2010 MADISON COUNTY DRINKING WATER FESTIVAL

“GO GREEN! Keep Our Water Clean”

Madison County Drinking Water Festival
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The following resources are available by fax or mail:

**Please contact Anne Burkett at 532-3505 if you are interested in obtaining a copy.*

TEACHER'S PACKET

MADISON COUNTY DRINKING WATER FESTIVAL

WELCOME TO THE FESTIVAL!

OUR MISSION is to educate students and their families about how groundwater and surface water, as well as other associated natural resources (i.e. wetlands, forestry, wildlife, etc.) relate to drinking water and to instill in them a general environmental awareness and stewardship ethic.

In this packet you will find information and activities to prepare you and your class for the Drinking Water Festival. It includes terms and definitions, maps, classroom activities, games, a list of songs about water, quotes, a bibliography and resources list. Student objectives for this unit of study are:

- Evaluate evidence supporting a conclusion
- Interpret a diagram of earth events
- Use mathematics to interpret a chart
- Utilize techniques essential to scientific investigation
- Relate events to aspects of the water cycle
- Recognize the relationship between science and society

A complete unit outline is provided at the end of the introduction. Please refer to the bibliography and resources list for additional activity information or contact:

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The 2010 Festival is made possible by financial support provided by Huntsville Utilities, Madison County Water Department, Water and Wastewater Board of the City of Madison, the Harvest-Monrovia Water Authority, Madison County Soil and Water Conversation Distrct, the University of Alabama in Huntsville and area businesses and civic organizations.

2010 Festival Committee

Huntsville Utilities

Madison County Water Department

Water and Wastewater Board of the City of Madison

Harvest-Monrovia Water Authority

University of Alabama in Huntsville

Alabama Department of Environmental Management

Madison County Commission Department of Planning& Economic Development

Madison County Farmers Federation

Madison County Soil & Water Conservation District

Top of Alabama Regional Council of Governments

Alabama Mountains Rivers and Valley Resource Conservation & Development Council

U.S. Army Garrison-Redstone

The City of Huntsville
Operation Green Team

UNIT OUTLINE

When introducing your class to water resources, you may want to use this outline. Many of the sources in the back of this packet can provide you with more information. Water terms on the next page may be copied and distributed to your students or used just for your own information.

I. The Nature of Water

- A. Hydrological Cycle
    1. Amounts of water
    2. Forms (fresh, salt, frozen)
- B. Water Makeup
    1. Solid, liquid, gas
    2. Universal solvent
- C. Groundwater
- D. Surface Water

II. Water Uses

- A. Home
- B. Agricultural, Industrial
    1. Irrigation
    2. Transportation
    3. Manufacturing
- C. Recreational
- D. Uses in the environment
    1. Plants
    2. Animals

III. Water Issues

- A. Quantity
    1. Drought
    2. Flooding
    3. Interstate water transfers
    4. Dam Building
- B. Quality
    1. Contamination/Pollution
    2. Agricultural Uses
        - a. Sediment, erosion
        - b. Irrigation
        - c. Chemigation
    3. Hazardous Wastes
        - a. Landfills
        - b. Radioactive dump sites

4. Environmental disasters
    a. Oil spills
    b. Medical wastes
    c. Ocean dumping sites
    d. Preservation of whales, dolphins
    e. Disappearance of wetlands

IV. *Water Conservation*

A. In the home
B. At school
C. National and worldwide

WATER TERMS

Groundwater: Water located below ground level.

Surface water: Water found in rivers, streams, lakes, oceans.

Aquifer: Underground water is stored in dozens of reservoir-like layers. Most of the water in aquifers is contained in beds of sand, gravel or other materials and can be pumped to the surface.

Acre-foot: The acre-foot is the equivalent of 325,851 gallons and will cover an acre one foot deep.

Depletion: Water supplies that are being used up, gradually in most cases, without being replaced.

Recharge: This refers to putting water back into the ground, via rainfall or melting snow. Water from passing rivers and streams also percolates downward.

Mining: If you take more water out of the ground each year than you put in, it's mining. We are taking five to six million acre-feet of water a year from underground sources, while restoring only about one million acre-feet.

Water table: This refers to the position of the underground water or the depth to which you must drill to reach it. The water table may be a few feet down, or hundreds of feet. The depth depends in part on the amount of water that has been removed.

Impoundment: Water can be seized or impounded in storage areas known as reservoirs, behind dams. Impoundment prevents flooding and allows for irrigation, recreation and power generation.

Watershed: Imagine a maple leaf. The stalk in the leaf is a river such as the Tennessee. The veins threading into the stalk are the tributaries flowing into the river. The complete leaf represents a river drainage system or watershed.

Contamination: This is any physical, chemical, biological or radiological substance found in a water source. Contaminants can be naturally occurring, or human made.

Hydrologic cycle: The endless circulation of water between earth and the atmosphere, the cycle uses the same amount of water now as a million years ago.

Protection: These steps taken to protect current or future releases into the ground or groundwater.

Saturation: The region below the ground surface, which all pore spaces are filled with water. The upper surface of this zone is known as the water table.

DEFINITION

Groundwater: The Hidden Resource

Approximately half of the people living in the U.S. rely on groundwater for their drinking water. Groundwater is also one of the most important sources of irrigation water. Unfortunately some of the groundwater in every state has become tainted with pollutants. And some scientists fear that the percentage of contaminated groundwater may increase as toxic chemicals dumped on the ground during the past several decades slowly make their way into groundwater supplies.

So What Is Groundwater? Many people picture groundwater as underground rivers or lakes. It's actually water that fills the spaces between rocks and soil particles underground – in much the same way as water fills a sponge. Most groundwater is precipitation that has soaked into the ground. And groundwater sometimes feeds lakes, springs, and other surface water.

A Seeping Problem: Pollutants that contaminate groundwater seep into it through the ground. And the pollutants themselves are many of the same compounds that contaminate surface water. For example, pesticides and fertilizers often seep into groundwater supplies. Road salt, toxic substances from mining sites, and used motor oil may all end up in groundwater too. Untreated waste may leak into groundwater from faulty septic tanks. And toxic chemicals may leach out of landfills or leak from underground storage wells and seep into groundwater. Unlike tainted surface water, contaminated groundwater can be almost impossible to clean up.

The Health Impact: Contaminated groundwater can have serious health effects. For instance, people whose drinking water has become contaminated by septic tank waste may contract hepatitis, dysentery, or other diseases. People may also be poisoned by toxics that have seeped into their well water. And if they drink water contaminated with certain chemicals over a long enough period of time, they may develop liver and kidney problems, cancer, or other serious illnesses. Contaminated groundwater can also harm wildlife if it gets into surface water.

PROTECTION AND PREVENTION

Finding answers to our water pollution problems won't be easy. For one thing, in addition to the pollutants we've already mentioned, there are others getting into our water that we must deal with too, such as radioactive waste, heated industrial wastewater, and trash. There are also many stumbling blocks in the way. For example, cleanup of toxic waste dump sites that could be or are polluting groundwater is progressing slowly because of legal battles over responsibility and high cleanup costs. And many of the laws designed to protect our water resources are not being enforced. But because water is such a vital part of our lives, there's too much at stake not to deal with the problems.

New Technologies: One thing people are working on is the development of new methods of treating wastewater. For example, people-made wetlands and other systems that are often cheaper and cleaner than traditional treatment plants are being used in some communities to treat sewage. People are also trying to find new ways to remove toxics from water and from bottom sediments.

An Ounce of Prevention: Cleaning up polluted water can be extremely expensive. So keeping pollutants out of our water in the first place is the best way to ensure that we have clean water. Many individuals and industries around the country are taking steps to do just that. For example, some industries are reducing their production of toxic chemicals and developing ways to make their products without using toxic raw materials. And many people have switched to phosphate-free detergents and other less-polluting products. In addition, governments are passing tough water pollution control measures designed to prevent water pollution.

DRINKING WATER IN MADISON COUNTY

Background

Water is an important resource in the development of Madison County. Big Spring attracted early settlers In 1823 it became the first public water supply in the South, and second in the Nation. It also supplied water for the Indian Creek Canal, which provided water transportation to the Tennessee River.

Big Spring was Huntsville's primary water source until the 1950's. Rapid population growth and the missile and aerospace industry resulted in an increased demand for water. The demand was met by developing new wells and utilizing the Tennessee River. Several water and fire protection authorities were formed in rural areas of Madison County. They obtained their water supply from wells.

Rural Madison County's Water Supply

Groundwater is the primary water source for customers of the Madison County Water Department. However, Madison County does purchase some water from Huntsville Utilities: the South Parkway Water Treatment Plant, a surface water source drawing water from the Tennessee River, and the Lincoln/Dallas Water Treatment Plant, a groundwater source, pumping water out of the Tuscumbia/Ft. Payne Aquifer.

Madison County's 3 public wells, Hazel Green Well, Bo Howard Well and Cress Well, are supplied by groundwater from the Tuscumbia-Ft. Payne Aquifer. The Mountain Fork Water Treatment Facility, which went on-line in 2002, treats the water from the Cress Well. The Madison County Water System has the capacity to produce 13 million gallons of water per day, serving in excess of 27,000 customers over a 400 square mile area. The Madison County Water Department has a 16 million gallon storage capacity. This makes it one of the largest rural water systems in Alabama.

As our population grows, so does the demand on this aquifer. In fact, the U.S. Geological Survey has identified this region as one of the most susceptible to pollution from surface sources, such as nitrates and pesticides from farming, industrial wastes, and runoff from urbanized areas.

There are over 2,000 springs and private wells in Madison County. Generally, wells are not located in highland areas of the county; however, there are a few small yield wells in Madison County. Wells with the highest yield are located in the flatter topographic areas of the county. Important factors in high groundwater yield are 1) extensive open underground cavities, 2) a thick soil layer, and 3) shallow water levels. North Alabama has a karst geologic structure, this means that there are many open cavities under the surface. The southwestern quadrant of the county best meets these criteria, and does indeed have the highest number of wells and wells with the highest yields.

Please see the Madison County Water Department's Annual Drinking Water Report for more information.

Huntsville's Water Supply

Huntsville's first water treatment plant went on-line in 1964, providing 8 million gallons of water per day from the Tennessee River. Until that time, all of Huntsville's water came from wells. The plant currently provides 30 million gallons per day. A second water treatment plant was added in 1988 and provides up to 48 million gallons per day. The current water supply system is made up of five wells and two surface water treatment plants.

The Dallas and Lincoln Wells each delivers 4.5 million gallons per day to the N.E. area of the city. They once belonged to the Dallas and Lincoln Mills. In the 1950's, they became part of the city's public water supply. At that time the city stopped drawing water from the Big Spring in downtown Huntsville. The aquifer supplying the Dallas and Lincoln Wells is the same aquifer that supplies the Big Spring. In 1992, Huntsville Utilities began treating the water from Dallas and Lincoln wells at the James S. Wall Sr. Treatment Plant.

The Lowe Mill Well provides 1.3 million gallons of water per day. Its water is blended with surface water from the Water Treatment Plants.

The Williams well provides 4 million gallons per day to the industrial area surrounding the Jetport and to west Huntsville. Its water is also blended with surface water from the Southwest Water Treatment Plant. In addition, the Hampton Cove well is capable of providing 1.3 million gallons per day to the Hampton Cove, Cove Creek and Dug Hill Road areas. Please see Huntsville Utilities Water Quality Report, included in this packet, for more information.

Harvest-Monrovia Water Authority

Harvest-Monrovia Water, Sewer and Fire Protection Authority serves 36,000 people in the Harvest and Monrovia Communities of Madison County. The Authority can produce 10 million gallons of water per day from and has storage capacity of 11.5 million gallons. A new Membrane Water Treatment Plant was opened in the Spring of 2008 with the ability to produce 1 million gallons of water per day.

Sewer service was started in the area in 2005. One new Sewer plant is operating with another under construction that will be operating in the the summer of 2008. Several sand filter systems are operating in the system within subdivisions.

The Authority is in the middle of $25 million dollars of construction for water and sewer services to the community. The latest technology is being used for water and sewer treatment with membrane plants being used for both treatment processes.

Water and Wastewater Board of the City of Madison

All of Madison's water supply comes from groundwater sources (wells) located in and around the outskirts of the City. The current system has nine wells, two treatment plants, and three storage tanks.

Dublin Well was the first water source in Madison, it opened in 1936 and produces 400,000 gallons per day. The Fiorentino Well, permitted in 1999, produces 1,600,000 gallons per day. The Drake Well, permitted in 1990, produces 5,000,000 gallons day. The New Gillespie Well, permitted in 1999, produces 1,400,000 gallons per day. Nickelson Well, permitted in 1999, produces 500,000 gallons per day. The McCrary Well, permitted in 2000, produces 250,000 gallons per day. Both the Williams and Hardiman Wells were permitted in 2001 and produce 430,000 and 150,000 gallons per day respectively.

The Kurt Keene Water Treatment Plant opened in 1999 and is currently permitted at 4 million gallons per day (MGD). It is scheduled to be upgraded to 8 MGD. The Quarry Site #2 Water Treatment Plant opened in 2005 produces 7 MGD.

The water system has 12 million gallons of water in three storage tanks. The Stoneway Tank holds 5 million gallons, Quinn Tank holds 5 million gallons, and the Rainbow Tank holds 2 million gallons.

For further information, please see the Annual Drinking Water Quality Report of the Water and Wastewater Board of the City of Madison.

Student Activities

Alabama Cave Shrimp Project

Paleamonias alabamae

- This crustacean is a Federally listed endangered species and only occurs in Madison County. It is very sensitive to changes in water quality, and has been extirpated in one cave system in the city of Huntsville (that we know of).

- To draw attention to water quality issues, the adoption of the Alabama Cave Shrimp as the county endangered species would be one of the goals, with the overall goal to improve water quality in the county. The cave shrimp could be the "Water Canary" of Madison County.

- The protection of the watersheds in the county and particularly those that feed the cave systems now supporting cave shrimp would naturally protect thousands of other species that are water-dependent, including ***us!***

- How to do this? Get students in all grade levels interested in Project-Based Learning by using science in the field to determine problems and then devising and implementing restoration programs to alleviate the problems.

- Resource specialists in TVA, AMRVRC&D, the Flint River Conservation Association, NRCS, and the Alabama Forestry Commission, would serve as advisors for restoration projects. This partnership would include the County Commission, landowners, farmers, and many, many other stakeholders all working together toward a common goal—water source protection.

What are some projects students could get involved in?

1. Write to county commission about various things you see going on in the watershed involving non-point source pollution. Take pictures, document location and date. The county can't always take action, but sometimes the Alabama Department of Environmental Management (ADEM) office in Decatur can.
2. Disseminate ***Tackling Nonpoint Source Pollution in Madison County*** brochures to folks in and around the county.
3. Tell other classes about the cave shrimp, including other schools in the county. Lets get enough support to eventually have the Cave Shrimp designated as our "Madison County Endangered Species".
4. Get involved with river groups like the Flint River Conservation Association to learn of restoration projects that you can get involved in.

For more information on getting your class involved, contact: Susan Webber, Director, Hays Nature Preserve: 427-5116.

Or susan.weber@hsvcity.com

ECOLOGY OF THE ENDANGERED
Alabama Cave Shrimp (Palaemonias alabamae)

Description: This species is colorless and nearly transparent with a length of up to 30 mm (1 inch). It differs from most shrimp because of the first and second legs, its spiny shell, and unfaceted and unpigmented eyes. It closely resembles the endangered Kentucky Cave Shrimp ***Palaemonias ganteri,*** but it is smaller in size, has a shorter snout, usually lacks abdominal scales, and has fewer scales on its back.

Distribution: The Alabama cave shrimp was officially listed as endangered by the U.S. Fish and Wildlife Service in 1988 because of its limited range and low numbers. It was known to occur from only 5 caves (three cave systems) in Madison County, Alabama. It is still found in Bobcat Cave on Redstone Arsenal, and in Hering, Brazelton, and Glover (one cave system). It has been eliminated from Shelta Cave (one cave system), most probably due to groundwater pollution from adjacent suburban development.

Population density of the species is unknown but no more than 80 shrimp have been observed in the summer of 1998. The species travels up and down with the water table in caves, so can disappear into caverns and holes that cannot be accessed by biologists.

Habitat: Silt bottom pools in caves provide an environment for the cave shrimp. The caves these shrimp inhabit are in Mississippian age rocks (325-360 my). All of the caves contain water, but the levels fluctuate dramatically as the seasons change. During the spring and winter months, heavy precipitation causes high water levels. In the summer and fall, water flows can drop by as much as 15 feet. During these periods, flows are fed by ground water of unknown origin.

Biological Information: Cave shrimp graze non-selectively on detritus (organic matter) in shallow pools. Most cave species have low reproductive rates, including the Kentucky cave shrimp which is closely related to the Alabama cave shrimp. During the months of July through January, Alabama cave shrimp have been observed with ova (eggs) attached beneath them. Their eggs may mature and hatch during the winter. The larval development of this species is unknown. Female cave shrimp are slightly longer than the males.

Reasons for Current Status: Habitat degradation and groundwater contamination appear to be the major threats to the Alabama cave shrimp. Cadmium has been detected in Shelta Cave at 5 times the drinking water standard, introduced through municipal waste. Cadmium and several other toxins present a danger of bioaccumulation in the food web. The loss of a colony of gray bats in Shelta Cave may also have contributed to the decline of the cave shrimp. Bat guano provided food for many of the aquatic and non-aquatic species, and a gate across the entrance to Shelta Cave has prevented bats from reentering the cave for several decades. A new bat-friendly fence was installed in 2003. Disease and predation, although a normal part of life, may have increased mortality when combined with these other threats. The southern cavefish, the cave salamander, and the cave crayfish pose the greatest predation threats, but loss of habitat, either through cave destruction or groundwater pollution, are far greater threats to the Alabama Cave Shrimp, and indeed to their food as well as their predators.

