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ABSTRACT

This document features lesson plans for teachers and students on Florida's water resources. The guide is divided into four grade levels: K-2, 3-5, 6-8, and 9-12. Each grade level includes objectives, guides, and five lesson plans. K-2 lesson plans include: (1) "We Are Water"; (2) "Why Water is Extra Special"; (3) "Water's Changing Shapes"; (4) "Water Makes Things Float and Disappear"; and (5) "Plants Drink Water Too". Grades 3-5 lesson plans include: (1) "Lots of Water, Little To Drink"; (2) "The Water Circle: Using Water Over and Over Again"; (3) "Florida Floats on Water"; (4) "Protecting Our Water Supply"; and (5) "Wastewater Treatment". Grades 6-8 lesson plans include: (1) "Water is a Closed System"; (2) "Water Conservation and Measuring Home Water Use"; (3) "Environmentally Friendly Non-Toxic Alternative Cleaners"; (4) "Florida Water is Hard"; and (5) "Basics of Water Treatment". Grades 9-12 lesson plans include: (1) "Florida's Underground Water Supply"; (2) "Water Pollution"; (3) "Impact of Location, Climate and Population on Water Supply"; (4) "Importance of Water Conservation"; and (5) "Xeriscaping[TM] and Water Wise Landscaping and Irrigation". Attachments include a glossary; home water use survey; and listings of potential sources of groundwater pollution, common groundwater pollutants, and drought-resistant plants suitable for dry, sandy Florida soils. (YDS)

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LESSON PLANS FOR TEACHERS AND STUDENTS

THE SCIENCE OF FLORIDA'S WATER RESOURCES

Prepared by Florida Water Services

These Lesson Plans can be found online at http://www.florida-water.com

Water Foundations

Teachers Guide

PRESENTED BY FLORIDA WATER SERVICES

Water Foundations Teachers Guide

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Table of Contents

Teachers Guide

OBJECTIVE

Provide Teachers with an Overview of Florida's Water Resources.

Grade Level/Subject Area

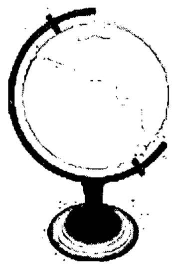
Teachers Guide

Additional Resources

NASA
United Nations University
Utah Water Research Laboratory
The Water Sourcebook, University of South Alabama
United States Environmental Protection Agency
Partners in Environmental Education
The Georgia Water Wise Counsel
Florida Department of Environmental Protection
University of Michigan – Flint
St. John's River Water Management District
South Florida Water Management District
Southwest Florida Water Management District
Suwannee Water Management District
Northwest Florida Water Management District
California Department of Water Resources

How Much Water is There?

1. Use the globe below or one in your classroom as a visual, showing that the oceans comprise more than 70 percent of the Earth's surface.



2. The amount of water on Earth is perpetual. There is the same amount of water here today as there was three billion years ago. The Earth is a closed system, with all water and other substances confined within the Earth's atmosphere and gravitational pull.

3. The amount of water on Earth is somewhere near 400 billion billion gallons. That's a four followed by 20 zeros, or 400,000,000,000,000,000,000. It sounds like a lot, but only one percent of that is even available to drink.

   a. 97 percent of the world's water is salt water stored in the oceans, leaving 3 percent fresh water.

   b. Of that 3 percent fresh water, more than 2/3 is locked away as ice, ice caps, icebergs or glaciers in the oceans surrounding the poles and northernmost and southernmost landmasses, such as Greenland and Antarctica.

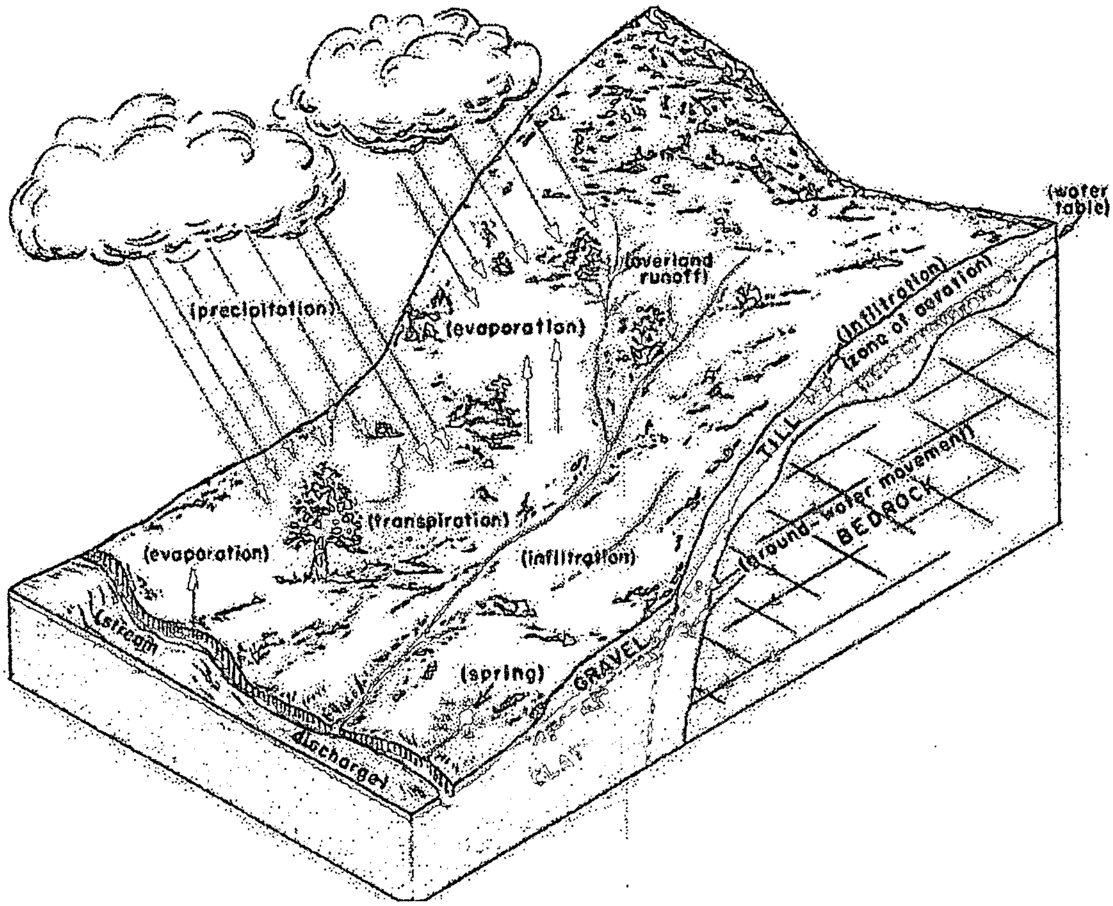
   c. That leaves only one percent remaining for our drinking water and other uses. Of this remaining one percent, .6 percent (six tenths of one percent) is underground, and .15 percent (one fifteenth of one percent) is in streams, lakes or the atmosphere as humidity or clouds.

4. Consider the amount of water on Earth as filling a 55-gallon drum. From that, a bathtub full would be the oceans (53 gallons, 1 quart, 1 pint and 12 ounces), a gallon would be in icecaps and glaciers (1 gallon 12 ounces), a small bucket full as underground water (1 quart, 11.4 ounces), 1/2 ounce in lakes, one half cup in the atmosphere (1

pint, 4 1/2 ounces) and a few eyedroppers full in rivers (1/100 of an ounce) and in the soil (1/4 ounce).

The Water Cycle

1. It is water's presence and ability to be in three forms – solid (ice), liquid (water) and gas (humidity)– that makes Earth unique in our solar system and makes possible life as we know it. Water is also in constant motion, moving from the oceans to the sky, back down to Earth. Nature recycles the Earth's water supply through a process known as the Hydrological Cycle. This cycle is responsible not only for our ability to live, but also for our weather and climate.



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2. The Hydrological Cycle includes evaporation, condensation, precipitation, run-off, infiltration, and percolation.

   a. Evaporation – Each day, the heat of the sun draws billions of tons of water as a vapor or gas from the liquid water on the Earth's surface. This water vapor eventually cools to form clouds, and then falls back to earth as rain.

   b. Condensation – The changing of water from its gas or vapor state to a liquid or solid state.

   c. Precipitation – Rainfall, sleet or snow caused by the water formerly lifted from the Earth's surface by evaporation, which has condensed back to a liquid or solid state and falls back to Earth. Rainfall varies considerably worldwide. Some locations get as little as five inches of rain per year, others 400 inches annually. Florida averages between 53 and 65 inches of rainfall per year.

   d. Run-off –Water that flows across a surface rather than sinking in and eventually ends up in a body of water.

   e. Infiltration- The gradual movement of water downward from the Earth's surface into the soil.

   f. Percolation – Water movement down into the Earth through pores and fractures in rocks and soils.

3. Temperature plays a large role in changing water in and out of its three possible forms. Heat vaporizes water and turns it into a gas. As it cools, it turns back into liquid form, and as it travels over the Arctic regions, it turns into ice.

4. Water collects numerous harmful elements and compounds throughout this cycle, some naturally occurring and some man-made.

5. The water collects impurities while passing though the smog and dust laden lower atmosphere. As the water percolates through the Earth, it can absorb hard minerals, iron, metals, radioactivity, organic contaminants and many other elements and compounds. The water also collects numerous harmful man-made chemical impurities that are the result of a massive global increase in harmful chemical waste over

the last 50 years. Even pouring gasoline or other wastes in your yard, pollutes our groundwater.

6. This is particularly true in Florida where we literally walk on water, making it very susceptible to pollution. The State has a series of underground limestone caverns beneath it, full of water. This is called the Floridan Aquifer and is the major source of drinking water for 95 percent of all Floridians.

Water Pollution

1. Water is called the universal solvent because of the huge number of things that dissolve in water. As water travels through the Hydrological Cycle, it picks up pollutants every step along the way.

2. As water is evaporated from the seas by the sun and returned after cooling in the form of rain, hail, sleet or snow, it collects pollution from the atmosphere.

    a. It can get so bad that it is called "acid rain." There are natural causes of this pollution, like emissions from volcanoes, sea spray, rotting vegetation and plankton. However, the burning of fossil fuels, such as coal and oil, are largely to blame for approximately half of the emissions in the world.

    b. Acid rain impacts the ability of the Earth's vegetation's to replenish oxygen through photosynthesis and our fish's ability to reproduce. And, acid rain can cause deterioration of just about any man-made structure or item, like buildings and cars.

3. As the water falls to the ground and percolates through the different geological formations and eventually finds its way to a surface water supply or collects in an aquifer, it can absorb hardness minerals, iron, heavy metals, radioactivity, organic contaminants and other elements and compounds.

4. Water also collects numerous harmful man-made chemical impurities throughout this cycle. There are more than 70,000 chemicals in use

today, which can get mixed with our water along the Hydrological Cycle.

5. There are five major types of water pollutants:

   a. Biodegradable wastes –Human and animal wastes, plus food scraps and other types of organic material. These cause oxygen-consuming bacteria to multiply consuming all of the oxygen in the water making it uninhabitable for marine life and undrinkable. These can also cause the spread of disease.

   b. Plant nutrients – A balanced amount of these in water is healthy, but an excess amount can cause some plants to have explosive growth choking off all other life forms.

   c. Heat or thermal pollution – An important relationship exists between the amount of oxygen in the water and its temperature. The more heat, the less oxygen.

   d. Sediment –This type of pollution is caused by the washing or blowing of mineral or organic matter into rivers, streams and other water sources. America's waters are polluted by one billion tons of sediment annually, and the results can be devastating. Some of this pollution is from naturally occurring events like volcanoes, earthquakes, storms or fires.

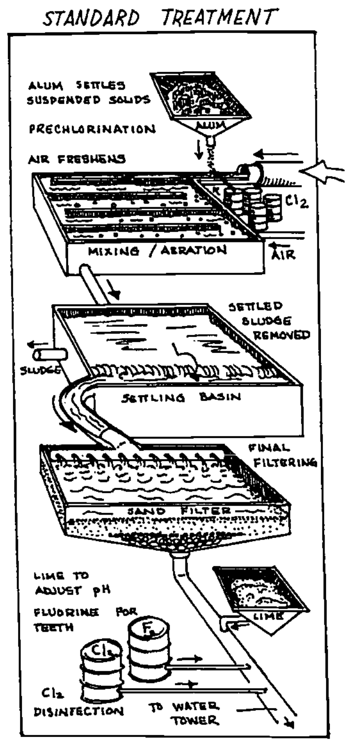
   e. Chemical pollution – This is normally man-made. It can range from improperly treated industrial discharges and pesticides to improper disposal of household chemicals.

6. When rain falls on animal grazing lands, municipal dump sites, toxic waste sites, industrial refuse depots, military test sites, leach fields, mining operations, farmers fields, etc., the water dissolves the chemicals that are present. These chemicals move along with water on its constantly moving path.

7. Some people continue to throw trash into our rivers, streams, lakes and oceans, all of which pollute our drinking water.

8. Each time we use water, we change its quality by adding substances to it. Some of the larger spills become obvious pollutants. However, some materials, even in small quantities, can damage water quality to the point that it is unusable. A single quart of motor oil, for example, could pollute as much as 250,000 gallons of water.

Water Treatment



1. The United States is fortunate to have one of the safest drinking water supplies in the world. That is because of water treatment illustrated in the drawing to the right. Sadly, over 12 million children worldwide die each year because of a lack of water or unsafe drinking water.

2. 95 percent of Florida's drinking water comes from the Floridan Aquifer, through wells dug into the ground.

3. Water must be cleaned before it's sent to homes. Rivers, lakes and aquifers are living systems with fish, insects, bacteria and protozoa. They can also be polluted with chemicals from factories and rainwater flowing off roads and highways.

4. The first step in water treatment is to screen the water entering the treatment plant to eliminate any large objects or particles. Analysis of the water comes next.

5. Water treatment in Florida always includes the addition of antibacterial chemicals like chlorine. Another additive is alum, which traps pollutants. Additional additives might include lime and powdered carbon, similar to what is used in aquarium pumps.

6. After treatment, the water is sent to a mixer to make sure all the additives have fully done their job.

7. A settling process occurs after the mixing to allow trapped pollutants to settle to the bottom of the tank for removal.

8. Finally, the water slowly filters through coal, sand and/or gravel, and chlorine is added again to disinfect distribution pipes. In some instances, a corrosion inhibitor is added to prevent rusty pipes.

9. Finally, the water is forced through transmission lines to homes and other users.

10. Reverse osmosis, or desalinization, is another form of water treatment used to remove salt from salt water or brackish water and turn it into drinking water. In this form of treatment, water is forced through membranes to remove the salt. Membrane technology is becoming increasingly common though it is much more expensive than regular water treatment techniques.

Making Wastewater Usable

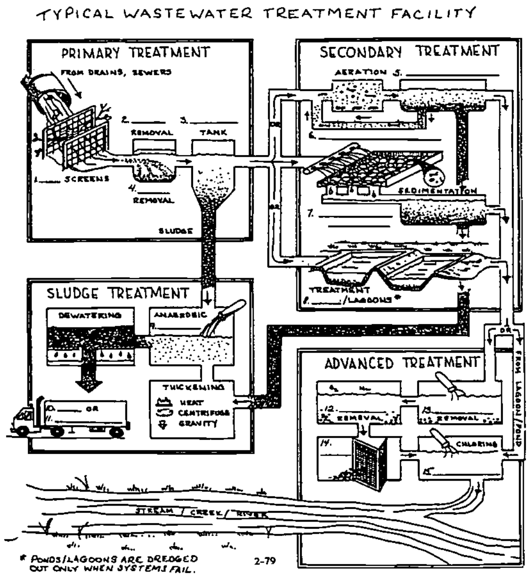
1. Wastewater is water that has been used in a domestic waste, agricultural or industrial process. Almost any use adds contaminants to water that must be removed before it can be returned to the environment.

2. Because water is constantly moving, it needs cleaning after use to avoid polluting another body of water.

3. There are basically three kinds of wastewater treatment:

    a. Primary treatment is the first stage of wastewater treatment. Screens and settling tanks remove most of the solids in the water. Solids make up about 35 percent of the pollutants in wastewater.

    b. Secondary treatment converts dissolved and suspended pollutants into a form that can be removed, producing a relatively highly treated effluent. Bacteria are used to digest the remaining pollutants in the water. After the bacteria digests the pollution, the



activated sludge enters a large settling tank where it sinks to the bottom and clear water is drawn off of the top. At least 85 percent of the solids should be removed from the wastewater by this activated sludge process. Finally the water is disinfected with chlorine, ozone or ultraviolet light and discharged. Secondary treatment for wastewater is the minimum level of treatment required by the federal law. Advanced secondary treatment includes filtration with sand filters or other media.

c. Advanced treatment is treatment beyond the secondary treatment that includes additional nutrient removal. This third level of treatment, called tertiary treatment, is now required under Florida law for reuse of the wastewater. It is very expensive, but a good way to both protect and replenish fresh water supplies.

Ways to Save Water

1. Only one half gallon (Less than 0.5 percent) of the 150 gallons of water consumed each day by Americans is used for drinking, or to sustain our lives. The other 149 1/2 gallons are used for cleaning, cooking, flushing, watering the lawn, washing cars or simply running down the drain unattended and unnecessarily. Floridians use an average of 175 gallons of water each day per person, much higher than the national average.

