from the ground or from a pipe. Many farmers use water from the ground to water their crops.”

**Facilitation Tip:** Please tailor this brief content phase to your knowledge base, and to the water sources in your community. Additional important concepts include infiltration and run-off.

## Project-based Learning Phase 3: Make Predictions and Explain Data Results

### ✦ Introduce Experiment B: A standard developed community model.

- Explain that homes and business have now been built in your community model.
- Distribute the Developed Surface cards that represent familiar surfaces you would find outside in your own community: streets, sidewalks, parking lots, rooftops, and concrete.
- Instruct families to set up their community models. Say:
  1. “Reset your community model by placing it on top of the six plastic cups like you did before. Match the blue cup under the blue muffin cup, and create your hill by placing the roll of tape under the opposite corner cup.”
  2. “Place a sponge circle in each of the five parcels of land. Make sure that your sponges are still moist, but most of the water should be squeezed out.”
  3. “Cover each of the five parcels of land, but not the water body, with a laminated Developed Surface card. The cards should overlap and extend beyond the edge of the community model.”

**Family Prompt 4:** With your family, predict where you think the water will go this time in your model. After you are done with your experiment, discuss what actually happened.

- After families talk for a few minutes, engage them in a whole-group discussion so the families can share what they discussed.
  - Ask families to repeat the experiment by creating rain over their communities and measuring the water collected in the plastic cups and in the sponges.
- ### ✦ Ask families to compare the data they obtained from Experiments A and B.

**Family Prompt 5:** Discuss with your family the results of experiments A and B. How do you think the water in your town is affected when the rain runs off of hard surfaces, such as roads, parking lots, and sidewalks?

- After families talk for a few minutes, engage them in a whole-group discussion so the families can share what they discussed.
- Explain that water can move in different ways when it falls on the land. When water falls on developed surfaces, it has the potential to run off into nearby bodies of water, carrying pollutants from the land surface. When water falls in natural environments, the majority of water soaks into the ground, with only a small amount of runoff occurring.
- Explain that water falling in natural environments decreases the chances of flooding because natural environments can absorb more water than developed environments. Water falling in natural environments also decreases water pollution by filtering pollutants from the soil before the water

reaches a water body. Water falling in natural environments increases the groundwater supply because more water can infiltrate the ground than in a developed environment.

- Remind families that they have observed these phenomena using the previous models.

♦ **Introduce Experiment C: Green community model.**

- Reiterate the driving question: **How can we build a better world around water in our community?**
- Distribute the Green Surface cards, and explain what geocells, grass, green parking lots, rain gardens, and gravel do for the environment.
- Say, “In this final experiment, imagine that your community was given \$10,000 to redesign their developed community to increase groundwater and decrease runoff. Each community can purchase up to two green surfaces. The rest of the sponges must be covered with a developed surface. How would you re-design your community to have better water quality?”

**Family Prompt 6:** Discuss with your family your predictions for your green community design: Will there be more runoff (in the blue cup) or more infiltration into the groundwater (in the green sponges and cups)? After you are done with your experiment, discuss what actually happened.

- After families talk for a few minutes, engage in a whole-group discussion to allow families the chance to share their predictions.
- Ask families to repeat the experiment by creating rain over their communities and measuring the water collected in the plastic cups and in the sponges.



**Project-based Learning Phase 4: Share**

♦ **Hold a whole-group discussion about the families' green community models.**

- Ask what was successful or unsuccessful, and what they learned.
- Ask one final family prompt:

**Family Prompt 7:** Discuss with your family what green designs you chose and how they worked. How could these green design be implemented in your community?

♦ **Wrap up the workshop.**

- Wrap up the workshop by re-addressing the driving question: **How can we build a better world around water in our community?**
- Conclude program with attainable calls to action on water conservation. Provide local examples related to topics discussed.

**End of workshop**

## Acknowledgments

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Images and curriculum ideas were adapted from Penn State Extension's Rain to Drain: Slow the Flow Curriculum. The Rain to Drain curriculum is available at the following link:  
<https://extension.psu.edu/rain-to-drain-slow-the-flow-curriculum>

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## Appendix

### Water Quality in My Community: Materials

- Rain to Drain Kits (one kit for each family; refer to pp. 11–13 for setup)
  - A foil cupcake/muffin pan (half-dozen size; each cup should have 5 small holes, about the circumference of a pea, cut out, and one cup should be colored blue)
  - 6 disposable plastic cups (approx. 9 ounces each)
  - 5 small circle cellulose kitchen sponges
  - A roll of clear tape
  - 20-oz plastic soda bottle
  - Developed Surface cards (laminated)
  - Green Surface cards (laminated), small rocks, and 3" x 3" green felt cutouts
  - A tray with a lip around the edge (baking sheet or similar)
  - A liquid measuring cup, at least 8 ounces
  - Water
  - Reusable towels
  - Zip-top bags (for wet materials)
- Water Quality in My Community Workbook (one per family)
- Driving question poster
- Name tags for workshop attendees and facilitator (optional)

Note: Developed and Green Surface cards available at:

<https://extension.psu.edu/rain-to-drain-slow-the-flow-curriculum>

## Water Quality in My Community: Setting up the community model

In this workshop, you will set up three community models with each representing a type of community surface: 1) the undeveloped community, 2) the developed community, and 3) the green community. You will conduct an experiment with each community model to observe the flow of groundwater on different surfaces. Follow the steps below to set up your community.