Management and Protection: The National Speleological Society (NSS) owns Shelta Cave and Redstone Arsenal owns Bobcat Cave. These two caves are protected from access. Both caves are monitored for the aquatic species. The other caves are on private property and these are monitored infrequently. Recharge areas have been identified for all three cave systems, in order to identify threats and to take corrective action to protect the source water. A number of partnerships will be formed to help educate people about the importance of protecting the groundwater, by beginning with the surface and what happens there. Activities such as fertilizing the lawn, driving the car, changing oil, and spraying pesticides contribute to non-point source pollution, to which all citizens contribute.

For copies of ***Tackling Nonpoint Source Pollution in Madison County***, please call Susan Weber at Hays Nature Preserve, 427-5116.

Figure 1: The actucal size of a Cave Shrimp.

Little is known about the habitat requirements of the Alabama cave shrimp (USFWS, 1997). It is found in both high energy and low energy caves, but always in lower-energy sections of the caves that have silt bottom pools. The caves in Madison County are found in several different geologic strata. Shelta and Bobcat Caves were formed in the Warsaw Unit of the Tuscumbia Limestone of Mississippian Age. Glover, Hering and Brazelton Caves formed in the Monteagle Limestone of the Upper Mississippian Age. Solution caves, springs, and sinkholes are prominent karst features of Madison County. Karst is an extensive region of limestone characterized by sinks, caverns, underground streams, springs, and cracks or conduits in the bedrock. Ground waters in Tuscumbia and Monteagle limestones are interconnected within solution cracks and crevices in the bedrock. Precipitation in the form of rain and occasionally snowfall recharge the groundwater in this area by slow percolation. The Huntsville area gets the majority of precipitation during winter and spring months, which causes a rapid rise in groundwater levels.

Land use and associated non-point source pollution can have a significant affect on the quality of ground water in these systems and a direct affect on the habitat of the Alabama cave shrimp, a pollution intolerant species. Urbanization of the lands surrounding Shelta and Bobcat Caves and suburban expansion around Glover, Hering and Brazelton Caves, pose threats of contamination to the aquifers from several sources: 1) sewage leakage 2) industrial contaminants, 3) road and highway runoff, 4) toxic spills, 5) runoff from residential sites, and 6) siltation (USFWS 1997).

Cave environments are relatively simple ecosystems characterized by moderate, stable temperatures and lack of visible light (Cooper 1975). Because of a lack of light the only autotrophs present are chemosynthetic, and the resident aquatic fauna are dependent on allochthonous material, or in this case carbon detritus washing in from outside the cave as the basis of the food chain. The author observed shrimp scraping bacteria or other protists from hickory nuts washed in from the outside. Cooper (1975) observed Alabama cave shrimp ingesting silt and other bottom debris in shallow pools of Shelta Cave. Observations of the Kentucky cave shrimp demonstrated that they graze on a complex assemblage of bacteria, protozoans, and minute crustaceans that feed on detritis particles.

A population of gray bats (***Myotis grisescens***) which inhabited Shelta Cave until the early 1970's may have been providing the main energy input to the aquatic system in the form of guano (Hobbs and Bagley 1989). The colony of bats abandoned the use of the cave after it was gated, and has never returned in spite of modification to the gate to allow passage of bats. The lack of organic input from the bats may have caused the decline of associated species in the food chain. Although no bat colonies have been seen in Brazelton, Hering, Glover or Bobcat Caves, individuals of non-colonial species of bats have been seen in all those caves. The carbon basis of the food chain in these systems is more likely from leaf litter.

Predation of cave shrimp may have an impact on cave shrimp populations. Cooper (1975) observed a southern cavefish ***Typhlichthys subterraneus***, regurgitate a cave shrimp in Shelta Cave. In Bobcat, Brazelton, Hering and Glover Caves, other potential predators observed were several cave salamanders, southern cavefish, troglobitic crayfish, bullfrogs, and raccoons (Bagley 1986, in litt. Rheams et al. 1992, McGregor et al. 1994). In the fall, as water recedes to lower levels, organisms that may be trapped in pools are preyed upon by raccoons, as observed in the fall of 1998. Predation is a natural aspect of population dynamics, and the few shrimp trapped in pools would succumb to some level of the food chain as they succumb to desiccation.

One other threat to Alabama cave shrimp could be through collection or through disturbance of the habitat in general by humans. Since cave species are known to have a very low reproductive potential due to limited food resources, any kind of human disturbance in cave shrimp habitat could affect the ability of the species to survive and reproduce. Batteries disposed of in the caves and trash thrown into a sinkhole leading into Glover Cave are two sources of possible contamination of cave shrimp habitat.

Reasons for Listing

The Alabama cave shrimp was listed because of the apparent extirpation of one of only two known populations (at the time of listing) and the vulnerability of the surviving population to ground water contamination. Factors which are most likely to limit or cause the decline of the Alabama cave shrimp include: 1) destruction of habitat (through gating of caves, groundwater pollution, etc.), 2) collecting, and 3) predation. A search for other cave habitat in Madison County revealed no other caves with Alabama cave shrimp (Rheams et al. 1992). The low reproductive rate of the shrimp, in combination with these threats warranted the listing of the shrimp as endangered in 1988.

The primary threat to the cave shrimp metapopulation is habitat destruction (USFWS 1997). This is probably true of the population on Redstone Arsenal, since pollution of groundwater recharge areas is difficult to control. Sanctioned or unsanctioned visits by humans to Bobcat Cave which disrupt the silt pools or cause degradation of waters would also fall under habitat destruction or modification. Lastly, natural predation could be a factor in Bobcat cave because of the ease of access by wild animals to small shrimp-inhabited pools.

Conservation Measures

According to the recovery plan for the Alabama cave shrimp, protection of the species is dependent on proper stewardship of surface land and waters, particularly in existing cave shrimp watersheds. The habitat for the Alabama cave shrimp in Bobcat Cave includes the Bobcat Cave watershed. The delineation of the watershed is based on observations made by Dr. Warren Campell during heavy rains of January 7-8, 1998, and on the series of dye traces (Campbell pers. comm. 1998). A broad shallow sinkhole captures runoff on the south end of the hill of outcropping limestone where Bobcat and Cottrell's Caves, which are hydrologically connected, are located. The water then disappears down a swallet into Cottrell's cave. This rapid flow into the cave system does not allow for soil filtration of pollutants that might be present. Therefore, it is imperative to protect the surface watershed, which is approximately 160 acres (Campbell 1998, unpublished report).

Land use practices are intimately tied to water quality within cave recharge areas. To better understand the size of the watersheds, including those for groundwater, the Geologic Survey of Alabama and the U.S. Fish and Wildlife Service have conducted hydrologic studies of Shelta, Matthews, and Bobcat Cave aquifers (McGregor et al. 1994). The Geological Survey of Alabama and the USFWS have also searched and inventoried other caves in Madison County to locate other populations of cave shrimp. In cooperation with the Army, the University of Alabama in Huntsville has done hydrological studies on Keel Mountain (for Hering, Glover and Brazelton Cave connections), completed hydrologic modeling for Bobcat Cave, and has developed a pollution model for the cave (Campbell et al. 1995, Campbell 1997). In addition, the Geological Survey of Alabama in cooperation with the Army has done a water quality and risk assessment study for the Bobcat Cave watershed (McGregor et al. 1997, 1999).

Conservation Goals

The primary goal is to protect extant populations of the Alabama cave shrimp. Because of the cryptic nature of karst habitats and their vulnerability to contamination by surface activities, protection of the Alabama cave shrimp is dependent on good stewardship of lands within the watershed. Recharge area management plans for each watershed need to be developed with review and input by all potential partners within the recharge area. The partners involved in the Bobcat Cave watershed should include the Cities of Madison and Huntsville (for lands west of the Arsenal boundary), the USFWS, Alabama Department of Conservation and Natural Resources, and the Directorate of Environmental Management and Planning on Redstone. The USFWS recommends the development and implementation of a Bobcat Cave management plan similar to one done for Shelta Cave (Hobbs and Bagley 1989). Studies on water quality, recharge area, and pollution modeling will serve as the basis for writing a management plan.

Redstone Arsenal will continue monthly monitoring of water quality. Following a fluctuation of the shallow water table within the cave, the shrimp move to lower levels during the dry season (usually fall), and upper pools in the caves during the winter, spring, and summer. Because of the use of "windows" to move from one level to another (McGregor 1994), and the fact that the extent of the system below groundwater level is unknown, it is impossible to get an accurate count of the shrimp population in Bobcat Cave. The numbers vary from month to month and from year to year, not necessarily because the population is fluctuating, but because their subterranean existence takes them out of reach and site of investigators. At this time, the extent of the flooded cavern system associated with Bobcat Cave, and the extent of the shrimp population or how far the population occupies is unknown in both systems in which it exists. Due to the importance of groundwater quality to cave shrimp survival, it is more important to monitor the water quality than it is to account for a cryptic population of shrimp. This in conjunction with tracer dye studies demonstrate where sources of contamination could be traced and mitigated.

WATER, WATER EVERYWHERE!

OBJECTIVES

The student will do the following:

1. Illustrate the quantity and distribution of water on the earth.

2. Recognize the amounts of water used in daily activities such as bathing.

3. Compare the amounts of water used by different groups such as farming and manufacturing.

SUBJECTS:
Geography, Social Studies, Language Arts, Science

TIME:
50 minutes

MATERIALS:
large sheets of paper (construction, newsprint, or posterboard)
art supplies
index cards (optional)
paste or glue stick
globe or map of the world
hole punch
ring binders or yarn
teacher sheet (included)
gallon jug of water (optional)

BACKGROUND INFORMATION

Water is one of our most important resources. We use water to produce food, provide energy, and manufacture and transport goods. Water is also essential for the life of every organism on our planet.

Because water covers three-quarters of the earth's surface, it is easy to think of it as an endless resource. Of all water, more than 97 percent is found in the oceans as salt water. Of the remaining 3 percent that is fresh water, two-thirds is frozen in ice caps, glaciers, and on snowy mountain ranges. Only about one-half of one percent of all the water on the earth is usable fresh water. Of this amount, experts estimate that there is 30 to 50 times more water found in aquifers (underground), than in all the lakes, rivers, and streams on the surface. Most of the water we use (78 percent), however, comes from these surface waters.

We use fresh water for a variety of purposes. About 11 percent is used in urban and rural homes, offices, and hotels. Another 8 percent is used in manufacturing goods and mining. The production of electricity accounts for almost 39 percent of water usage, although using water to cool power plants and to turn turbines in hydroelectric power plants does not consume the water. The largest consumer of water is agriculture, which uses about 42 percent.

As individuals, we use large amounts of water. An average American uses around 150 gallons (over 570 L) a day. We are even composed of water; our bodies are about 75 percent water.

ADVANCE PREPARATION

A. Gather enough large sheets of paper and art supplies for students in teams of 2 or 3.

B. Copy teacher sheet "Water Fact Cards" and cut into individual cards. (NOTE: These would be more durable if pasted to 3 x 5 inch [7.5 x 12.5 cm] index cards or construction paper.)

PROCEDURE

I. Setting the stage

   A. Show the class a globe or map of the world.

      1. Ask students which there is more of: water or land? (water)

      2. Explain that water covers more than three-fourths of the earth's surface.

   B. Instruct the students to think of as many different uses of water as possible in three minutes.

      1. Briefly review their answers, noting unique responses.

      2. Explain that everyone uses water for a variety of purposes. Today's lesson will illustrate the quantity of water in the world and how much is used for different purposes.

II. Activity

   A. Have the class construct a "Big Book."

      1. Divide the students into teams of two or three.

      2. Pass out art supplies and large sheets of paper or posterboard.

      3. Distribute one "Water Fact" card to each group.

      4. Instruct the students to use the information on the card to make an illustrated page for the classroom big book on water facts. Each page should have:

         a. The fact given on the card

         b. An illustration of the fact (NOTE: Remind students to think about symbols that would help illustrate their fact. For example, a salt shaker may be a good symbol for salt water, especially if it is filled to the level noted on the card.)

         c. The names of the illustrators.

      5. Monitor and make suggestions to each team as they work.

   B. Upon the teams' completion of the pages, punch three or four holes on the left-hand side and connect them together with loose-leaf rings or yarn.

III. Follow-Up

   A. Allow each group to read and share their page with the class. (NOTE: Provide students with a gallon [4 L] jug of water to compare the amounts given in the book.)

   B. Have the students write other questions about water quantities they think would be interesting to know.

IV. Extensions

A. Have the students find answers to their water quantity questions from III. B.

B. Assign groups to design a bulletin board or door covering to present information out of their "Big Book."

C. Have the students make charts or graphs of all the different percentages out of the book.

D. Present copies of the book to other classes or to the school library.

RESOURCES

Debnam, Betty, "Treat Water Well" (from "The Mini-Page" educational activities), Knoxville News-Sentinel, October 30, 1990, p. B6.

Namowitz, S., and N. Spaulding, Earth Science, D.C. Heath and Company, Lexington, Massachusetts, 1989.

Pringle, L., Water: The Next Great Resource Battle, Macmillan Publishing, New York, 1982.

"Water: Essential to Life (1992 Utah's Young Artist's Water Education Classroom Calendar)," International Office for Water Education, Utah State University, Logan, Utah.

WATER FACT CARDS

Water Fact Three-fourths of the earth's surface is covered with water.	**Water Fact** The largest user of water is agriculture, for growing crops and raising livestock. This uses 42% of our fresh water.
Water Fact 97% of our water is salt water found in the ocean.	**Water Fact** Our bodies are made of 75% water.
Water Fact While 3% of our water is fresh, 2% is trapped in ice caps, glaciers, and on snowy mountain ranges.	**Water Fact** It takes 1,400 gallons of water to produce a meal of a burger, fries, and a soft drink.
Water Fact Most of the fresh water we use comes from lakes, rivers, and streams (surface waters).	**Water Fact** The average American uses 150 gallons of water a day.
Water Fact There is about 40 times more fresh water in the ground than found in rivers, lakes, and streams.	**Water Fact** A person can use up to 50 gallons of water taking a bath.
Water Fact Homes, hotels, and offices use about 11% of our fresh water.	**Water Fact** For every inch of rain in a square mile, there will be more than 17 million gallons of water. (For every centimeter of rain in a square kilometer, there will be 10 million liters of water.)
Water Fact 8% of the fresh water we use goes to making goods and mining.	**Water Fact** A tree is 75% water.
Water Fact 39% of the fresh water we use helps us make electricity.	**Water Fact** If you leave the water running while brushing your teeth, as much as 10 gallons (40 L) of water can go down the drain.
Title Page Group **Complete a title page with the following:** **1) A catchy title about water facts,** **2) An illustration about water,** **3) The name of the grade, school, and teacher working on the book.**	

THE RETURNING RAINDROP

OBJECTIVES

The student will do the following:

1. Realize that water moves in a never-ending natural cycle.
2. Build a model of the water cycle in the form of a terrarium.
3. Explain how a terrarium demonstrates the water cycle.

SUBJECTS:
Science, Art, Social Studies

TIME:
90 minutes

MATERIALS:
2-liter clear plastic bottles with caps
potting soil
gravel
small plants or moss
tape
ruler
scissors (teacher use only)
student sheets (included)
crayons or colored markers (optional)
drawing paper (optional)
writing paper (optional)
ice cubes (optional)
heat source (optional)
beaker, jar, or saucepan (optional)
cookie sheet (optional)
sealable plastic bag (optional)
teacher sheet (included)

BACKGROUND INFORMATION

Water moves in a never-ending natural cycle, so the water you are using may have been a drink for some dinosaur! The forms of water are always changing. They move from sky to earth and back to the sky again. This is called the water cycle. Water falls to earth as rain or snow. Some of the water soaks into the ground and is stored as groundwater. The rest flows into streams, lakes, rivers, and oceans. The sun warms surface water and changes some of it into water vapor. This process is called evaporation. Plants give off water vapor too in a process called transpiration. The heated water vapor rises into the sky and forms clouds. When the vapor in the clouds condenses, it falls back to the earth as rain or snow. The water cycle has then come full circle and begins again.

Terms

condensation: the change of water from a gas to a liquid.

evaporation: the process of converting or changing into a vapor.

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.

water: a resource needed by all living things in an ecosystem.

water cycle: the cycle of the earth's water supply from the atmosphere to the earth and back which includes precipitation, transpiration, evaporation, runoff, infiltration, and storage in water bodies and groundwater.

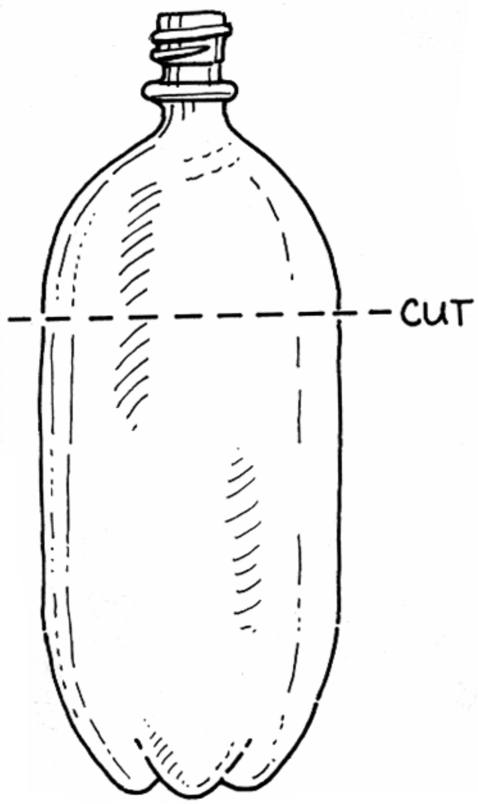
water vapor: the gaseous state of water.

ADVANCE PREPARATION

A. Gather the materials for the terrarium(s). (NOTE: One terrarium can be made for a class demonstration or each student or team of students can make one. Materials for each terrarium include: a 2 liter clear plastic bottle, 2 inches (5 cm) of potting soil, small plants (moss works great), 1/2 inch (1.25 cm) of gravel, and tape.

