Ground Water Introduction and Demonstration

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http://www.ngwa.org/Fundamentals/teachers/Pages/Ground-Water-Introduction-and-Demonstration.aspx

Objective

Students will be able to define terms pertaining to groundwater such as permeability, porosity, unconfined aquifer, confined aquifer, drawdown, cone of depression, recharge rate, Darcy's law, and artesian well. Students will be able to illustrate environmental problems facing groundwater, (such as chemical contamination, point source and nonpoint source contamination, sediment control, and overuse).

Introduction

Looking at satellite photographs of the planet Earth can illustrate the fact that the majority of the Earth's surface is covered with water. Earth is known as the "Blue Planet." Seventy-one percent of the Earth's surface is covered with water. There also is water beneath the surface of the Earth. Yet, with all of the water present on Earth, water is still a finite source, cycling from one form to another. This cycle, known as the hydrologic cycle, is an important concept to help understand the water found on Earth. In addition to understanding the hydrologic cycle, you must understand the different places that water can be found—primarily above the ground (as surface water) and below the ground (as groundwater). Today, we will be starting to understand water below the ground.

General definitions and discussion points

"What is groundwater?"

Groundwater is defined as water that is found beneath the water table under Earth's surface.

"Why is groundwater important?"

Groundwater, makes up about 98 percent of all the usable fresh water on the planet, and it is about 60 times as plentiful as fresh water found in lakes and streams. Because groundwater is not visible (in most cases), it is often overlooked when considering all of the water on Earth, and yet, water beneath the land surface is a valuable resource. Protecting it from contamination and carefully managing its use will ensure its future as an important part of ecosystems and human activity.

How does groundwater move through rock and/or soil?

Water in the ground travels through pores in soil and rock, in fractures, and through weathered areas of bedrock.

Other important definitions

1. The amount of pore space present in rock and soil is known as **porosity**.
2. The ability of fluids to travel through the rock or soil is known as **permeability**.
3. The permeability and porosity measurements in rock and/or soil can determine the amount of water that can flow through that particular medium. A "high" permeability and porosity value means that the water can travel very quickly.
4. Groundwater can be found in aquifers. An **aquifer** is a body of water-saturated sediment or rock in which water can move readily.
5. There are two main types of aquifers: **unconfined and confined**.

6. An **unconfined aquifer** is an aquifer that is exposed to the surface of the land. Because this aquifer is in contact with land, it is impacted by meteoric water and any kind of surface contamination. There is not an impermeable layer to protect this aquifer.
7. A **confined aquifer** is an aquifer that has a confining layer that separates it from the land surface. This aquifer is filled with pressurized water (due to the confining layer).
8. If the water is pressurized at a high enough value, when a well is drilled into the confining aquifer, water rises above the land surface. This is known as a flowing **artesian water well**.
9. The pressure of the water is called the **hydraulic head**. Groundwater movement or velocity is measured in feet (or meters) per second.
10. **Darcy's law** is one method used to compute this value (because groundwater cannot be viewed completely, like surface water, volume cannot be accurately measured). Darcy's law uses both the hydraulic head value, the hydraulic gradient, and the permeability of the material that the aquifer is traveling. The actual computation is velocity = permeability x hydraulic gradient (hydraulic head/distance).
11. In some areas, the bedrock has low permeability and porosity levels, yet groundwater can still travel in the aquifers. Groundwater can travel through fractures in the rock or through areas that are weathered. Limestone, for example, weathers in solution, creating underground cavities and cavern systems. At the land surface, these areas are known as**"karst"**.
12. The voids in the rock, created as limestone goes into solution, can cause collapses at land surface. These collapses are known as **sinkholes**. Sinkholes often are a direct conduit to the groundwater and are areas where contamination can easily infiltrate the aquifers. On topographic maps, sinkholes appear relatively circular with hacher marks (indicating a depression); they may or may not be filled with water (depending on the groundwater levels). These areas also can have land subsidence as mass wasting occurs in areas with a sudden change in slope and contact with water.
13. Porosity and permeability of the sediment, soil, and bedrock in the area also affects the**recharge** rate of the groundwater. This means that in some areas, the groundwater can be pumped out faster than it can replenish itself. This creates a number of problems.
14. One of these problems is called **"drawdown."** This is a lowering of the aquifer near a pumping well. This can occur in areas where the well is pumping faster than the groundwater aquifer is recharged. This creates voids in the bedrock and can lead to additional land subsidence or sinkholes (as there is no longer water present and the void cannot hold the weight of the material above and collapses).

Demonstration

This uses a large Plexiglass groundwater simulator.

Instructions:

1. Make sure that the groundwater simulator and all other materials were set up prior to class beginning. Simulator should be in the very front of the class for all students to see.
2. Stand behind the simulator. Show students each feature of the simulator. Emphasize the new vocabulary words that were just introduced earlier in the

lesson. Be sure that students are recording their observations in their lab books, along with the definitions of the new words.

3. Students will be evaluated by turning in their observations and definition at the end of the class. Review the standard format for lab observations.
4. Ask for at least two to three student volunteers. One will be the groundwater recharge person and the other will be the “polluter”. The third can be the one that empties the buckets and fills bottles as needed.
5. Have the recharge student begin to fill the reservoir with plain tap water. As this is slowly saturating the sand, gravel and clay, ask students what they see. Water begins to fill the simulator and enter the wells. Finally, water enters the river and pond.
6. Point to the clay layer (it's black). Clay is the confining layer in the simulator. Explain that this could be bedrock. Point to the confining aquifer. Ask students to list the wells (they are numbered) that are drilled into the confined aquifer, and in the unconfined. What are the benefits?
7. Ask for another volunteer. This will be the well pump student. Ask the student to pump one of the wells in the confined aquifer. What happens to the water levels in all of the wells when this is done vigorously? Review drawdown and cone of depression and how this can work with contamination.
8. Now, ask the "polluter" to fill up the UST (underground storage tank) with red dye. This will represent gasoline (high BTEX and with MTBE!). Ask them to fill the landfill with blue or green dye. This represents the leachate. Both leak!
9. Have student record their observations. The chemicals are slowly leaking into the unconfined aquifers and river and pond.
10. Now, have the pumper pump the well hard again. Have students pay attention to what happens (the contamination is going towards that well and polluting the other wells in its path). Explain how industries can easily do this.
11. Eventually the recharge reservoir also becomes contaminated.
12. Students should observe that the confining aquifer was the last to be polluted.