   How much water does it take?

   a. To shower – five gallons a minute

b. To tub bathe – 36 gallons each time
c. To flush our toilet – six gallons each flush
d. To brush our teeth – three gallons a minute
e. To hand-wash dishes – three gallons a minute
f. To run the dishwasher – six gallons a load
g. To wash clothes in the washing machine – 48 gallons each time
h. To water our lawn or other outside uses – ten gallons per minute

2. Take a family water audit by visiting www.florida-water.com and double clicking on the water use link.

3. There are many ways to save water:

   a. Indoors:

      1) Throw waste in a wastebasket instead of flushing it down the toilet.
      2) Regularly check for leaks or drips in faucets and toilets.
      3) Turn off the water while brushing teeth or washing dishes.
      4) Use a hose with a nozzle that automatically shuts off when washing the car or pets.
      5) Wash dishes or clothes only when there is a full load.
      6) Remind friends and family to conserve water.
      7) Don't let the tap water run to get cool. Keep a bottle of drinking water in the refrigerator.
      8) Retrofit toilets with low-flow water saving devices that can save 150 or more gallons a month.
      9) Replace shower heads with low-flow models combined with shorter showers save up to 2,600 gallons a month.

   b. Outdoors:

      1) Watering lawns less frequently, but for longer periods, trains grass to become drought tolerant. In Florida, watering grass for 45 minutes once a week, if there has been no rainfall, encourages the roots to grow deeper. The grass is stronger and less susceptible to disease. Grass needs approximately one inch of water per week. A good way to measure that is to place an empty tuna can on the lawn and see how long it takes to fill up. That's your watering time.

2) It is best to water early in the morning or late in the evening to avoid a 30 percent evaporation rate. That water never reaches the lawn.
3) Landscape your yard with plants that are native to Florida. They are used to Florida's climate and are drought and salt tolerant, requiring very little, if any, extra watering beyond normal rainfall.
4) Build dikes around trees and shrubs to hold water.
5) Rake, sweep or blow driveways and sidewalks instead of hosing away debris. This can save up to 50-60 gallons of water.

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Grades K to 2

OBJECTIVE

Expand the student's relationship to water beyond drinking and swimming to include personal health issues like how the children feel and water's importance to plant life and the growing of food.

Grade Level/Subject Area

K – Grade 2, Sciences

Materials Required

Paper, pencil, crayons, paper towels, saucer-like containers, oil, food coloring, a glass, sugar, water, a penny, a piece of fabric, and a piece of styrofoam.

Anticipatory Set

In what way will you activate their PRIOR KNOWLEDGE and EXPERIENCE to help them relate to today's lesson?

- Through lessons and activities.

Assessment of Comprehension

How will you determine that the students have understood/learned the objectives?

- Teacher observation
- Q&A
- Completed assignment

Lesson 1 – We Are Water

1. Up to 75 percent of our bodies are made of water. This water forms the method of transportation, like roadways, for essential nutrients to reach every part of our body.

2. Water is the single most important substance that the body needs to keep operating. We can live up to five weeks without food. We can only live a few days without water.

3. Water is involved in every function of our body. Water helps us digest our food. Water forms a cushion to protect our vital organs, like our heart, lungs and stomach. Water keeps our temperature level. Water acts as a lubricant, allowing our joints to move. This includes our wrists, fingers, feet, knees, hips and elbows. And, water is what carries the waste products from our bodies.

4. Our brain is up to 85 percent water. Our blood is almost all water. Our muscles are about 75 percent water. Even our bones have considerable water, 22 percent or almost one-quarter.

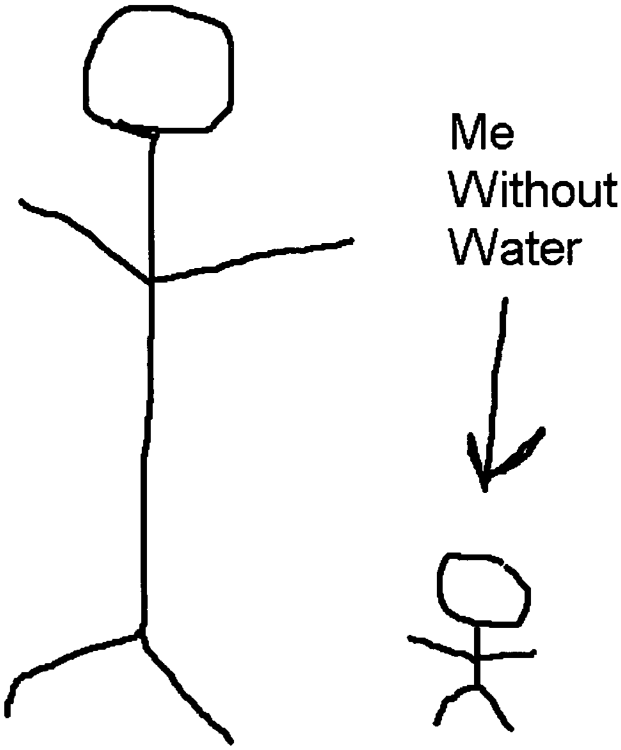
5. For these reasons, we should all drink eight glasses of water a day. Sodas and drinks that contain caffeine or alcohol don't count. They are called diuretics and actually make the body lose more water than the drink puts in.

6. And, we should not wait until we are thirsty to drink. Thirst is one of the signs that your body is already well below its level of needed water. We should drink water all day whether we are thirsty or not.

Activity

Supplies: Paper, pencil and crayons

Show the students the stick figures on the next page. Ask them to draw what they, or something else like a dog or tree, would look like first with water, and then without water.



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Lesson 2 – Why Water is Extra Special

1. Water is special because not only it is the very foundation of life, but because it is unique among the elements.

2. Most things fall to the Earth because of gravity, but water can also rise and climb.

3. Water moves to the tops of tall trees, up from the roots through tubes, evaporating from openings in the leaves. This is how a tree gets its food. Water will also climb up paper.

4. Water also sticks together, and it absorbs and mixes with most things. It will mix with detergent, water-soluble dye, and many pollutants in the Earth. One of the few things it will not mix with is oil.

5. Most things when filled with water get very heavy and drop to the bottom of a glass of water. Water on the other hand gets lighter as it becomes ice and will float on top of a glass of water.

6. Did you know that 10 billion molecules of water would fit on the head of a pin?

Activities

Supplies: paper towels, saucer-like containers, food coloring, oil and a glass.

Roll the paper towel and place it vertically rising from a saucer full of water with food coloring. Watch the colored water rise in the paper towel.

Fill a glass with water and a few drops of oil. Mix vigorously. Then have the class watch as the oil and the water separate.

Lesson 3 – Water's Changing Shapes

1. If you think that everything has a shape, that's not true. Water doesn't really have one. It changes shapes as well as form.

2. When water is in liquid form, it takes the shape of its container. Every time it is moved from one container to another, it takes on another shape.

3. Water can become three separate things – a liquid, a gas and a solid. We see water as a liquid when we take a bath or fill a glass. It becomes a gas when heated and rises, like when we see the steam coming out of a

boiling pot or rain evaporating from a hot sidewalk. The water doesn't disappear; it turns into a shapeless and sometimes invisible gas and rises into the sky. In the sky, it forms clouds, and when it gets cold it becomes heavy again and falls to the Earth as rain. We see water as a solid when we make ice or see snow or hail.

4. Only when water is a solid does it take on a shape. But, as soon as it melts, it becomes shapeless again.

Activities

Ask students to watch their parents boil a pot of water and observe the water turn into a gas and rise into the air. Also, ask them to watch an ice cube melt and become shapeless. Have the students bring in a paper describing what they saw.

Lesson 4 – Water Makes Things Float and Disappear

1. One of the unique things about water is that it is constantly in motion. Without a container to trap it, it moves around and around. And, it takes whatever is in it with it.

2. Some things totally dissolve in water so that you can no longer see them. Other things sink to the bottom of the water and disappear.

3. There are some things that sink to the bottom, but when they fill with water, they once again float to the top.

4. Other things that are lighter than water float on the top and move wherever the water goes.

Activity

Supplies: sugar, water, glass, a penny, a piece of fabric, and a piece of Styrofoam

Fill a glass with water. Mix in sugar to show how some things dissolve and disappear. Then place the penny in the glass, and watch it sink. Wet the fabric and drop it in the glass, it will sink and float. Then place the piece of Styrofoam in the water and watch it float without sinking.

Lesson 5 – Plants Drink Water Too

1. All living things need water to survive. A plant is a living thing. Therefore, plants drink water.

2. Plants get water in several ways. They drink it through their roots in the ground. Or they absorb it through their leaves or stems, or, in the case of trees, through their leaves, branches or trunks.

3. Plants use minerals in water as food to make their parts grow.

4. Plants absorb carbon dioxide, which is poison to humans, and create oxygen, which is what we breathe.

5. Plants also cleanse dirty water by filtering out pollutants. Part of this filtering takes place as rainwater enters the ground and seeps into groundwater below the surface.

6. A large part of this cleaning occurs in wetlands, or soggy areas that lie between land and rivers, streams, lakes and the ocean. These wetlands act much like our body's kidneys to filter out harmful wastes that flow over land before they reach the water. They do this through roots submerged in the wetland.

Activity

Supplies: a stalk of celery, a package of food coloring and plastic cups

Ask students to put a stalk of celery in a plastic cup with different colors of food coloring. Let the celery stalks soak in the colored water over night.

The next day, show the students the color in the celery.

Explain to students that plants have a tube system that carries dissolved food from the soil to all of the plant's parts

Grades 3 to 5

OBJECTIVE

Impress upon students how there is a limited fresh drinking water supply in the world and how Florida's drinking water supply is especially fragile and subject to pollution.

Grade Level/Subject Area

Grades 3 to 5, Sciences

Materials Required

Globe, 100 pennies, rocks, clear container, water, sand, food coloring

Anticipatory Set

In what way will you activate their PRIOR KNOWLEDGE and EXPERIENCE to help them relate to today's lesson?

- Through lessons and activities.

Assessment of Comprehension

How will you check that the students have understood/learned the objectives?

- Teacher observation
- Q&A
- Completed Assignment

Lesson 1 – Lots of Water, Little to Drink

1. Water covers 70 percent of our planet, but only a fraction of that is usable to us.

2. 97 percent is found in the oceans and is undrinkable salt water

3. Of the three percent that is freshwater, two thirds is frozen in icecaps, glaciers and on snowy mountain ranges.

4. Less than one percent of the planet's water is usable to humans. Almost half of this water is used to grow our food in agriculture.

5. Most of the usable freshwater is underground. According to many experts, there is more than 40 times more fresh water underground than found in all the lakes, rivers and streams on Earth.

Activities

Supplies: a globe, 100 pennies

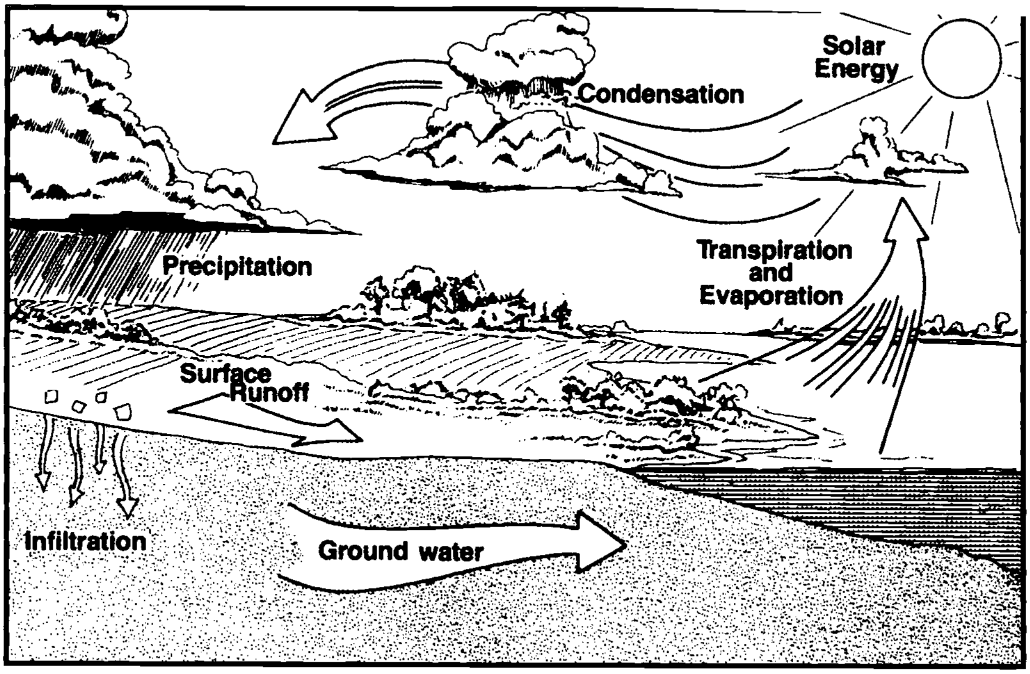
First, ask students to carefully examine the globe and see how much more water there is on Earth than on land.

Next, ask students to bring in some pennies. Use 100 of them to show 100 percent of the water. Remove 97 of them to show oceans and undrinkable salt water. Remove two more to show how much is frozen in icecaps, glaciers and snow. Show them the one penny that is the only part of the water usable to humans (one half of the penny) and plant life (one half of the penny) on the planet.

Lesson 2 – The Water Circle: Using Water Over and Over Again

1. The supply of water in the world today is the same amount of water that was available when Christopher Columbus landed in the Americas. The amount goes back to the creation of the Earth.

2. Nature reuses this set amount of water repeatedly in an endless loop of water recycling (see drawing on the next page).



Hydrologic cycle

3. Water evaporates from lakes and the oceans to form clouds. Rainfall establishes lakes and streams. Some water percolates into the ground to become ground water and some flows into streams and lakes. Water in the lakes and streams evaporates or flows to the sea where it evaporates. And, the cycle goes on and on. The same water has been used and reused through this cycle millions and millions of times.

4. It is the use and reuse of water that introduces pollution in the form of wastes and chemicals. Wastewater treatment along the way of the use and reuse is our human way of protecting our water resources.

5. Reuse is safe because we have learned to treat our wastewater to extremely high levels. Secondary treatment and basic disinfection are the minimum treatments required for reclaimed water to be used to irrigate pastures and animal crops. Even higher levels of treatment and disinfection are required for reusing water in areas where the public has access such as parks, golf courses,

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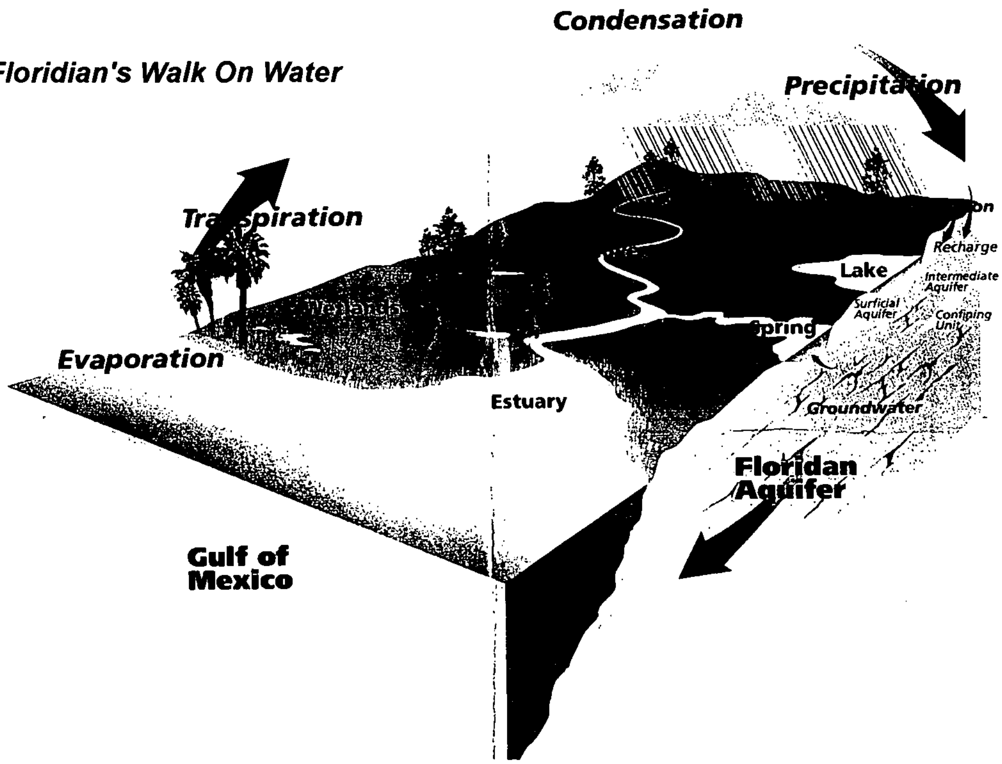
playgrounds, school yards, highway medians and for irrigation of human food crops.

