Water and Your World
Teacher's Guide

Introduction
Water and Your World introduces basic water science to upper elementary and middle school students, stresses the importance of protecting water quality and conserving water supplies, and explains how to do so. The booklet supports National Science Education Standards in the areas of physical and earth sciences. Topics include the hydrologic cycle, groundwater and surface water, watershed protection, drinking water and wastewater treatment, and water conservation.

This presentation guide provides the objective for each lesson, background and ideas for classroom discussion, experiment tips, extension activities, and activity answers.

Page 2: Water Is a Scarce and Vital Resource
Objective: To help students appreciate the value of clean, safe water through awareness of the scarcity of fresh water on our planet and the many ways we use water in our daily lives.

Background/Discussion: To drive home the concept of usable water's scarcity, introduce the famous line from Samuel Taylor Coleridge's poem, "The Rime of the Ancient Mariner": "Water, water, everywhere, nor any drop to drink," which was the case for the thirsty seamen in the poem who were becalmed at sea without fresh water supplies. Explain that in our country we are so used to seeing water and having it in abundance that grasping the need to conserve it can be difficult.

Water in Your Life Activity Answers: Give students five minutes to think about this on their own, and then five minutes to combine ideas and brainstorm in small groups before sharing with the class as a whole. Some ways that kids and their families use water include:

Indoors: baths, showers, toilets, cooking, washing clothes, washing dishes, mopping, watering plants, drinking (both humans and pets), fish tanks
Outdoors/For Fun: watering lawns and gardens, washing cars, swimming, boating, and water play such as balloons, squirters, and water parks

To follow up on the discussion of the need for *clean* water, have students circle the responses they made that require clean water.

Water Words Definitions: Context clues for these words are found on the pages noted below.
aquifers – layers of soil and rock that are saturated with water, p.4
condensation – when water changes state from vapor to liquid, as occurs in clouds, p. 3
evaporation – when heat from the sun causes water in oceans and other bodies of water to rise into the air as vapor, p. 3
groundwater – water that is stored beneath the ground in aquifers, p. 4
percolates – soaks into the earth, p. 3
pollutants – substances that make water dirty or toxic to life forms, p. 10
precipitation – water that falls to earth as rain, snow, or hail, p. 3
reservoirs – natural or man-made lakes used for storing water, p. 4
runoff – precipitation that is not absorbed by soil, pp. 3, 8
surface water – water stored aboveground in lakes, rivers, ponds, or reservoirs, p. 4
transpiration – the process of water evaporating from plants into the air, p. 3
watershed – the land area that drains storm water runoff into a body of water, p. 8

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Page 3: The Water Cycle
Objective: To help students understand the hydrologic cycle.

Background/Discussion: The water cycle is a continuous natural system that keeps water always in motion. Explain that every molecule of water that was present when the earth was formed is still present today. The same water has moved from the oceans to the atmosphere, dropped down to the land, and eventually moved back to a body of water. *Evaporation* occurs when the sun heats up water in rivers, lakes, or oceans and turns it into vapor or steam, which then rises up into the air. *Transpiration* also helps move water into the air when plants transpire (sweat) and lose water out of their leaves. *Condensation* happens when the water vapor in the air gets cold and changes back into liquid, forming clouds. *Precipitation* occurs when so much water has condensed that the air cannot hold it anymore. The clouds get heavy and drop water back to the earth in the form of rain, hail, sleet, or snow. Once back on the land, water will either soak into the earth (percolate) or run over the soil as runoff. The sun's energy, in combination with the force of gravity, keeps the water moving without end.

Labeling Activity Answers: Clockwise from lower left: percolates; runoff; precipitation; transpiration; condensation; evaporation.

Extension: Ask students to design their own water cycle diagram, drawing and labeling the main concepts: evaporation, transpiration, condensation, precipitation, percolation, and runoff.