Summary

Students will typically have many different questions concerning the terms and the scenario. Take time and really go over it with them. By watching the aquifers and seeing what happens with the simulator, students can understand and apply these difficult concepts to the real world. Students can also mark the different features on the simulator using a grease pencil.

PREDICTING GROUND WATER FLOW

Grades 9-11

OBJECTIVES

- Be able to draw a ground water contour map.
- Have a basic understanding of how to predict the direction of ground water flow.
- Understand the interrelated nature of ground water and surface water flow.

INTERDISCIPLINARY SKILLS

Science, Math

ESTIMATED TIME

45 minutes

MATERIALS

❏ Activity handout

TEACHING STRATEGY

Through the handout, students will learn how to draw ground water contours and will understand how ground water flow may be predicted. A teacher's copy of the correct ground water contour map is included with this activity. Be sure students have read "Getting Up to Speed" for this section and are familiar with the material in the activity "Revealing Stories—Resource Maps Tell All."

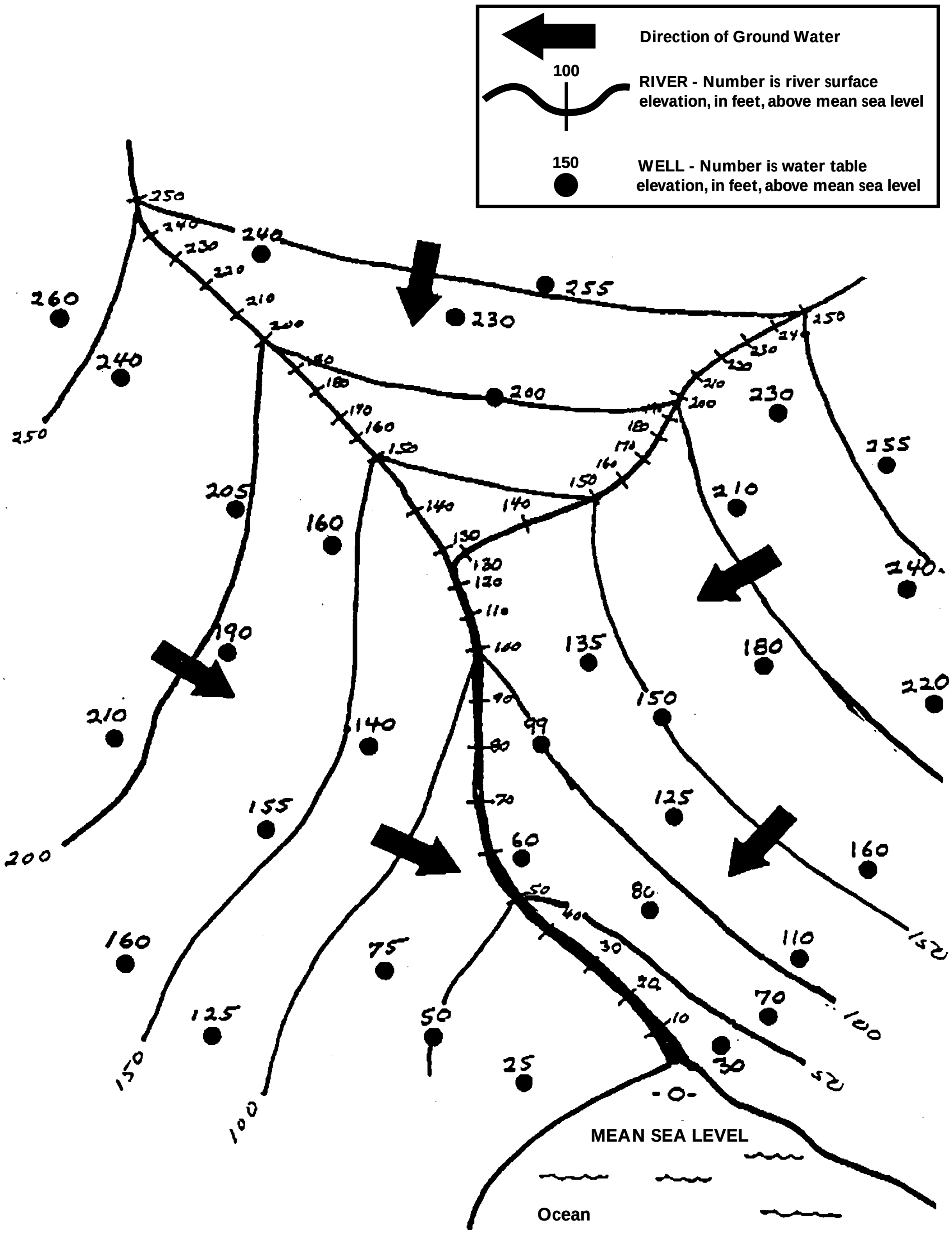
1. Distribute copies of the handout to each student.
2. Either lead students through the exercise as a class activity, or divide the students into teams to complete the assignment.

Follow-up Questions

1. Why should communities be aware of the direction of ground water flow? *By knowing the direction of ground water flow, communities can map out the land area that recharges their public water supply wells, streams, rivers, lakes, or estuaries and thereby take steps to ensure that land use activities in the recharge area will not pose a threat to the quality of the ground water and the resources dependent on it. Since contaminants generally move in the direction of ground water flow, communities can also predict how contaminants might move through the local ground water system.*
2. Why is it important to know if a stream in your community is a "gaining" stream or a "losing" stream? *Gaining streams receive much of their water from ground water, and the water level in the stream is generally at the same elevation as the water table in the adjacent aquifer. Water quality in the stream will be affected by the quality of ground water entering the stream. Because the water table elevation is approximately the same as the gaining stream surface elevation, both elevations may be used to construct water table maps and to predict ground water flow direction.*

   Losing streams lose water to the adjacent aquifer because the water table has dropped below the stream level. If there is no major source of upstream flow, the stream may dry up between storm events.