**Note:** See page 7-8 for more information on what the materials used in the model represent in real-world environments.

### Experiment A: The undeveloped community model



**1.** Place 5 uncolored cups and 1 blue-colored cup on the tray. Dampen 5 sponge circles. Make them moist but not too wet.



**2.** Place the muffin pan on top of six cups so that the pan fits into the top of each of the cups, matching the blue cup to the blue muffin cup. Place a sponge into each uncolored muffin cup.



**3.** Gently lift the cup that is farthest from the blue cup (the opposite corner), and place the roll of tape underneath it. Now, your community model is ready for the experiment.



**4.** To start the experiment, fill the measuring cup with 250 ml of water and pour the water into the plastic bottle (the rainmaker) to make rain over the model.

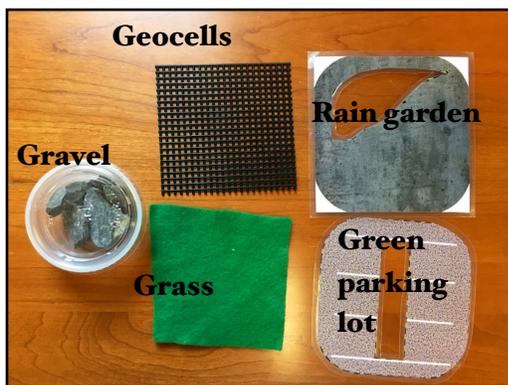
### Experiment B: The developed community model



**1.** In experiment B, you will use the Developed Surface cards to create a developed community model.

**2.** To set up the developed community model, place the Developed Surface cards on the undeveloped community model you created in experiment A. Cover all the sponges with the cards and leave the blue muffin cup open.

### Experiment C: The green community model



**1.** In experiment C, you will use some Green Surface cards to create a green community model.

**2.** To design the green community model, choose and place 2 Green Surface cards on the community. Then, cover rest of the sponges with Developed Surface cards used in experiment B. Remember to keep the blue muffin cup open.

# Sample Completed Workbook

### Resources

**Local Volunteer Opportunities:**

- Centre County Conservation District
- Huntingdon County Conservation District
- ClearWater Conservancy

**Citizen Science Opportunities:**

- National Water Quality Monitoring Council - <https://acwi.gov/monitoring/vm/index.htm>
- Water Action Volunteers - <http://watermonitoring.uwex.edu/wav/>
- SPLASH - <https://www.splash.org/>
- Pennsylvania Amphibian & Reptile Survey - <http://paherpsurvey.org/>

**Books to check out to learn more about water:**

- *A Drop Of Water: A Book of Science and Wonder* by Walter Wick
- *National Geographic Readers: Water* by Melissa Stewart
- *A River Ran Wild* by Lynne Cherry
- *Three Days on a River in a Red Canoe* by Vera B. Williams
- *The Drop in my Drink: The Story of Water on Our Planet* by Meredith Hooper
- *One Well: The Story of Water on Earth* by Rochelle Strauss
- *Water Is Water: A Book About the Water Cycle* by Miranda Paul

Ask your Librarian for more books on water science!

2

### Natural Community

Discuss with your group, which will have more water:  
The white cups & sponges or the blue cup

*Shade in your results above*

Which category had more water? Discuss how this is different or the same as your prediction.

3

### Green Community

*Shade in your results above*

Discuss with your family if there are any of these designs that are currently in your neighborhood, or that you could potentially implement inside your community.

6

### Reflection

If a community depends on groundwater to provide the drinking water for the people who live and work there, how might adding parking lots, buildings, and other similar surfaces impact the drinking water supply over time?

*reduce the water supply and pollute the water*

What might be some ways to increase groundwater in your developed community?