Lesson 3 – Florida Floats on Water

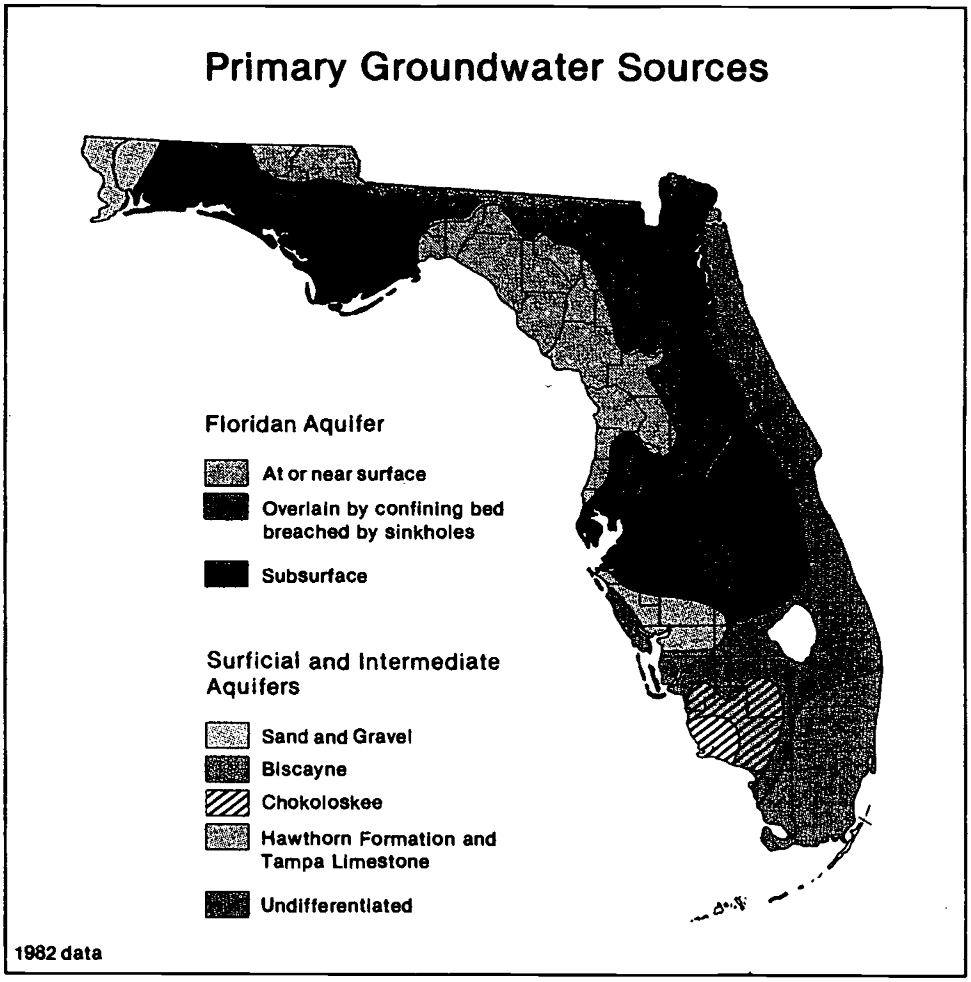
1. In Florida, we literally walk on water.

2. Below Florida's surface are many caves and caverns filled with fresh water from the rain.

3. The caves and caverns are mostly interconnected. Ever try to confine water? These underground sources of water are called aquifers. (See below what an aquifer might look like under the ground).



4. Florida has one major aquifer that it shares with our neighboring states to the north – Georgia, Alabama and South Carolina. It is called the Floridan Aquifer. It is from this large aquifer that most Floridians get their fresh water. There are other aquifers in special



places in the State called surficial and/or intermediate aquifers that are separate and apart from the Floridan aquifer and have other names. (See diagram above).

5. There are more than a quadrillion (that's 15 zeros; 1,000,000,000,000,000) gallons of water stored in Florida's natural aquifer network, yet in some areas, aquifer levels have dropped 40 to 60 feet below predevelopment levels.

6. Why? The State's population growth, salt-water intrusion, development and pollution are depleting the supply.

7. Floridians use more than 1.4 billion gallons of water each day. Beyond that, nearly 3 billion gallons of water per day are used for agriculture in Florida. All of that water has to be replaced by rainfall.

8. Nearly 80 percent of Florida's population lives near coastal areas where fresh water supplies may not be adequate. The southern half of Florida has just 44 percent of the State's water supply yet it is responsible for 75 percent of the state's water use.

9. And, when development, such as buildings or parking lots, covers the surface, it prevents rainwater from re-entering the aquifer.

10. When more water is removed from the aquifer than can be replaced by rain, which is happening in Florida, the resulting gap is filled with saltwater moving in from the ocean. That saltwater can quickly contaminate the freshwater, making it brackish. In some places, Floridians are using groundwater about 100 times as fast as rainwater can replenish it. Only about 20 percent of the rainwater that falls in the U.S. becomes groundwater. That number is higher in Florida since aquifers rest underneath virtually the entire State.

11. But, saltwater and lack of replacement are not the only water enemies. Pollution is another major challenge because our fresh water is right beneath our feet. Contaminated groundwater can remain contaminated for many years and is very expensive to correct.

12. Groundwater is always on the move. It carries contamination, if any, with it as it moves. But, how quickly it moves depends on what type of aquifer. In confined aquifers, it can move as slowly as a few inches a day. In limestone aquifers, like Florida's Floridan aquifer, it can move several miles in one day.

13. The best way to protect our groundwater is to not use more than is replenished by rainfall and to prevent contamination before it has a chance to occur.

Lesson 4 – Protecting Our Water Supply

1. Because our fresh water is just beneath us, toxic chemicals and waste are a threat to our fresh water supply.

2. In Florida, rainwater used to be absorbed directly into the soil. Now, gallons of rainwater run off roofs, streets and parking lots, carrying chemicals, fertilizers, oil, gasoline and other waste that are absorbed into the soil, and, consequently, the water supply.

3. Add to that the occasional industrial waste landfill, pesticides and leaking underground storage tanks to the mix and it becomes clear that Florida's water supply is in a fragile state. Just as rainwater can soak into the groundwater, so can harmful contaminants.

4. To keep our fresh water supply safe, water has to be treated before it enters the ground, and then treated again as it is withdrawn for use.

5. Because our water is so vulnerable and in need of protection, regulatory control over water and wastewater facilities in Florida is very strict. These strict regulations increase the amount of money people pay each month to get treated water.

6. New technology is continually being developed to protect our water. One such technology produces drinkable water out of salty water. Called reverse osmosis, water is pushed through extremely fine membranes to remove the salt. Similar technologies are used to get useable or "reclaimed" water from wastewater. Highly treated and filtered, this "reclaimed" water is used for landscape irrigation.

7. Another new idea is to put treated water or wastewater in the ground for later use. Florida's population is highly seasonal, meaning we have a lot of people that live here only in the winter months when it is cold up north. So we can withdraw some water during low usage times, treat it and store it underground until the high demand comes in the winter. It is stored in what are called aquifer storage and recovery wells.

Activity

Supplies: Some rocks, clear container, water, sand, and food coloring

Place some rocks in a clear container. Fill the container with water to the top of the rocks. This is a simulated aquifer. Pour a layer of sand on top. The top of the sand is the surface of Florida. Pour some food coloring (pollutant) into the container. Ask the students to watch as the pollutant reaches all the water in the aquifer. Explain that this pollutant can be seen, but most pollutants are invisible and can only be detected by regularly testing the water.

Lesson 5 – Wastewater Treatment

1. Wastewater treatment cleans used water and sewage so it can be returned safely to the environment.

2. Wastewater comes from our homes in the form of human and household wastes from toilets, sinks, baths and drains. It also comes from schools, industry and businesses, like restaurants, airports, shopping centers and factories. Wastewater is also collected in street drains during a storm as well as groundwater that enters through cracks in sewers. The latter is called stormwater runoff.

3. Wastewater treatment protects our water quality so we can enjoy clean drinking water, and clean oceans, lakes, streams and rivers.

4. Septic tanks that are used by people not connected to a centralized wastewater treatment plant are a form of wastewater treatment. With a septic system, the waste is carried from the house by pipes to a large container called a septic tank. The water rises to the top of the tank and the solids settle on the bottom. The liquid flows through another pipe to a drainfield where it is filtered as it enters the ground. Bacteria help break down the solids in the tank, but the tank must be pumped clean at least every five years. Septic systems that are not properly maintained or leaking can cause big problems in contaminating groundwater.

5. It is public policy in Florida to encourage everyone within range of a centralized wastewater treatment plant to hook up to it to avoid the possibility of groundwater contamination.

6. Wastewater treatment removes solids from the wastewater. It also introduces helpful bacteria and other microorganisms to consume some wastes. The bacteria are separated from the water, oxygen is restored and the water is disinfected.

7. Wastewater treatment in plants involves two steps. First, primary treatment removes 40-50 percent of the solids. Sewer lines carry wastewater from homes and business to the treatment plant. Screens allow the water to pass through to the plant, but not trash such as rags or sticks. A large tank slows the flow of water, allowing sand, grit and other heavy solids to settle to the bottom of a sedimentation tank. Scrapers collect the solid material, scum or grease floating on the top of the tank. The water then goes on to secondary treatment.

8. In secondary treatment, 85 to 90 percent of the pollutants are removed. An aeration tank supplies large amounts of air to a mixture of wastewater, bacteria and other microorganisms. This oxygen speeds the growth of helpful microorganisms that consume harmful organic matter in the wastewater. Then a secondary sedimentation tank allows the microorganisms and solid wastes to clump and settle. The settled material referred to as residuals or solids is further treated and used as a fertilizer. Finally, a disinfectant such as chlorine is added to the wastewater before it leaves the treatment plant. The disinfectant kills disease-causing organisms in the water.

9. After treatment, the water can be returned to the environment by land for agricultural uses and other purposes or with permits into nearby waterways.

10. Reusing highly treated wastewater – called reclaimed water – is public policy in Florida. Extensive treatment and disinfection ensure that public health and environmental quality are protected. The reused water is used for irrigating landscapes on golf courses, parks, highway medians and residential lawns. It can also be used for recharging groundwater, for some manufacturing processes, to restore wetlands, for fire protection, or, in a separate piping system for toilets in industrial and commercial buildings, like hotels, motels and apartments.

Grades 6 to 8

OBJECTIVE

Introduce students to steps they and their families can take to prevent pollution of Florida's fresh drinking water supply.

Grade Level/Subject Area

Grades 6 to 8, Sciences

Materials Required

2-liter plastic soft drink bottle, soil, a plant, plastic wrap, attached self-calculating water use audit

Anticipatory Set

In what way will you activate their PRIOR KNOWLEDGE and EXPERIENCE to help them relate to today's lesson?

- Through lessons and activities.

Assessment of Comprehension

How will you check that the students have understood/learned the objectives?

- Teacher observation
- Q&A
- Completed Assignment

Lesson 1 – Water is a Closed System

1. The amount of water available to Earth never changes. There is the same amount of water here today as there was 3 billion years ago when the Earth was formed. The Earth is a closed system with all water and other substances confined within the Earth's atmosphere and gravitational pull.

2. The amount of water on Earth is somewhere near 400 billion billion (yes, that's a double billion) gallons. That's a four followed by 20 zeros, or 400,000,000,000,000,000,000. This sounds like a lot, but only one percent of that is even available to drink.

3. 97 percent of the world's water is salt water stored in the oceans, leaving three percent fresh water.

4. Of that three percent fresh water, more than 2/3 is locked away as ice, ice caps, icebergs or glaciers in the oceans surrounding the poles and northernmost and southernmost land masses, such as Greenland and Antarctica.

5. That leaves only one percent remaining for our drinking water and other uses. Of the remaining one percent, .6 percent (six tenths of one percent) is underground, and .15 percent (one fifteenth of one percent) is in streams, lakes or the atmosphere as humidity or clouds.

6. Consider the amount of water on Earth as filling a 55-gallon drum. From that, a bathtub full would be the oceans (53 gallons, 1 quart, 1 pint and 12 ounces), a gallon would be in icecaps and glaciers (1 gallon 12 ounces), a small bucket full as underground water (1 quart, 11.4 ounces), 1/2 ounce in lakes, one half cup in the atmosphere (1 pint, 4 1/2 ounces) and a few eyedroppers full in rivers (1/100 of an ounce) and in the soil (1/4 ounce).

7. It is water's constant amount and presence and ability to transform itself in and out of three forms – solid (ice), liquid (water) and gas (humidity)– that makes Earth unique in our solar system and make life possible as we know it. Water is also in constant motion,

moving from the oceans to the sky, back down to Earth. Nature recycles the Earth's water supply through a process known as the Hydrological Cycle. This cycle is responsible not only for our ability to live, but also for our weather and climate.

Activity
Supplies: 2-liter plastic soft drink bottle, soil, a plant and plastic wrap.

Creating and observing water in a terrarium.

Cut off the top of the two-liter bottle. Place soil in the bottom of the bottle. Put the plant in the soil, water, and then cover and seal the terrarium with plastic wrap. Students should write down their observations of the water movement in the terrarium each day.

Lesson 2 – Water Conservation & Measuring Home Water Use

1. The average Floridian uses 175 gallons of water a day. That is 25 gallons more than the U.S. per capita average. Mostly warmer Florida temperatures and year round irrigation requirements help account for the difference.

2. Almost half of all home water use in Florida is for irrigating lawns. To prevent over watering when sufficient rainfall is present, Florida law requires that any new automatic lawn sprinkler system must have a rain sensor device or switch that overrides the irrigation cycle when adequate rainfall has occurred.

3. Grass can be trained to be drought resistant. Watering once a week with one inch of water encourages deep root growth that in turn requires less watering. Conversely, watering many times a week for short time periods causes the grass to grow shallow roots that require more water and makes the grass more prone to disease.

4. Most automatic sprinklers have a default setting if the electricity goes off. Unfortunately, these defaults are for frequent short time periods and are not good for growing healthy hardy grass.

5. Another way of conserving water is to use Xeriscape™ for outdoor landscaping. What this means is to plant plants and foliage that is

native to Florida, and grows heartily in the State's normal weather patterns. Subsequently, they need less supplemental watering.

6. Flushing toilets account for 30 percent of indoor water use. Low flow toilets that use less water are now a legal requirement in Florida.

7. A dishwasher (6 gallons per load) uses less water than washing dishes by hand (16 gallons for the same amount of dishes).

8. Showers (5 gallons per minute) and baths (36 gallons) account for another 30 percent of indoor water use. Low flow showerheads can reduce by one half the amount of water used.

9. A dripping faucet can waste 2,300 gallons of water per year. Most of these faucets can be repaired with a 20-cent washer.

Activity
Supplies: see attachment 1 on page 81

Have students take a home water use survey. A form is attached to these lesson plans (page 81) or can be accessed online as a self-calculating water-use audit at http://www.florida-water.com. If the form is used, have the students complete it with the help of their family and return it to class to do the math and calculate total monthly water usage. This will help students get a better understanding of how much water their family uses.

Ask the students to write down all the ways they can think of to conserve water.

Lesson 3 – Environmentally Friendly Non-Toxic Alternative Cleaners

1. Because Floridians literally walk on our fresh water resources, it is extremely important that we pay attention to what pollutants we use and are returned to the ground.

2. The greatest threat to Florida's water resources is contamination, including human waste, industrial chemicals, mining residue, pesticides and herbicides, gasoline and street wash and hazardous waste from landfills and illegal dumping.

3. Individually, there is a lot we can do to protect our water resources.

4. In Florida, the average home has between 10-15 gallons of toxic cleaners and other chemicals at any given time.

5. There are many safe, "home-brewed" substitutes for these chemicals that are more environmentally friendly.

6. Although the substitutes listed below are better for the environment, they are still not safe for human consumption. These mixtures need to be treated with care and kept out of the reach of small children.

List of environmentally friendly household cleaners and insect repellants:

A. Drain Cleaners:

- Dissolve 1 lb. washing soda (not baking soda, but also made by Arm and Hammer called "Super Washing Soda") in 3 gallons of water and pour down the drain.

- Grind lemon rinds and 1/4 cup Borax in the garbage disposal and rinse with hot water.

- Pour 1/2 cup baking soda into the drain followed by 1/2 cup vinegar or lemon juice (beware of a strong reaction from these two chemicals). Let the mixture sit for 15 minutes before rinsing with hot water.

- Best Bet: avoid dumping grease down the drain. Instead pour grease into soup can, freeze it, and throw it out on garbage day.

B. Appliance Cleaner: Combine 1 tsp. Borax, 1 tbs. vinegar, 1/4 tsp. liquid soap and 2 cups of very hot water in a spray bottle. Shake gently until ingredients are dissolved. Spray the mixture onto appliances and wipe with a rag.

C. Oven Cleaner: Mix 2 tbs. liquid soap, 2 tps. Borax and warm water. Spread the mixture generously over the oven surface. Let sit overnight and wipe up. If desired, wipe entire oven with liquid soap and rinse thoroughly.

D. Creamy Soft Scrubber: Combine 1/2 cup baking soda in a bowl with vegetable oil-based liquid soap, stirring into a creamy paste. Scoop onto a sponge and wash desired surface. Rinse thoroughly. If a disinfectant is desired, add Borax. For heavy washing jobs, add washing soda.