Page 4: Where Does Your Water Come From?
Objective: To explain that our water is supplied from two main sources: underground, as groundwater that is stored in aquifers; or aboveground, as surface water that is stored in streams, ponds, lakes, or other fresh water sources.

Background/Discussion: Groundwater comes from precipitation that soaks into the ground. Because of gravity, water seeps downward, passing between particles of soil, sand, gravel, or rock. Ask students to think about a time when they dug a hole in the sand while next to a lake or ocean. What happened? *(They eventually reached water.)* This is an example of shallow groundwater. A deep underground layer of porous rock that holds a lot of groundwater is called an aquifer. Wells pump groundwater up from aquifers and then pipes deliver the water to cities, houses, and farms. Most groundwater is clean, but sometimes groundwater can become polluted by leaky underground tanks, landfills, or fertilizer.

Fresh surface water makes up about 3% of the total water found on earth. This water is found in rivers, streams, lakes, springs, and swamps.

Extension: Have students build their own water molecule with toothpicks and balls of colored clay or gumdrops. If students can find out where their water comes from at home, map their answers on a local area map on a bulletin board using colored pushpins. For a math extension, graph the results.

Page 5: Water Matters
Objective: To help students realize the importance of water conservation and recycling.

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Background/Discussion: Explain to students that countries that have a lot of industry use more water than other countries that are not as developed. The United States consumes much more water than other countries—about 400 billion gallons of water per day! Ask students if they think it would be fair to restrict everyone on the planet to the same amount of water per day, or if those groups who need more water should be allowed to have it.

As a class or in small groups, brainstorm ways to save water individually and ways to limit water use in your city or town. Ask students if they think this plan would work. For older students, consider expanding the debate to include what we know about how other countries are polluting our ocean waters and rivers without any consequences for cleanup.

Activity Answers:
Explain to students that in some vending machines a can of soda would cost more than $1, but if buying a 12-pack, it would cost less, so $1 is an average.
$1.00 x 10 = $10.00 for a gallon of soda; 60 x $10 = $600 for 60 gallons of soda
Comparison: The price of 60 gallons of tap water is less than a penny, while the price of 60 gallons of soda is $600. Big difference!

Extension: Have students compare the price of water to other drinks their family buys, such as fruit juices or bottled water.

Page 6: Making Water Clean
Objective: To help students understand that water must be cleaned before people can use it, and to familiarize them with the process involved in a water treatment plant.

Background/Discussion: Water may be treated differently in different communities depending on the quality of the water that enters the plant. Groundwater typically requires less treatment than surface water from lakes, rivers, and streams. Either way, it requires a lot of work to provide our homes with safe and clean water. Following a drop of water through a water treatment plant, you will find the following process: Coagulation removes dirt and other particles suspended in the water. Certain chemicals are added to water to form tiny sticky particles called “floc,” which attract the dirt particles. The weight of the dirt and floc become heavy enough to eventually sink to the bottom during sedimentation. Next, the clear water moves to filtration. Then a small, safe amount of chlorine or other type of disinfection is used to kill any type of bacteria or microorganisms that might be in the water. From there water is stored in a reservoir or closed tank until it is sent through pipes to the community. Ask students if they have ever seen a water treatment plant. If so, ask students to share what part(s) of the process they have seen.

Diagram Labeling Answers: Top left: 1; top right: 2; center: 3; lower left: 4: bottom next to Chlorine: 5; lower right: 6.

Extension: Arrange a field trip to your local water treatment plant; many plants offer tours for local school groups.

Page 7: Build Your Own Water Filter
Objective: To help students understand the process of filtration.

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Procedures: Make sure students know not to drink the dirty water even after it has been filtered. *Variations:* 1) Have students work in four groups. Each group builds a filter in the exact same way. Then give each group a different material to "dirty" their water with. See what dirty element is hardest or easiest to get out of the water. 2) Working again in four groups, each group builds a different filter. Then give each group the same substance to dirty their water with. See which filter works the best to clean the water. Compare and discuss results as a whole class.

