GROUNDWATER

MATERIALS

- 1 Presenter table
- 7 Groundwater models
  - 6 student models, 1 presenter
- 14 syringes with tubes
- 14 earth material tubes
  - 7 gravel and 7 sand
- 14 (100ml) graduated cylinders
- 14 small pitchers
- Bucket(s) for dye water
- 1 Bucket of dry sand
  - Small cups for filling sand tubes
- 1 Bucket for wet sand
- 1 Food coloring dropper
- Picture of Groundwater Bin Contents - please return materials to match the picture.

Learning Objectives:

Model aquifer recharge and discharge, connecting water availability to human behavior.

BIG IDEAS

1. **Groundwater is pulled underground by gravity through the spaces between Earth materials**
2. **In Arizona, we rely on groundwater**
3. **Groundwater and surface water are connected**

Activity Flow

1. Greet class **as they approach** & **set expectations before** they reach shade structure/models
   - Activity involves taking turns, listening to instructions, raising hands
   - Practice **Attention Grabber** together
   - Ask teacher to assist in splitting class into 6 small groups around models, facing presenter
2. Think, Pair, Share: “What is a Model”
   - What is groundwater? (**Big Idea 1**)
   - Why do we care about it? (**Big Idea 2**)
3. Earth Materials Race using graduated cylinders
   - Sand 1st, then gravel
4. Make it Rain using pitchers
5. Pump it Out using pumping syringes
6. Pollution in the Lake using food dye
   - Lead discussion on groundwater and surface water connection (**Big Idea 3**)
7. Wrap Up and Reset
8. One presenter reviews **Big Ideas** away from tarp/models while the other resets activity

GROUNDWATER

Supporting Information:

Water Use: 41% of Arizona's water comes from groundwater. 82% of the water used in Arizona is for agricultural purposes.

Aquifers: Groundwater is the actual water found underground in between cracks and spaces in sand and rock. An **aquifer** is the underground geologic container (made of layers of rock, sand or gravel) that stores and transmits that groundwater. Aquifers are naturally replenished by precipitation and snowmelt as water percolates into the ground. Aquifers can also be intentionally recharged with reclaimed water through human-engineered methods.

Pumping Effects: If we pump groundwater irresponsibly, we will eventually run out. Over pumping of groundwater is called overdraft (just like a bank account) and can cause land subsidence, sinkholes, and erosion. Once this water is gone, the spaces between the rocks collapse, reducing ground permeability and aquifer capacity, and increasing the risk of floods.

Pollution: Human activities like mining, agriculture, industry, and pet waste introduce pollutants into the watershed. Pollution does not remain where it is introduced; it is pulled into groundwater by gravity and spreads throughout the watershed.

Set the Stage for Success:

- Model excitement with your expressions and encourage engagement by asking open-ended questions
- This activity is not a lecture, and the students do not need to be paying attention to you the whole time. They should actively engage with each other and the model in between your instructions and guiding questions.
- Introduce expectations about how to interact with the materials at the start. Remind students these are not toys, but scientific models we will be using to conduct experiments, and to please treat them gently so other students can use them in the future.
- Make sure students are dividing responsibilities equitably in their group and sharing materials. Every student should do something at least once. Students can help reset your station whenever there is time!
- At the end of the activity, take each wet sand tube and empty it into the wet sand bucket. Use a cup to refill the first few inches of the tube with dry sand. **PLEASE DO NOT DUMP OR REFILL THE GRAVEL TUBES.**
- Please note how the bin of materials is packed when you begin your setup and do your best to return the contents to the same configuration when you pack up. There is a laminated picture to help you remember.
- Please do not hesitate to ask for help with materials, instruction, breaks, or anything else that you need! We are so grateful for your help in educating Arizona's youth about groundwater!

BLACK = KEY INSTRUCTIONS **BLUE = WHAT YOU SAY** **ORANGE = ACTION BASED INSTRUCTION**

WHAT YOU SAY AND DO

6 Minutes - What is a model?

- Greet class **as they approach** and **before** they get to models. **Set the stage for success right away!**
- One presenter can be finishing reset as the other greets class and sets expectations
- Explain that this is an experiment that will involve taking turns, listening to instructions, raising hands
- **Practice attention grabber together** and ask teacher to help split class into 6 groups around models

You all have a **model** in front of you.
In your groups, **"Think, pair, and share"** for a moment: **What is a model** and **what do you see** in this one? What can we do with a model?
(Allow students to **discuss** for a minute and then take some responses) Yes! A model **represents something in the real world**. We can use a model to do experiments. This is a Groundwater model.
What is **groundwater?** (Let students respond) Yep! It's **water under the ground**!

Where is the groundwater underground and **how does it get there**? Is it in a big open cave?
Let students respond, then emphasize Big Idea:

GROUNDWATER IS PULLED UNDERGROUND BY GRAVITY THROUGH THE SPACES OF EARTH MATERIALS

Why do we care about groundwater? (Let students respond) We care, because we use it everyday!