E. Window Cleaner: shake up 1 tsp. liquid soap, 3 tbsp. vinegar and 2 cups of water in a spray bottle. Use as you normally would.

F. Linoleum Floor Cleaner: Blend 1/2 cup liquid soap, 1/2 cup lemon juice and 2 gallons warm water. Wash floors as usual.

G. Stain Removers:

- Coffee stains – moist salt
- Rust stains on clothes – lemon juice, salt and sunlight
- Scorch marks on clothes – grated onions
- Ink spots on clothes – cold water, 1 tbs. cream of tartar and 1 tbs. lemon juice
- Oil stains on clothes – rub white chalk on stain before laundering
- Perspiration stains on clothes – white vinegar and water
- General spots on clothes – club soda, lemon juice or salt

H. Bathroom Cleaners:

- Mildew remover – equal parts vinegar and salt
- Toilet bowl cleaner – paste of Borax and lemon juice, or just Borax, left in toilet overnight and flushed in the morning
- Tub and tile cleaner – 1/2 cup baking soda, 1 cup white vinegar and warm water

I. Polishes for Around the House:

- Chrome – cider vinegar

- Silver – 1 qt warm water, 1 tbs. baking soda, 1 tbs. salt and polish with a piece of aluminum foil
- Copper – lemon juice and salt
- Stainless Steel – mineral oil
- Brass – Worcestershire sauce or vinegar and water

J. Shoe Polish – banana peel

K. Insect Problems at Home:

- Ants – red chili powder at point of entry into house
- Moths – cedar chips
- Fleas on pets – gradually add brewers yeast to pet's diet
- Nematodes in garden – plant marigolds
- Flies – well-watered pot of basil
- Roaches – chopped bay leaves and cucumber skins
- Insects on outdoor plants – soapy water on leaves, then rinse; or boil elderberry leaves in water and add a touch of liquid soap to make a spray

L. Liquid Fabric Softener: baking soda or Borax in the rinse water

M. Rug & Upholstery Cleaner: club soda

N. Decal Remover (on Glass): white vinegar

O. Rusty bolt/nut remover: carbonated beverage or vinegar

Caution: Be judicious using any of these mixtures. Test on a small, hidden area when cleaning clothes, carpets, etc. As indicated earlier, these mixtures can be harmful if ingested or used carelessly. The easiest and safest way to manage household hazardous waste is not to use it in the first place. Choose less toxic products and those that process results in less toxic waste.

Activities

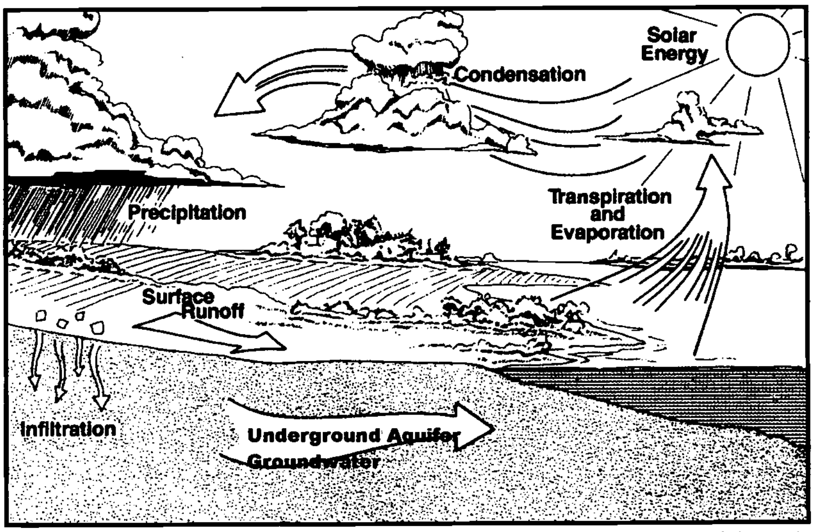
Have the students take home the above list of more environmentally safe cleaners and insect repellants and try them with their parents. Ask them to write a paper describing their parents reaction and the results.

Have students take an inventory of the cleaning supplies in their home. Discuss environmentally safe alternatives to each item.

Lesson 4 – Florida Water is Hard

1. Unlike most states, Florida is underlain virtually everywhere by aquifers that are essentially underground reservoirs full of water. While there are six primary aquifers in Florida, by far the largest is the Floridan Aquifer that has been called Florida's rain barrel. This aquifer is a massive body of limestone and dolostones with minor amounts of clay, sand and marl. It covers 82,000 square miles and underlies Coastal Plain areas of Alabama, Georgia and South Carolina as well as Florida.

2. Florida's groundwater moves through these aquifers over periods of years and dissolves and transports with it minerals from surrounding limestone and rocks. This groundwater generally contains a higher concentration of minerals than waters from other sources (mountains, lakes, rivers and streams) because it remains in contact with rocks and soils for a much longer period.



Hydrologic cycle

Florida Water Services Corporation
P.O. Box 609520 • Orlando, FL
Phone 407-598-4150 • Fax 407-598-4145

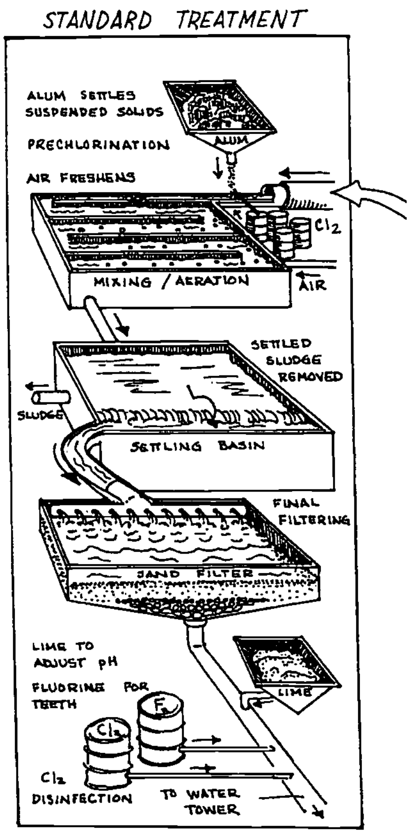
3. These dissolved minerals make Florida's groundwater, our water supply, very hard. Essentially, it smells different, reacts with soap differently and feels different from the surface water from the northern parts of the U.S. However, it is just as healthy considering it contains minerals that some people pay money for as dietary supplements.

4. One of the first comments heard from northerners that move to Florida is that they do not like the water because it is so different from what they are used to.

5. Florida's water also requires higher doses of disinfectant because it remains warm so much longer in the underground aquifers.

Lesson 5 – Basics of Water Treatment

1. The United States is fortunate to have one of the safest drinking water supplies in the world. That is because of water treatment illustrated in the drawing to the right. Sadly, more than 12 million children worldwide die each year because of a lack of water or unsafe drinking water.



2. 95 percent of Florida's drinking water comes from the Floridan Aquifer through wells dug into the ground.

3. Water must be cleaned before it's sent to homes. Rivers, lakes and aquifers are living systems with fish, insects, bacteria and protozoa. They can also be polluted with chemicals from factories and rainwater flowing off roads and highways.

4. The first step in water treatment is to screen the water entering the treatment plant from surface water to eliminate

any large objects. Most groundwater is not prescreened. Analysis of the water from the source comes next.

5. A treatment plan is then decided for the water. In Florida, this plan always includes antibacterial chemicals, like chlorine. Other additives might include alum that traps pollutants, lime and powdered carbon, somewhat like what is used in aquarium pumps.

6. Then the water is sent to a mixer to make sure all the additives have fully done their job.

7. A settling process occurs after the mixing to allow trapped pollutants to settle to the bottom of the tank for removal.

8. Finally, the water slowly filters through coal, sand and gravel, and chlorine is added again to disinfect distribution pipes. In some instances, a corrosion inhibitor is also added to prevent rusty pipes.

9. Finally, the water is forced through transmission lines to homes and other users.

10. Reverse osmosis, or desalinization, is another form of water treatment used to remove salt from salt water or brackish water and turn it into drinking water. In this form of treatment, water is forced through membranes to remove the salt. Membrane technology is becoming increasingly prevalent although the cost of this drinking water could be three times as high as the cost of traditionally treated drinking water.

Grades 9 to 12

OBJECTIVE

Impress upon students the importance of water conservation.

Grade Level/Subject Area

Grades 9 to 12, Sciences

Materials Required

Paper and Pencil

Anticipatory Set

In what way will you activate their PRIOR KNOWLEDGE and EXPERIENCE to help them relate to today's lesson.

- Through lessons and activities.

Assessment of Comprehension

How will you check that the students have understood/learned the objectives?

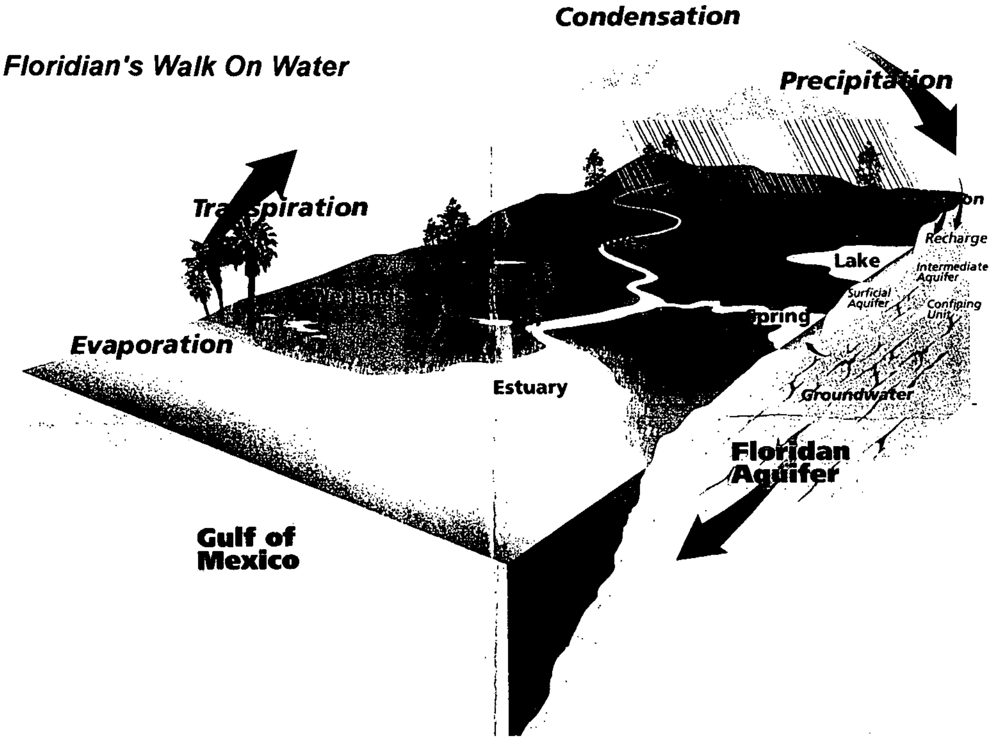
- Teacher observation
- Q&A
- Completed Assignment

Lesson 1 – Florida's Underground Water Supply

1. In Florida, we literally walk on water.

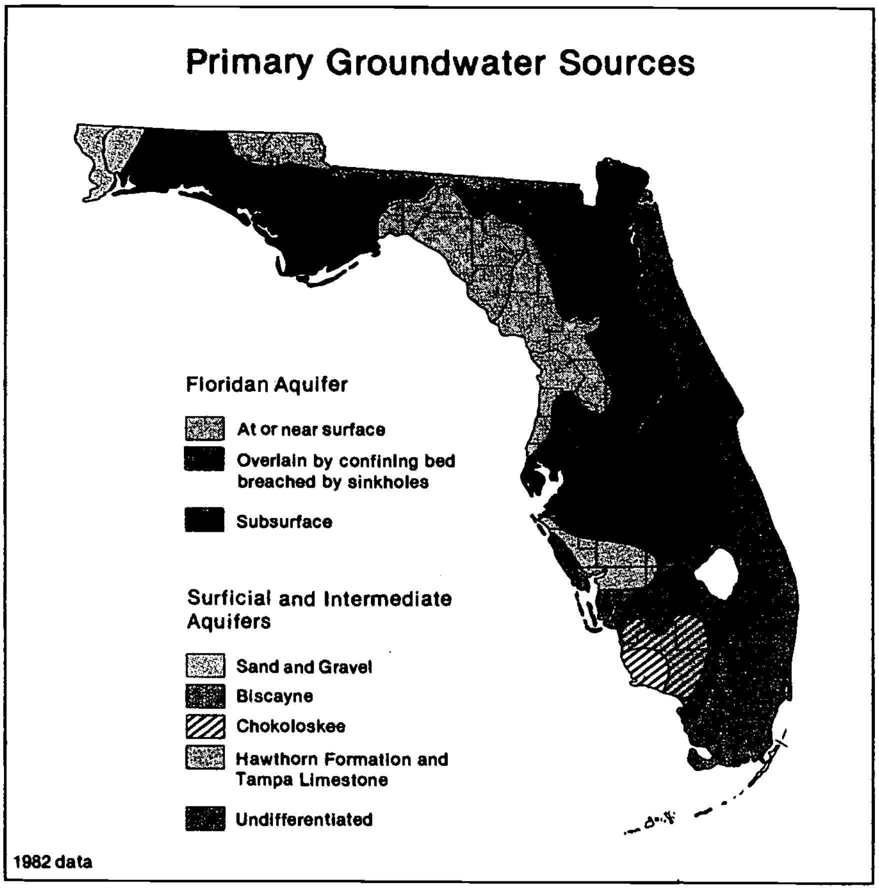
2. Below the surface of Florida, there are many caves and caverns filled with fresh water from the rain.

3. The caves and caverns are mostly interconnected. Ever try to confine water? These underground sources of water are called aquifers. (See what an aquifer might look like under the ground below.)



4. Florida has one major aquifer that it shares with our neighboring states to the north – Georgia, Alabama and South Carolina. It is called the Floridan Aquifer. It is from this large aquifer that most Floridians get their fresh water. There are other aquifers in special places in the State called surficial and/or intermediate

aquifers that are separate and apart from the Floridan Aquifer and have other names. (See diagram below.)



5. There are more than a quadrillion, that's 1,000,000,000,000,000,000, gallons of water stored in Florida's natural aquifer network. Yet in some areas, aquifer levels have dropped 40 to 60 feet below pre-development levels.

6. Why? Florida's population growth, salt water intrusion, development and pollution all contribute to the depletion of the State's water supply.

7. Floridians use more than 1.4 billion gallons of water each day. Beyond that, nearly 3 billion gallons of water per day are used for agriculture in Florida. All of that water has to be replaced by rainfall.

8. Nearly 80 percent of Florida's population lives near coastal areas where fresh water supplies may not be adequate. The southern half of Florida has just 44 percent of the State's water supply yet it is responsible for 75 percent of the water use.

9. Development, such as buildings or parking lots, covers the surface and prevents rainwater from re-entering the aquifer.

10. If more water is withdrawn from the aquifer than can be replaced by rain, which is what is happening in Florida, the resulting gap is filled with saltwater moving in from the ocean. That saltwater can quickly contaminate the freshwater. In some places, Floridians are using groundwater about 100 times faster than rainwater can replenish it. Only about 20 percent of the rainwater that falls in the U.S. becomes groundwater. That number is higher in Florida since aquifers rest underneath virtually the entire State.

11. Saltwater and depletion are not the only water enemies. Pollution is another major challenge because our fresh water is right beneath our feet. Groundwater can remain contaminated for many years and is very expensive to correct.

12. Groundwater is always on the move. How quickly it moves depends on the type of aquifer. In confined aquifers, it can move as slowly as a few inches a day. In limestone aquifers, like the Floridan Aquifer, it can move as quickly as several miles in one day.

13. The best way to protect our groundwater is to not use more than is replenished by rainfall and to prevent groundwater contamination before it has a chance to occur.

Lesson 2 – Water Pollution

1. Because the amount of water on Earth is constant and used over and over again, pollutants are a challenge.

2. Wastewater comes from our homes in the form of human and household wastes from toilets, sinks, baths and drains. It also comes from schools, industry and businesses, like restaurants, airports, shopping centers and factories. Wastewater is also collected in street drains.

3. It would be ideal if whenever water was used, the discharge was free of pollutants. But, pollutants come from the home, from us, from factories, from runoff from roads and concrete slabs symbolic of development and from fertilizers for our lawns and farmlands.

4. Water pollution is particularly acute in Florida where we literally walk above our water supply. Just about everything that hits the Earth below our feet ultimately ends up in our groundwater supply, the major source of Florida's drinking water.

5. Our government, particularly through the Environmental Protection Agency and the Florida Department of Environmental Protection, sets quality criteria for water discharges after use and issues permits for any discharges of treated water that enter receiving waters, including groundwater and surface water.

6. These agencies test and monitor the amount of pollutants in this discharge water with very specific tests and very specific limits.

7. Advancements in technology are making it possible to detect smaller and smaller amounts of pollutants. This requires tradeoffs. The cleaner the water the more it helps us and our cohabiting animals and plants on the planet. But, it also costs more for industry and the taxpayers.