Discussion: Discuss which filtering material cleaned the water the best. Did the order of the filtering materials make a difference in how clean the water became? *(Students should find that using more than one material makes the water cleaner, and that having the cotton on the bottom and gravel on the top filters the water best.)* Discuss how the process of filtration that students are exploring mimics that of a water treatment plant.

Extension: Put oil or vinegar in water and filter this instead of dirty water. See whether the filtering media can filter these out. Explain to students how, similarly, excess motor oil sometimes washes off the streets and into the watershed and needs to be filtered at a treatment plant. Then try confetti or colored sand as an alternate filtering medium. Discuss the results.

Page 8: Everyone Lives in a Watershed

Objective: To help students understand that a watershed is any area of land that water flows across or through on its way toward a common body of water such as a stream, river, lake, or ocean. Everyone lives in some type of watershed.

Background/Discussion: Watersheds can be big or small, but they have places of higher elevation as their upper boundaries. Watersheds capture water and eventually release it downhill. Ask students to think about whether the land where they live is steep or flat and how that might affect the way the water runs off. *(Steep land will make the water flow into fast-moving creeks and rushing rivers. Flat land will allow the water to collect into lakes, ponds, and swamps.)* Explain that the runoff from smaller watersheds joins together to form larger watersheds. Examples of these are the Mississippi River and the Chesapeake Bay, which eventually drain into larger bodies of water and cover immense land areas. While looking at a map discuss where the students see possible smaller watersheds that might flow into larger bodies of water.

Get students thinking about the impact that pavement and roofs have on a watershed. Tell them that a typical city block generates nine times more runoff than a forested area of the same size. Ask them why they think this is so. *(Because a paved city block is an impervious surface that does not absorb runoff.)*

Word Game Answers:

runoff (first blank)	**watershed** (second blank)	**earth** (third blank)
soak (fourth blank)	**pavement** (fifth blank)	

Extension: Either individually or as a class, have students find out what type or types of storm water drainage occurs in your area. Have them find a storm drain near their home or your school. Ask them where they think the water flows from. What possible pollutants could get washed down into this drain? Some towns and cities label their storm drains with the names of the creeks or bodies of water they flow into. Have students find out if theirs does. For a further extension, have them draw their own storm drain logo. (Find examples on the Internet.)

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Page 9: Create Your Own Watershed
Objective: To understand the basic properties of a watershed: how water flows from higher elevations to lower elevations and how the placement of geographical features such as mountains, valleys, hills, rivers, and lakes can affect the path of water. Students will also gain an understanding of how contaminants and pollution can affect watersheds.

Procedures: After marking the plastic wrap in the places where students think the runoff will accumulate, it is not necessary to put the plastic wrap back on if it feels difficult to do. The act of marking it in the beginning serves to help students think about where they think the pools will occur.

Discussion: Ask students what direction the water flowed in and how it matched their predictions. What other features might affect the flow of watersheds? Students should notice that the water flowed to the lowest point, and that the contaminants collected in pools. To clean these pools, the water would need to be filtered. The model watershed resembles a real one in that it has various elevations and depressions, and the water flows down to create pools because of gravity. Also, pollution can also be very evident and extremely difficult to remove in both this and real watersheds. However, the model is different from a real watershed in that there are no trees or plants or soft surfaces to soak up the water. Ask students what ideas they have to reduce the impact of pollution on our watersheds and surrounding environment. (See page 11 for ideas.)

Extension: Have students draw what they observed when they poured the water over their model watershed.

Page 10: Runoff and the Environment
Objective: To understand that polluted runoff is a huge threat to our waterways and can create "dead zones"—places where no plants, fish, or animals can live.