Contouring the Water Table



Predicting Ground Water Flow

NOTE: Read this entire handout before beginning the activity.

BACKGROUND

The water table is the surface of the saturated zone, below which all soil pores or rock fractures are filled with water. Ground water moves through the subsurface much like water on the ground surface, except that it travels a great deal more slowly. If the soil is mostly sand and gravel, ground water can move as much as five feet per day. But, more often than not, ground water moves at speeds of a few inches per day (or less).

Like streams and rivers, ground water moves from high areas to low areas. In this exercise, you will draw the contours of the water table to show how ground water moves beneath the ground, down the sides of a valley, to a river that flows to the sea. Before you begin this exercise, however, it is important that you understand three main principles.

First, ground water and surface water share a strong connection in New England. Have you ever noticed that streams continue to flow even when it hasn't rained for days? Where does the water come from? In most areas of New England, water is discharged to surface waters from ground water at the point where the water table intersects the surface of the land. In this situation, the surface water is called a **gaining stream** or **gaining pond**.

Second, because the water table is at the land surface adjacent to "gaining" surface waters, the elevation of ground water is generally the same as that of the river, especially between rain storms.

Third, ground water is assumed to flow at right angles to water table contours. This is because ground water moves downhill in the path of least resistance due to gravity. In this exercise, you'll use all three of these principles.

During this activity you will learn how to draw a water table contour map. Water table measurements that are taken at the same time of year can be used to develop a water table contour map to show the direction of ground water flow. Monitoring wells are typically used to determine the elevation of the water table. The elevation of the water table is determined at several locations throughout the area of interest. Like topographic map contours, water table contours represent lines of equal elevation. The difference between the maps is that water table elevations are measured in wells and at the river channel, not on the ground surface. Thus, just as surface water flow is downhill and perpendicular to topographic contours, the direction of ground water flow is also downhill and perpendicular to the water table contours.

Don't worry—drawing contours is easier than you think. Just follow these simple steps:

DIRECTIONS

ASSIGNMENT

1. Using the "Contouring the Water Table" worksheet, take a pencil (in case you make mistakes), and *lightly* draw in 3 or 4 arrows to show your prediction for the direction(s) of ground water flow.

2. Draw contours at 50-foot intervals. The pencil lines can always be inked-in later. Begin at 50 feet (the shoreline along the ocean will be sea level), then draw the other contours for 100, 150, 200, and 250 feet.

3. To get started, draw the 50-foot contour. Find the 50-foot elevation on the river. Draw a line from that point through the 50-foot elevation at the well just southwest of the river. Don't go much past the well, because there are no more data to tell you where to go!

4. Draw the contour on the other side of the river. When locating a contour between two points, you will have to **interpolate**—that is, figure out the proportional distance between the points.The 50-foot contour between the 30- and 80-foot elevations should be drawn closer to the 30-foot value (20 feet difference) than the 80-foot value (30 feet difference). You can do this by hand after a little practice, or measure it precisely with a ruler and calculator. For the other two wells, draw the contour exactly between the 30- and 70-foot elevations, because they are both 20 feet different from the 50-foot contour's value.

5. When you are finished, you will notice that the contours form V's with the river and its tributaries. That's because the river is a "gaining" river. It is receiving recharge from the aquifer. The contours show that ground water is moving down the sides of the valley and into the river channel. The opposite of a gaining stream is a "losing" stream. It arises when the water table at the stream channel is lower than the stream's elevation, or stage, and stream water flows downward through the channel to the water table. This is very common in dryer regions of the Southwest. In the case of a losing stream, the V will point downstream, instead of upstream.

NOTE: When making a water table map, it's important that your well and stream elevations are accurate. All elevations should be referenced to a standard datum, such as mean sea level. This means that all elevations are either above or below the standard datum (e.g., 50 feet above mean sea level datum). It's also very important to measure all of the water table elevations within a short period of time, such as one day, so that you have a "snapshot" of what's going on. Because the water table rises and falls over time, your map will be more accurate if readings are made before these changes occur.

Understanding how ground water flows is important when you want to know where to drill a well for a water supply, to estimate a well's recharge area, or to predict the direction contamination is likely to take once it reaches the water table. Water table contouring can help you do all these things!