8. Pollutants can come in many forms – microorganisms, chemicals and metals are examples:

    a. Microorganisms – microscopic or ultramicroscopic organisms are those too small to be seen with the unaided eye, like bacteria, protozoa, viruses and some algae. These can create and become waterborne diseases like typhoid fever, cholera, infectious hepatitis, dysentery or cryptosporidious, which in 1993 sickened 500,000 people in Milwaukee and was fatal to 100. On the average, however, according to the Center for Disease Control, 7,400 Americans become sick each year from polluted drinking water.

    b. Chemicals – These are substances created by the mixture or transformation of the basic elements. Some can be helpful, like medicines. Others can be extremely toxic, like poisons.

    c. Metals – These are substances with special qualities that fuse, are typically lustrous, are solid yet can be molded and are good conductors of electricity and heat. We use metals everywhere. Pens, irons, appliances, etc. Even yarns and threads are coated in metal. Some metals are healthy. For instance, some people take iron substitutes regularly. Others are harmful. For example, high doses of lead have been found to cause learning disabilities in young children. In 1986, all future use of lead in pipes of public water systems was banned.

9. The United States Congress passes all laws that assure our drinking water is safe. It is in the halls of Congress that competing forces attempt to strike a balance between taxes/cost and environmental protection.

10. All environmental concerns involve costs -- either the cost of losing clean water or the cost of keeping it clean. Infrastructure to purify water and protect the water source, water and wastewater treatment facilities, is very expensive and normally beyond what any individual can afford. Therefore, the costs are initially borne by business or government. But, eventually through consumer purchases or taxes, the individual pays the cost.

Activities

No Supplies Required.

Have the students discuss the ethics of striking a balance between the environment and the cost. Have them participate in a two sided debate, one side being industry which does not want to pay more to clean up environmental wastewater, and the other side being a consumer protection group focused on assuring clean drinking water.

Have your class study the lists of potential sources of water contamination, common groundwater pollutants and potential sources of groundwater pollution (attachments 2 & 3, pages 83, 84 & 85) and ask them to discuss what surprised them the most from each list.

Lesson 3 – Impact of Location, Climate and Population on Water Supply

1. Most people are aware that usable fresh water is unevenly distributed on Earth, but few realize just how drastically water is disproportionately located. Rainfall varies from less than five inches annually in some locations up to 400 inches per year in other places.

2. To understand the impact of humans on our water supply, consider Florida as a microcosm.

3. The southern half of Florida, defined as a line between New Smyrna Beach on the east coast and Cedar Key on the west coast (called Florida's Hydrological Divide,) gets all of its water from the rain that falls upon it.

4. This southern half of Florida gets 44 percent of the State's rain, yet is home to 78 percent of its population and uses 75 percent of the State's water.

5. Most of Florida's population is located along the coasts. However, the abundant fresh water aquifers are inland.

6. While Florida has abundant rainfall, only a maximum of 30 percent is available for human use. The remainder vaporizes or is returned to the atmosphere by evaporation or transpiration, the process by which plants move water from the roots upwards towards the leaves where it becomes vapor.

7. Another key factor in Florida's fresh water availability is the geology of being a peninsula surrounded by salt water. Our Floridan Aquifer is not only surrounded but is underlain completely by salt water. The fresh water is much less dense and literally floats on the heavier salt water. For every foot of fresh water withdrawn but not replaced from and to the aquifer above sea level, the salt water rises up 40 feet.

8. Another anomaly in Florida is that the wet season is six months in the summer when the population is at its lowest levels. When the water demand is highest during the seasonal winter, Florida has little rain. Water needs to essentially be stockpiled in the aquifer during the summer to provide for the winter demands.

9. And, the problem is not restricted to the disproportionate distribution of population of water and people.

10. If the population forecasts come true, Florida will continue to grow and the demands for water will continue to increase in exactly the same areas where water availability is already stressed by high withdrawals, proximity to salt water, excessive drainage and paving of recharge areas.

11. Population growth in Florida has always been accommodated by drainage and paving.

12. The drainage thwarts nature's natural ability to clean water as it filters through wetlands, and the paving greatly impairs aquifer recharge by hard surfacing over areas where water can reenter the aquifer. Paving and development diverts water to surface waters ending up in the ocean, rather than replenishing our drinking water supply.

13. And, with population growth comes the pollution issues discussed in the previous lesson.

Lesson 4 – Importance of Water Conservation

1. One only has to look at California to recognize the importance of water conservation. Because of explosive growth in population and development there, the State now has to operate what is called the State Water Project. It initially cost

the voters $1.75 billion, a staggering number 40 years ago. It now has an annual budget of more than $600 million.

2. The California State Water Project is a water storage and delivery system of reservoirs, aqueducts, power plants and pumping plants. Its main purpose is to store water and distribute it to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay area, the San Joaquin Valley and Southern California. These are areas that do not have enough of their own water to support their population and economies. It consists of 32 storage facilities, reservoirs and lakes, 17 pumping plants, three pumping generating plants, five hydroelectric power plants and about 6,660 miles of open canals and pipelines. It provides supplemental water to approximately 20 million Californians and 660,000 acres of California farmlands.

3. Florida is now undergoing the same explosive growth that California experienced a decade earlier.

4. We take water out of the aquifer faster than rainwater can replenish it. If this continues, it will eventually run dry, leaving Florida without its own water resources to provide for its citizens and industries.

5. Great difficulty has been occurring around the State as demand for water begins to outstrip real supply limitations.

6. There have been many long-drawn out lawsuits in the State over cities and counties trying to move into other cities and counties to get new water supplies as population increases.

7. This is particularly apparent in times of drought which is a familiar occurrence in Florida.

8. In Florida, it is very difficult to determine exactly how much water is available. Most of it is buried well below the surface. Climate plays a major role given our dependence on rainfall for fresh water supplies.

9. Surface waters—lakes, rivers and wetlands – whose flows and levels may be reduced by water use – can be replenished in wet years. And, the underground water supply can be drawn way down depending on the amount of water withdrawals and weather conditions.

10. There are many detrimental impacts of too much water use – saltwater intrusion, draw-downs of surface water, wells interfering with one another or simply running

the aquifers dry. Sometimes these conditions are only temporary and manageable.

11. However, when long-term water use becomes excessive, when these negative trends cannot be reversed and when wellfields go dry or the environment suffers irreparable harm, Floridians and the State's economy will truly suffer.

12. Eventually, like California, Florida will have to go in the direction of reallocation and redistribution of water.

Lesson 5 – Xeriscaping™ & Water Wise Landscaping and Irrigation

1. Irrigation is the largest use of fresh water in Florida. And, agriculture is among Florida's largest industries. The water needs of agriculture and the general population have continually clashed, particularly during times of drought.

2. Agriculture has been asked to improve its irrigation techniques. This includes using drip irrigation to reduce evaporation and water only the necessary roots, and reclaiming and cleaning the used water to avoid the infiltration of fertilizers and pesticides into the fresh water supply.

3. Irrigation also amounts to approximately 50 percent of water use in homes.

4. One easy solution to cut down on home irrigation use is called Xeriscape™.

5. Essentially, Xeriscape™ refers to using plants native to an area that thrived in that particular climate long before sprinkler systems, hoses, fertilizers and pesticides became the norm.

6. There are seven principles of a good Xeriscape™. They are:

    a. Analyze your soil. Done by local county extension offices, this analysis can tell you the pH balance of your soil, the level of acidity or alkalinity. This is important to the plants you choose.

    b. Carefully plan a landscape. Determine how you will use your yard. Do you need a grassy play area for your children or pets? Where is it sunny or shady and for how long? What size do you want the mature plants to be?

    c. Choose the proper plants. Select plants native to Florida and place them depending on their mature size, need for sun, shade, soil and water and tolerance to cold and salt.

d. Be careful of your grass. Grass is probably your yard's heaviest user of water. Use grass where you need it, but place ground covers or mulched walkways in other places.

e. Carefully plan your irrigation. Plants should be planted together in separate zones depending on their water needs. The right irrigation system should be selected for each zone. For example, pop up sprinklers are best for grass, but low volume irrigation that just reach the roots areas best for shrubs and flowers.

f. Mulch around your plants with wood shavings, pine straw or leaves. The mulch should be several inches deep to help conserve water. It will hold moisture longer, reduce weed growth and slow any erosion.

g. Keep your yard weeded, mowed, pruned and irrigated. A well-maintained yard will remain healthy and reduce the need for fertilizers, pesticides and herbicides that can infiltrate Florida's aquifer system.

7. A list of native Florida plants is attached (see attachment 4, page 87).

8. While not necessarily a part of Xeriscape™, proper lawn irrigation is crucial for water conservation. Most lawns in Florida need approximately 3/4 to 1 inch of water per week. If it doesn't rain, this watering should be done all at once. Watering once a week for a longer period encourages deeper root growth and a healthier lawn. You can actually train your grass to become drought tolerant.

9. Carefully monitor your automatic sprinkler system if you have one. Some systems default to a program of every day watering if the electricity is interrupted like so frequently happens in a Florida thunderstorm. This frequent watering for short periods of time causes shallow rooted, unhealthy lawns more vulnerable to disease.

10. It is now the law in Florida that rain sensors be installed with any irrigation system. There are very inexpensive mechanisms that keep sprinkler systems from turning on if there has been a sufficient amount of recent rainfall.

Activity

Supplies: Plain paper and pencil.

Have the students survey the landscape of their yards or the closest yard or park area. Ask them to re-design the landscape using the Xeriscape™ principles and write a one page explanation.

Glossary of Terms

above ground storage tanks (ASTs): any type of container used above the surface to store products. Regulated ASTs include those containing 660 or more gallons (in one container) or 1320 gallons (in more than one container) of oil of any kind that may pose a potential discharge to surface waters.

absorption field (drainfield): area where effluent from a septic tank is discharged.

accretion: the process of growing by being added to.

acid mine drainage: acidic waters that are formed in mine areas from water coming into increased contact with sulfate and sulfide minerals. This forms sulfuric acid.

acidic: having a pH value of less than 7. Acidic liquids are corrosive and sour.

acidity: (1) a characteristic of substances with a pH less than 7; (2) tending to form an acid.

acid rain: rain with a pH of less than 5.6 often resulting from atmospheric moisture mixing with sulfur and nitrogen oxides emitted from burning fossil fuels or from volcanic activity. May cause damage to buildings, monuments, car finishes, crops, forests, wildlife habitats, and aquatic life.

activated sludge: sludge particles produced by the growth of microorganisms in aerated tanks as a part of the activated sludge process to treat wastewater.

activated carbon (charcoal): material made from coal by driving off hydrocarbons under intense heat without oxygen, leaving a tremendous surface area on which many chemicals can be adsorbed.

acute (toxic) effects: adverse health effects that are observed rather quickly after exposure to a toxin; illness with rapid onset caused by a toxin.

adhere: to stick fast; stay attached to another substance.

adhesion: the act of sticking (surface attraction) or the state of being stuck together.

adsorption: phenomenon by which molecules in a fluid phase are attracted to a solid surface (e.g., activated carbon) and held there by physical or weak chemical bonds.

advanced wastewater treatment: any level of treatment beyond secondary treatment that includes secondary treatment plus nutrient removal. Advanced treatment generally removes greater than 85% of the biochemical oxygen demand (BOD) and total Suspended Solids (TSS)- typically required when the waters receiving effluent from a treatment plant do not provide adequate dilution. It is generally very expensive to construct and maintain advanced treatment facilities.

aeration: exposing to circulating air; addition of oxygen to wastewater or water, as in first step of both activated sludge wastewater treatment process and drinking water treatment.

aerobic: with oxygen; needing oxygen for cellular respiration.

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aesthetic: (1) drinking water - refers to water characteristics such as taste, odor, color and appearance that reduce the quality but do not necessarily result in adverse health affects; (2) of or relating to the sense of the beautiful; artistic quality or appearance.

AF: (acre foot) - volume of any substance required to cover one acre of a surface to the depth of 1 ft (43,560 ft^3) or (1232.75 m^3).

agriculture: science of cultivating the soil, producing crops, and raising livestock; farming.

air sparging: injecting air into groundwater to help remove contaminants.

algae: any various, primitive, chiefly aquatic, one-celled or multi-cellular plants that lack true stems, roots, and leaves, but usually contain chlorophyll. Algae are divided into three groups: chlorophyta (green), phaeophyta (brown), and rhodophyta (red), typically grow in sunlit waters in proportion to the amount of nutrients available, and serve as food for fish and small aquatic animals.

algae bloom: a sudden increase in the amount of algae, usually causing large, floating masses to form. Algae blooms can affect water quality by lowering oxygen content and decreasing sunlight penetration, are usually caused by excessive nutrient addition, and can be characteristic of a eutrophic lake.

alkaline: having a pH greater than 7; alkaline liquids are caustic and bitter.

alkalinity: (1) a characteristic of substances with a pH greater than 7; (2) the capacity of water to neutralize acids, imparted primarily by the water's content of carbonates, bicarbonates, and hydroxides (expressed in mg/I of CaCO).

alum: aluminum salt (typically, aluminum sulfate) used as a flocculent.

anaerobic: in the absence of oxygen; able to live and grow where there is no air or free oxygen, as certain bacteria.

anhydrite: a white to grayish or reddish mineral of anhydrous (free from water) calcium sulfate ($CaS0_4$) occurring as layers in gypsum deposits.

aqueous: of, pertaining to, or dissolved in water.

aquiclude: a low-permeability unit that forms either the upper or lower boundary of a groundwater flow system.

aquifer: porous, water-bearing layer of sand, gravel, and rock below the Earth's surface; reservoir for groundwater.

aquifer recharge: the addition of water by any means to an aquifer.

aquitard: a low-permeability layer of rock or clay that can store water but transmits it very slowly from one aquifer to another.

arid: lacking enough water for adequate growth; dry and barren.

artesian well: a well that produces water without need for pumping due to pressure exerted by confining layers of soil.

artesian aquifer: an aquifer that is sandwiched between two layers of impermeable materials and is under great pressure, forcing the water to rise without pumping. Springs often surface from artesian aquifers.

aseptic: free or protected from disease-producing or putrefying microorganisms.

assessment: a fact-based evaluation or judgment.

atmospheric pressure: the pressure or force per unit area exerted by the atmosphere on any surface beneath or within it.

atmospheric water: water found in vapor form in the atmosphere.

atom: any of the smallest particles of an element that combine with similar atomic particles of other elements to produce molecules; made up of electrons, neutrons, and protons.

attenuation: dilution or lessening in severity.

bacteria: typically one-celled, non-photosynthetic microorganisms that multiply by simple division. They occur in three main forms: spherical (cocci), rod-shaped (bacilli) and spiral (spirilla).

bar-built estuary: type of estuary formed by a series of bars or islands created from offshore depositing of sand, washed down by rivers or in from deep water. The sand walks up the continental shelf and stabilizes. A bar-built estuary is usually laterally extended along the shore, and is long, narrow and low.

barrier island: a ridge of sand and gravel deposited parallel to a coastline by the waves and tides with a lagoon behind it.

barrier reef: a rock or coral reef aligned roughly parallel to a shore and separated from it by a lagoon.

bathymetry: the measurement of the depth of the ocean.

bay: a body of water partly enclosed by land but with a wide outlet to the sea.

bedrock: the solid rock that underlies all soil, sand, clay, gravel and loose material on the Earth's surface; the bottom layer.

benefit: help or reward; positive factors to consider.

benthic: living on the bottom of a lake or sea; pertaining to the ocean bottom.

benzene: (1) a clear, inflammable, poisonous, aromatic liquid, C_6H_6, obtained by scrubbing coal gas with oil and by the fractional distillation of coal tar. It is used as a solvent for fats and in making lacquers, varnishes, many dyes, and other organic compounds; (2) a structural unit in the molecules of organic aromatic compounds.

Bernoulli Principle: the statement in hydraulics that, under conditions of uniform steady flow of water in a conduit or stream channel, the sum of the velocity head, the pressure head and the head due to elevation at any given point is equal to the sum of these heads at any other point plus or minus the losses in head between the two points due to friction or other causes.

best management practices (BMPs): techniques that are determined to be currently effective, practical means of preventing or reducing pollutants from point or nonpoint sources, in order to protect water quality. BMPs include, but are not limited to: structural and nonstructural controls, operation and maintenance procedures, and other practices. Usually, BMPs are applied as a system of practices rather than as a single practice.

bicarbonate: an acid salt of carbonic acid containing the radical Hco_3^-.

bioaccumulate: to accumulate larger and larger amounts of a toxin within the tissues of organisms at each successive trophic level.

bioaccumulation: the process by which a substance is taken up by an (aquatic) organism both from water and through food.

bioassessment: an evaluation of the biological condition of a water body using biological surveys and other direct measurements of resident biota in surface waters.

biochemical oxygen demand (BOD): a laboratory measurement of wastewater that is one of the main indicators of the quantity of pollutants present; a parameter used to measure the amount of oxygen that will be consumed by microorganisms during the biological reaction of oxygen with organic material.

biodegradable: capable of being decomposed (broken down) by natural biological processes.

biodegradation: the breakdown of materials by living things into simpler chemicals.

biodiversity: the number of different varieties of life forms in a given area, or an index derived from this number.

biological treatment: treatment of wastewater using microorganisms to decompose undesirable organic compounds in an aqueous waste stream.

biological magnification (biomagnification): bioaccumulation occurring through several levels of a food chain; process by which certain substances (such as pesticides or heavy metals) are deposited into a waterway, are eaten by aquatic organisms which are in turn eaten by large birds, animals, or humans, and become concentrated in tissues or internal organs as they move up the food chain.

biomes: area or groups of ecosystems with similar climates, soils, and communities.

bioremediation: a biologically mediated corrective process that occurs naturally over time; humans may speed up this process through technology (see in-situ bioremediation).

biosolids: sludge that is intended for beneficial use. Biosolids must meet certain government specified criteria depending on its use (e.g., fertilizer or soil amendment).

biota: the plant and animal life of a region.

biotic: living or derived from living things.

blackwater: domestic wastewater containing human or animal waste or other sources of pathogens.