Background/Discussion: Ask students to think of all the pollutants that can be in runoff water in their neighborhoods. *(Some examples are yard debris, soaps, trash, motor oil, pool chemicals, animal waste, sediment, pesticides, fertilizers.)* Fertilizer is a big problem because it causes an overgrowth of algae when it reaches surface water. The algae consumes the oxygen in the water and blocks the sunlight needed by other plants and animals. Sediment (dirt, rust, or sand) from unplanted bare land also poses a problem. Sediment gets into runoff through the process of erosion, when storm water carries soil and gravel into the watershed. While not strictly pollution, excess sediment poses many problems in an estuary, threatening the lives of fish and other organisms that live there, as well as the animals the feed on them.

Extension: Have students conduct some Internet research about a "dead zone" that has been created by polluted runoff and report back to the class. There are a few around the country now, such as off the coast of Oregon and in the Chesapeake Bay.

Page 11: Protect Our Water
Objective: To increase awareness of specific ways students and their families can protect water.

Background/Discussion: Discuss how important it is that everyone helps to keep our water clean. Discuss the actions that the students and their families currently do, and what things they want to start doing. What *new* suggestions do the students have? Ask them to share these with their families.

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Extension: Spread the word about water protection at your school by having your class give a presentation to a younger grade or in a school assembly.

Page 12: Our Water Supply Is Limited
Objective: To help students understand the importance of conserving water.

Background/Discussion: Ask students if they understand the connection between saving water and saving energy. Explain that it takes energy to pump and clean water, both before and after it is used, so when we save water we save energy. (And in saving energy we also save water, because it takes water to produce electricity!)

Water Math Answers: 1) 200 x 365 = 73,000 gallons of water saved by fixing the leaking toilet. 2) 200 x 12 = 2400 gallons of water saved by fixing the leaking faucet.

Page 13: Here's How You Can Save Water!
Objective: To increase awareness of the many ways students and their families can save water.

Background/Discussion: Refer back to any ideas your class may have written down when reading *Thirsty World* on page 5. Are there some ideas they hadn't thought of? Also have them look back at their lists from page 2 on the ways they use water in their lives. Ask them if they have learned some tips for saving water while still using it in the ways they are used to.

Sign and Save Activity: As a way to encourage students' participation at home in signing on to new water-saving practices, reward students who bring in their *Sign and Save* coupon signed by parents. Perhaps put their names on the board and offer them a prize.

Page 14: Where Does Our Used Water Go?
Objective: To understand what happens to our water after it goes down our drains.

Background/Discussion: As the world's population has grown, so has our need for clean water. As we have improved our understanding of what causes outbreaks of diseases such as cholera and dysentery, we have also improved the treatment of our wastewater. Before wastewater treatment systems were created, the streets were collection points for waste materials that were washed out to open sewers. In the late 1880s Louis Pasteur demonstrated the "germ theory" of disease that explained how microscopic organisms could transmit disease through water. In 1908 chlorine was used for the first time as a disinfectant in drinking water in New Jersey. Today we have a very advanced wastewater treatment process in the United States that protects our water supplies from harmful and deadly microbes. However, this is not true in many undeveloped countries and regions around the world.

Extension: Invite a speaker from your local wastewater treatment plant to share information with your class about the work they do. Have students prepare questions for him or her and consider this an "interview" experience rather than a mere lecture.

Page 15: Water Innovations
Objective: To motivate students to think creatively about ways to save water so we will have plenty available to us in the future.

What's Your Idea? Activity: Encourage students to think of wild and creative ideas, such as capturing the water that is released from plants and trees through transpiration and putting it to use in people's homes, capturing tears or sweat from humans and using it to water plants, etc.

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Back Cover: Get Water Wise Quiz
Objective: To encourage students to review the important water concepts covered in the booklet.

Activity Answers: 1. glaciers; 2. vapor; 3. evaporates; 4. aquifers; 5. disinfects; 6. impervious; 7. watershed; 8. pollutants; 9. clean; 10. protect; 11. leaks; 12. oceans

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