*plant more trees and grass use the new material for surfaces*

7

Workbook pg. 1

# **Water Quality in My Community**

## **A STEM Pillars Workshop**

*How can we build a better world around  
water in our community?*

This book belongs to:

Workbook pg. 2

## Resources

### Citizen Science Opportunities:

- National Water Quality Monitoring Council - <https://acwi.gov/monitoring/vm/index.html>
- Water Action Volunteers - <http://watermonitoring.uwex.edu/wav/>
- SPLASSH - <https://www.splash.org/>

### Books to check out to learn more about water:

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- *A River Ran Wild* by Lynne Cherry
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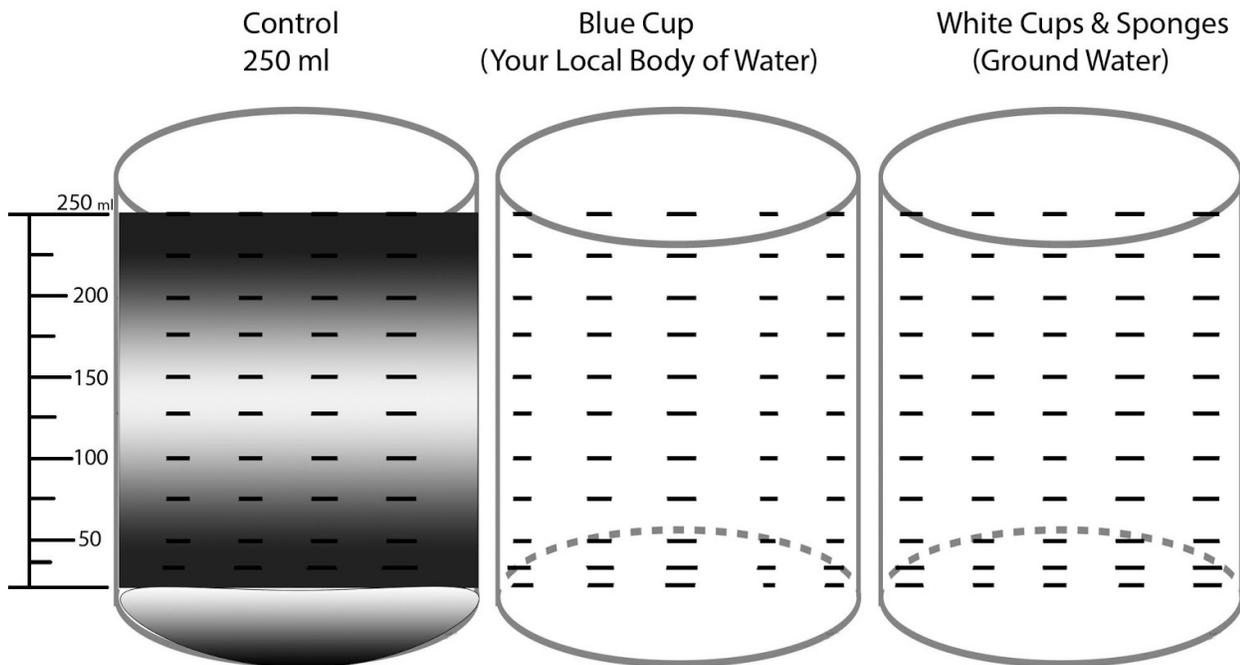
**Ask your librarian for more books on water science!**

Workbook pg. 3

# Experiment A: Natural Community

Discuss with your group, which will have more water:

The blue cup or the white cups and sponges



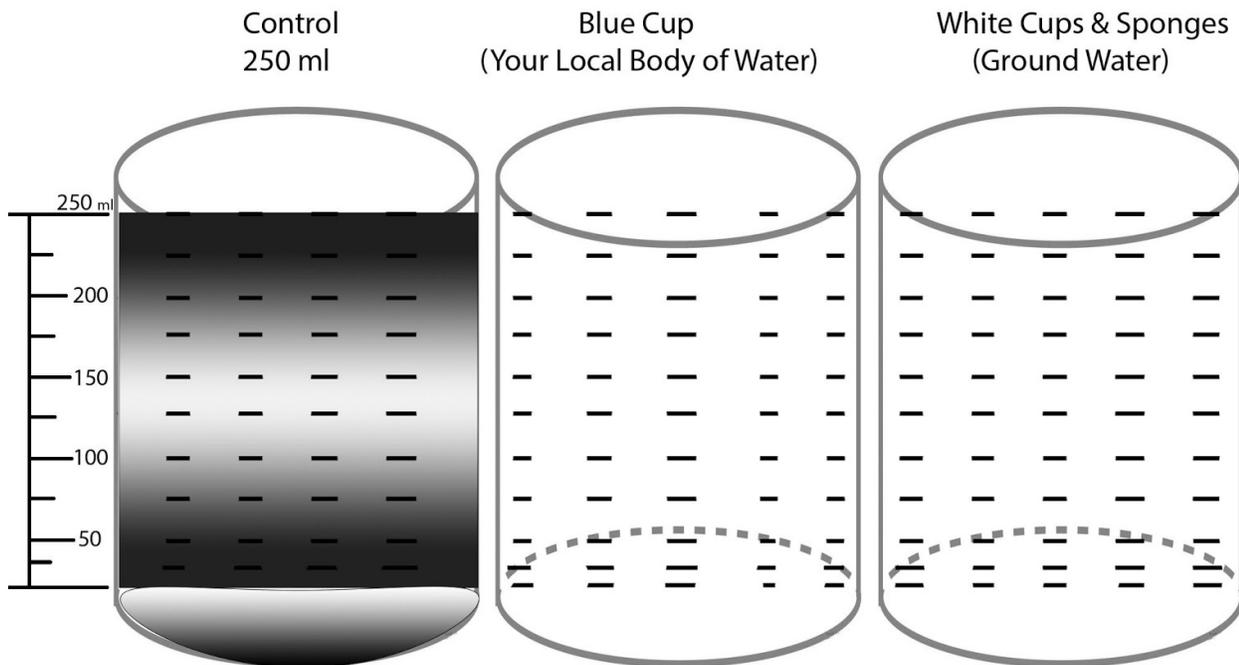
*Shade in your results above*

Which category had more water? Discuss how this is different from or the same as your prediction.

# Developed Community

Discuss with your group, which will have more water:

The blue cup or the white cups and sponges



*Shade in your results above*

Which category had more water? Discuss how this is different from or the same as your prediction.

Workbook pg. 5

## Experiment C: Green Community

Record your green community's surfaces in this diagram:

*Map your new community:*

The diagram is a large rounded rectangle containing six circles arranged in two rows of three. Each circle has two horizontal lines for writing. The circles in the top row and the first two circles in the bottom row are pre-filled with two horizontal lines. The third circle in the bottom row is empty.

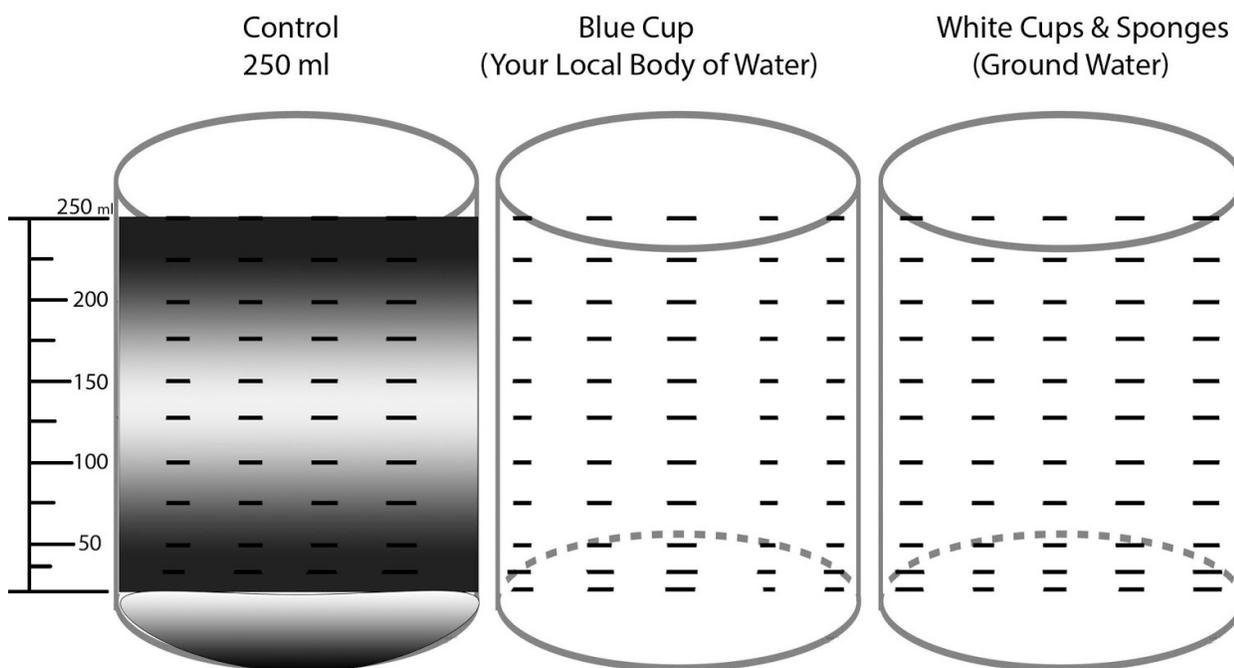
*Write or draw which surface cards you chose.*

Workbook pg. 6

# Green Community

Discuss with your group, which will have more water:

The blue cup or the white cups and sponges



*Shade in your results above*

Discuss with your family whether any of these materials are currently used in your community. Could you potentially implement any of these suggestions in your community or encourage others to?

Workbook pg. 7

## Reflection

If a community depends on groundwater to provide the drinking water for the people who live and work there, how might adding parking lots, buildings, and other similar surfaces impact the drinking water supply over time?

What might be some ways to increase groundwater in your developed community?

Workbook pg. 8

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