Follow-up Questions

1. Why are communities interested in learning the direction of ground water flow?

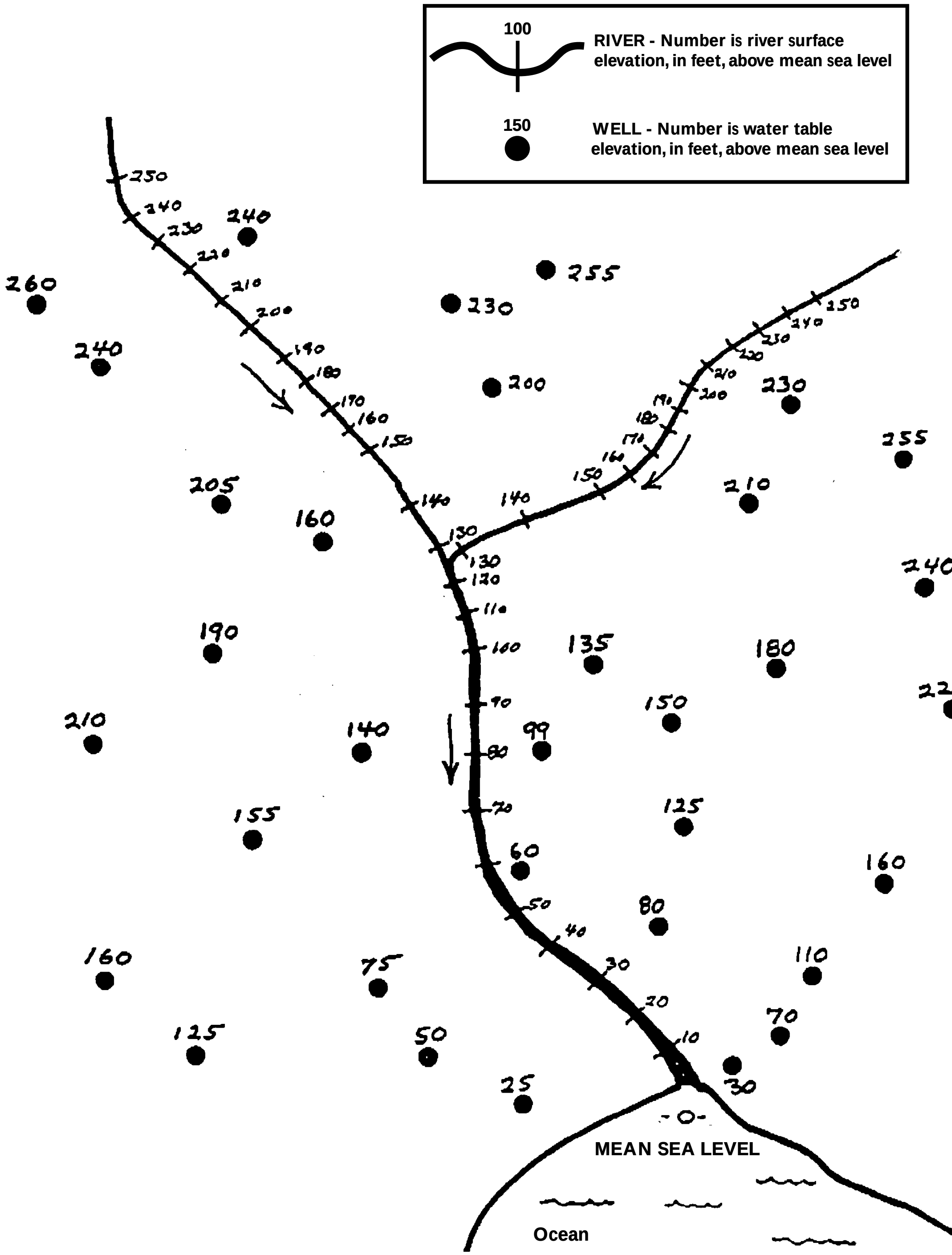
2. Why would it be important to know if a stream in your community is a **"gaining" stream** or **"losing" stream**?

3. Compare and contrast your predictions for ground water flow to your mapped ground water flow direction(s). Briefly explain and differences.

KEY TERMS

- **Gaining Stream/Pond**
- **Interpolate**
- **Losing Stream/Pond**

Contouring the Water Table



Deep Subjects—Wells and Ground Water

Grades
3 - 6

Objectives

- Demonstrate knowledge about what ground water is in terms of how it exists in the ground.
- Explain how ground water moves through the soil and how it interacts with surface water.
- Demonstrate knowledge about how ground water is extracted for use as drinking water.

Estimated Time

- Part A - 20 minutes
- Part B - 20 minutes
- Part C - 45 minutes
- Part D - 25 minutes
- Part E - 20 minutes
- Part F - 25 minutes
- Part G - 20 minutes

Background Information

Water that falls to the earth in the form of rain, snow, sleet, or hail continues its journey in one of three ways: It might land on a waterbody and, essentially, go with the flow; it might run off the land into a nearby waterbody or storm drain; or it might seep into the ground. Water that seeps into the ground moves in a downward direction because of gravity, passing through the ***pore*** spaces between the soil particles, until it reaches a soil depth where the pore spaces are already filled, or saturated, with water.

When water enters the ***saturated zone***, it becomes part of the ***ground water***. The top of this saturated zone is called the ***water table***. The water table may be very close to the ground surface, which is often the case when it is adjacent to a waterbody, or it may be as much as 200 to 600-feet deep, which is the case in many areas of the Southwest United States. A water-bearing soil or rock formation that is capable of yielding enough water for human use is called an ***aquifer***. In bedrock aquifers, water can move through cracks, or fractures. Some types of bedrock—like sandstone—can absorb water like a sponge; other types of bedrock—like granite—do not.

How quickly water passes through, or ***infiltrates***, the soil is a function of the size and shape of the soil particles, the amount of pore space between the particles, and whether or not the pore spaces interconnect. For example, soils that consist primarily of larger sand and gravel particles tend to have larger, interconnected pore spaces that allow water to flow easily and relatively quickly. In contrast, some soils, such as silts and clays, have poorly connected pore spaces, a soil structure which tends to slow down infiltration.

Materials

- ❏ Flip chart or black board
- ❏ Markers
- ❏ Clear plastic cups
- ❏ Pea-sized un-colored aquarium gravel (available from pet supply stores)
- ❏ Sand
- ❏ Water bottle spray nozzles (available from a hardware store)
- ❏ Pieces of nylon stockings or tights
- ❏ Cake pan(s) (glass is preferable) or a clear, plastic salad tray
- ❏ Water
- ❏ Food coloring (at least one teaspoon per gallon)
- ❏ Unsweetened red Kool-Aid
- ❏ "Rain cups" - paper cups with holes punched in the bottom
- ❏ Water Maze handout