IN ARIZONA, WE RELY ON GROUNDWATER

Over **40%** of the water used in Arizona comes from the ground, and in **some Arizona towns**, **100%** of water used is groundwater!

5 Minutes - Earth Materials Water Race

Look at the sides of your model. What do you see? Let students respond *(rocks)*
Now, let's do an experiment to see **how fast water travels through different earth materials**.

Remember, **everyone** will get a chance to **do something** today–Let's work together!
When everyone is back and ready, we will do the experiment together.
Direct groups to **Choose who will**:

- **Fill graduated cylinders** with water *(from nearby refill station or extra water bucket)*
- If empty from last rotation, **bring up sand tubes to fill**
- **Hold earth materials** over model during experiment
- **Pour water** into material tubes during experiment

Before we start, it's **prediction time**! Which material will water travel through faster?
Hold up 1 finger **for sand**, **hold up 2** fingers **for gravel** (Let students respond) Let's find out!
When I say **go**, but not before, we will **pour** one **whole cylinder**'s water into the sand tube.
Use presenter model to show how the experiment will work; emphasize holding tubes **over the model.**
We are going to **count out loud together**, "one Arizona, two Arizona…"

Yell "STOP!" when you see the first drop of water leave the bottom of your tube!

Lead students in **pouring their graduated cylinders** through **sand first**, and **then gravel**
Pour **ALL** of the water from the cylinder into the tube all at once!

Were your predictions correct? Why was the gravel so much faster? **Think, Pair, Share** for a minute!
(Let students respond) Yes! The **spaces between** the gravel are **much bigger.**

4 Minutes - Make it Rain

What do you think the **empty cup** in the center of your model **represents**? Take some guesses.
It represents **a lake**, which is also known as **surface water** (we can see it from the surface of the land)!

The lake is pretty **empty right now** and there is **not a lot of groundwater** inside of our model.

GROUNDWATER

We are about to **"make it rain"** and I want you to **watch for changes**

Explain basics of next experiment and then direct groups to **choose who will:**

- **Fill pitchers** with water
- **Pour water** all over model

Now that it has rained, **what changed?** Let students respond.

Yes, the water in our **lake went up** and you **can see water underground** now!

Ask students to **use index finger to draw a line where they see water** on sides of model

In real life, **that line** is called the **water table**!

Do you think groundwater and surface water are **connected?** Let's test that idea in the next experiments

4 Minutes - Pump it Out

How do we get groundwater up **out of the ground** and then **to our house**?
What do you think the **blue tubes** in your models **represent**?
Let students respond.
Yes, **wells in the ground** pump water out **to pipes**, which deliver water to treatment plants or even straight **to your house** (*city water vs. private wells*). The blue tubes represent **wells.**

Now, you will **use these pumping syringes** to pump water **out of the blue wells** and into the **pitchers**.
Use presenter model to **demo instructions**; show **where to stop pulling** pump plungers.

Make sure to **take turns pumping** and **watch for changes** in your model as you pump.

Pass **2 pumping syringes to each** group and walk around to **assist** and **talk to groups** as they pump.

6 Minutes - Pollution in the Lake

Use **Attention Grabber to pause pumping** and ask for **raised hands** to answer:

What changes are you noticing as you pump? *(lake and water table go down)*

What happens **if it doesn't rain** for a long time? **Do we stop using water** during a drought? **No**!

Have **students return to pumping** as one presenter begins pollution rotation:

Add **1-2 drops of dye** to each lake and **pour a bit of pumped pitcher water back** in cup so dye spreads out

What do you think is going into your clean lake? (**Rotate around and interact** with student groups as they continue pumping) What do you think that **food dye represents**? *(pollution)*

Use **Attention grabber to pause** again and discuss:

Pollution was **only added to the lake**, so why is your **well water turning green**?
Let students **think, pair, share** and respond.

GROUNDWATER AND SURFACE WATER ARE CONNECTED

The lake, or surface water, **went up when it rained**, it went **down when we pumped** groundwater out, and the **pollution from the lake flowed underground** and traveled into our well water

5 Minutes - Wrap Up and Reset

Now, we want to make sure to pump out **ALL** of the water. You can **help your neighbors** if you finish early.

Walk around to **assist students in tilting models slightly**, to pump as much water out as possible.
Watch out for **full and overflowing pitchers** and **carry dye bucket around** to empty them.

If your pitchers are full, **please let me know** so we can empty it into this bucket.

Don't pour it back into your model! (At this time, you can **utilize student help** to reset for the next group.)

Reset tasks include:

- Collect pumping syringes
- Empty wet sand (**gravel never gets emptied**, only sand)
- Drain residual water out of models (be sure to **drain away from where students sit**!)
    - Students can hold material tubes as you drain
    - Hold turf and lake in place with one hand as you drain excess water out from one corner
- Ensure **lake cup is nested ALL the way down** to bottom so that lake fills up for next rotation
- You can either refill dry sand now or during Earth Materials Water Race in next rotation

Have students line up and get ready to rotate, away from models.

One volunteer reviews Big Ideas, while the other finishes reset.