"bloom" (algae bloom): a sudden excessive growth of algae that can affect water quality adversely; large floating masses of algae; characteristic of a eutrophic lake.

blowouts: when an oil well blows its top and spews crude oil into the air.

"blue baby" syndrome (methemoglobulinemia): pathological condition where the skin of infants (or other sensitive groups) turns blue due to nitrates bonding with red blood cells, which prevent the transport of oxygen throughout the body; can be caused by nitrate contamination in drinking water.

BOD (Biochemical Oxygen Demand): a laboratory measurement of wastewater that is one of the main indicators of quantity of pollutants present.

bog: freshwater marsh with build-up of peat and high acidity, that typically supports mosses adapted to acidic soil conditions (particularly, sphagnum); many are located in colder regions.

boiling point (BP): the temperature at which a liquid starts to bubble up and vaporize by being heated.

bottled water: water that is sealed in food grade bottles and is intended for human consumption.

bottomlands: lowlands along streams and rivers that are typically flooded.

brackish water: water that is a mixture of fresh and salt water.

buffer zone: an area between the water supply source and the possible contamination sources where no contamination activities are likely to occur.

calcium carbonate: one of the most stable, common and widely dispersed materials on Earth; occurs naturally in oyster shells, calcite, limestone, marble, chalk and other forms; used to express hardness and alkalinity (mg/l of $CaCO_3$).

capillary action: the action by which the surface of a liquid where it is in contact with a solid (as in a capillary tube) is elevated or depressed depending on the relative attraction of the molecules of the liquid for each other and for those of the solid.

carbon column: compressed activated carbon in a tube, used for adsorption processes.

carbonate aquifer: underground layer of limestone that is saturated with usable amounts of water.

carbon dioxide: colorless, odorless gas made of carbon and oxygen (Co_2); exhaled by animals and humans, utilized by plants in photosynthesis and contained in automobile exhaust.

carbonic acid: substance formed by combining water (H_2O) and carbon dioxide (CO_2); chemical formula H_2CO_3.

carcinogen: cancer-causing agent.

cartographer: a person whose work is making maps or charts.

channel: (1) a body of water joining two larger bodies of water; (2) a channel could also be the physical dimensions of a stream or river.

channeling: to make a channel.

channelization: the straightening and sometimes deepening of stream or river channels to speed water flow and reduce flooding. A waterway so treated is said to be channelized. However, channelization can cause unstable situations and may cause adverse environmental impacts.

chemical oxidation: a means of destroying dissolved organic contaminants in water using ultraviolet (UV) radiation, hydrogen peroxide or other processes.

chemical water pollution: introduction of chemicals into a water body.

chlorination: the addition of chlorine to water to destroy microorganisms especially for disinfections.

chlorine: a chemical compound used as disinfectant in wastewater treatment and drinking water treatment processes.

chronic (toxic) effects: adverse health effects that are either the result of long-term (chronic) exposure or those that are permanent or long-lasting (e.g., cancer).

clarifier (settling tank or sedimentation tank): a vessel in which solids settle out of water by gravity during drinking water or wastewater treatment processes.

Clean Water Act (CWA): water pollution control law passed to restore and maintain the nation's waters; the nation's primary source of federal legislation that specifies the methods to be used in determining how much treatment is required for discharges (effluents) from publicly owned treatment works (POTWs).

Cnidaria: phylum name for a group of invertebrates that includes coral animals, jellies, sea anemones, and the hydra.

coagulant: a substance added to a mixture that will cause precipitates (flocs) to form; also called "flocculent".

coagulation: the process by which dirt and other small suspended solid particles are chemically bound, forming flocs using a coagulant (flocculent) so they can be removed from the water (the second step in drinking water treatment).

cohere: to be united by molecular cohesion; to stick to the same substance.

cohesion: the force by which the molecules of a substance are held together.

colloid: a solid, liquid or gaseous substance made up of very small, insoluble, non-diffusible particles that remain in suspension in a surrounding solid, liquid or gaseous medium of different matter.

commensal relationship: a relationship between two organisms in which one is benefited by the relationship and the other is neither benefited nor harmed.

community: assemblage of populations of species living together and interacting with each other within a certain area.

compound: a substance formed by the bonding of two or more atoms or ions that share electrons (covalent compounds) or transfer electrons (ionic compounds).

concentration: strength or density of a solution, as in amount of solute per volume of solution.

condensation: (1) the process of changing from a vapor to a liquid; (2) a liquid obtained by the coming together of a gas or vapor.

confined aquifer: an artesian aquifer.

conservation: act of using the resources only when needed for the purpose of protecting from waste or loss of resources.

contaminant: an impurity that causes air, soil or water to be harmful to human health or the environment; something that makes a substance impure, infected, corrupted or polluted.

continental shelf: a shallow, submarine plain of varying width, forming a border to a continent and typically ending in a steep slope to the oceanic abyss.

contour: (1) imaginary line on the surface of the Earth connecting points of the same elevation; (2) a way of shaping the surface of the land in a particular form, commonly used to prevent erosion and control water flow.

conversion: a physical transformation from one material state to another.

coral reef: erosion-resistant marine ridge or mound built slowly over thousands of years by coral polyps (tiny animals) bound together with algal material and biochemically deposited carbonates.

corrosion: a substance formed or an action of wearing away by chemicals; formed by deterioration.

cost: price; practical factors to consider.

covalent bond: bond formed between two atoms when they share pairs of electrons.

crude oil: unrefined petroleum; a mixture of many different hydrocarbons.

cryptosporidiosis: acute, highly infectious disease caused by the protozoan Cryptosporidium parvum that can be transmitted by contaminated food or water.

current: a flow of water or air, especially when strong or swift, in a definite direction; specifically, such a flow within a larger body of water or mass of air.

cypress domes: small, depressional swamps, typically with tall cypress trees at the center characterized by subsurface hardpan overlain by organic matter.

dam: man-made or animal-made barrier across a stream that holds and regulates the flow of water.

decomposition: the process of breaking down into constituent parts or elements.

deltaic estuary: type of estuary formed by a delta.

delta: a deposit of sand and soil, usually triangular, formed at the mouth of some rivers.

density: the ratio of the mass of an object to its volume.

deposition: a laying or putting down (settling out suspended materials in a liquid due to a decrease in velocity of the suspension).

detritus: decomposed or disintegrated organic matter (found in water and on land) and associated microbial elements.

diatomic molecule: molecule made of two atoms.

digested solids: sewage solids that have been broken down by microorganisms.

digestion: the process of sewage treatment by the decomposition of organic matter; decomposition of organic waste materials by the action of microbes.

dike: elevated structure alongside of stream or perpendicular that acts as a barrier to flood waters.

discharge area: an area where groundwater flowing toward the surface escapes as a spring, seep, or baseflow, or by evaporation and transpiration.

disinfection: the use of chemicals and/or other means to kill potentially harmful microorganisms in water; used in both wastewater and drinking water treatment.

dissolved oxygen (DO): oxygen gas (O_2) dissolved in water.

distributary: a branch of a river that flows away from the main stream.

diversions/channeling: altering the course of a river or stream causing the stream to change its direction.

dolomite: a mineral [$CaMg(CO_3)_2$] consisting of a calcium magnesium carbonate found in crystals and in extensive beds as a compact rock.

domestic wastewater: wastewater that comes primarily from individuals and does not generally include industrial or agricultural wastewater.

dowsing: to search for a source of water or minerals with a divining rod.

drawdown: the lowering of the water table as water is removed from an aquifer.

drinking water standard: maximum contaminant level or treatment technique requirement.

drowned river valley: type of estuary that is wider than deep and triangular in shape.

eddy: a current (of water or air) running contrary to the main current.

effluent: treated wastewater, flowing from a lagoon, tank, treatment process or treatment plant.

electron: any of the negatively charged particles that form a part of all atoms; exists outside the nucleus; involved in bond formation.

element: natural substances that cannot be broken into anything simpler by ordinary chemical means.

elevation head: the elevation of the point at which the hydrostatic pressure is measured, above or below an arbitrary horizontal datum.

emergent: rising from a surrounding liquid.

Environmental Protection Agency (EPA): the U.S. agency responsible for efforts to control air, land and water pollution, radiation and pesticide hazards and to promote ecological research, pollution prevention and proper solid waste disposal.

epidemic diseases: diseases that spread rapidly by infection among many individuals in an area.

epilimnion: one of three temperature or thermal zones located at the top of a thermally stratified lake; varies in size and temperature characteristics based on a seasonal cycle.

equipotential line: a line in a two-dimensional groundwater flow field such that the total hydraulic head is the same for all points along the line.

erosion: the process of detachment, transport and deposition of soil material.

escarpment: a long cliff or steep slope separating two comparatively level or more gently sloping surfaces.

estuarine: formed or deposited in an estuary; of or having the characteristics of an estuary.

estuary: a marine ecosystem where freshwater enters the ocean. The term usually describes regions near the mouths of rivers, and includes bays, lagoons, sounds and marshes.

ethics: the study of the general nature of values and of the specific moral choices to be made by the individual in relationships with others and his/her environment.

eutrophic: refers to a body of water characterized by nutrient-rich water supporting abundant growth of algae and/or other aquatic plants at the surface.

eutrophic lake: a lake containing a high concentration of dissolved nutrients; often shallow, with periods of oxygen deficiency.

eutrophication: the process in which a body of water becomes oxygen deficient, nutrient-rich and supports an abundant growth of surface aquatic plants and algae; natural aging cycle of lakes, normally taking centuries, but it can be rapidly accelerated when outside sources of nutrients are added, such as wastewater, fertilizer or feed lot runoff.

evaporate: to pass off in vapor or in invisible minute particles (to cause evaporation).

evaporation: the process of changing from a liquid to a vapor.

facultative anaerobic: describes an organism that can use another electron accepting molecule other than oxygen for cellular respiration, if oxygen is not present.

fault: a fracture in the Earth's crust accompanied by displacement of one side of the fracture with respect to the other.

fecal coliform bacteria: a type of coliform bacteria found in the intestines of humans and warm-blooded animals that aids in the digestion process and is used as an indicator of fecal contamination and/or possible presence of pathogens.

feed lots: confined areas where livestock is kept.

ferment: to break down sugars only partially, producing a gas (usually CO_2) and alcohol.

fertilizer: natural and synthetic materials including manure, nitrogen, phosphorus and treated sewage sludge that are worked into the soil to provide nutrients and increase its fertility.

filter strip: area of land that infiltrates surface runoff and traps sediment and associated pollutants.

filtration: the process of passing a liquid or gas through a porous article or mass (e.g. paper, membrane, sand) to separate out matter in suspension, used in both wastewater and drinking water treatment.

fjord: narrow, deep valleys carved by glaciers and flooded by the sea.

fjord-drowned glacial valley: type of estuary usually found in arctic and polar regions, U-shaped, deeper than wide, that has a small river discharge and a large tidal volume; important to shipping.

flocculant: a substance added to a mixture that will cause precipitates (flocs) to form; also called Coagulant.

flocculation: physical process of growing flocs from smaller flocs or particles.

flocs: lumpy or fluffy masses of particles agglomerated by a flocculant or coagulant.

floodplain: relatively flat area on either side of a river that may be under water during a flood.

flow line: the line of flow of groundwater.

flow net: the set of intersecting equipotential lines and flow lines representing two-dimensional steady flow through porous media.

fluid: a substance, as a liquid or gas, that is capable of flowing and that changes its shape at a steady rate when acted upon by a force.

fluid pressure: the mechanical energy per unit mass of a fluid, at any given point in space and time, with respect to an arbitrary state and datum (fluid potential).

fluoride: a binary compound of fluorine added to drinking water to help prevent tooth decay.

fluvial: found in, produced by or relating to a river.

forested wetland: wetland dominated by trees. "Trees" (for the purpose of this definition) are defined as woody vegetation with diameter greater than 3 inches at breast height (approximately 4 feet from ground level).

fossil fuels: hydrocarbon fuels, such as petroleum, derived from living things of a previous geologic time.

fracture: a break in rock that may be caused by compressional or tensional forces.

freezing point (FP): the temperature at which a liquid begins to precipitate crystals.

freshwater marsh: a wetland frequently or continually inundated by freshwater, characterized by herbaceous vegetation.

geologic map: a map of the Earth's surface with surface geologic formations superimposed over existing features such as roads, streams, lakes, and other features.

geological formation: a body of rock identified by lithic characteristics and stratigraphic position; the fundamental unit in lithostratigraphic classification.

geology: a science that deals with the structure and history of the Earth and its life, especially as recorded in rocks.

glacier: a large mass of ice formed on land by compacted snow

gradient: change of elevation, velocity, pressure or other characteristics per unit length; slope.

gram negative: the result of a certain laboratory test done on microorganisms to divide them into two groups (either gram negative or gram positive). Gram negative bacteria have a cell membrane composed of lipopolysaccharide and protein.

graywater: wastewater from households that does not come into contact with sewage.

grit chamber: a chamber or tank used in primary treatment where wastewater slows down and heavy, large solids (grit) settle out and are removed.

groundwater: water that infiltrates into the Earth and is stored in usable amounts in the soil and rock below the Earth's surface; water within the zone of saturation.

groundwater divide: a crest of the water table with flow going in opposite directions on either side.

gulf: a large area of a sea or ocean partially enclosed by land.

gulf stream: the oceanic current that brings warm Gulf of Mexico water up along the east coast of the U.S. and across the Atlantic to the British Isles.

habitat: the place or type of site where a plant or animal naturally or normally lives and grows.

harbor: a body of water where wave action is reduced or dampened.

hard water: water high in mineral.

hardness: a measure of all the multivalent ions (primarily calcium and magnesium) expressed as mg/l of calci carbonate ($CaCO_3$).

hazardous waste: waste materials that are dangerous to human health and/or the environment.

headwaters: the streams that are the sources of a river.

homogeneous: (1) uniform throughout in structure or make-up (for a substance or material); (2) of the same or similar nature or kind (for a group).

hot spot: region where an unusually high number of deaths are due to cancer that might be linked to environmental contamination.

hydraulic head: the height of the free surface of a body of water above a given subsurface point; the sum of elevation, pressure and velocity components at a given point in an aquifer.

hydrocarbons: a very large group of chemical compounds consisting primarily of carbon and hydrogen. The largest source of hydrocarbons is petroleum (crude oil).

hydrogen sulfide: gas emitted during organic decomposition by anaerobic bacteria which smells like rotten eggs and can cause illness in heavy concentrations (chemical formula, H_2S).

hydrologic cycle: the cyclical process of water's movement from the atmosphere, its inflow and temporary storage on and in land, and its outflow to the oceans; cycle of water from the atmosphere, by condensation and precipitation, then its return to the atmosphere by evaporation and transpiration.

hydrology: the study of water, its properties, distribution on Earth and effects on the Earth's environment.

hydroxide precipitation: using the hydroxide ion ($0H^-$) to cause a material to come out of solution.

hypolimnion: one of three temperature or thermal zones located at the bottom of a thermally stratified lake; varies in size and other characteristics based on a seasonal cycle.

hypoxic: containing very little or decreased oxygen.

igneous rock: rock that solidified from a hot, liquid state.

impermeable (substance): a substance through which other substances are unable to pass.

in-situ bioremediation: a means of degrading hydrocarbon-based contaminants at the site of contamination.

indicator organism: an organism whose presence or absence typically indicates or provides information on the certain conditions within its environment.

infiltration: the flow of water downward from the land surface into and through the upper soil layers.

influent: wastewater flowing into a treatment plant.

ingestion: the process of taking into the body, as by swallowing.

injection well: a well in which fluids, such as wastewater, saltwater, natural gas or used chemicals are injected in the ground for the purpose of disposal or to force adjacent fluids like oil into the vicinity of oil-producing wells.

inspect: to examine in detail, especially for flaws.

interstitial: of, forming or occurring in a small or narrow space between things or parts.

intertidal: of or pertaining to a shore zone bounded by the levels of low and high tide.

inventory: a detailed list of items in one's view or possession, especially a periodic survey of all goods and materials.

ion: an atom or molecule that has lost or gained one or more electrons.

ionization constant: a comparison of the strengths of acids or bases in a given solvent, such as water.

isotropic: having physical properties such as conductivity and elasticity, that are the same regardless of the direction of measurement.

kinetic energy: the energy of a body resulting from its motion.

kinetic movement: movement of electrons, atoms and molecules as a result of their energy state.