Deep Subjects—Wells and Ground water

NOTES

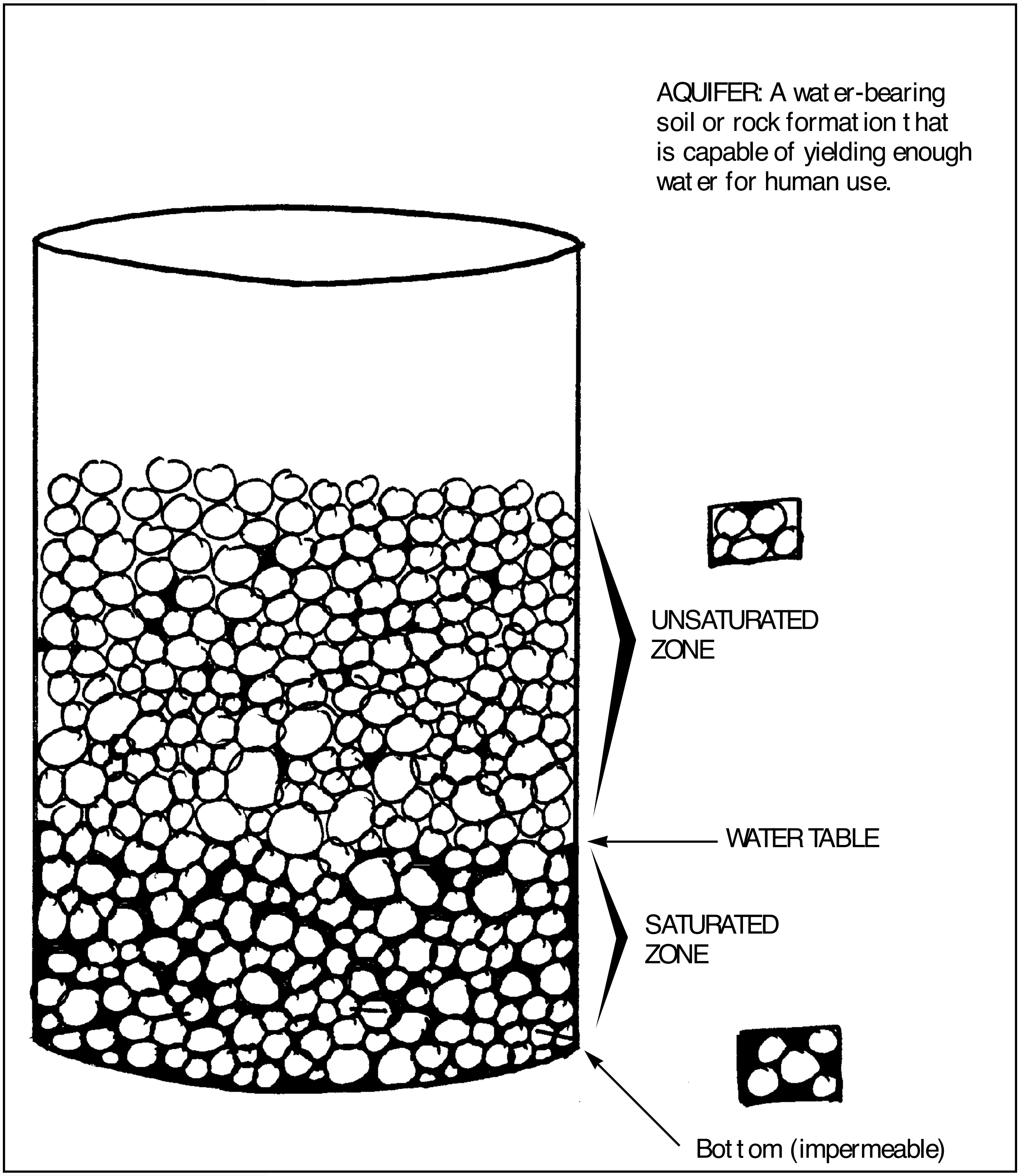
When infiltrating water reaches the water table, it begins to move along with the ground water flow, which tends to follow a downhill, or down slope, direction. Compared with water in rivers and streams, ground water moves very, very slowly, from as little as a fraction of a foot per day in clay to as much as 3-4 feet per day in sand and gravel.

In time, ground water "resurfaces"—perhaps when it intersects with a nearby waterbody, such as a stream, river, lake, pond, or ocean; or perhaps when it emerges from a hillside as a spring or as water seeping out of a cutaway roadside rock formation. Ground water is very much a part of nature's water cycle.Another way ground water resurfaces is when it is withdrawn from the ground by way of a well. Wells are drilled and installed to capture ground water and pump it to the surface. In New England, the average depth to ground water ranges between 8-20 feet.

When pollutants leak, spill, or are carelessly discarded into and onto the ground, they, like water, move slowly or quickly through the soil, depending on the soil, the nature of the pollutant, and the amount of extra help it gets from incoming precipitation. If there is a water supply well near a source of contamination, that well runs the risk of becoming contaminated by polluted ground water. If there is a nearby river or stream, that waterbody may also become polluted by the ground water. Because it is located deep in the ground, ground water pollution is generally difficult and expensive to clean up. In some cases, people have had to find alternative sources of water because their own wells were contaminated.

GROUND WATER DIAGRAM

GROUND WATER TERMS



NOTES

TEACHING STRATEGY

NOTE: These exercises may be completed over several class periods.

Part A - Brainstorming About Ground Water

1. Have a discussion with the class about ground water so that you can get some idea of what, if any, preconceptions exist. (Many adults still think ground water exists as an underground lake or river.) Ask students to describe what they think ground water is, where it is, and how it got there. List the answers on the board or a flip chart.
2. Ask for a volunteer(s) to come to the board and draw a X-section of what he/she thinks the ground water environment might look like. Allow the students to contribute to the drawing by making suggestions or even volunteering to draw their own versions. Keep the drawings on hand so you can refer back to them when you have completed the demonstrations.

Part B -The Water Cycle Connection

1. Take your students outside onto the school grounds. Ask them to think about the last time it rained. Where did the water go when it fell on pavement? On roofs? On soil?
2. Take a cup of water, and ask a student to pretend it is rain. Have the student pour the water on unpaved ground. What happens to the water? *First, it makes a puddle. Then, it soaks into the ground.*
3. Discuss what might be happening to that water once it disappears into the soil.

Part C - Demonstrating Ground water

You may want to do this exercise as a class or as small groups.

1. Ask the students to think of the cup and sand and gravel models that they are about to make as part of a ground water system. Explain that the bottom of the cup is similar to bedrock or clay that is found beneath the earth's soil layers. Because we can't see ground water, we make models to demonstrate how it looks.

NOTES

2. Fill one clear cup(s) 3/4 full with gravel and the other(s) with sand. Ask the class to describe the spaces (pores) between the gravel and between the sand. *The gravel has bigger spaces.*

3. Pour water slowly into each of the cups until it reaches the top of the gravel or sand (not the top of the cup). Where is the water? *It has filled in the pore spaces.*

4. Explain that when we refer to ground water, we are talking about that part of the soil where all the pore spaces are filled, or saturated, with water.