B. Cut bottle(s) ahead of time. (NOTE: Scissors easily and evenly cut the plastic bottles.)

C. Make copies of each of the two student sheets for each student's use in follow-up exercises.



PROCEDURE

I. Setting the stage

A. Have the students name all the ways they use water in a day. Encourage them to include ways that water is used indirectly (e.g., food preparation, manufacturing, farming, etc.).

B. Tell the students the same water they are using today has been on earth from its beginning. It is recycled continuously in the water cycle.

II. Activity

A. Introduce and explain the new terms using the chalkboard (evaporation, water vapor, condensation, precipitation, water cycle). Give everyday examples of each term.

1. Condensation - water droplets on the outside of a cold soda can

2. Precipitation - snow, rain, sleet, hail

3. Evaporation - dew disappearing from the grass

4. Water vapor - steam rising from a boiling pan of water

5. Water cycle - snowfall or puddles appearing and disappearing (The technical term is the "hydrologic cycle." If your students enjoy "big" words, introduce this term and discuss with them the "hydro-" root word.)

B. So that students may observe the water cycle, build a terrarium (or have students or teams build their own). (NOTE: See teacher sheet, "Terrarium Concept.")

1. Place 1/2 inch (1.25 cm) of gravel in the bottom of the bottle. (This is for drainage.)

2. Cover the gravel with about 2 inches (5 cm) of rich potting soil.

3. Plant the small plants or moss you have gathered.

4. Gently water the soil until moist.

5. Place the top back on the bottle and tape securely in place.

6. Place in a well lighted – but not too sunny – area. If all goes well, the plants will thrive and the water cycle can be observed all year.

C. Together with the students, observe the container after 24 hours. Note all changes and discuss the water droplets on the inside of the terrarium(s).

D. Ask the students how this demonstrates the water cycle.

E. Ask the students where the droplets come from and where they go.

III. Follow-Up

A. Have the students complete the water cycle student sheet, "The Returning Raindrop." List the terms on the board. (NOTE: They may color the picture when they are finished.) (Answers: 1. evaporation, 2. condensation, 3. precipitation, 4. water cycle.)

B. Have the students draw a representation of the water cycle demonstrated in the terrarium. (See the teacher sheet.)

C. Relate the water cycle to lakes, rivers, or other water sources in your immediate area.

D. Have the students complete the water cycle term sheet, "Water Cycle Matching." (Answers: 1A, 2D, 3E, 4B, 5C, 6F, 7G.)

IV. Extensions

A. Discuss ways that water supplies become polluted and the water quality declines.

B. Have the students write a story about being a raindrop and traveling through the water cycle.

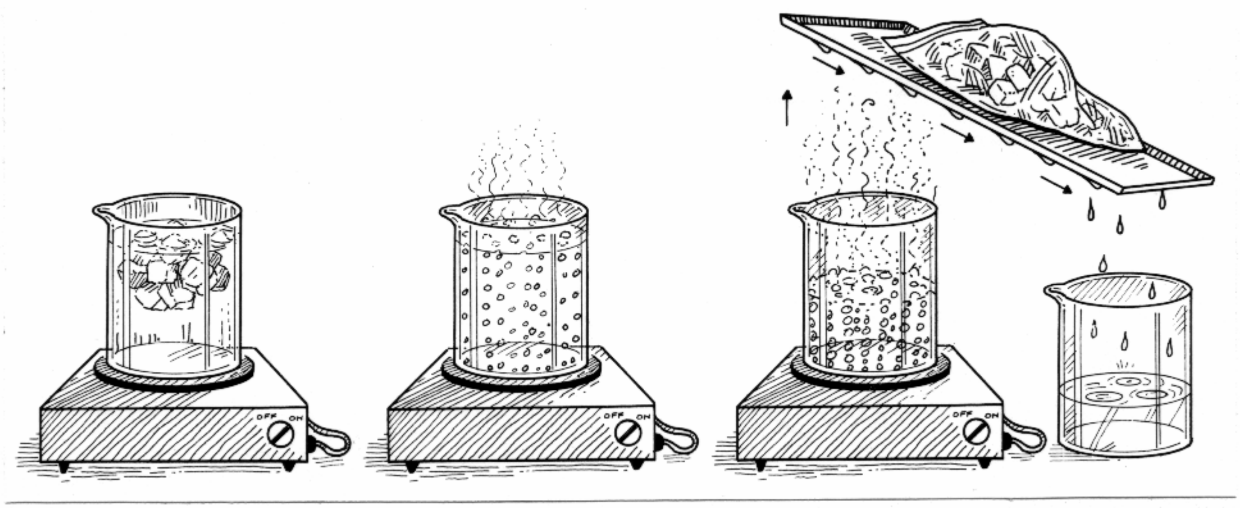
C. Demonstrate the three forms of water (solid, liquid, gas) as depicted below.

1. Ice cube - solid

2. Liquid - melted ice cube

3. Gas - evaporated water from melted ice cube.

RESOURCES



The Energy Sourcebook: Grades 3-5 Unit, Tennessee Valley Authority, 1990.

Hackett, Jay K., Science in Your World (Grade 3), Macmillan McGraw-Hill, New York, 1991.

"The Story of Drinking Water," American Water Works Association, Denver, Colorado, 1984.

TVA: A World of Resources, Tennessee Valley Authority, 1986.

"Water Fun," Los Angeles Department of Water and Power, Los Angeles, California, 1984.

Student Sheet

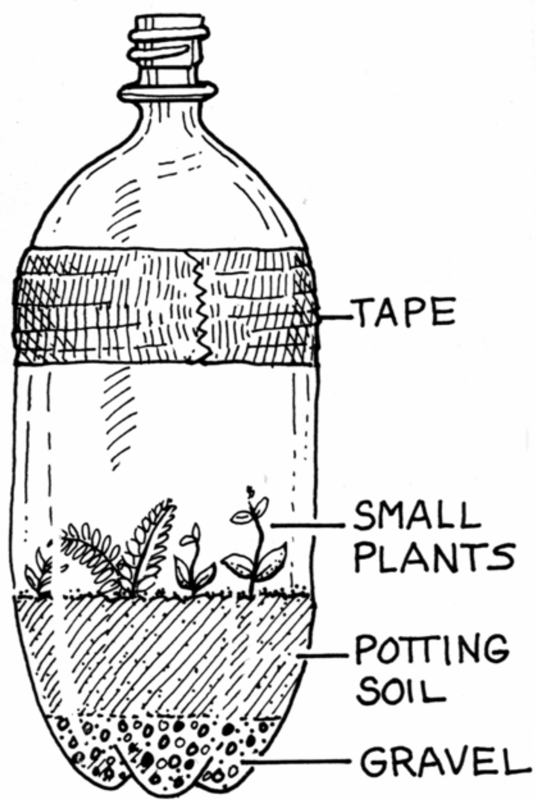
TERRARIUM CONCEPT

A terrarium is a simple and effective way for your class to watch the water cycle operating on a small scale. The plants take up moisture from the soil and release it through their leaves. The water molecules later condense on the inside of the plastic bottle and “rain” back to the soil. You never need to add water to the terrarium as long as it stays closed.

This classroom water cycle works in miniature much the same way the water cycle works on a large scale for our planet. It is also a good introduction to the concept of ecological cycles.

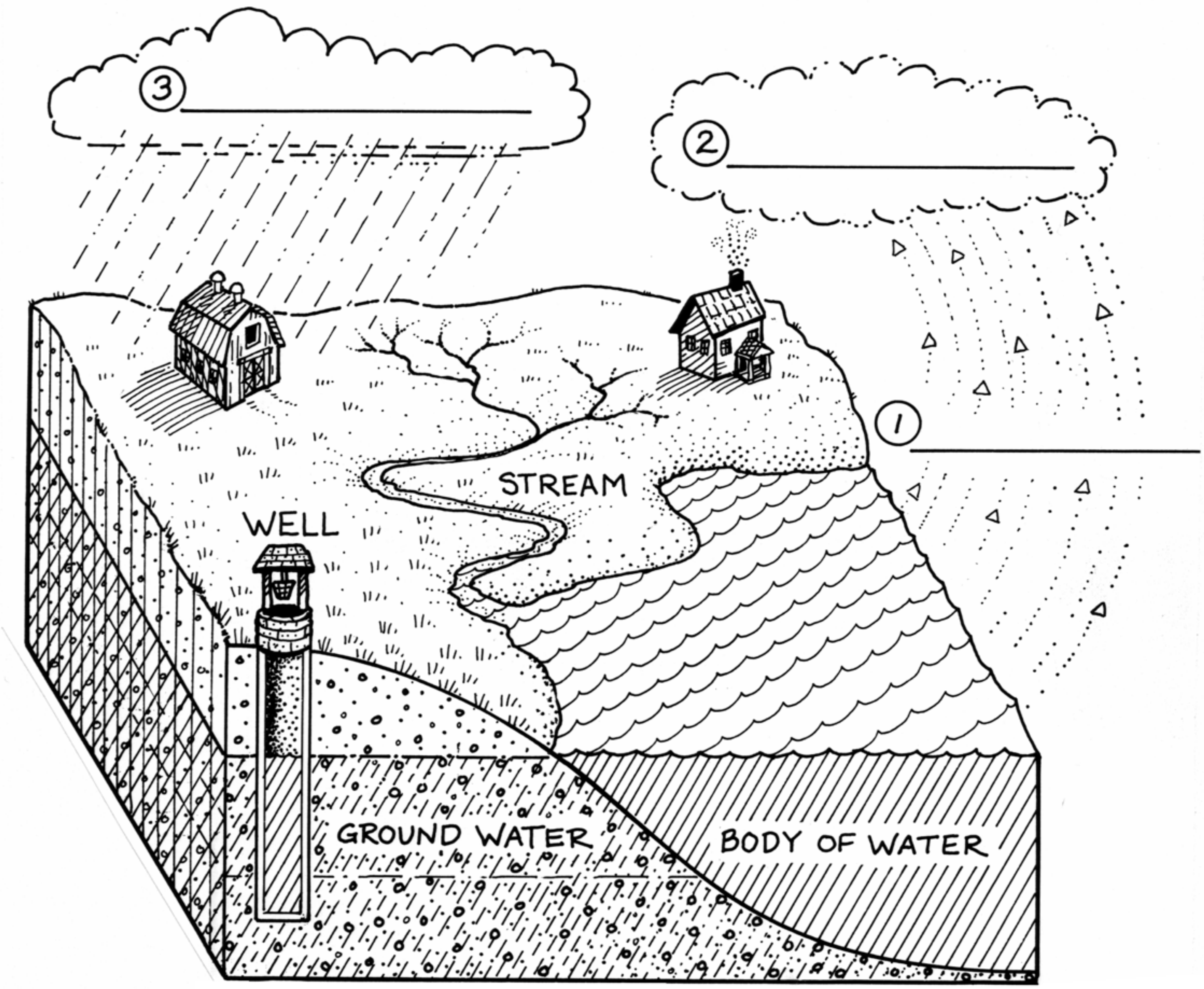
The students can present terrariums as gifts to their parents. You might ask parents to donate some small plant cuttings as well as other supplies needed.

The terrariums are easily assembled, but be sure to cut the plastic bottles before starting the students on the assembly.



THE RETURNING RAINDROP

Fill in the blanks to label the picture. Use the terms at the bottom.



Terms: water cycle
evaporation
condensation
precipitation

Student Sheet

WATER CYCLE MATCHING

Match the definitions with the terms in the word bank below. Put the letter of the term in the blank.

____1. The change of water from a gas to a liquid.

____2. The process in which water becomes a vapor in the atmosphere.

____3. The method in which water continually moves from the earth to the atmosphere and back again.

____4. A resource needed by all the living things in an ecosystem.

____5. The gaseous state of water.

____6. The forms of condensed water vapor such as snow, rain or sleet.

____7. Water stored in the ground.

Word Bank:

A. Condensation

B. Water

C. Water vapor

D. Evaporation

E. Water cycle

F. Precipitation

G. Groundwater

AQUIFER ADVENTURE

OBJECTIVES

The student will do the following:

1. Observe and/or use several simple aquifer models.
2. Locate areas of major aquifers on a U.S. map and name states.
3. Infer the meaning of terms based on the Latin root word "aqua."

SUBJECTS:
Science, Social Studies, Language Arts

TIME:
90-120 minutes

MATERIALS:
acetate sheets
overhead projector
wipe-off transparency pens
U.S. map
clear plastic cups (1 per student)
drinking straws (1 per student)
chipped ice
lemonade or juice drink
clear glass bowl
aquarium gravel
modeling clay
water
jar or bottle
blue food coloring
pump (from liquid soap bottle)
teacher sheets (included)

BACKGROUND INFORMATION

An aquifer is an underground layer of rock or soil that holds the water that we call groundwater. The word "aquifer" is derived from the Latin "aqua," meaning "water," and "fer," meaning "to yield." The ability of a geological formation to yield water depends on two factors—porosity and permeability. Porosity is determined by how much water the soil or rock can hold in the spaces between its particles (as with a sponge). Permeability means how interconnected the spaces are so that water can flow freely between them.

There are two types of aquifers. One is a confined aquifer, in which a water supply is sandwiched between two impermeable layers (geological formations through which water cannot pass). These are sometimes called artesian aquifers because when a well is drilled into this layer, the pressure is so great that water may spurt to the surface without being pumped. This is an artesian well. The other type of aquifer is the unconfined aquifer, which has an impermeable layer (or one of lower permeability) under but not above it. It is the most common type.

Aquifers may be categorized according to the kind of material of which they are made. A consolidated aquifer is composed of a rock formation (that is porous or fractured). An unconsolidated aquifer is composed of a buried layer of sandy, gravelly, or soil-like material.

The top surface of the groundwater is called the water table. The water table depth varies from area to area and fluctuates (rises and falls) due to seasonal changes and varying amounts of precipitation. Excessive pumping from the aquifer can also lower the water table.

Perhaps the largest aquifer in the world is the Ogallala aquifer located in the Midwestern part of the United States. This aquifer is named after a Sioux Indian tribe. It is estimated to be more than two million years old and to hold about 650 trillion gallons (2,500 trillion liters)! It underlies parts of 8 states, stretching about 800 miles (1,288 km) from South Dakota to Texas. The Ogallala aquifer supplies vast amounts of water to irrigate the crops grown in this vitally important agricultural area.

Terms

aquifer: an underground layer of unconsolidated rock or solid that is saturated with usable amounts of water.

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.

confined aquifer: see artesian aquifer.

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.

impermeable: not permitting water or other fluid to pass through.

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

water table: the top surface of the groundwater.

ADVANCE PREPARATION

A. Collect materials for activities and demonstrations.

1. Fill a jar or bottle with water. (Size will depend on how large the glass bowl is.) Tint the water blue with food coloring (probably one drop). Set it aside.

2. Pat out a "pancake" of modeling clay. Size it to fit into the glass bowl with a good (but not necessarily tight) fit.

B. Make a transparency of each of the teacher sheets.

C. Have several dictionaries available.

PROCEDURE

I. Setting the stage

A. Pass out clear plastic cups and drinking straws to each student.

B. Put the word "aquifer" on the board and ask students if anyone knows what the word means. Then put the Latin derivation on the board so they can see the parts of the word and how we arrived at its definition.

C. Tell students they are all going to make a model aquifer. Fill each cup with chips of ice. The ice represents rock and soil-like materials underground. Pour into each of their cups lemonade or juice drink. The drink represents groundwater. Explain that the cup and drink represent an aquifer and groundwater. The bottom of the cup is the layer of rock or soil that keeps the water from seeping down any further. The top of the water is the water table, the top of the underground water layer.

D. Have students sip some of the liquid. Explain that they have just simulated a well by using their straw to "pump" the liquid from the aquifer. They have lowered the water table.

E. Ask what they would have to do to bring the water table back up to its original level. Compare adding more liquid to rainfall, which replenishes or “recharges” groundwater.

II. Activity

A. Show the students the transparency of the aquifer diagram teacher sheet.

1. As you point out the aquifers, the water table, and the wells, relate these to the drink cup model. (NOTE: Do not go into differentiating between confined and unconfined aquifers at this time. You will do this later.)

2. Let several students color the diagram with wipe-off transparency pens. Have them use blue for water (including groundwater) and other colors for the ground’s layers. This will make it more clear for the students.

B. Construct a more complicated aquifer model for the students to observe.

1. Use one glass bowl (instead of cups each student used before). As you layer materials in the bowl, talk to the students about what each one represents. (NOTE: Leave the aquifer overhead up.)

2. The bottom of the bowl is an impermeable layer (water cannot pass through it), just as impermeable layers of rock or clay underlie other layers underground.

3. Put in a layer of sand. It represents an aquifer (it can hold water). Pour enough of the blue-tinted water into the sand to saturate it. What kind of water is this? (groundwater)

4. Put in a layer of modeling clay overlying the sand aquifer. Clay is impermeable, so the aquifer is trapped between two impermeable layers. Ask the students what kind of aquifer this is. (confined) Point out the confined aquifer on the overhead.

5. Pour a layer of aquarium gravel on top of the clay. This represents an aquifer. Pour in some blue-tinted water. Tell the students to note the top of the water. What is this called? (water table) What kind of aquifer is this? (unconfined, because there is no impermeable layer on top of it) Point out the unconfined aquifer on the diagram.

6. Tell the students that this is quite like the ground under their feet may be. Aquifers are present in many locations, although in some places they are deeper in the ground than in other places.

7. Put the pump from a liquid soap or other container in the model’s unconsolidated aquifer. Ask the students what they think will happen if you work the pump. Let one of them try it while you hold it so the end of the tube stays above the modeling clay layer. Dispense some blue-tinted water into a cup.

8. Tell the students that this is much the way a well works. Remind them of the demonstration they completed using the drink cups. Point out the well on the overhead.

9. (Optional) The students may be curious about the artesian well on the overhead. Tell them that your “groundwater-in-a-glass-bowl” model will not show how an artesian well works. A model is a <u>representation</u> of something else; it cannot actually function like the real thing does.