lactose: a type of simple sugar that can be digested by fecal coliform bacteria.

lagoon: a shallow body of water, especially one separated from the sea by sandbars or coral reefs.

lagoons (oxidation ponds or stabilization ponds): a wastewater treatment method that uses ponds to treat wastewater. Algae grow within the lagoons and utilize sunlight to produce oxygen, which is in turn used by microorganisms in the lagoon to break down organic material in the wastewater. Wastewater solids settle in the lagoon, resulting in effluent that is relatively well treated, although it does contain algae.

lake: a standing body of water which undergoes thermal stratification and turnover by mixing.

leachate: a liquid that results from water collecting contaminants as it trickles through wastes, or soil containing agricultural pesticides or fertilizers.

leaching: the removal of chemical constituents from rocks and soil by water.

leaking underground storage tank: underground storage tank that has spilled, leaked, emitted, discharged, leached, disposed or otherwise allowed an escape of its contents into groundwater, surface water or subsurface soils.

leeward: in the direction toward which the wind blows; of the side of anything away from the wind.

lentic system: surface water that is standing such as a lake or a pond.

levee: an embankment, natural or artificial, built alongside a river to limit high water events from flooding bordering land.

limestone: a rock that formed chiefly by accumulation of organic remains; consists mainly of calcium carbonate.

limnetic zone: a zone in a lake extending over open water from the edge of one littoral zone to the other and above the profundal zone; characterized by floating vegetation and moderate to high sunlight penetration.

limnology: the science that deals with the physical, chemical and biological properties and features of fresh waters, especially lakes and ponds.

liquid: fluid composed of molecules that move freely among themselves but do not tend to separate like those of gases; state of matter that has a definite volume but not a definite shape.

lithic: of stone.

lithostratigraphy: the arrangement of rocks in layers or strata; the branch of geology dealing with the study of the nature, distribution and relations of the stratified rocks of the Earth's crust.

littoral drift: movement of materials along the shore.

littoral zone: a zone along the shore of a lake that is characterized by very shallow water, rooted vegetation and high sunlight penetration.

log landing: site where logs are sorted and loaded onto trucks for hauling.

longshore current: a flow of water that runs along the shoreline that is usually strong or swift.

loop current: oceanic current that enters the Gulf of Mexico through the Yucatan Channel and/or exits through the Straits of Florida (Parent of the Gulf Stream).

lotic system: surface water that is flowing such as a river or stream.

man-made: made by humans; artificial or synthetic.

management: to effect a plan of action; to solve a problem by direction, guidance, administration, or control.

mangrove swamps: tropical, wet, coastal areas dominated by mangroves (trees). Mangroves have extensive root systems that form a dense thicket, providing cover for aquatic life.

MARPOL Treaty: international treaty that regulates the disposal of solid waste, including plastics.

marsh: wetland dominated by grasses.

maximum contaminant level (MCL): maximum permissible level of a contaminant in water which is delivered to any user of a public water system; drinking water standard.

mechanical treatment plant: uses blowers and surface aerators to transfer oxygen into the wastewater.

metamorphic rock: rock made by heating and pressurizing preexisting rocks.

Method Detection Limit (MDL): the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

microalgae: plant-like microorganisms that use chlorophyll for photosynthesis.

microbe: microorganism (microbiological organism).

microbiological: referring to microscopic or ultramicroscopic organisms such as algae, bacteria or protozoa.

microbiology: study of microorganisms, a large and diverse group of organisms that exist as single cells or cell clusters.

microorganisms: microscopic or ultramicroscopic organisms (e.g., bacteria, protozoa, viruses).

mineral waters: sparkling (carbonated) waters generally used as an alternative to soft drinks or cocktails.

model: using simple or familiar objects to explain or demonstrate a new, unfamiliar or complicated concept.

molecule: the smallest particle of a compound that can exist in the free state and still retain the characteristics of the compound.

mud flats: large estuarine expanses composed of rich muds exposed at low tides.

multimedia filters: filters that contain more than one type of filtering material.

multivalent (ion): ion that has lost or gained more than one electron (also called "polyvalent" ion).

municipal: of or relating to municipality (city, town, etc.). Municipal wastewater is primarily domestic wastewater.

natural: produced or existing in nature, not artificial or manufactured.

natural water: water that comes from springs or streams and does not have any chemicals added to it.

nitrates: compounds containing nitrogen as nitrates (NO_3^-). In the environment, these compounds are found in animal wastes, fertilizers and in septic tanks and untreated municipal sewage. Their primary public health hazard is the cause of methemoglobulinemia or "blue baby" syndrome.

non-degradable: not capable of chemical or biological decomposition.

nonendospore-forming: does not form an encapsulated nucleus resistant to most harsh environmental conditions.

nonpoint source: general or collective source of contamination.

nonpoint source pollution (NPS): pollution that cannot be traced to a single point (e.g., outlet or pipe) because it comes from many individual sources or a widespread area (typically urban, rural, and agricultural runoff).

nonrenewable resource: a resource in a fixed amount; all minerals, coal, crude oil, and natural gas.

NPDES (National Pollutant Discharge Elimination System): a program created by the Clean Water Act to ensure that water quality is maintained by dischargers of wastewater. NPDES permits require the operator of wastewater treatment plants to test and report the quality of the effluent discharged to streams. The NPDES permit specifies pollutant limitations on the effluent that prevent damage to receiving waters.

nutrients: compounds, minerals or elements needed by living organisms to carry on their functions. Nitrogen, phosphorus, potassium and other elements are examples of nutrients required for plant growth.

ocean: the entire body of salt water that covers about 71 percent of the Earth's surface.

oceanography: a science that deals with the oceans and includes the delineation of their extent and depth, the physics and chemistry of their waters, marine biology, and the exploration of their natural resources.

oligotrophic: refers to any ecosystem that has nutrient-poor water.

optimum pH: the pH condition that will produce the best results for a given purpose.

organic: of, pertaining to, or derived from living organisms.

organic molecule: any molecule that contains carbon and hydrogen.

osmotic pressure: the force per unit area exerted by a solvent passing through a semipermeable membrane in osmosis, equal to the pressure that must be applied to the solution in order to prevent passage of the solvent into it.

overturning (turnover): process by which water and nutrients are circulated in a lake due to thermal processes which can occur on a seasonal basis.

parts per million (ppm): a measurement of concentration of 1 unit of material dispersed in 1 million units of another (for water, same as mg/l).

pathogenic: producing disease.

pathogens: disease-causing agents, especially disease-producing microorganisms.

percolate: to drain or seep through a porous and permeable substance; to filter such as a liquid passing through a porous body (water through soil to the aquifer).

percolation: the downward movement through the subsurface soil layers to groundwater.

percometer: an instrument to measure the rate of percolation.

permeability: the capacity of a porous material to transmit fluids. Permeability is a function of the sizes, shapes, and degree of connection among pore spaces, the viscosity of the fluid and the pressure driving the fluid.

pH: a measure of the concentration of hydrogen ions (H^+) in a solution; the pH scale ranges from 0 to 14 where 7 is neutral. Values less than 7 are acidic, and values greater than 7 are basic or alkaline. An inverted logarithmic scale measures it so that every unit decrease in pH means a 10-fold increase in hydrogen ion concentration. Thus, a pH of 3 is 10 times as acidic as a pH of 4 and 100 times as acidic as a pH of 5.

phosphate: an ion composed of a phosphorus atom with 4 oxygen atoms attached (PO_4^{-3}). It is an important plant nutrient.

phosphorus: an element considered the key nutrient in controlling eutrophication in lakes and ponds.

phytoplankton: any of the many species of plants (such as algae) that consist of single cells or small groups of cells that live and grow freely suspended in the water near the surface.

picocuries per liter (pCi/L): units for measurement of radioactive element concentrations in water and in air.

plane of turbulence: the flat, level or even surface in which there is violent, irregular motion or swirling agitation of water.

plankton: microscopic plants and animals in water that are influenced in mobility by the movement of water (i.e., as opposed to nekton (fish) which can swim).

plume: an area where a contaminant has spread out.

point source: known source of contamination.

point source pollution: pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial, wastewater treatment plant and certain storm water discharges).

pollutant (water): any substance suspended or dissolved in water that builds up in sufficient quantity to impair water quality.

pollution: an unwanted change in air, water or soil (usually through the introduction of pollutants or contaminants) that can affect the health and survival of humans and other organisms.

pollution prevention: preventing the creation of pollutants or reducing the amount created at the source of generation, as well as protecting natural resources through conservation or increased efficiency in the use of energy, water or other materials.

pond: a still body of water smaller than a lake where mixing of nutrients and water occurs primarily through the action of wind (as opposed to turnover).

population: group of organisms of a single species living in a certain area and interbreeding (or interacting).

pore: a passage; channel; a tiny opening, usually microscopic.

pore space: the volume of the open spaces in rock of soil.

porosity: a description of the total volume of rock or soil not occupied by solid matter.

potable water: water suitable for drinking without harmful effects.

potentiometric surface: a surface that represents the level where water will rise in a tightly cased well. The water table is the potentiometric surface for an unconfined aquifer.

precipitation: water droplets or ice particles condensed from atmospheric water vapor and sufficiently massive to fall to the Earth's surface, such as rain or snow.

pressure head: the height of a column of liquid supported, or capable of being supported, by pressure at a point in the liquid.

pressurize: to put (gas or liquid) under a greater than normal pressure.

primary productivity (producers): in an ecosystem, those organisms, mostly green plants, that use light energy to construct their organic constituents from inorganic compounds.

primary treatment: the first stage of wastewater treatment that removes settleable or floating solids only; generally removes 40% of the suspended solids and 30-40% of the BOD in the wastewater.

Prior Appropriations Water Rights: doctrine of western states that says that "one who is first in time is first in right," or whoever occupies a location first receives the water that he/she wants or needs.

privy: an outhouse; a latrine.

pro: for; in support of, affirmative consideration.

profundal zone: a zone in a lake extending from the bottom of the limnetic zone to the bottom of the lake; characterized by deep waters, decomposing vegetation and little to no sunlight penetration.

protozoa: mostly microscopic animals made up of a single cell or a group of more or less identical cells. Protozoa live chiefly in water, but many are parasitic.

radionuclides: types of atoms which spontaneously undergo radioactive decay; usually naturally occurring, and can contaminate water or indoor air (e.g., radon).

radon: colorless, odorless, tasteless, naturally occurring radioactive gas formed from natural deposits of uranium that can cause lung cancer. It can enter the home around plumbing pipes and/or through cracks and openings in the foundation. It can also be brought in with the home's water supply.

radon decay products: the radioactive elements that immediately follow radon in the decay chain. They are ultrafine solids that tend to adhere to other solids, such as dust particles in the air or lung tissue if inhaled.

raw/untreated solids: settleable solids, grit and other solid material removed by the primary clarifier (not treated by microorganisms).

recharge: (1) to replenish a body of water or an aquifer with water; (2) the replacement of any water that may have flowed out or been pumped out of the aquifer.

recharge area: an area where infiltration moves downward into an aquifer.

reclamation: bringing land that has been disturbed by some process back to its original condition.

red tide: a reddish discoloration of coastal surface waters due to concentrations of certain toxin-producing dinoflagellates. Can cause pulmonary irritations in man and can cause death of marine mammals.

reef: a strip or ridge of rocks, sand or coral that rises to or is near the surface of a body of water.

refractory wastewater: wastewater containing an organic or nutrient content that will not oxidize in normal treatment processes.

regeneration: the process of being renewed or reconstituted.

renewable resource: a resource that can be used, then grown or replenished in some manner from year to year; plants and some animals.

residual: the quantity left over at the end of a process; remainder.

residue: something that remains after a part is taken away.

resource: natural assets: air, water, soil, oil, gas, coal, trees, minerals, land, wildlife, people; the materials needed for the satisfaction of wants and needs.

respiration: the sum total of the process of oxygen being conveyed to the cells and tissues of living organisms and the process by which the products of this oxidation process, CO_2 and H_2O, are given off.

riffle: fast moving area in a stream. Usually the surface is broken by small waves or rocks.; the slope of a stream bed is steeper in riffles than it is in open pools where the water surface tends to be smoother.

riparian: of, adjacent to, or living on the bank of a river, stream, or sometimes, of a lake or pond.

riparian communities: living organisms adjacent to or living on the bank of a river, lake, or pond.

riparian rights: water rights enjoyed by owners of land adjacent to a body of water.

risk: exposure to danger; negative factors to consider.

river: a large body of flowing water that receives water from other streams and/or rivers.

river mouth: where the river empties into a larger body of water.

river source: where the river begins.

road cut: a hill, ridge or mountain side excavated for a road right-of-way. Road cuts leave exposed strata, rock and soil that can be viewed in their natural state if not covered or vegetated.

Runoff: water (originating as precipitation) that flows across surfaces rather than soaking in; eventually enters a water body; may pick up and carry a variety of pollutants

Safe Drinking Water Act: a law passed by the U.S. Congress in 1974 and amended in 1986 and 1996 to help ensure safe drinking water in the United States. The Act requires that regulations be enacted to set maximum contaminant levels (MCLs) or treatment technique requirements for a variety of chemicals, metals and pathogens in public water supplies; also requires protection of surface source waters and underground sources of drinking water.

salinity: the amount of salt dissolved in water.

salt marsh: estuarine habitat submerged at high tide, but protected from direct wave action, and overgrown by salt-tolerant herbaceous vegetation; aquatic grasslands (coastal "prairies") affected by changing tides, temperatures, and salinity.

sand bar: a ridge or narrow shoal of sand formed in a river or along a shore by the action of currents, tides, and waves.

sand dune: a pile of sand on the shore that is created by wind or water movement of the sand. Most are affected by wind and water.

saturated zone: a portion of the soil profile where all pores are filled with water. Aquifers are located in this zone. There may be multiple saturation zones at different soil depths separated by layers of clay or rock.

saturation: being filled to capacity; having absorbed all that can be taken up.

seasonal: happening based on the yearly seasons of spring, summer, fall and winter.

Secchi disc: a black and white circular plate that is used to determine water clarity.

secondary containment for above-ground fuel storage tanks: spill containment facility that will sufficiently contain 110 percent of the capacity of the largest tank located within the area of management.

secondary treatment: a type of wastewater treatment used to convert dissolved and suspended pollutants into a form that can be removed, producing a relatively highly treated effluent. Secondary treatment normally utilizes biological treatment processes (activated sludge, trickling filters, etc.) followed by settling tanks and will remove approximately 85% of the BOD and TSS in wastewater. Secondary treatment for municipal wastewater is the minimum level of treatment required by the Clean Water Act.

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sediment: eroded soil material, containing primarily inorganic constituents.

sedimentary rock: a rock that consists chiefly of either small pieces of rock cemented together (sandstone) or crystals that grew from water (rock salt, limestone).

sedimentation: (1) the process of depositing sediment, or the addition of soils to lakes, that is part of the natural aging process; (2) the drinking water treatment process of letting heavy particles in raw water settle out into holding ponds or basins before filtration (also called settling"); (3) the process used in both primary and secondary wastewater treatment that takes place when gravity pulls particles to the bottom of a tank (also called "settling").

seltzer water: natural mineral water that is effervescent.

septic system: on-site equipment or system to treat wastewater, consisting of a septic tank and an absorption field.

septic tank: a tank, commonly buried, to which all of the wastewaters from the home should flow and in which primary digestion of the organic matter occurs by anaerobic bacteria; the main part of a septic system where scum and solids accumulate; derived from "sepsis"-meaning "putrid decay" or "decay without oxygen".

settling tank (sedimentation tank or clarifier): a vessel in which solids settle out of water by gravity during wastewater or drinking water treatment process.

settling pond: usually a human-made pond that is designed to remove many of the particulates from runoff water.

sewage: waste and wastewater produced by residential, commercial and light industrial establishment; typically discharged into sewers and sometimes into septic tanks.

sewage contamination: the introduction of untreated or improperly treated sewage into a water body.

sinkhole: a hole caused by collapse of the land surface, commonly because underlying limestone rock has dissolved away.

site preparation: the use of machines, herbicides, fire or combinations thereof to dispose of slash (unmerchantable debris), improve planting conditions and provide initial control of competing vegetation.

slope: degree of deviation of a surface from the horizontal, measured in degrees.

sludge: any solid, semisolid or liquid waste that settles to the bottom of sedimentation tanks (in wastewater treatment plants or drinking water treatment plants) or septic tanks.

soda water: water charged under pressure with carbon dioxide gas.

soft water: water that is low in mineral content because it has flowed through soils and rocks containing minerals that react poorly. Soaps are very "sudsy" in soft waters.

solubility: ability or tendency of one substance to blend uniformly with another.

solution: a homogenous mixture of two substances, usually a gas or solid in a liquid.

solution mining: a type of mining wherein water is injected into a well to remove a desired mineral.

solvent: a substance that dissolves another to form a solution.

sound: long, broad inlet of the ocean larger than a strait or channel, connecting larger bodies of water.