5. Explain that when it rains, some of the rain (or other precipitation) flows into the soil. It moves through the spaces or pores between the particles. As water flows through the soil, it eventually reaches an impermeable layer of rock or clay and begins to fill the pore spaces of the soil.

6. Have students complete the water maze activity. This activity illustrates how water must find its way through available openings and paths in the soil structure.

7. To demonstrate where ground water (the saturated zone) begins, fill another cup(s) to nearly the top with gravel. At the edge of the cup, gently pour in the water (dyed with food coloring) until the cup is half filled with water. (If you pour the water too fast, you may have to let it "settle" for a few minutes). Tell students that the ***water table*** is the place where the soil becomes saturated and the drier sand or gravel ends. Water found below the water table is called ***ground wate***r. For older students, you may want to mention that the area above the water line is called the ***unsaturated zone***; the area that has every space filled with water is called the ***saturated zone***.(See "Ground Water Terms" diagram on page C4 with this activity.)

Part D - Well Demonstration

1. Explain to students that many people use ground water as a source of drinking water or as a source of water for crops/plants.

2. Explain that wells are used to pump water out of the ground. This demonstration shows how wells pump out ground water.

NOTES

3. Cover the bottom of the tube of a spray nozzle with a piece of nylon stocking. Secure the stocking with a rubber band.

4. Put the spray nozzle into an empty cup. Fill the cup 3/4 full with gravel. Pour water into the cup until it reaches the top of the gravel (not the top of the cup). The sprayer is used to simulate pumping water through a well.

5. Pump water through the spray nozzle into another cup or into the sink.

Follow-up Questions

1. Why did we use the stocking at the base of the spray nozzle? *To keep sand and gravel from being pumped into the tube. Real wells have screens too.*

2. How are most real wells powered? *By an electric pump.*

Part E - The Ground Water/Surface Water Connection

1. Put a layer of un-colored aquarium gravel in a clear cake pan or clear plastic salad bowl (about 3” deep). Dig a hole (depression) in the gravel, so that when water is added students can see the water table (the thoroughly wet gravel, or saturated zone, versus the area that is dry or just damp) as well as the relationship between ground water and surface water.

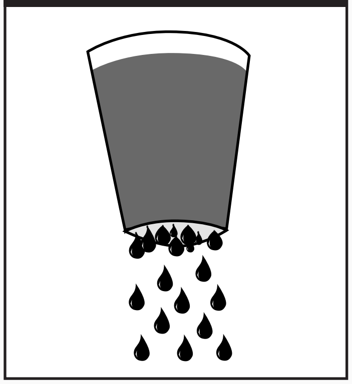
2. Add light blue food coloring to a pitcher of water. Gently pour the water into the pan at one edge until it saturates about 1 1/2” of the gravel throughout the pan. What happens? *Water will seep into the hole.*

3. Explain that in many parts of the country, when people dig a big hole in the ground it slowly fills up with water and becomes a man-made pond or lake. From where does the water come? *Ground water flows into the hole.*

4. Explain to students that lakes and ponds receive their water from many sources—direct rainfall and melted snow, runoff of water during storms, and ground water. Just as ground water fills a man-made lake or pond, it also moves and discharges into naturally occurring waterbodies. For grades 4-6, hand out the ground water diagram in this activity (see page C3) to show how the water table intersects with lakes and streams.

NOTES

RAINCUPS



Part F - Polluting Ground Water

1. Using the ground water/pond set up from Part E, take the spray nozzle and withdraw water from the ground. (Do this in a corner away from the pond.) What happens to the water level in the pond as you withdraw more and more water? *The water level in the pond goes down.*

2. Replenish the ground water level, then place 1 tablespoon of the red Kool-Aid in one location on the ground surface, away from the pond. Make it rain by adding water using "rain cups." What happens to the pond? *Eventually, the contamination make its way into the pond.* This exercise demonstrates how ground water quality can impact surface water quality.

3. Using your spray nozzle to simulate a well, withdraw water from the ground. What happens? *As you continue to withdraw water, the contamination eventually moves into the well.* Look underneath the clear pan to see how it spreads.

Part G - Wrap-up Discussion

1. Have students review the earlier ground water brainstorming discussion to see how their answers might have changed as a result of what they now know about ground water. What have they learned?