C. Have the students examine a map showing groundwater resources in the United States.

1. Share the following information with the students: Groundwater is almost everywhere. The

layers of rock and soil-like material under the ground hold water in varying amounts. Some places have a lot of groundwater, but it is deep in the earth and not easy to get from wells. Some places do not have as much groundwater. Some places have abundant supplies of groundwater. In these places people rely on water from wells for irrigating crops and for water supplies for both individual families and whole communities.

2. Show the students the transparency of the teacher sheet "Major U.S. Aquifers." Explain that the crosshatching on this map marks the places in the continental U.S. where abundant fresh water is available from aquifers. In these areas, large groundwater supplies are used by industries, communities (municipal water systems), and irrigation of crops. In the areas where there are no markings there is less likely to be plentiful groundwater available. These places will, however, have wells that supply individual households and livestock operations.

3. Ask a student volunteer to come up and mark on the map (with a wipe-off transparency pen) about where your community is located. Is it in an abundant aquifer region?

4. Ask the students to answer the following questions by naming states. (Allow them to refer to a labeled map if it is needed.)

   a. Name several states where plentiful groundwater is available almost everywhere. (Florida, Mississippi, Louisiana, Iowa, Delaware, Nebraska, Michigan, New Jersey)

   b. Name several states that have the least groundwater in many places. (Montana, Wyoming, Colorado, Utah, Pennsylvania, Kentucky, West Virginia, New York, Vermont, New Hampshire, Maine)

III. Follow-Up

A. Have the students choose their state and four others (their choice). Have each student write down his/her five states and indicate whether each is likely to have large groundwater supplies or not. They may use yes/no answers, a symbol of their choice, or a sentence.

B. Have the students research specific U.S. aquifers (and perhaps others in different parts of the world). After sharing the information with the rest of the class, the students could plot the U.S. aquifers on the maps from activity II C.

IV. Extensions

A. Share with students the following information about dowsing or "water witching" and divining rods. Some people will not have a well drilled without calling a "water witch" or a "dowser" to locate the groundwater. Water witches or dowsers have been around for hundreds of years. They use metal or wooden sticks ("divining rods") to locate places where wells should be drilled. Some even predict the depth of the water table. Dowsers are not always successful in their efforts, but many people believe in their special ability to find water. Ask students to research the local use of dowsing.

B. Refer the students to the Latin derivation of the word "aquifer." Write on the board a list of other words that share the root word "aqui" or "aqua." Have the students list the words on their paper. (List these words on the board: aquacade, aqualunger, aquamarine, aquanaut, aquaplane, aquarelle, aquarist, aquarium, aquarius, aqueduct.) Divide the students into groups. Have them discuss and record what they think each word means, then look each one up in a dictionary to see how close they came to the correct definition. If they were not correct, have them write the dictionary meaning.

RESOURCES

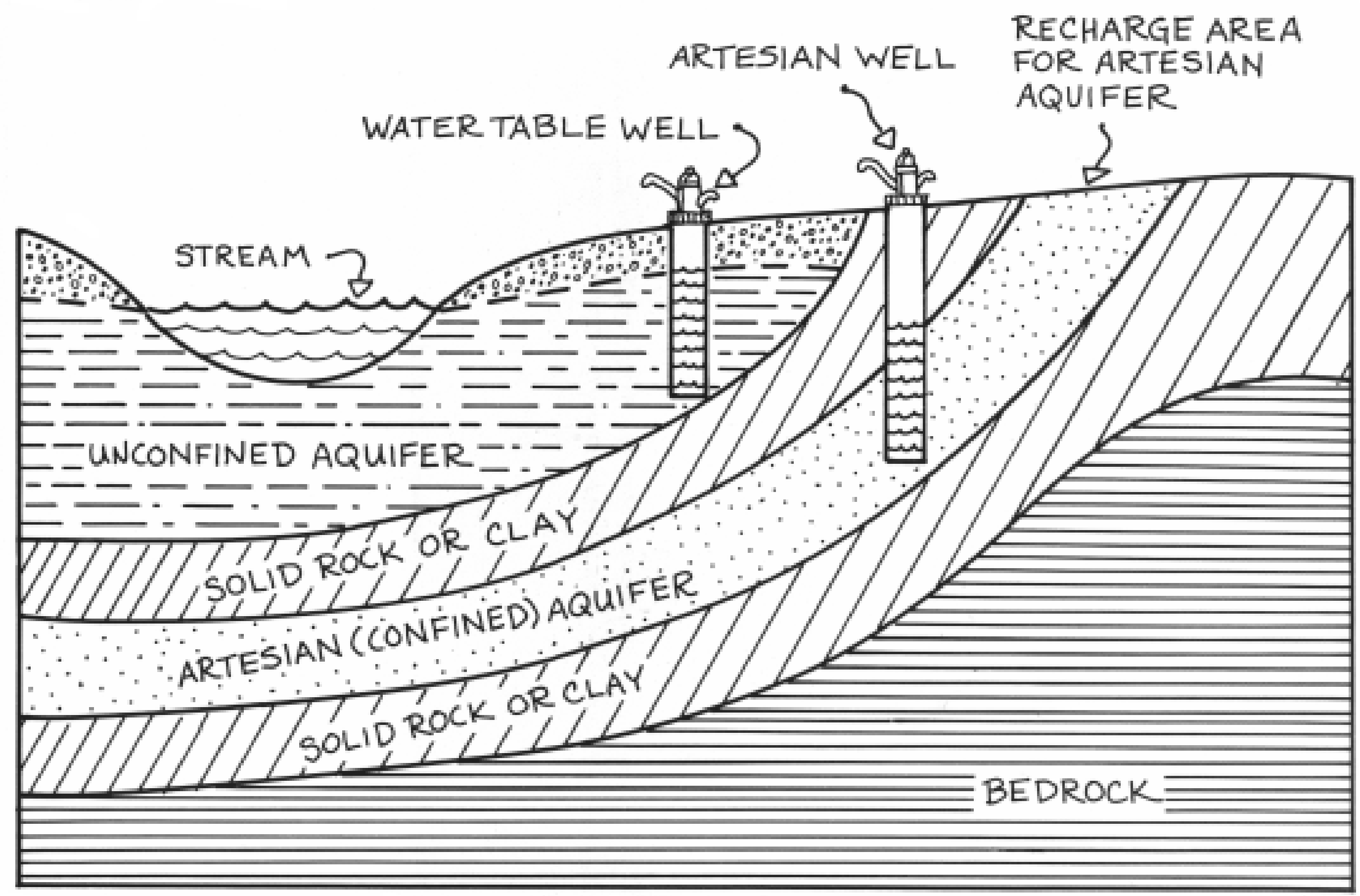
Branley, F. M., Water for the World, T. Y. Crowell, New York, 1982.

"Ground Water: Issues and Answers," American Institute of Professional Geologists, Arvada, Colorado, 1984.

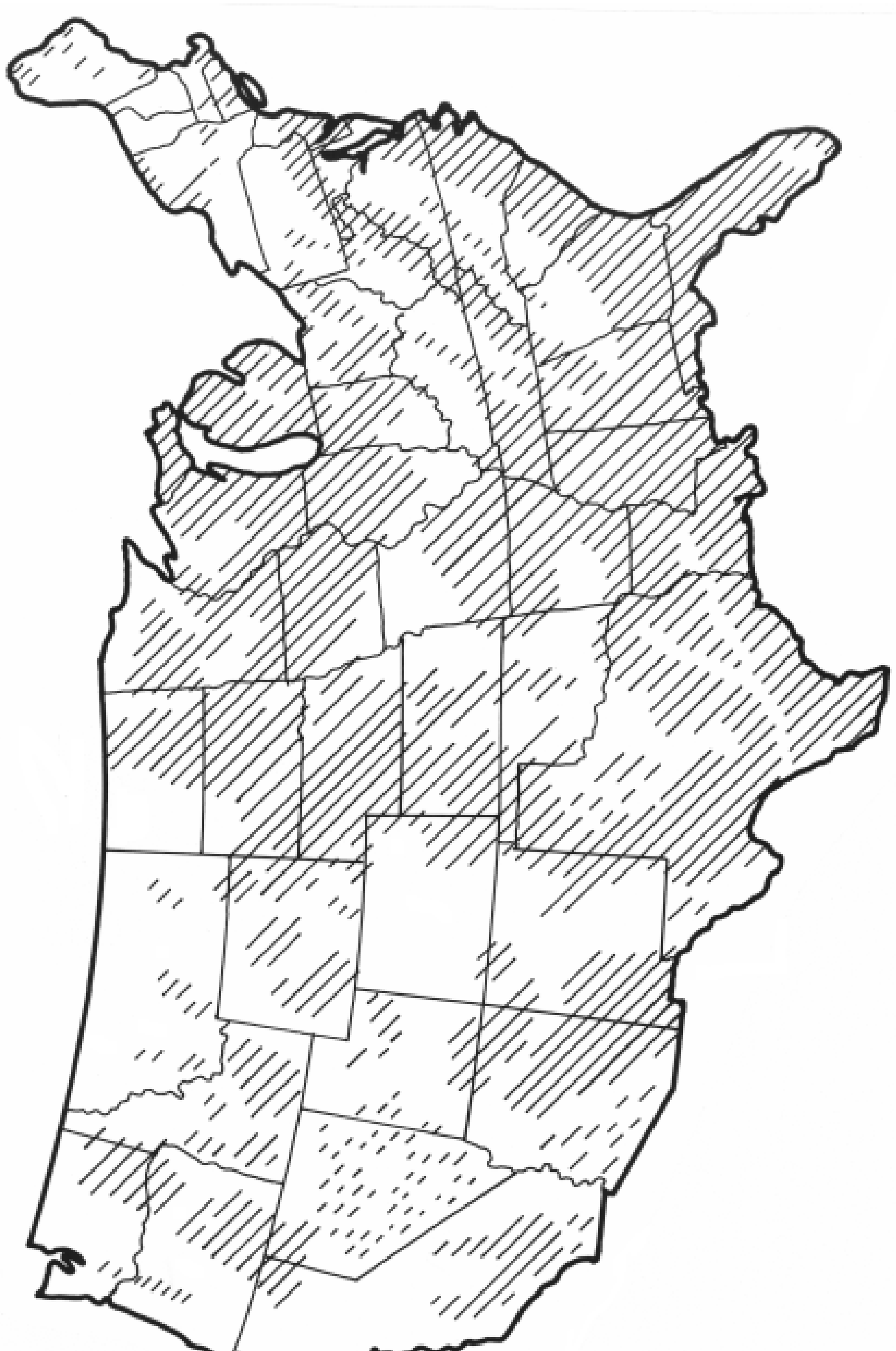
Haberman, M., Water Magic, American Waterworks Association, Denver, Colorado, 1991.

Pringle, L., Water: The Next Great Resource Battle, Macmillan Publishing Co., New York, 1982, pp. 68-70.

AQUIFER DIAGRAM



Student Sheet



LET'S GO DOWN UNDER!

OBJECTIVES

The student will do the following:

1. Define appropriate groundwater terms.
2. Explain where groundwater is found.
3. List the steps of the water cycle in correct sequence.
4. Identify sources of groundwater pollution and possible solutions.

SUBJECTS:
Science, Language Arts

TIME:
90 minutes

MATERIALS:
student sheets (included)
index cards
clear plastic sweater box or similar container
posterboard
string or fishing line
colored markers
clay
soil
sand
gravel
plastic sandwich bag
small plastic bowl
grass
plastic tree figures
water
teacher sheet (included)
materials to make puppets (optional)
posterboard and art supplies (optional)

BACKGROUND INFORMATION

Every day, people all over the world depend on a hidden resource—groundwater. Only 3 percent of the earth's water supply is fresh water and almost 2 percent of that is groundwater. In fact, more than 50 percent of the people in the United States get their drinking water from groundwater, including almost all who live in rural areas.

There is really nothing mysterious about groundwater. We just can't see it like we can see a pond, a stream, or the ocean. This water collects below the earth's surface in aquifers, spaces between soil and rock particles. It is also found in cracks and crevices and inside porous rocks.

The top surface of groundwater is called the water table. When the water table is high enough, groundwater comes to the surface naturally in springs, lakes, ponds and rivers, and it can also be brought to the surface by drilling wells. But the top level of the groundwater (the water table) is usually underground. Groundwater is a vital part of the water cycle and is replenished by rainfall. The amounts of groundwater in different areas of the world vary, and the amount at any one place can change due to prolonged drought, heavy withdrawal for human use, or other factors..

Groundwater quality is generally better than that of surface water because it is not as readily exposed to pollution sources. Also, the movement of groundwater through various layers of soil and rock filters out many impurities. However, some groundwater can be polluted by pesticides, chemicals, landfill leachate, and other materials that seep into groundwater supplies.

Terms

aquifer: an underground layer of unconsolidated rock or soil that is saturated with usable amounts of water (a zone of saturation).

filter: to remove contaminants by using a porous material such as paper or sand.

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.

impurities: substances that make another substance unclean.

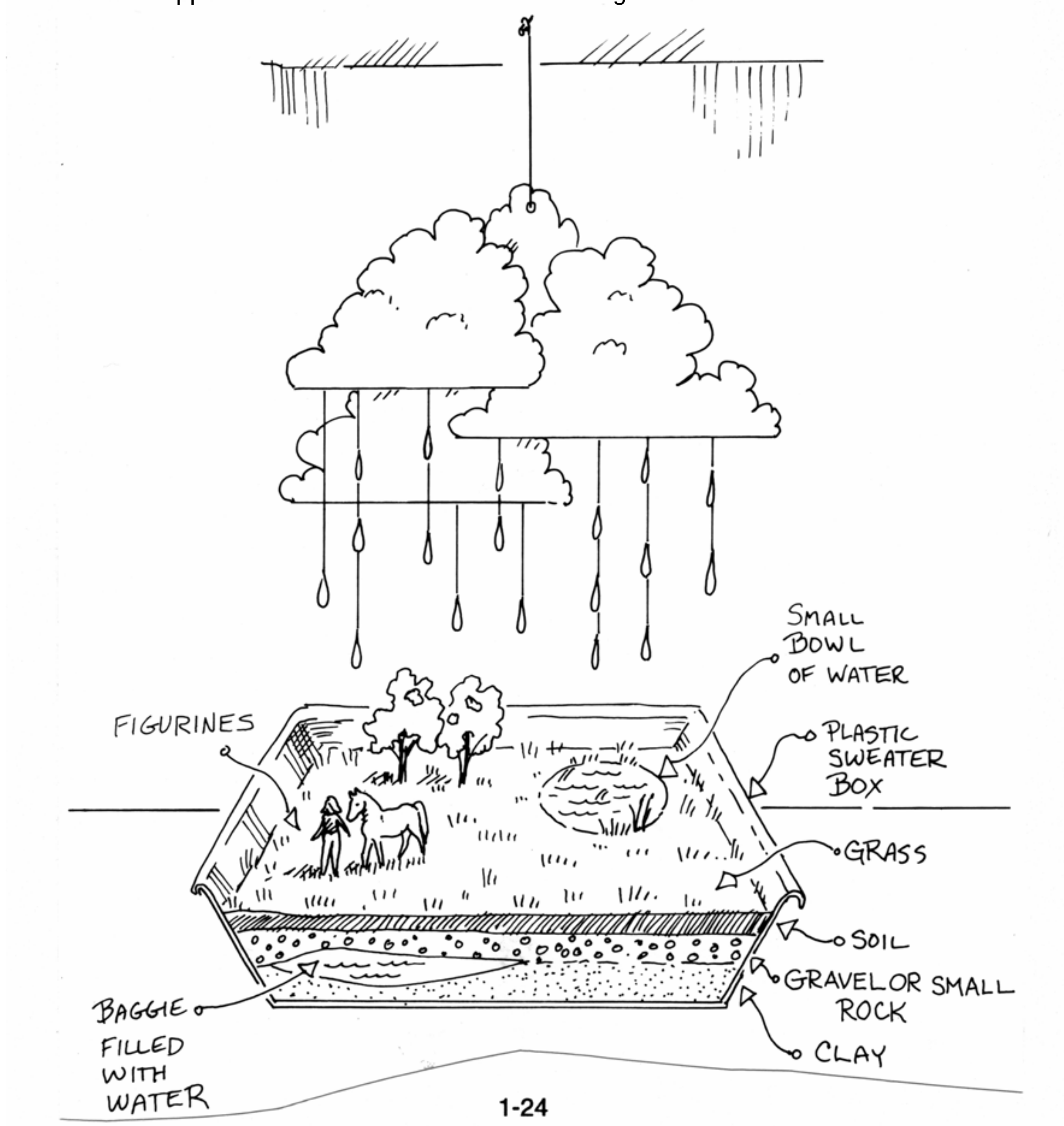
pollution: contaminants in the air, water, or soil that cause harm to human health or the environment.

porous: having pores or cavities that can hold substances such as water.

source: where something originates.

water cycle: the cycle of the earth's water supply from the atmosphere to the earth and back which includes precipitation, transpiration, evaporation, runoff, infiltration, and storage in water bodies and groundwater.

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



ADVANCE PREPARATION

A. Construct model of water cycle. Use posterboard to make clouds and raindrops. Hang clouds with raindrops below them (use string or fishing line). In a clear container, such as a plastic sweater box, create "the ground" area. From the bottom up, layer the following: clay, gravel or small rock, a plastic sandwich bag filled with water, layer of soil, small plastic bowl filled with water (sink the bowl into the soil so the top will be at surface level to simulate a pond or lake), grass, trees, and other figures.

B. Photocopy and cut out 5-6 sets of game cards for "Pollution Solution" (similar to "Old Maid"). Glue the game cards to index cards for durability and uniformity.

C. Photocopy the student sheets, "What's Wrong With This Picture?," "The Water Cycle," and "Groundwater: Fact or Opinion?"

PROCEDURE

I. Setting the stage

A. Pour a small amount of water into the water cycle model. Ask students where the water went. Explain that since it soaked into the ground and will seep into underlying rock formations, it is called groundwater.