Source water protection: process that involves delineating areas contributing water to a water well or surface water intake; identifying potential contaminant sources that may threaten the water supply; and using management strategies to protect the source water from contamination. Source water protection is applied to both surface water and groundwater supply sources.

sparkling water: carbonated drinking water.

specific heat: the number of calories needed to raise the temperature of one gram of a given substance 1°C relative to the number of calories (one calorie) needed to raise the temperature of 1 gram of water 1°C.

spring: a surface flow of water originating from subsurface sources (groundwater); often a source of a stream or pond.

stagnation: inactivity or without change.

strait: a narrow passage of water that connects two larger bodies of water.

stream gauging: the measurement of velocity of streams (stream velocity).

stream velocity: the volume of water in a stream flowing past a certain point per unit time, typically measured in cubic feet per second (cfs).

streamside management zone (SMZ): area left along streams to protect them from sediment and other pollutants, protect streambeds, and provide shade and woody debris for aquatic organisms.

succession (lake): gradual, orderly process of changes in a lake ecosystem brought about by changes in species types and populations; occurs over long periods of (geologic) time and ultimately results in the lake reverting back to land (a terrestrial ecosystem).

suction: a force causing a fluid or solid to be drawn into interior space or to adhere to a surface due to the difference between external and internal pressures.

sulfuric acid: (chemical formula, H_2SO_4) the most widely used industrial chemical; a major component of acid rain that is formed by sulfur oxides combining with atmospheric moisture.

surface water: precipitation that does not soak into the ground or return to the atmosphere by evaporation or transpiration. It is stored in streams, lakes, rivers, ponds, wetlands, oceans and reservoirs.

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suspended solids: small particles of solid materials in water that cause cloudiness or turbidity.

suspension: a mixture whose particles are temporarily dispersed through a fluid but not dissolved in it.

swamp: wetland dominated by shrubs and trees.

synergistic: more than one agent working together to produce enhanced combined effects (i.e., a greater total effect than the sum of the individual effects).

tectonic estuary: type of estuary formed when the Earth's crust shifts suddenly as in an earthquake, volcanic eruption or a tsunami; has no definite shape.

temperature zones: regions characterized by different temperature characteristics.

tertiary treatment: any level of treatment beyond secondary treatment, which could include filtration, nutrient removal (removal of nitrogen and phosphorus) and removal of toxic chemicals or metals; also called "advanced treatment" when nutrient removal is included.

thermocline: one of the three temperature or thermal zones located between the upper and lower thermally stratified zones of a lake; also called the metalimnion. The thermocline is a thin boundary layer between two layers of distinctly different temperatures. The thermocline is a place characterized by dramatic vertical temperature change.

thixotropy: the property of certain gels and emulsions to become fluid when agitated and then settle again when left at rest.

tidal creeks: meandering, creek-like channels within salt marshes and mud flats through which seawater enters and leaves as the tide rises and falls.

tidal flats: flat-topped banks of sand and silt that comprise the most elevated portion of the salt marsh.

tide: the alternate rise and fall of the surface of oceans, seas, and the bays, rivers, etc. connected with them, caused by the attraction of the moon and sun. The tide occurs once or twice in each period of 24 hours and 50 minutes.

time-of-travel: the time required for groundwater to move from a specific point beneath the surface to a well.

tolerance: the natural or developed ability to endure or resist the harmful effects of a substance.

toluene: a colorless, liquid, flammable, poisonous hydrocarbon, C_7H_8, obtained originally from balsam of Tolu but now generally from coal tar or petroleum; used in making dyes, explosives, and as a solvent; structurally consisting of a methyl radical attached to a benzene ring.

total suspended solids (TSS): a laboratory measurement of the quantity of solids present in wastewater that is one of the main indicators of the quantity of pollutants present; amount of solids in suspension in water or wastewater.

toxic chemical: a chemical with the potential of causing death or damage to humans, animals, plants or protists; poison.

toxic: harmful to living organisms.

transpiration: process in which water absorbed by the root systems of plants moves up through the plants, passes through pores (stomata) in their leaves or other parts, and then evaporates into the atmosphere as water vapor; the passage of water vapor from a living body through a membrane or pores.

treatment technique: drinking water treatment requirement in lieu of a maximum contaminant level (MCL); typically used when establishing an MCL is too difficult or when compliance with an MCL would be too costly; drinking water standard.

tributary: a stream that flows into a larger stream, river or another water body.

trickling filter process: a biological treatment process that uses coarse media (usually rock or plastic) contained in a tank that serves as a surface on which microbiological growth occurs. Wastewater trickles over the media and the microorganisms remove the pollutants (BOD and TSS). Trickling filters are followed by settling tanks to remove microorganisms that wash off or pass through the trickling filter media.

TSS (Total Suspended Solids): a laboratory measurement of the quantity of wastewater that is one of the main indicators of the quantity of pollutants present.

turbidity: the cloudy or muddy appearance of a naturally clear liquid caused by the suspension of particulate matter

typhoid fever: acute, highly infectious disease caused by *Salmonella* typhosa bacteria that can be transmitted by contaminated food or water.

unconfined aquifer: an aquifer containing unpressurized groundwater, having an impermeable layer below but not above it.

underground injection well: a type of well used for wastewater disposal, aquifer recharge, and solution mining of minerals.

underground storage tank (UST): any tank, including underground piping connected to the tank, that has at least 10 % of its volume underground and contains petroleum products or hazardous substances (except heating oil tanks and some motor fuel tanks used for farming or residential purposes).

universal solvent: water; a material that can dissolve almost any other substance.

unsaturated zone: a portion of the soil profile that contains both water and air; the zone between the land surface and the water table. The soil formations do not yield usable amounts of free-flowing water. It is also called zone of aeration and vadose zone.

vadose zone: the zone of aeration between the Earth's surface and the water table; area of the soil that contains both air and water; same as unsaturated zone--zones between land surface and the water table.

vapor: a substance in gaseous form.

variable wastewater: wastewater that comes from different sources (regular sewage, storm water or industrial wastewater) .

viscosity: the state or quality of having a cohesive and sticky fluid consistency; a measure of resistance to flow upon applying a force.

water analysis: series of tests to determine various chemical or physical characteristics of a sample of water.

water bar: a long mound of dirt constructed across the slope to prevent soil erosion and water pollution by diverting drainage from a road or skid trail into a filter strip.

Water borne diseases: diseases spread by contaminated water.

waterfall: a cascade of water, as over a dam.

Water logging: condition that occurs when the water table rises too near the surface causing plant to die as a result of water filling air spaces in the soil.

water quality: the condition of water with respect to its content of contaminants, natural or anthropogenic.

water quality criteria: levels of water quality needed to support a designated use for a body of water, usually expressed as concentration values for specific chemicals.

water rights: rights, sometimes limited, to use water from a stream, canal, etc., for general or specific purposes, such as irrigation.

watershed: land area from which water drains to a particular surface water body.

waters of the state: includes every natural or artificial watercourse, stream, river, wetland, pond, lake, coastal, ground or surface water wholly or partially in the state that is not entirely confined and retained on the property of a single landowner.

water table: upper surface of the zone of saturation of groundwater.

Water table aquifer: an unconfined aquifer.

water treatment: a method of cleaning water for a specific purpose such as drinking.

water vapor: water in a gaseous (vapor) form and diffused as in the atmosphere.

wave: a ridge or swell moving along the surface of a fluid or body of water as a result of disturbance, as by wind.

well: a bored, drilled or driven shaft or dug hole. Wells range from a few feet to more than 6 miles in depth, but most water wells are between 100 and 2,000 feet in depth.

Well head: the physical structure or device at the land surface from or through which groundwater flows or is pumped.

Well-head Protection Area: the surface and subsurface area surrounding a public water supply well through which contaminants are reasonably likely to move toward and reach such well.

Well head Protection Program (WHPP): a groundwater-based source water protection program

wetland: areas that periodically have waterlogged soils or are covered with a shallow layer of water resulting in reduced soil conditions. Wetland areas typically support plant life that are adapted to life in wet environments.

zone of influence: area surrounding a pumping well within which the potentiometric surface has been changed due to groundwater withdrawal.

zone of saturation: that region below the surface in which all voids are filled with liquid.

zoning: to divide into areas determined by specific restrictions; any section or district in a city restricted by law for a particular use.

Attachment 1

HOME WATER USE SURVEY

This survey will tell you about how much water your family uses daily. Your family may need to help with some of the answers. If you have water saving appliances or toilets, your water use may be less than some amounts on the chart. Answer all the questions that apply to you, click on the button labeled Compute Totals, and then scroll down for your usage.

Make Every Drop Count!

Question	Answer	Unit	Calculation	Per Day		Per Month
How many showers a day does you family take?	______	(No.)				
How long is each one?	______	(Min.)	Multiply (No.) x (Min) x 5		X30days	
How many baths does your family take?	______		Multiply x 36		X30days	
How many times does your family usually flush the toilet?	______		Multiply x 6		X30days	
How many family members do you have?	______	(No.)				
How many times a day does each one brush their teeth?	______	(Min.)	Multiply (No.) x (Min) x 3		X30days	
How many times a day does your family wash dishes?	______	(No.)				
How long does the water run?	______	(Min.)	Multiply (No.) x (Min) x 3		X30days	
How many times does your family use the dishwasher?	______		Multiply x 30		X30days	
How many loads of laundry does your family do each week?	______		Multiply x 48		X30days	
How many times do you water the lawn?	______	(No.)				
For how long?	______	(Min.)	Multiply (No.) x (Min) x 10		X30days	
How many times a week do you wash car/boat/driveway?	______	(No.)				
For how long?	______	(Min.)	Multiply (No.) x (Min) x 10		X30days	
How much water, other than the uses above, would you say you use a day?	______ (Gallons)					
				Total Per Day		Total Per Month

There is an automatic calculator at http://www.florida-water.com

Water conservation saves water, energy and money

The average Floridian uses 175 gallons of water each day -- about 65 more gallons per day than the average American.

What do you do with your 65 additional gallons? Do you drink more, do more laundry, wash your car more, water your lawn more? The answer is likely "all of the above" plus a myriad of other reasons related to our warm climate. Here's the irony: Survey shows that 80 percent of our customers believe water conservation is critical, yet they continue to use nearly three gallons of water per hour more than the average American.

For several years, Florida's rainfall has been below normal. Lack of rain has caused record low levels in out underground drinking water supply. The average adult needs only 2.5 quarts of water a day to maintain health, but each person in Florida uses about 120 to 150 gallons of water a day. And, with thousands of people moving to our state each month, future demand on fresh water supplies will continue to increase. That's why it's important to use water wisely (whether there's a drought or not) in our homes, schools and businesses. By conserving water today, we can do our part to keep water pure and plentiful for future generations. By following a few simple steps, a typical family can save 50,000 to 100,000 gallons of water each year.

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You can score **big** by following this water-saving game plan:

- **Stuff It.** In the wastebasket, that is. Toss tissues, insects or anything else you want to get rid of in the trash, not in the toilet. (each time you flush, that's 5-7 gallons down the drain.)
- **Limit your dribbling.** Check for leaks or drips in faucets and toilets. Don't leave the water running while you brush your teeth or wash the dishes. When washing the car, watering your lawn, or even bathing your dog, use a hose with a nozzle that automatically shuts off.
- **Make a clean sweep.** Use a broom, not a hose, to clean your driveway or sidewalk.
- **Be a team player.** When helping with chores around the house, remember to water lawns and gardens during cool times of the day -- early morning or evening. When doing dishes or washing clothes, use only full loads in automatic machines. Use one dishpan for washing and one for rinsing when doing dishes by hand.
- **Blow the whistle**...on water wasters. Remind your friends and family to conserve.
- **Take water breaks,** but don't let the tap water run to get cool. Instead, keep a bottle of drinking water in the refrigerator.
- **Don't linger in the locker room.** Take shorter showers or fill you bathtub only partly full.
- **Play by the rules.** Abide by any watering rules or restrictions that may be in effect in your community.
- **Upgrade your house.** Retrofit toilets with low-flow water saving devices, which can save you 150 or more gallons a month. Replacing shower heads with low-flow alternatives and combined with shorter showers can save you up to 2,600 gallons a month.
- **Fill it Up.** Maximize appliance efficiency by making sure that dishwashers and washing machines are fully loaded. This can save you 15-55 gallons per load.

Lawn watering accounts for a whopping 50% of all home water use!

Keeping your lawn irrigation in proper working order is a vital part of water conservation. When irrigation systems malfunction or develop leaks, it both wastes water and costs money. Below are some examples of common irrigation solutions...

- Watch your watering time. After a half-hour of lawn watering with the average sprinkler system, lawns become saturated and further watering only becomes wasteful runoff. It's also best to water before 9 a.m. or after 6 p.m. Otherwise, as much as 30 percent of the water is lost to evaporation by the midday sun.
- Evaluate your irrigation system. Outdoor irrigation can account for more than 50 percent of a home's total water consumption. Drip irrigation that uses a network of pipes and hoses to provided a slow trickle of water to landscape root systems works best. Moisture sensing devices that shut off automatic sprinkler systems prevents over-watering.
- Rake, sweep or blow driveways and sidewalks instead of hosing away debris. You will save up to 50-60 gallons of water.
- Build dykes around trees and shrubs to hold water.
- Xeriscape your yard by using drought and salt tolerant plants which are native to Florida.

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Attachment 2

Potential Sources of Groundwater Pollution

1. Truck terminals and service stations
2. Petroleum pipelines, stores and tank farms
3. Auto repair, body shop and auto supplies
4. Rust proofers
5. Pesticide, herbicide wholesalers
6. Dry cleaners
7. Painters, finishers, furniture strippers
8. Printers, photo processors
9. Auto washes, laundromats
10. Beauty salons
11. Medical, dental and vet offices
12. Food processors, meat packers and slaughter houses
13. Concrete, asphalt, tar and coal companies
14. On-site sewage disposal
15. Railroad yards, industrial sites
16. Storm water impoundment
17. Cemeteries
18. Airport maintenance, fueling
19. Machine shops
20. Metal platers
21. Heat treaters, smelters, annealers, descalers
22. Wood preservers
23. Chemical reclamation
24. Industrial waste disposal
25. Municipal and private waste retailers
26. Wastewater treatment plants, lagoons
27. Landfills, dumps and transfer stations
28. Junk, salvage yards, recycle centers
29. Subdivisions, individual residences
30. Heating oil storage (consumptive use)
31. Golf courses, parks, nurseries
32. Sand gravel and other mining
33. Abandoned wells, existing wells and sinkholes
34. Feed lots, manure piles
35. Agricultural chemical storage, handling, spreading, spraying

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36. Construction sites
37. Transportation corridors
38. Fertilized fields, agricultural areas

Attachment 3

Common Groundwater Pollutants

1. Antifreeze (for gasoline coolant systems)
2. Automatic transmission fluid
3. Engine and radiator flushes
4. Hydraulic fluid (including brake fluid)
5. Motor oils/waste fuels/grease lubricants
6. Gasoline, jet fuel
7. Diesel fuel, kerosene, #2 heating oil
8. Degreasers for driveways and garages
9. Battery acid (electrolyte)
10. Rust proofers
11. Car wash detergents, waxes and polishes
12. Asphalt and roofing tar
13. Paints, lacquer thinners and rust cleaners
14. Floor and furniture strippers
15. Metal polishes
16. Laundry soil and satin removers (including bleach)
17. Spot removers, cleaning solvents
18. Disinfectants
19. Household cleaners (oven, drain, toilet)
20. Cesspool cleaners
21. Road salt (Halite)
22. Refrigerants
23. Pesticides (insecticides, herbicides, rodenticides)
24. Photochemicals/printing ink
25. Wood preservative (creosote)
26. Swimming pool chlorine or bromine compounds
27. Lye or caustic soda
28. Jewelry cleaners
29. Leather dyes
30. Fertilizers (if stored outdoors)
31. Polychlorinated biphenyls (PCB's)
32. Other chlorinated hydrocarbons, including carbon tetrachloride
33. Any other product with "poison" labels
34. Other products not listed that you would not want to drink

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Attachment 4

Drought Resistant Plants Suitable for Dry, Sandy Florida Soils

Trees
Pindo Palm
Crape Myrtle
European Fan Palm
Jerusalem Thorn
Chinese Fan Palm
Japanese Yew
Cabbage Palm
Live Oak
Mexican Washington Palm

Shrubs:
Century Plants
Aloe
Japanese Boxwood
Pampas Grass
Pineapple Guava
Yaupon
Primrose Jasmine
Shore Juniper
Wax Privet
Heavenly Bamboo (Nandina)
Pittosporum
Firethorn
Boxthorn
Spanish Bayonet
Spanish Dagger
Bear Grass

Groundcovers, Grass, Flowers
Coral honeysuckle
Weeping lantana
Spreading cultivars (Gold Rush)
Creeping lilyturf
Small-leaf confederate jasmine
Wedelia
Junipers
Carolina yellow jasmine
Algerian ivy
English ivy
Purple queen
Asparagus fern
Gopher apple
Zamia or Coontie
Bear grass or Adam's needle
Powderpuffs
Baby's bath brush
Saw palmetto
Needle palm
Bigleaf periwinkle
Coral vine
Four-O'clocks
Boston fern
Greenbrier
Partridgeberry
Coral Vines
Trumper Creeper
Carolina Yellow Jasmine
Argentine Bahia Grass
Banksia Rose
Fortune's Rose
St. Augustine Grass
Asian Jasmine

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