2. How might they modify their earlier ground water X-section diagram?

Alternate Strategy

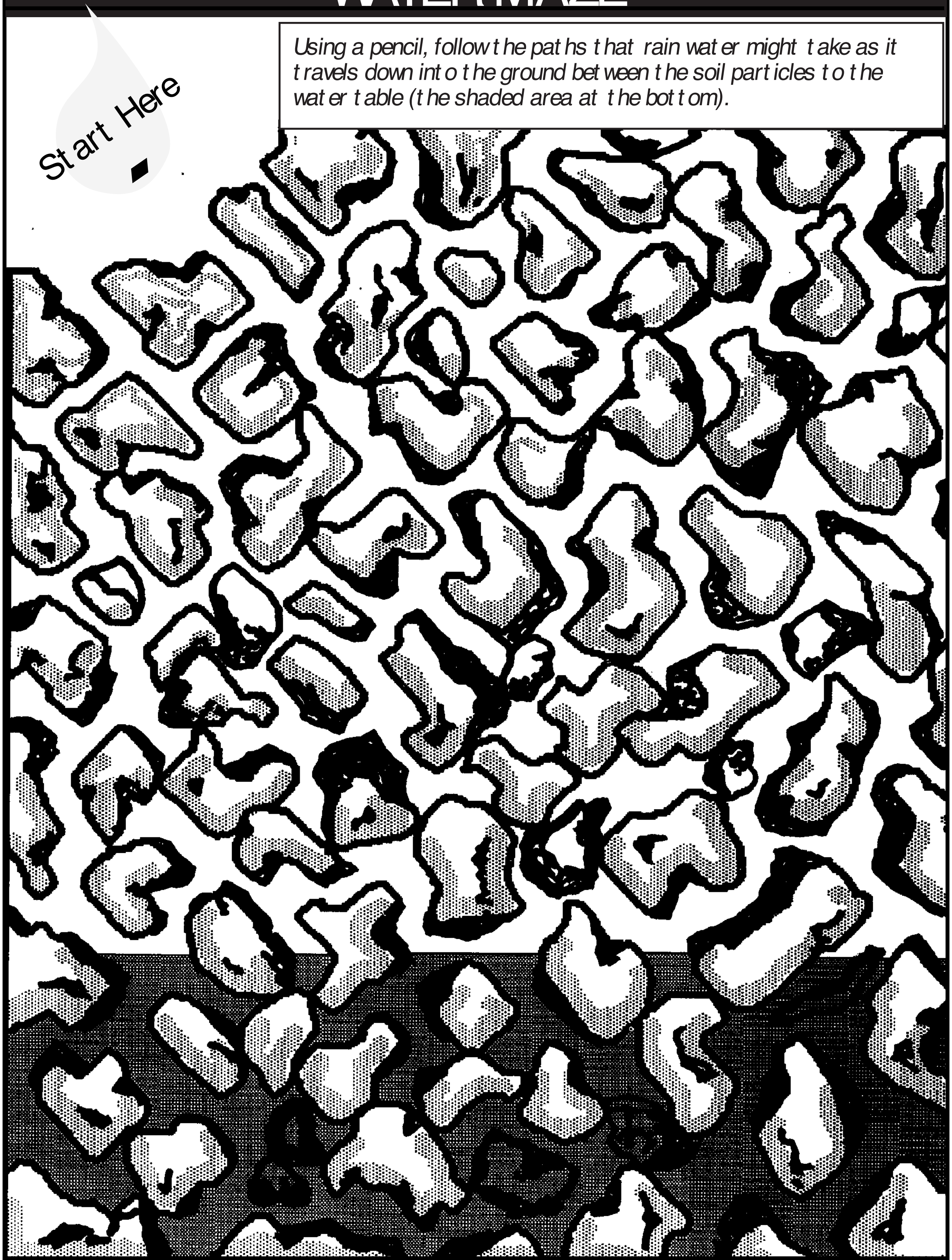
Make parts E-F more interesting and fun by having the students create whole, landscaped settings in larger see-through containers. Settings can include houses, roadways, ponds or rivers, bridges, etc. Using a spray nozzle, install a well near the home or business.

Adapted from: SEE-North. *Ground water Education in Michigan's Schools.* Petoskey, MI: Science and Environmental Education - North, 1991.

Adapted from *Watershed to Bay: A Raindrop Journey*, U. Mass. Cooperative Extension System. This curriculum was printed with funds from the U. Mass Extension Program, the U.S. Dept. of Agriculture, and the Massachusetts Bays Program.

WATER MAZE

Using a pencil, follow the paths that rain water might take as it travels down into the ground between the soil particles to the water table (the shaded area at the bottom).



All the Water in the World

Grades
K - 3, 4 - 6

➤ **Objectives**

- Recognize that there is a lot of water in the world, but that not very much of it can be used for our drinking water and other water supply needs.
- Recognize that ground water is a very small percentage of the earth's water.
- Understand how important it is that we take care of our ground water.

➤ **Interdisciplinary Skills**

Science and Math

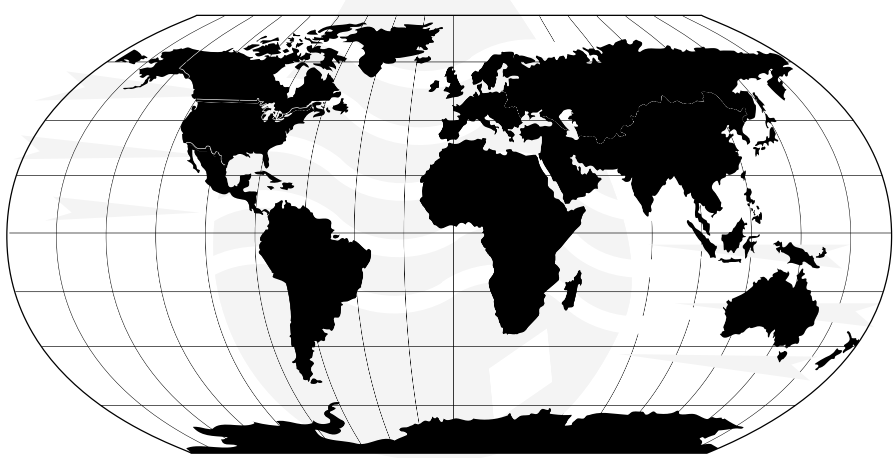
➤ **Estimated Time**

- 30 minutes (grades K-3)
- 2 hours (grades 4-6)

Background Information

Because water covers three-quarters of the earth's surface, it might appear that there is plenty to go around and that we will never run out of this valuable resource. In reality, however, we have a limited amount of usable fresh water. Over 97 percent of the earth's water is found in the oceans as salt water. Two percent of the earth's water is stored as fresh water in glaciers, ice caps, and snowy mountain ranges. That leaves only one percent of the earth's water available to us for our daily water supply needs. Our fresh water supplies are stored either in the soil (aquifers) or bedrock fractures beneath the ground (ground water) or in lakes, rivers, and streams on the earth's surface (surface water).

We use fresh water for a variety of purposes. Agricultural uses represent the largest consumer of fresh water, about 42 percent. Approximately 39 percent of our fresh water is used for the production of electricity; 11 percent is used in urban and rural homes, offices, and hotels; and the remaining 8 percent is used in manufacturing and mining activities.



Grades
K - 3

MATERIALS

- Globe
- 97 pieces of uncooked ziti dyed blue, 1 piece dyed red, and 2 pieces dyed green or 100 dixie cups (optional strategy)
- Food coloring

TEACHING STRATEGY FOR GRADES K-3

Part A - Exploring the Globe

1. Look at the globe with the students. See if they can find where they live on the globe. Have them point out lakes, rivers, and oceans. Explain that these are called surface waters.
2. Ask the students if they know which kinds of waterbodies are salt water and which are freshwater. Have they ever tasted salt water? Was it good?
3. Ask the students if they think there is more water or land on the globe. Is there water beneath the surface of the ground that we cannot see on the globe?