B. Explain that the top surface of the groundwater is called the water table.

C. Ask students which they think would be most easily polluted: surface water (lakes, ponds, etc.) or groundwater. Ask them to give reasons for their answers.

D. Point out the importance of groundwater as a part of the water cycle.

II. Activities

A. Discuss the steps in the water cycle. Refer to the model.

1. Distribute the student sheet "The Water Cycle." You may want to have the students do this in small groups or you may do this together, as a class.

2. Students number the steps in the water cycle in the correct sequence, beginning and ending with evaporation. (Answer: 4,3,6,5,2,1)

3. After students complete the activity, list the steps on the board as they call them out.

B. Divide students into 5-6 groups (of no more than 5) to play the card game, "Pollution Solution," which is similar to "Old Maid."

1. Hand out a card set to each group.

2. Explain that for each pollution card there is a corresponding solution card. After all the cards are dealt, students take turns laying down pairs of cards. If a student does not have a pair, he/she must draw a card from the person who played just before him. He then lays down cards if he makes a match, and it is the next person's turn. At the end, whoever is left with the "Groundwater Gobbler" loses.

C. Have the students do the "What's Wrong With This Picture?" worksheet. You might prefer to do this together as a class using the student sheet master to make a transparency. The illustration shows at least 17 possible sources of groundwater pollution. See the teacher key. (Have the students name at least 10 of these.)

III. Follow-Up

A. Have students complete the student worksheet called "Groundwater: Fact or Opinion?" (Answers: 1.0, 2.F, 3.0, 4.0, 5.F, 6.F, 7.0, 8.F, 9.0, 10.0)

B. Review with students the many sources of groundwater pollution. Summarize that anything that pollutes water can pollute groundwater, especially things stored on or under the ground or applied to it. Ask them to make a list of what they and their families can do to help keep groundwater clean.

IV. Extensions

A. After reviewing correct letter form, have students write to the American Ground Water Trust (and other sources) for additional information.

B. Have students make posters to display around the school using the information from III. B.

C. Have students write and direct a puppet show on pollution and its consequences and present it to another class.

RESOURCES

"America's Priceless Groundwater Resource," American Ground Water Trust, Dublin, Ohio, 1991.

"Groundwater Pollution Control," American Ground Water Trust, Dublin, Ohio, 1990.

THE WATER CYCLE

Number the steps in the water cycle in the correct sequence, beginning and ending with evaporation.

_____ Replenishes (recharges) water in rivers, lakes, streams, and ponds

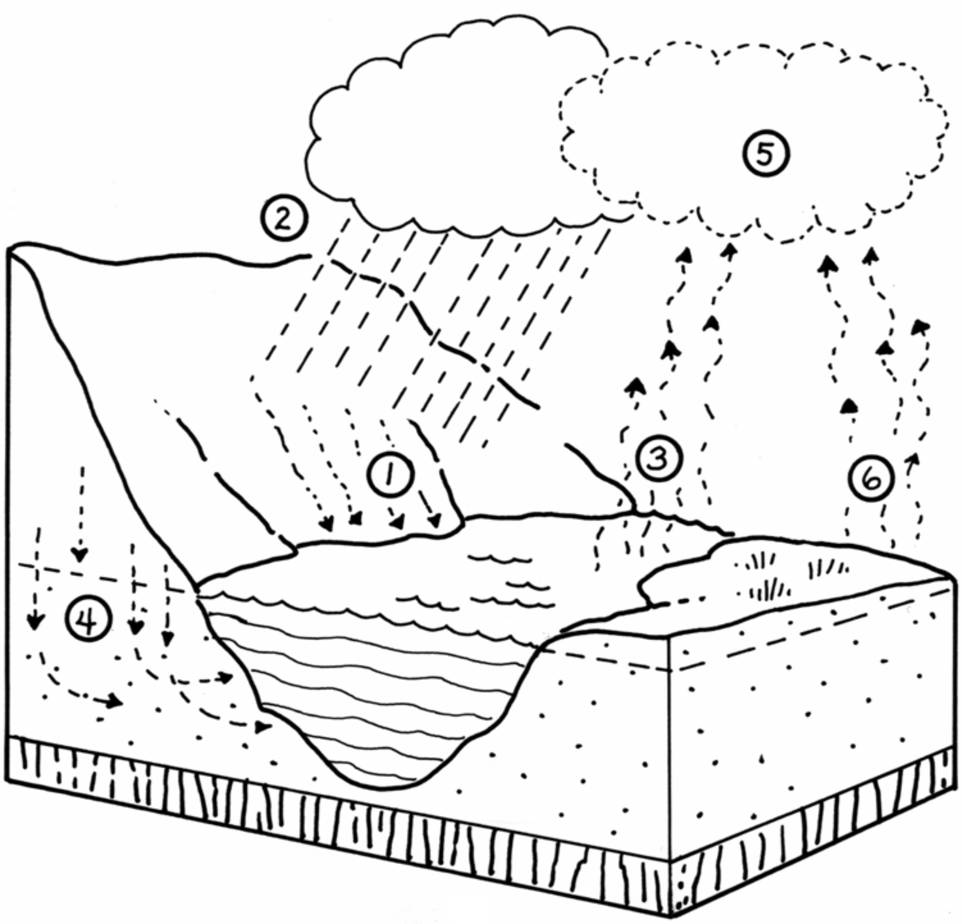
_____ Falls to the earth in some form of precipitation (rain, snow)

_____ Surface water evaporates again

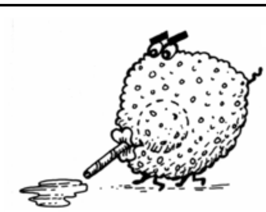
_____ Seeps into the ground and enters an aquifer

_____ Condenses in the atmosphere

_____ Evaporates from surface water, plants, and animals as water vapor



"POLLUTION SOLUTION"
GAME CARDS

S Require that people disposing of manure, garbage, or industrial wastes get permission from the government or make laws to control where they can dispose of them	S Make underground storage tanks from something other than metal (it can get rusty and get holes) and check how much is put in and taken out (to see if anything is "missing")
S Make laws to control how facilities to handle human waste are built and installed and to limit the number of them in an area	S Using only the amount of fertilizer and pesticide that is really needed, and making laws to control how they can be thrown away
S Build the cattle or hog feedlots and the chicken houses so that rain will not wash animal wastes into streams or ponds	P Fertilizers and pesticides put on farmlands or yards to help crops or yards grow and be healthy
P Holding ponds and lagoons used to hold liquid wastes or wastes mixed with water	P Human waste leaking from septic tanks, cesspools, or privies
P Improper disposal of waste such as manure, garbage, or industrial wastes	S Checking pipes to make sure they are working properly and not leaking
P Slimy liquid from garbage (leachate) leaking out of landfills	P Animal wastes produced in large amounts at places where many cattle, hogs, or chickens are kept
S Don't allow holding ponds or lagoons unless they are leakproof	P Leaks from underground storage tanks that hold gas or oil
S Locating landfills in places that are less likely to let the leachate reach groundwater	S Cover the piles of road salt with plastic or put it in sheds
P Piles of road salt stored until it is needed in winter	P Leaks in big pipes that carry oil, gas, or wastes
GROUNDWATER GOBBLER 	

GROUNDWATER: FACT OR OPINION?

If the statement is a fact, put an F on the line. If it is an opinion, put an O.

_____ 1. Groundwater is a mysterious source of water.

_____ 2. Groundwater is found beneath the earth's surface.

_____ 3. Groundwater tastes better than surface water.

_____ 4. Groundwater is the most important of all natural resources.

_____ 5. Groundwater is not as easily polluted as surface water.

_____ 6. Groundwater is a part of the water cycle.

_____ 7. Studying about groundwater is boring.

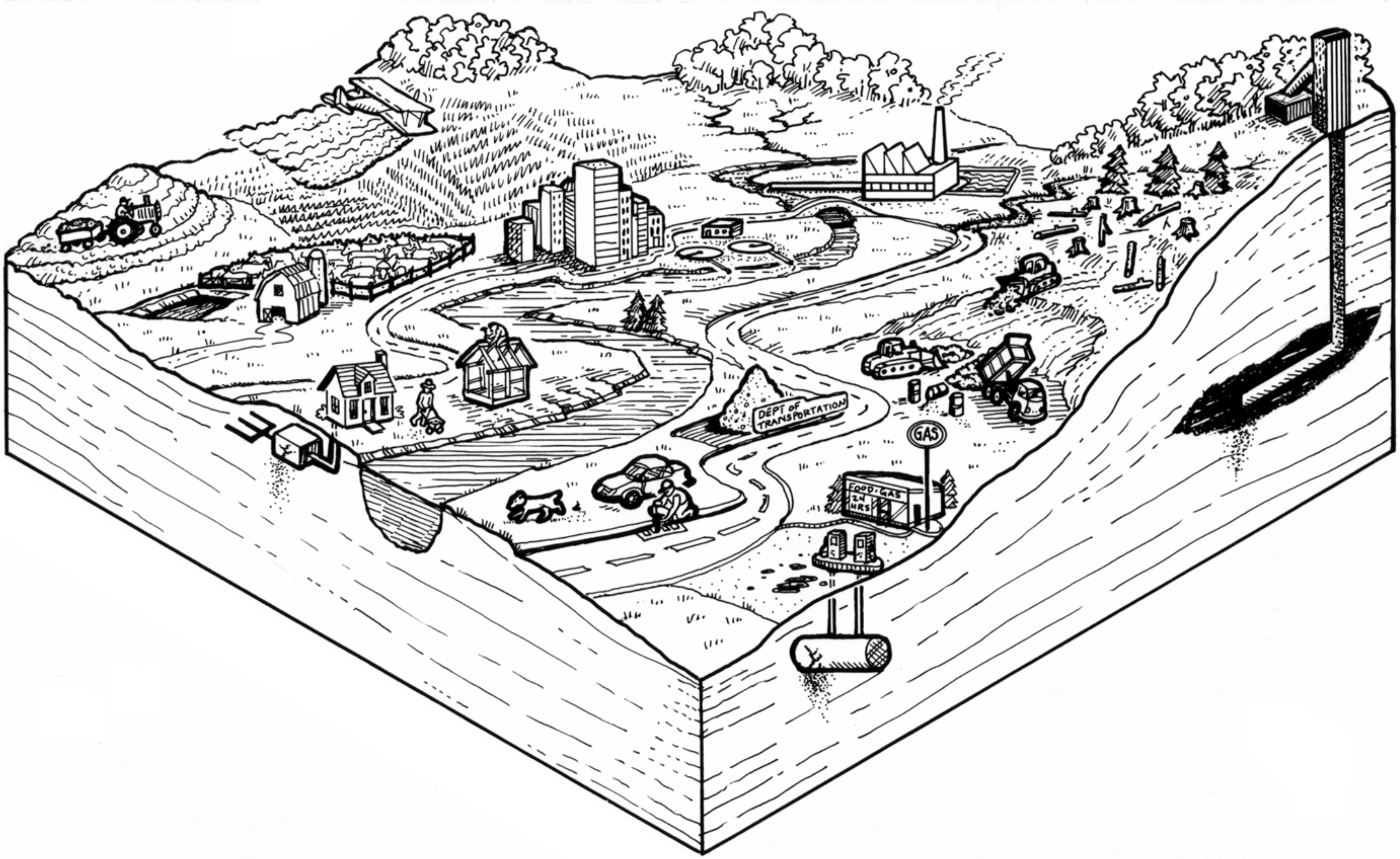
_____ 8. One person's actions can affect groundwater.

_____ 9. Landfills are yukky.

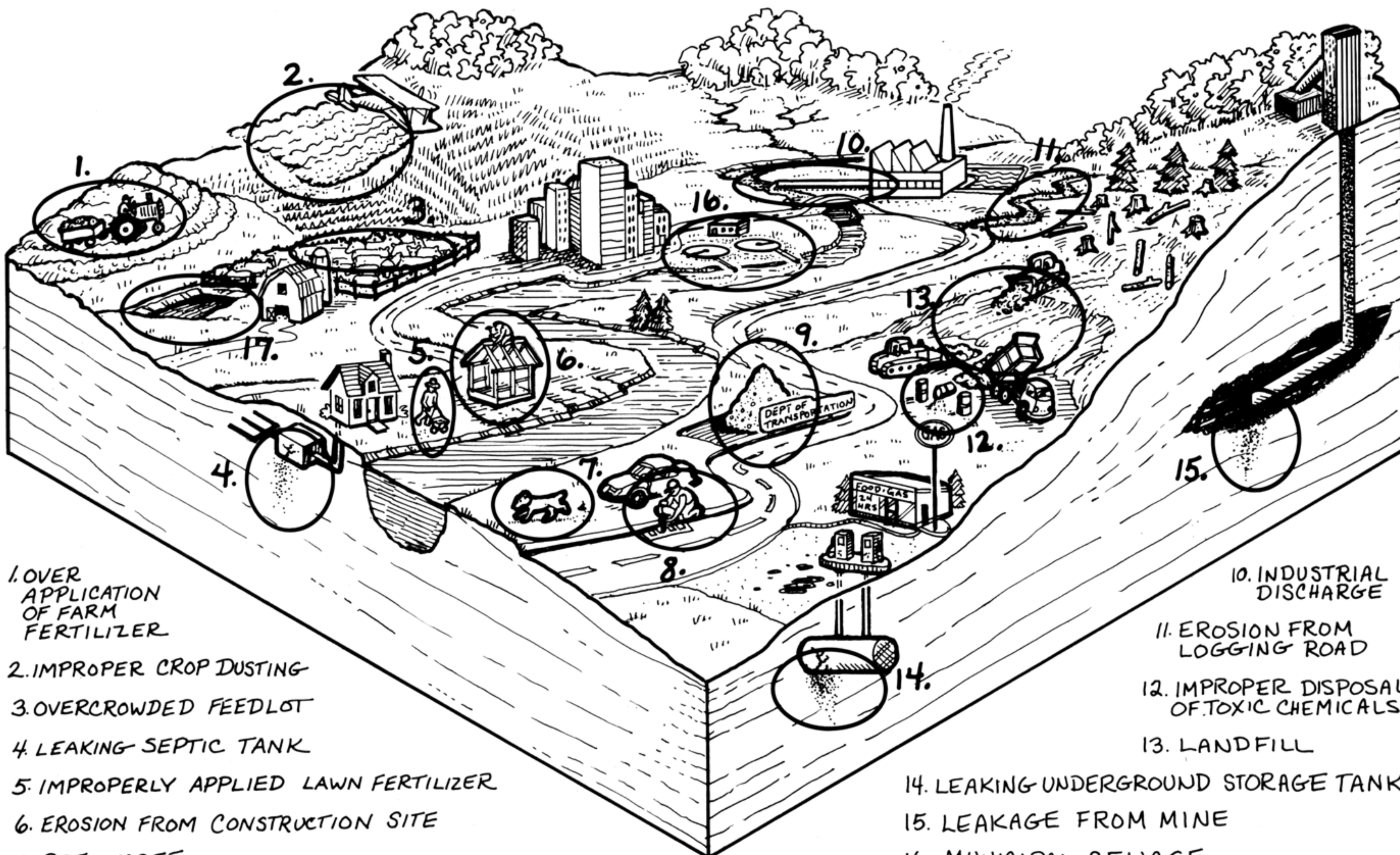
_____ 10. Farmers should not use pesticides.

WHAT'S WRONG WITH THIS PICTURE?

There are 13 potential sources of water pollution in this diagram. Circle them and label each one.



WHAT'S WRONG WITH THIS PICTURE? TEACHER KEY



1. OVER APPLICATION OF FARM FERTILIZER
2. IMPROPER CROP DUSTING
3. OVERCROWDED FEEDLOT
4. LEAKING SEPTIC TANK
5. IMPROPERLY APPLIED LAWN FERTILIZER
6. EROSION FROM CONSTRUCTION SITE
7. PET WASTE
8. IMPROPER DISPOSAL OF MOTOR OIL
9. ROAD SALT
10. INDUSTRIAL DISCHARGE
11. EROSION FROM LOGGING ROAD
12. IMPROPER DISPOSAL OF TOXIC CHEMICALS
13. LANDFILL
14. LEAKING UNDERGROUND STORAGE TANK
15. LEAKAGE FROM MINE
16. MUNICIPAL SEWAGE
17. LEAKING ANIMAL WASTE STORAGE LAGOON

SHEDDING LIGHT ON WATERSHEDS

OBJECTIVES

The student will do the following:

1. Simulate runoff using a watershed model.

2. Explain why rivers are necessary to drain water from watershed area.

SUBJECTS:
Science, Social Studies

TIME:
60 minutes

MATERIALS:
maps showing area watershed (1 per student)
salt flour dough (recipe included)
water
paper
waterproof paint
picture of a river and surrounding area
sprinkling can
9" x 13" (25 x 35 cm) pan — at least 2" (5 cm) deep
drawing paper
measuring cup
world maps (1 per team)
U.S. maps (1 per team)
teacher sheets (included)
transparency
overhead projector

BACKGROUND INFORMATION

The concept of "watersheds" is a useful way to divide areas of land according to how the land and the water flowing over and through it interact. A watershed is an area or region which drains into a particular watercourse or body of water.

Watersheds are important because scientists can study them in order to help determine how much surface water is available for people's needs. The topography, vegetation, soil, rock formations, and climate of a watershed also determine an area's lakes, streams, and rivers.

Generally, two adjacent watersheds are separated by a high area of land called a divide. As an example, the watershed of the Columbia River and America's largest watershed, the watershed of the Mississippi River, are separated by the Great Divide in the Rockies.

Large amounts of runoff from watersheds, occurring in short periods of time, can lead to severe flooding and destruction of land and property. Sometimes heavy rains can result in flooding even when a watershed's rivers are quite large.

<u>Terms</u>

basin: a low lying area where surface water flows, such as a river basin.

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.

topography: the physical features of a place or region.

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

ADVANCE PREPARATION

A. Construct a generalized relief map of a watershed. Use salt dough in a pan at least 9" x 13" (25 x 35 cm) and 2" (5 cm) deep. (NOTE: The recipe for salt dough is on the teacher sheet "Salt Dough Relief Map" [included].)

B. Order or locate maps showing your local watershed area. Obtain one per student. (NOTE: Call the United States Geological Surveys Earth Science Information Center at 1-800-USA-MAPS to request specific maps. For local maps, contact the local water department, state agricultural department, state geological survey, or perhaps the department of geology at the nearest college or university.)

C. Obtain enough U.S. maps and world maps for there to be one for each team of four students.

D. If you invite a geologist to class, make sure he/she is informed as to what the objectives are and what to teach the students.

PROCEDURE

I. Setting the stage

A. Show the students a picture of a river and the surrounding lands.

1. Ask the students where the water in the river came from. Write their responses on the board.

2. Explain to the students that most of the water in our rivers comes from water that has drained off the surrounding land. Remind the students that water runs downhill. If it is a rainy day, observe this at your school. What you can observe in your schools' parking lot or yard also happens on a much larger scale over very large areas of land.

3. Discuss the words "runoff" and "watershed."

B. Show your class a transparency or photocopy of the teacher sheet, "Watersheds." Note that it shows two watersheds.

II. Activity

A. Give each student a copy of a watershed map (or any map showing topography) of your local area.

1. Have the students trace some of the paths water takes to get from the various parts of the watershed area to the streams, rivers, and lakes.

2. Ask the students to tell you where they think the river will eventually take the water collected from the watershed area.

B. Present the model of the watershed area to the class.

1. Explain the concepts of valley, hill, mountain, and so forth, to your students by pointing them out on the model.

2. Using a sprinkling can, have it “rain” over the model. Ask the students to observe how water runs over the area and to note where it collects. (the rivers)

3. Explain to the students that areas where water has “pooled” become our bodies of water, such as lakes, ponds, streams, and rivers.

C. Continue sprinkling the model until the pan begins to fill.

1. Explain to the students that if water has no way to be carried off, then flooding occurs. (Flooding also occurs when water cannot be carried off quickly enough.)

2. Ask the students what is needed to carry the water away from the watershed. (river)

III. Follow-Up

A. Ask the students to write a paragraph telling you how a watershed and a river are interrelated.

B. Pass out drawing paper to the students. Have the students draw a watershed area and color it.

C. Divide students into teams of four and give each team a map of the U.S. Assign each team a particular area of the U.S. (New England, Southeast, etc.) and have them find and record the major rivers in that section of the country.

1. Ask the teams to list states that are not part of the Mississippi River watershed.

2. Tell teams to find two rivers that do not empty into another river, but empty directly into the ocean. Explain to the teams that some rivers have very small watershed areas.

D. Pass out the world maps to the teams.

1. Have the teams trace and list a few rivers that flow into Africa’s Congo River. Explain to the teams that the Congo is a major watershed river in Africa.

2. Ask the teams to trace and list some of the rivers that flow into South America’s Amazon River. Explain to the teams that the Amazon River is a major river for South America.

IV. Extension

Invite a geologist to class to explain how topographical maps are made. If possible, request they bring booklets that can be given to each student.

RESOURCE

Douglas, L. S., et al., Experiences in Earth-Space Science, Laidlaw Brothers, Irvine, California, 1985.

SALT DOUGH RELIEF MAP

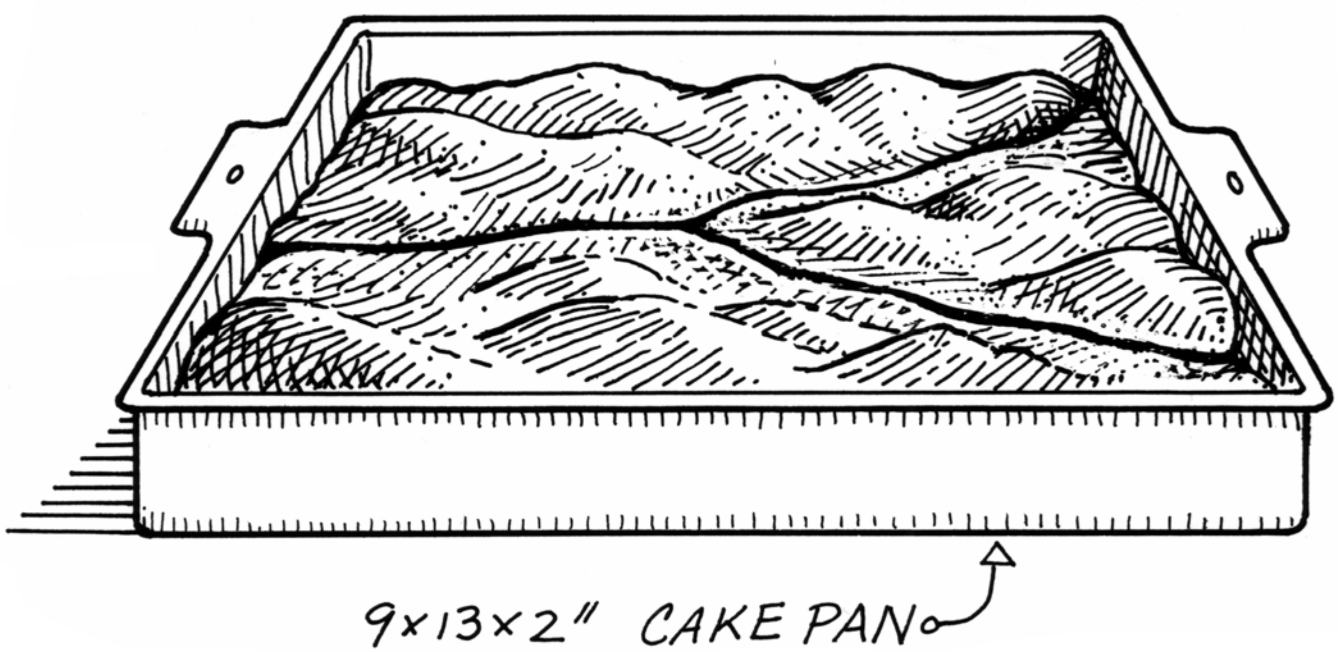
Salt Flour Dough (NOTE: Makes between 1-1/2 and 2 cups of dough. The recipe should be doubled in order to make enough for the relief map. You might make it in 2 batches to ensure success.)

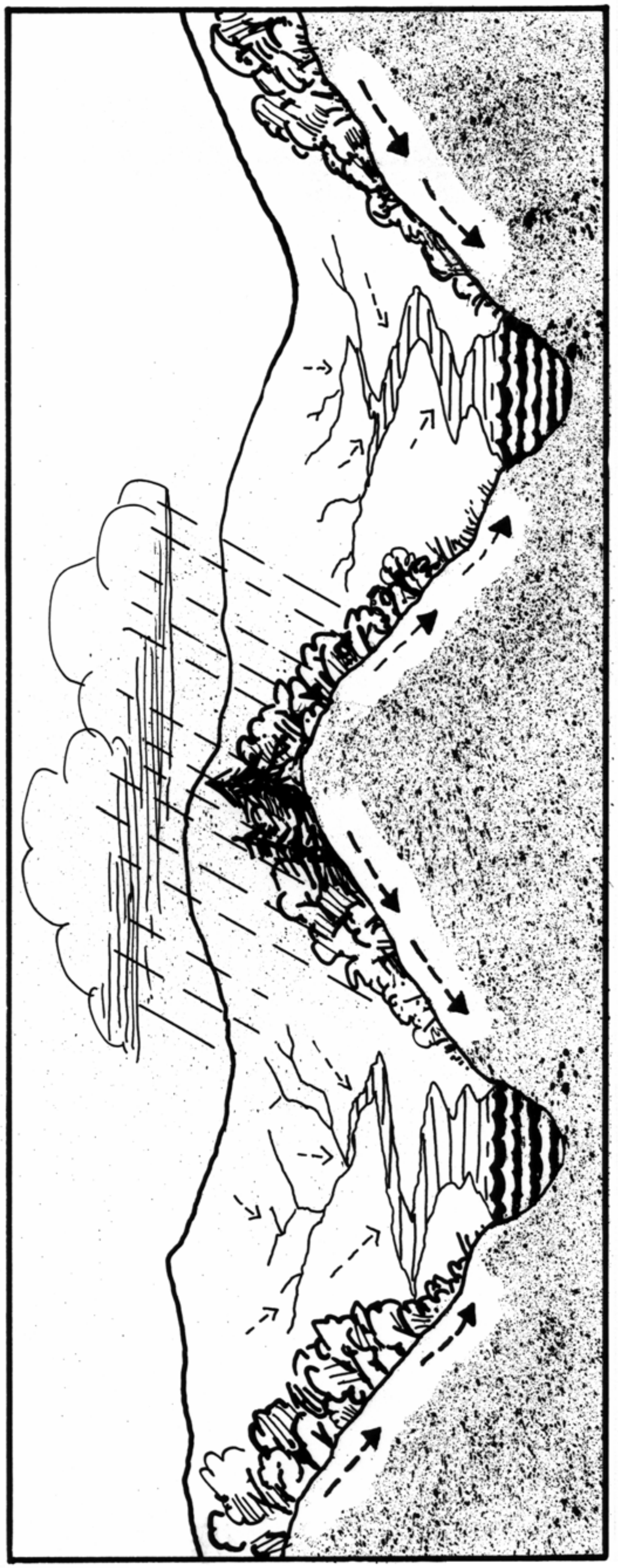
1 cup (250 mL) flour
1/2 cup (125 mL) salt
1 cup (250 mL) water
1 tablespoon (15 mL) cooking oil
2 teaspoons (10 mL) cream of tartar

Mix and heat ingredients until a ball forms. Add a touch of food coloring if desired.

To make model: Try to create a relief map similar to what is depicted on the teacher sheet, “Watersheds.” On one end of the pan, let the two major valleys come together to form one larger one (like a “Y”). Make a “riverbed” (depression) at the bottom of each major valley. Make sure that the end of the pan with the bottom of the “Y” is lower than the other end; i.e., the dough should be shallow at that end.

Allow the model to dry. Have several students paint it with waterproof paint. Using waterproof paint protects the model so that it can be reused.





WONDERFUL, WATERFUL WETLANDS

OBJECTIVES

The student will do the following:

1. List characteristics of wetlands.

2. Describe the functions of a wetland.

3. Observe a demonstration using a wetland model.

SUBJECTS:
Science, Language Arts

TIME:
60 minutes

MATERIALS:
glass lasagna pan (or clear plastic sweater box)
modeling clay
strip of indoor-outdoor carpet (3" [7.5 cm] wide by width of pan)
measuring cups
clear water
muddy water
pictures of different kinds of wetlands
construction paper (1 sheet per student)
student sheet (included)
teacher sheet (included)

BACKGROUND INFORMATION

Wetlands are areas of land that are wet at least part of the year. They are often transition zones between dry land and open water. Some wetlands are consistently covered with water, while others are flooded only at certain times. All wetlands do have water-soaked soil at some time, which affects the kinds of plants and animals that live there. Wetlands can be found in all parts of the world and are classified into many types. There are freshwater and saltwater wetlands. Some examples of freshwater wetlands are swamps, marshes, bogs, pasture ponds, and prairie potholes. Saltwater wetlands include mangrove swamps and saltwater marshes. Estuaries are the bodies of water found where rivers empty into the sea; they include saltwater wetlands. The water in estuaries is a mixture of fresh and salt (sea) water, and its salinity usually varies with its distance from the open ocean.

<u>Terms</u>

bog: a plant community that develops and grows in permanently water logged areas having a thick layer of peat (partly decayed organic material).

estuary: (EHS • choo • ehr • ee) the bay area of a river, where it widens to meet the ocean, that receives and mixes with tidal salt water.

mangrove swamps: saltwater wetlands located in tropical and sub-tropical areas and dominated by woody shrubs called mangroves.

marshes: wet areas sometimes found at the edges of ponds, lakes, and rivers, usually treeless and having plants with soft stems, grasses, rushes, and sedges.

pocosin: (peh • KOH • sehn) an inland swamp of the southeastern United States coastal plain.

prairie potholes: wetlands occurring in the North Central United States and South Central Canada that provide nesting grounds for waterfowl.

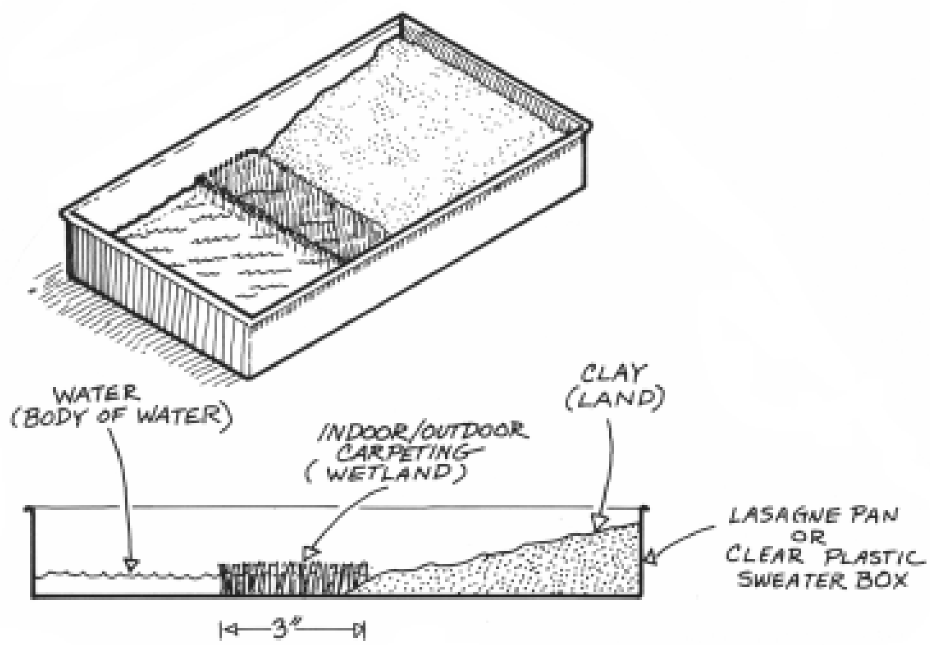
salinity: saltiness, or the amount of salt, in water or other liquids.

saltwater marshes: wetlands found in coastal areas; the transition zones between land and sea (the tide rises and falls in these marshes twice each day).

swamps: land (with saturated soils for some of the year) supporting a natural vegetation of mostly trees and shrubs.

ADVANCE PREPARATION

A. Spread a sloping layer of plasticene modeling clay in half of the lasagna pan or sweater box to represent land. Leave the other half of the pan empty to represent a lake or other body of water. Shape the clay so that it gradually slopes down to the body of water (see the diagram below). Smooth the clay along the sides of the pan to seal the edges.



B. Cut a piece of indoor-outdoor carpeting that will completely fill the width of the pan along the edge of the clay (see diagram). This will represent the wetland. Do not place the carpet into the model yet.

C. Use the enlargement capability of your school's photocopier to make copies of the small drawings on the teacher sheet "Wetland Pictures." Also, check your school or public library for books from which to get pictures. Travel or outdoor sports magazines are also good sources..

D. If you choose to do the word search puzzle in part IV. D, make a copy of the student sheet "Wonderful, Waterful Wetlands" for each student.

PROCEDURE

I. Setting the stage

A. Without giving the students a definition of wetlands, ask them to tell you what they think wetlands are. List their answers on the chalkboard and derive a definition from their answers.

B. Explain what a wetland is, comparing your definition with the students' answers. Stress that all wetlands have water-soaked soil, are covered with water at least part of the year, and support specialized plants that are adapted to life in wet conditions.

C. Show the students pictures of different kinds of wetlands and explain what they are. (NOTE: Use enlargements of those provided on the teacher sheet. If possible, get additional pictures from books or magazines.) Allow the students to compare the pictures (and definitions) to find the characteristics listed above.

II. Activity

A. Tell the students that until recently, most people did not consider wetlands to be important to our environment. Over the years, scientists have discovered that wetlands perform several vital functions for our environment.

B. Show the students the wetland model and explain what it and the clay represent. Explain to them that wetlands are complex systems and that no one yet knows exactly how they work. We do know, however, that there are three important functions wetlands perform; you will use your simplified model of a wetland to demonstrate these functions. (NOTE: For older students, you may adapt this procedure for cooperative groups. You may have them conduct it as an experiment.)

C. Begin the demonstration by pouring clear water slowly on the clay (this can represent rainfall, melting snow, drainage, etc.). Ask the students to describe what happens.

D. Drain the water back into the original container. Show the students the carpeting and, as you place it in the model, explain that it represents a wetland. Ask the students to predict what will happen when you pour the water onto the clay again.

E. Pour the same amount of water on the model again. Be sure to perform this exactly as you did before. Let the students describe what happens. (The water will drain more slowly into the body of water because it is now hindered by the wetland.) Explain that most wetlands are shallow basins that collect water and slow its rate of flow. Using the model, explain how this helps reduce flooding and prevent the deposition of eroded soil (sediment) in bodies of water. List these functions on the board.

F. Pour out the clear water. Leaving the carpet in place, pour some muddy water onto the clay. Ask the students to compare the water that flows through the wetland and into the body of water with the water left in the jar. Ask what happened. (Students should conclude that part of the soil in the muddy water was trapped by the wetland and that wetlands can act as a filter for sediment and some pollutants.) Add this function to the list on the board.

G. Remove the carpeting and repeat step F. Ask the students why all the soil particles end up in the body of water. The students should infer that without the wetland to act as a filter, most of the soil (and perhaps pollutants) flow directly into the body of water.

III. Follow-Up

A. Refer the students back to the list of wetlands characteristics written on the board. Review the definition of a wetland and the functions demonstrated. Ask questions such as "Why are wetlands important?" and "How can they help us?" Tell the students that wetlands are also important because they improve water quality, reduce erosion, provide habitats for a wide variety of wildlife and plants, help to store floodwaters, help to replenish groundwater during dry times, and provide recreation for many people to fish and hunt. They are also an important source of products such as seafood, rice, and timber.