Part B - Demonstrating With Ziti

1. Spread the ziti out on a table. Explain that there are 100 ziti pieces that represents all (100%) of the water in the world.
2. Using the concept of percentages, ask the students if they know what the red and green zitis represent. See if they can estimate percentages. Explain that the two green zitis represent water that is stored as ice in glaciers and at the poles (2%). The lonely red ziti represents the fresh water that is available for plants, animals, and people (1% of all the water on the earth). Ask the students what the remaining blue zitis represent. *They represent the water that's in the ocean, 97% of all the water on earth.*
3. Ask the students what we should do to take good care of the water we use in our homes and businesses. *Use only what we need.*

Optional Strategy

Use 100 dixie cups filled with water. Use food coloring (as described above) to indicate ice glaciers and fresh water.

Supplementary Activities

- Draw a water pie. Have students draw a circle that represents all the water in the world. Have them make pie slices in the circle that represent 97% ocean, 2% glaciers and ice, and 1% fresh water. Color and label the water pie.

- Make a water necklace. String the ziti (you'll probably need to have more on hand) on pieces of yarn. Have the students take the necklaces home and explain "all the water in the world" to their families.

Grades
4 - 6

➤ MATERIALS

- ❏ Globe
- ❏ 5 gallons of water
- ❏ Tablespoons
- ❏ Container (such as aquarium)
- ❏ Droppers
- ❏ Graph paper
- ❏ Small containers (quart jars)
- ❏ Copies of activity handout

TEACHING STRATEGY FOR GRADES 4-6

Part A - Exploring the Globe

Same as K-3

Part B - Aquarium Demonstration

As you do this experiment, stress that the amounts represent relative quantities of different types of water, not actual amounts.

1. Put 5 gallons of water in an aquarium or other container. Tell students to imagine the container represents all the water in the world.
2. Have students remove 34 tablespoons of the water and put them into a cup. Tell them this amount represents all the water in the world that is not ocean.
3. Have the students remove 26 tablespoons of water and then another 8 tablespoons of water from the cup containing the 34 tablespoons of water. Put each into separate cups. The 26 tablespoons represent the world's ice caps and glaciers. The 8 tablespoons represent the world's fresh water. A fraction of a tablespoon (1/10) represents the world's fresh water lakes and rivers. Of that, all rivers amount to less than a drop.
4. Be sure to recycle the water. Use it to water plants.

Part C - Work Sheet: All the Water in the World

1. Ask students to complete the activity work sheet.
2. The answers to the drinking water percentages: 0.419% total and 2.799% grand total.
3. Ask students if the numbers surprised them. Did they realize that such a small percentage of the water in the world is fresh?

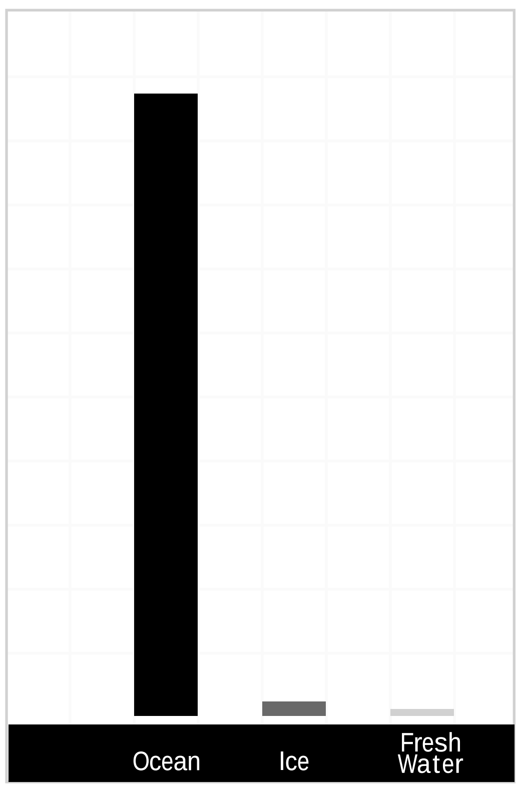
NOTES

Part D - Bar Graph

1. Distribute graph paper.
2. Ask students to create a bar graph that shows 97% ocean, 2% ice caps and glaciers, and 1% fresh water.

Follow-up Questions

1. Why isn't all fresh water usable? *Some is not easy to get at; it may be frozen or trapped in unyielding soils or bedrock fractures. Some water is too polluted to use.*
2. Why do we need to take care of the surface water/ground water? *Water is very important for humans, plants/crops, and animals. If we waste water or pollute it, we may find that there is less and less of it available for us to use.*



Adapted from: Project Aquatic Wild. *How Wet is Our Planet?* Western Regional Environmental Education Council, 1987.

D I D   Y O U   K N O W . . . . ?

- ❑ Earth is called the water planet.
- ❑ Between two-thirds (2/3) and three-fourths (3/4) of the earth's surface is covered with water.
- ❑ The earth has different types of water:

Oceans	97.2% of total water
Ice caps/glaciers	2.38%
Ground water	0.397%
Surface water (e.g., lakes, rivers, streams, ponds)	0.022%
Atmosphere	0.001%

Add up the percentages for water available for drinking water.

Ground water ____________

Surface water ____________

Total ____________

Now add ice caps/glaciers ____________

Grand Total ____________

Remember: Only a small percentage of water is suitable for humans to drink. Not all of the water in the ground and in lakes and rivers is easy to reach or clean enough to drink. Ice caps and glaciers are certainly hard to use for humans, plants, and animals. Some work is being done to take the salt out of ocean water (desalinate the water), but that is an expensive process.

Adapted from: *Water: The Resource That Gets Used and Used and Used for Everything.* Poster: Middle School Version. United States Geological Survey, Reston, Virginia. 1993.