B. Give each student a piece of construction paper. Have the students fold the paper in half, lengthwise. On one side of the fold, have them draw a picture of one of the demonstrations, and on the other side have them write a complete sentence telling what wetland function they have illustrated. For older students, you might want to reinforce paragraph writing by having them write a topic sentence about the important functions of wetlands and supporting sentences telling the functions that were demonstrated in Activity II.

IV. Extensions

A. If possible, take a field trip to a wetland near you. Include activities such as listing several types of plants or animals the students encountered, sounds they heard, and other observations. Back at school, extend these activities by having the students classify the types of animals, write a story or report about one of the animals, or illustrate one of the animals.

B. Divide the students into teams and provide each team with materials to create its own wetlands model. Have each team use measuring cups (NOTE: Canning jars with measurement marks work well for this) to measure an amount of water and add it to the model with carpet; then measure the amount of water that collects in the body of water. Have them repeat the experiment without the carpet, again measuring the water that runs off. They should repeat each step five times. Have them chart the measurements and compare them.

C. Acquire map(s) of wetlands in your area from the U.S. Geological Survey Earth/Science Information Center at 1-800-USA-MAPS (or the Canadian equivalent). Have the students research the type or types of wetlands most common in your area and report on the types of plants and animals found there.

D. To reinforce wetlands vocabulary, give each student a copy of the student sheet "Wonderful, Waterful Wetlands." Have the students find and circle the listed terms in the word search puzzle. A key is provided on the accompanying teacher sheet.

RESOURCES

"Wading Into Wetlands," NatureScope, Vol. 2, No. 5, National Wildlife Federation, Washington, DC, 1986.

"Wild About Wetlands," Nature Naturally (newsletter), Vol. 13, No. 3, Ida Cason Calloway Foundation, Pine Mountain, Georgia, 1990.

WETLAND PICTURES

MARSH

BOG

LAKE OR POND

SWAMP

RIVER OR STREAM

COASTAL WETLAND

WONDERFUL, WATERFUL WETLANDS

Find these words in the word search puzzle below. As you find each word, circle it, and mark it off the list. The words may go across, up and down, diagonally, or backwards.

animals
body of water
bogs
clean water
dry land
filters
flooding
freshwater marshes

habitats
important
mangrove swamps
plants
pocosins
pollution
prairie potholes
saltwater marshes

soil erosion
swamps
transition zone
water soaked soil
wetlands
wildlife

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E Z B A W C K S R F L O O D I N G R E T I S S A L
N T O M I F R M J A S O N M D B J B A L T J U Y M
O X N H L H A M J L W E E A T O C O S W A M P S E
Z O E C D H A B I T A T S W F G P D U L A D R A H
N D S B L I R E I H T E S T S S Q Y A W V P R P W
O R A G I E S O I L E R O S I O N O F C G O B X E
I E L U F C E U C O R G D A H P L F D L T C A F T
T S T A E G N R A C S R A T R E V W A E Y O T V L
I A W P A V D I D H O Y T A X B L A S A L S Y G A
S R A N I M A L S T A M A R B Q M T L N M I X S N
N R T R P E E D O U K S T N A L Y E A W B N I Q D
A Y E Y P S T B F R E S H W A T E R M A R S H E S
R U R C O E N M R R D C V A I K S R E T L I F A I
T G M I L M A A E D S N S C O R S M A E M Q F G K
U H A U L R T B A S O A A N Q B R W D R Y L A N D
L N R T U B R P R A I R I E P O T H O L E S B N O
E L S T T I O S E O L A R N Q X P N V F Q N J G R
Y U H M I E P N L R D Y A H C F W K W K R X W M G
S E E E O O M A N G R O V E S W A M P S N I P K H
B R S R N Y I E R Y U R O K C P L A N T S B R X W
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WONDERFUL, WATERFUL WETLANDS
ANSWER KEY

Find these words in the word search puzzle below. As you find each word, circle it, and mark it off the list. The words may go across, up and down, diagonally, or backwards.

animals
body of water
bogs
clean water
dry land
filters
flooding
freshwater marshes
habitats
important
mangrove swamps
plants
pocosins
pollution
prairie potholes
saltwater marshes
soil erosion
swamps
transition zone
water soaked soil
wetlands
wildlife

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E Z B A W C K S R F L O O D I N G R E T I S S A L
N T O M I F R M J A S O N M D B J B A L T J U Y M
O X N H L H A M J L W E E A T O C O S W A M P S E
Z O E C D H A B I T A T S W F G P D U L A D R A H
N D S B L I R E I H T E S T S S Q Y A W V P R P W
O R A G I E S O I L E R O S I O N D F C G O B X E
I E L U F C E U C O R G D A H P L F D L T C A F T
T S T A E G N R A C S R A T R E V W A E Y O T V L
I A W P A V D I D H O Y T A X B L A S A L S Y G A
S R A N I M A L S T A M A R B Q M T L N M I X S N
N R T R P E E D O U K S T N A L Y E A W B N I Q D
A Y E Y P S T B F R E S H W A T E R M A R S H E S
R U R C O E N M R R D C V A I K S R E T L I F A I
T G M I L M A A E D S N S C O R S M A E M Q F G K
U H A U L R T B A S O A A N Q B R W D R Y L A N D
L N R T U B R P R A I R I E P O T H O L E S B N O
E L S T T I O S E O L A R N Q X P N V F Q N J G R
Y U H M I E P N L R D Y A H C F W K W K R X W M G
S E E E O C M A N G R O V E S W A M P S N I P K H
B R S R N Y I E R Y U R O K C P L A N T S B R X W
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WHAT IS A SEPTIC TANK?

SUBJECTS:
Science, Math
TIME:
1 hour
MATERIALS:
- 1 plastic or aluminum container (6-8 inches deep)
- potting soil
- gravel
- ½ gallon paper milk carton, labeled "House"
- 1 quart paper milk carton, labeled "Septic Tank"
- plastic straws
- clay
- chart paper
- cup or container for water
- blackline master for "How a Septic Tank Works"
- tack or small nail

OBJECTIVES

At the end of this lesson, the students shall be able to do the following:

1. Identify, orally or in writing, the septic tank as a method of wastewater treatment;

2. Tell or write how a septic tank works;

3. Name, orally or in writing, the basic parts of a septic tank; and

4. Give an oral or written definition of the new terms: drain field, effluent, sludge, and septic tank.

BACKGROUND INFORMATION

Septic tanks are used to treat sewage in many rural areas that are not served by public sewers.

A septic tank is a large container usually made of concrete. The tank is buried underground at individual buildings.

Sewage flows through pipes that connect the septic tank to the building. The solids in the sewage sink towards the bottom of the tank where anaerobic bacteria break them down into carbon dioxide, methane, and water. The undigested residue (sludge) stays on the bottom of the tank. The effluent from the septic tank containing the remaining liquid waste flows through a piping network to a drainfield. Here, perforated pipes surrounded by gravel slowly release the wastewater into the soil where bacteria finish the treatment process.
Soil bacteria continue to destroy the remaining organic material in the effluent.

Solids (sludge) that remain at the bottom of the septic tank must be periodically pumped out and taken to a sewage treatment plant.

WHAT IS A SEPTIC TANK?

TERMS

drain field: the part of a septic system where the wastewater is released into the soil for absorption and filtration

effluent: treated wastewater, flowing from a lagoon, tank, treatment process, or treatment plant released to the environment.

sludge: solid material that isn't broken down by bacterial digestion which settles to the bottom of septic tanks or wastewater treatment plants; it must be pumped out and disposed of in landfills, application to land, or by incineration.

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."

wastewater: water that has been used for domestic or industrial purposes.

ADVANCE PREPARATION

A. Find a picture of a septic tank.

B. Construct a septic tank model. (See diagram.)

1. Fill an aluminum roasting pan or a large plastic storage container ½ full of potting soil.

2. House - Place a ½ gallon milk carton cut to a height of approximately six inches at one end of the container. Make a hole 2 inches from the base of the carton and insert a drinking straw. Seal the connection with clay or tape to prevent leakage.

3. Septic Tank - Cut a quart-sized milk carton to a height of three inches. On two opposite sides of the carton make a hole 2 inches from the base of the carton. Connect one hole to the straw that is attached to the house.

4. Make field lines as follows:

   a. Punch a large hole in one straw.

   b. Insert another straw horizontally through the hole and seal each end with clay.

   c. Punch a large hole near the end of this straw. Insert a straw in each hole. Seal the open ends with clay.

d. Using a tack or small nail, punch holes in each straw to allow drainage.

e. Connect the field lines to the septic tank by inserting the middle straw into the hole in the quart carton.

f. Test the system by pouring water into the house and checking for leaks as the water moves through the system. Use clay and or tape to seal any leaks.

g. Put a fine layer of gravel over the soil in the end of the container that represents the drain field.

h. Place the model in the container.

PROCEDURE

I. Setting the stage

A. Ask students to think of places wastewater can be found at school.

1. Make a list on chart paper.

2. Show students some drain pipes in school (under sinks).

3. Explain that wastewater must be treated to make it safe before it is discharged into the environment.

B. Show the students a picture of a septic tank.

1. Ask students:

a. What do you think this is?

b. What is it used for? Explain that it is a septic tank used to treat wastewater.

2. Tell students they are going to learn how a septic tank works.

II. Activities

A. Display the septic tank model and give the students time to examine it.

B. Explain each part of the model.

WHAT IS A SEPTIC TANK?

1. House - Wastewater leaves through a pipe, which is connected to the septic tank.

2. Septic Tank - Explain how solids (sludge) sink to the bottom and that liquids will flow into the field lines.

3. Field Lines - Field lines are placed on a bed of gravel. The wastewater seeps out of the holes in the field lines and passes through the gravel into the soil. Bacteria in the septic tank and in the soil destroy harmful organic material.

C. Demonstrate how the septic tank works by pouring water into the house and letting students observe as the water moves through the system.

III. Follow-Up

A. Give the students a copy of the blackline master, "How a Septic Tank Works."

1. Have the students label the parts of the septic tank system.

2. Use a blue crayon to color the path of wastewater movement through the system.

3. Use a brown crayon to illustrate sludge that settles in the septic tank.

B. Divide students into pairs. Ask each student to use the blackline master to tell his/her partner what happens to wastewater in a septic tank system.

IV. Extensions

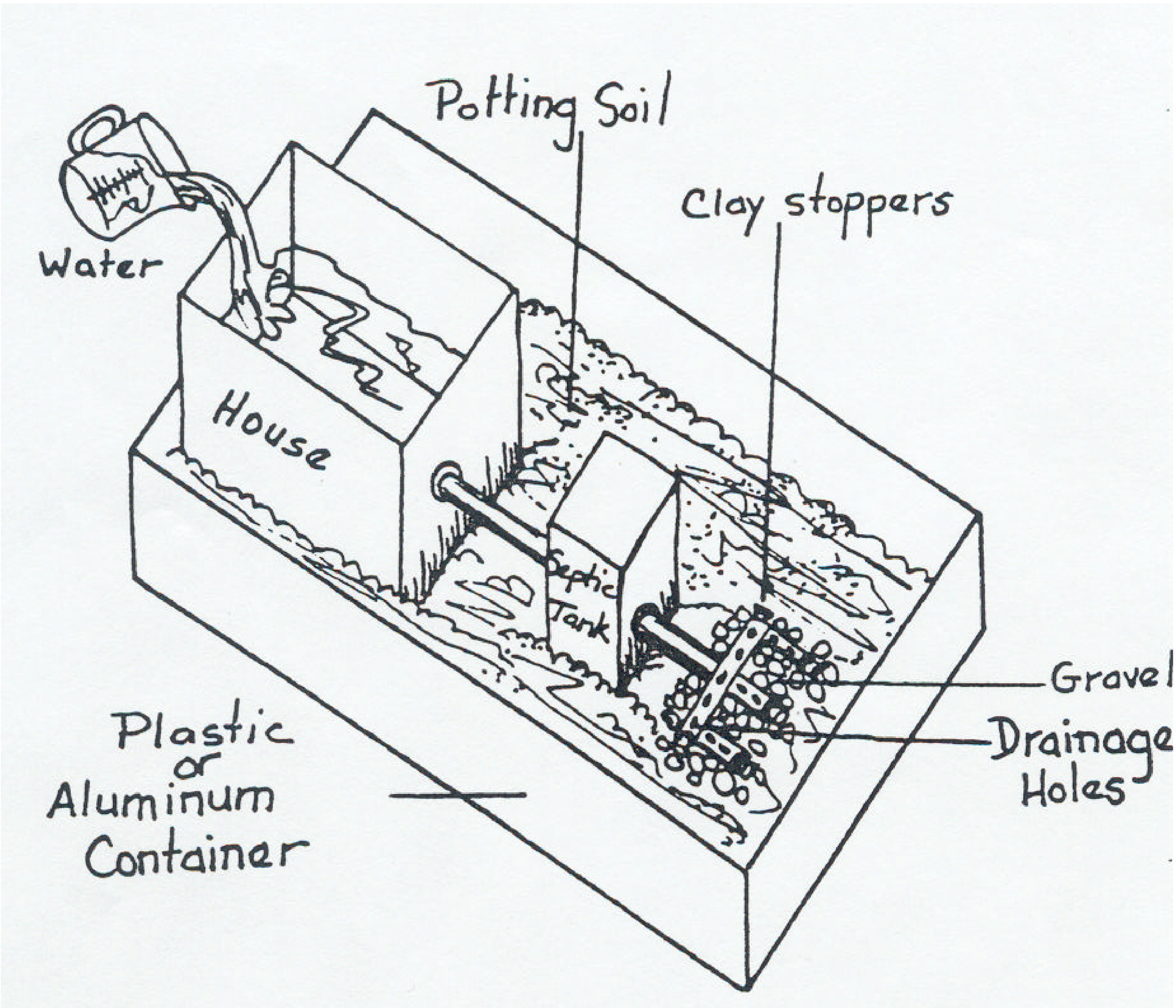
A. If possible, visit a site where a septic tank is being installed.

B. Ask each student to find out if his/her house has a septic tank for treating wastewater. Graph the results of the survey.

RESOURCE

Biddulph, Fred and Biddulph, Jeanne, <u>Getting Rid of Waste Water,</u> Wright Group.

Diagram

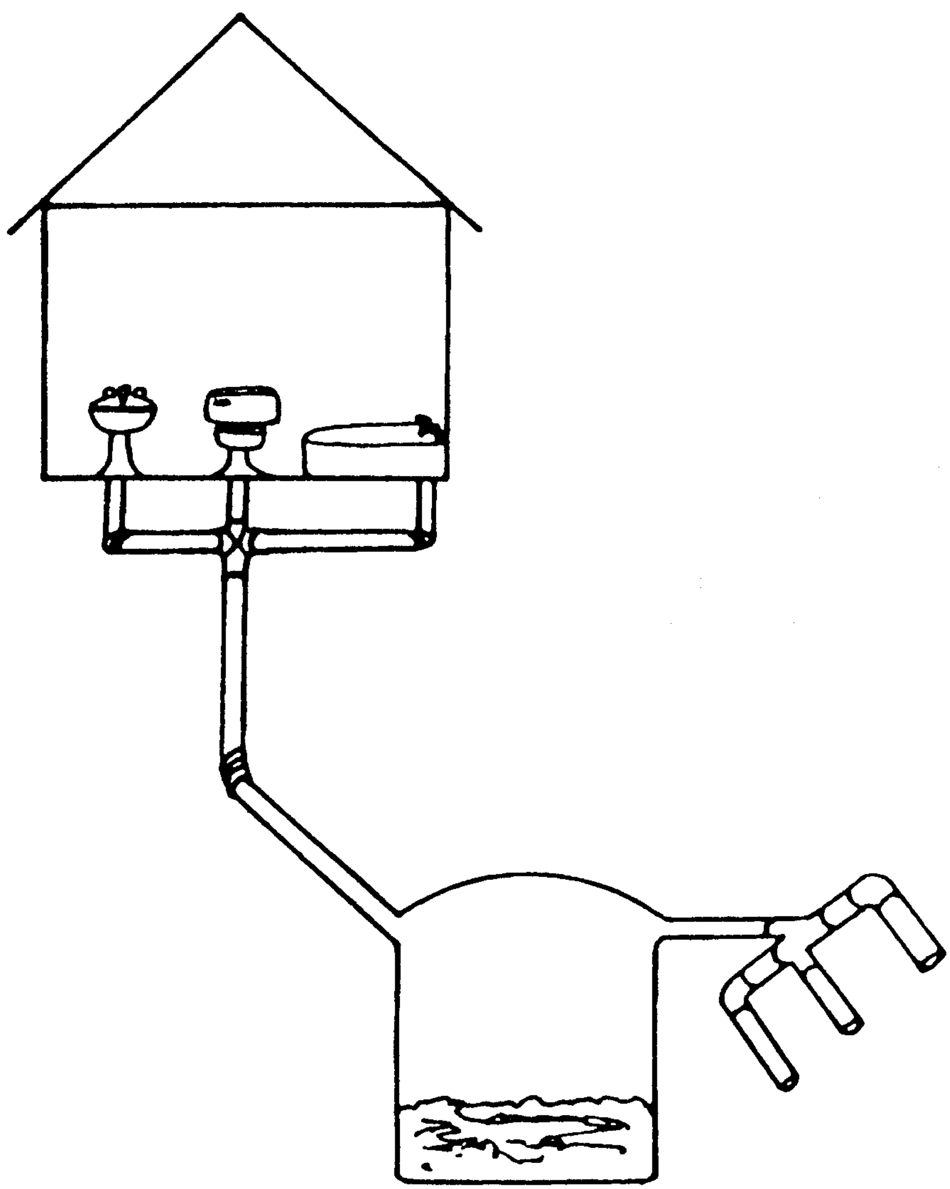

Potting Soil
Clay stoppers
Water
House
Septic Tank
Gravel
Drainage Holes
Plastic or Aluminum Container

How A Septic Tank Works

INSTRUCTIONS

1. Label the following:
   drainage pipes
   sludge
   septic tank
   field lines

2. Color the flow of the waste water blue.
   Color the sludge brown.



WATER WORKS

OBJECTIVES

The student will do the following:

1. Demonstrate the process that water treatment plants use to purify water for drinking by conducting a water purification experiment.

2. Describe what happens in the water treatment process by writing a story.

SUBJECTS:
Science, Social Studies, Language Arts

TIME:
120 minutes

MATERIALS:
1 gallon (4 L) jug of water
2 1/2 cups (600 mL) soil or mud
acetate sheet
four 2-liter plastic bottles
funnel
scissors
2 tablespoons (30 mL) of alum
2 tablespoons (30 mL) of bleach
2 cups (500 mL) fine sand
2 cups (500 mL) coarse sand
1 cup (250 mL) fine gravel
1 cup (250 mL) coarse gravel
1 cup (250 mL) activated charcoal
cotton for plug
tap water
a tablespoon
clock
student sheets (included)
tape recorder with tape (optional)
camera with film (optional)
teacher sheet (included)

BACKGROUND INFORMATION

Water treatment is the process of cleaning water and making it safe for people to drink. Because water is a good solvent it picks up all kinds of contaminants. In nature, water is not always clean and safe enough for people to drink.

Our drinking water comes from both surface and groundwater. Water in lakes, rivers, and swamps contains impurities that may make it look and smell bad. Water that looks clean may contain harmful chemicals or bacteria and other organisms that can cause disease.

In the past, waterborne diseases were a major public health concern but today these diseases are no longer a health threat in the United States because of the improved water treatment. Technicians working in drinking water facility laboratories make thousands of tests each year to insure that our drinking water supply is free of disease-causing bacteria. These test results are reported to the state and local governments.

It takes the efforts of both federal and state governments as well as local water supply systems to keep our drinking water safe and in good supply. The Safe Drinking Water Act and its amendments set the standards for public drinking water. The Environmental Protection Agency administers these standards.

Water treatment plants clean and maintain the quality of drinking water by taking it through the following processes: (1) aeration, (2) coagulation, (3) sedimentation, (4) filtration, and (5) disinfection (see definitions in "Terms" below).

<u>Terms</u>

aeration: to expose to circulating air; adds oxygen to the water and allows gases trapped in the water to escape; the first step in water treatment.

coagulation: the process by which dirt and other suspended solid particles are chemically "stuck together" so they can be removed from the water; the second step in water treatment.

disinfection: the use of chemicals and/or other means to kill potentially harmful microorganisms in the water; the fifth step in water treatment.

filtration: the process of passing a liquid or gas through a porous article or mass (paper, membrane, sand, etc.) to separate out matter in suspension; the fourth step in water treatment.

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.

sedimentation: the process that occurs when gravity pulls particles to the bottom of the tank; the third step in water treatment.

sludge: solid matter that settles to the bottom of septic tanks or wastewater treatment plant sedimentation tanks; must be disposed of by bacterial digestion or other methods or pumped out for land disposal or incineration.

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

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

ADVANCE PREPARATION

A. Make a copy of the diagram of a water treatment plant and water treatment word search puzzle for each student. You may use the diagram of a water treatment plant as a transparency.

B. Gather materials for demonstration of water treatment process.

C. Prepare "dirty water"; add approximately 2 1/2 cups (600 mL) of soil or mud to 1 gallon (4 L) of water.

D. Cut one 2-liter bottle in half, cut the bottom from another bottle, and cut the top from a third bottle.

E. Alum can be found at the grocery store in the spices section. It is commonly used for making pickles.

F. NOTE: You may want to construct the filter before beginning the activity or may choose to let a team of students prepare it. To prepare the filter use the bottle with its bottom cut off to construct the filter. Turn the bottle upside down. Loosely put a cotton plug in the neck of the bottle. Pour the fine sand over the cotton plug followed by activated charcoal, coarse sand, fine gravel, and coarse gravel. Clean the filter by slowly and carefully pouring through 1-2 gallons (4-8 L) of clean tap water.

PROCEDURE

I. Setting the stage

A. Ask the students the following questions.

1. How many of you used water in some way today?

2. How did you use water? (shower, brush teeth, flush toilet, prepare meal)

3. Where does your water come from?

4. How can you be sure your water is safe to drink?

B. Discuss the water treatment plant and what it does.

1. Hand out the diagram of a water treatment plant.

2. Discuss the process that takes place during each step. Use the definitions given to explain each step:

a. Aeration – Vigorously stirring up water to add air to it and drive out other gases that might be dissolved in it; similar to "whipping" it with a mixer (as in cooking).

b. Coagulation – Adding chemicals to make dirt and other particles clump together.

c. Sedimentation – Letting the clumps settle out (they're heavier than water, so they sink to the bottom).

d. Filtration – Pouring the water through a filtering system that has lots of layers of materials that trap things that did not settle out (including things too small to see).

e. Disinfection – Adding chlorine to kill germs that might make people sick (similar to swimming pool methods).

3. Write the letters A, C, S, F, and D on the board. Review with the students the words they stand for. Write simple-to-remember phrases for each one, such as:

a. A = Add air

b. C = Create clumps

c. S = Soil settles out

d. F = Fine filters to trap tiny things

e. D = Die, germs, die!

Leave these on the board while the class builds the model.

II. Activities

A. Review the diagram of the water treatment plant. Discuss with the students, checking for understanding. Allow for questions and comments from the students.

B. Divide the students into teams of four or five students. Each team will perform one step in the process. (Supervise closely.) Give Team I the materials and dirty water to start.

   1. Team I should pour about 1.5 quarts (1.6 L) of "dirty water" into the uncut 2-liter bottle with the cap. (Use a funnel) Ask the students to describe the water.

   2. Have a student in Team I put the cap on the bottle and shake for 30 seconds. Continue the aeration process by pouring the water back and forth between two bottles 10 times. Ask the students what part of the water treatment process we have demonstrated. (aeration) Ask the students to describe any changes they observe.

   3. Team II should pour the aerated water into the 2-liter bottle with the top cut off. Add 2 tablespoons (30 mL) of alum to the water. Stir the mixture slowly for 5 minutes. Ask the students what process this group has demonstrated. (coagulation) Ask the students to predict what will happen.

   4. Team III should allow the water to stand undisturbed for 20 minutes. Ask the students to observe the water at 5 minute intervals and record their observations as to changes in the appearance of the water. (NOTE: Other groups may do the student sheet word search during this time frame or Team IV may construct the filter from the bottle with its bottom cut off. If you prefer to construct the filter model yourself, you may do it now if you'd like.) Ask the students what step this is? (sedimentation)

   5. Team IV should carefully, without disturbing the sediment, pour the top two-thirds of the water through the filter. Ask the students what step this is. (filtration) Have them quickly rest the filter model in the 2-liter bottle cut in half to collect the filtered water.

   6. After waiting until you have collected more than half of the water poured through the filter, add 2 tablespoons (30 mL) of bleach to the filtered water. The bleach represents the chlorination process. (CAUTION: Wear eye protection when handling bleach and quickly wash it off your skin if some should splash.) This is <u>disinfection</u>. Ask the students: "Did we recover the same amount of water we started with?" Measure approximately. Discuss that there is a certain loss of usable water in the water treatment process.

C. Compare the treated and untreated water.

   1. Ask the students whether treatment has changed the appearance and smell of the water. How has it changed?

   2. Explain to the students that this is a simulation of the process that a water treatment plant does; therefore, this water is <u>not</u> safe to drink.

III. Follow-Up

A visit to the local water treatment plant is a valuable experience. If this is not possible, ask a representative from the water utility to visit the class.

A. As you tour the plant, use your A, C, S, F, and D memory devices to review the terms with the students.

B. Assign each student a responsibility to perform during the trip or visit. Develop assignments and questions in advance. You may use the student sheet, “Water Works.”

C. Send the contact person at the water treatment plant a copy of the assigned questions before the visit so he/she will be prepared for the group.

D. One student could also tape record the experience and another student could take photos for a visual record.

IV. Extensions

A. Have the students write a story or draw cartoons about “Betty Bacterium,” “Sediment Sam,” or other fictional characters and describe what happens to these characters as they go through the water treatment process.

1. Share the stories/cartoons with the class.

2. Use as a bulletin board activity to reproduce the water treatment process.

B. Ask the students to do the student sheet “Water Treatment Words” if you did not use it in the activity.

The answers to the word search are as follows:

```
a g b f o n i f g r o u n
r g r v u t s i d a o n i
d i c o a g u l a t i o n
s e n f u u n t t r a t s
m n s t a n a r t e f s a
u m n r u x d a r a s t e
s u r f a c e t n t i o r
m r t a f a c i l m s n a
s w a t e r a o a e o x t
n e b a v l o n m n a o i
b a c t o n b a c t t e o
s e d i m e n t a t i o n
a e l r o u s m f g o n t
```

RESOURCES

“Science Demonstration Projects in Drinking Water: Grades K-12,” U.S. Environmental Protection Agency, Washington, DC, 1990.

“The Official Captain Hydro Water Conservation Workbook,” East Bay Municipal Utility District, Oakland, California, 1982.

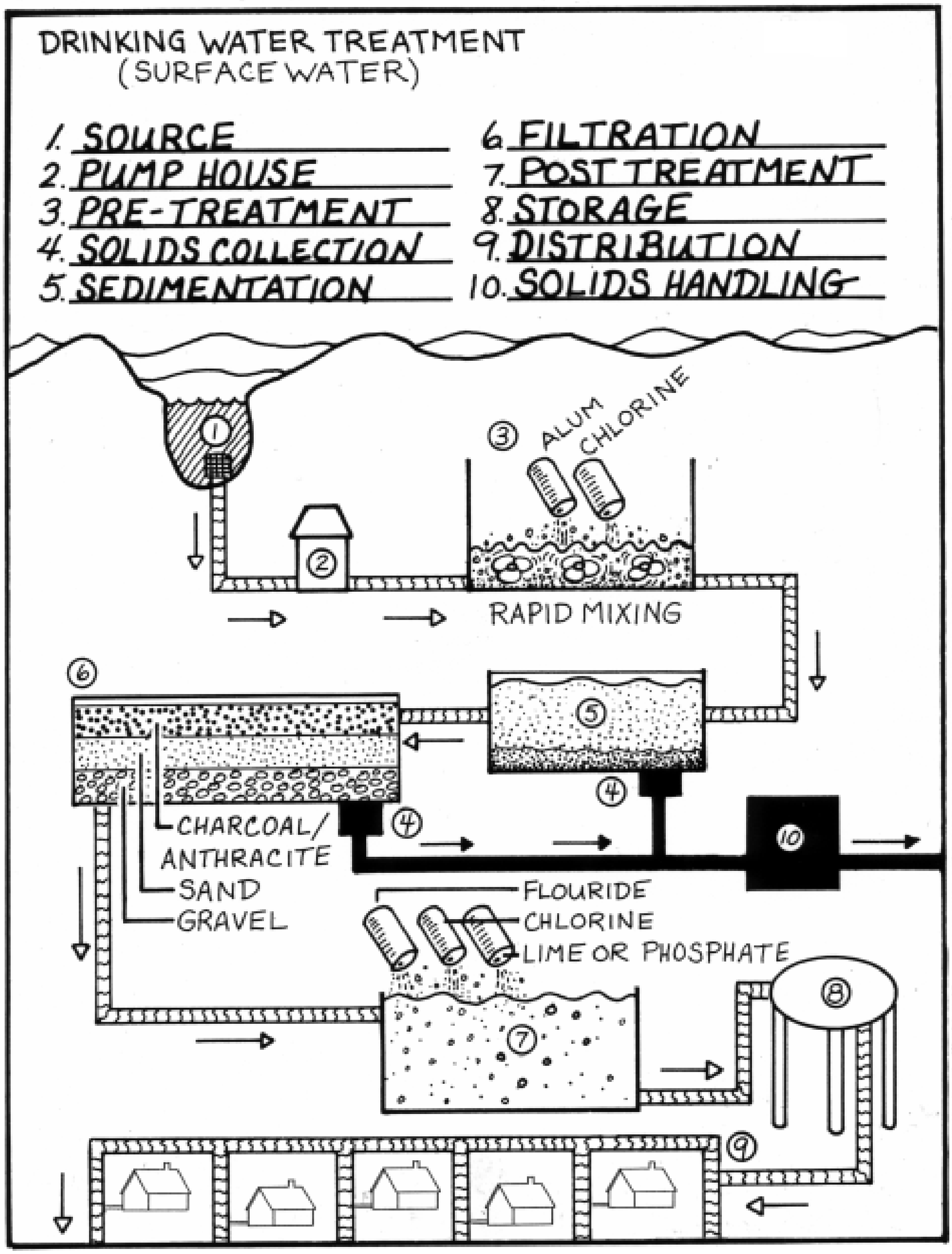
“The Story of Drinking Water” (student booklet), American Water Works Association, Denver, Colorado, 1984.

“The Story of Drinking Water: Teachers Guide, Intermediate Level, Grades 4, 5, 6,” 2nd ed., American Water Works Association, Denver, Colorado, 1988.

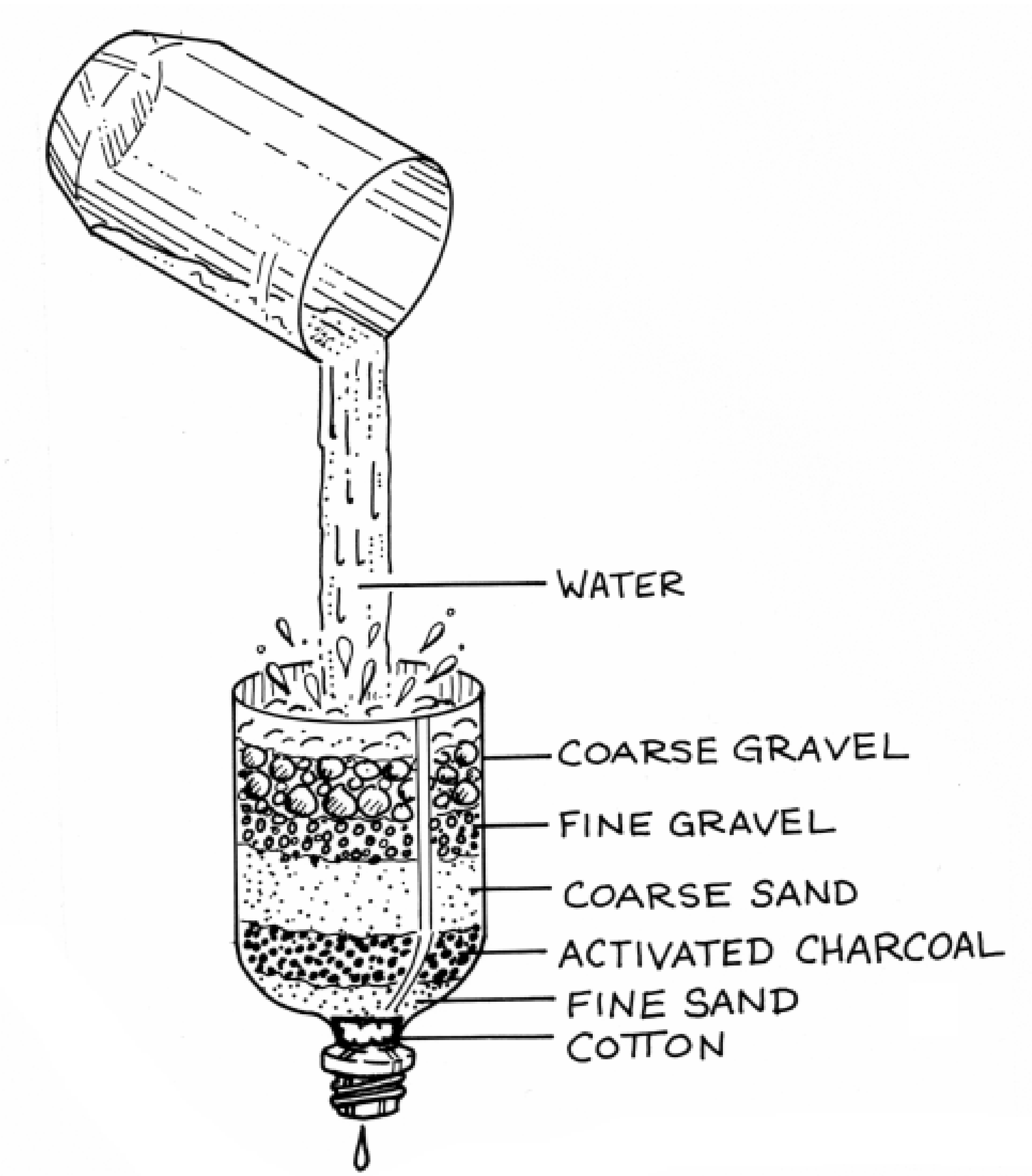
Student Sheet

DRINKING WATER TREATMENT PLANT

Student Sheet



FILTER MODEL



Answer the following questions.

1. Where does our water come from?

2. How much clean water is produced each day?

3. How is the water tested?

4. What is used to destroy bacteria in the water?

5. What are the future plans for the water treatment system? As our community

Can you find these words? Find the words, circle them, and check them off the list.

aeration
coagulation
filtration
water
treatment
sedimentation
surface
ground

a	g	b	f	o	n	i	f	g	r	o	u	n
r	g	r	v	u	t	s	i	d	a	o	n	i
d	i	c	o	a	g	u	l	a	t	i	o	n
s	e	n	f	u	u	n	t	t	r	a	t	s
m	n	s	t	a	n	a	r	t	e	f	s	a
u	m	n	r	u	x	d	a	r	a	s	t	e
s	u	r	f	a	c	e	t	n	t	i	o	r
m	r	t	a	f	a	c	i	l	m	s	n	a
s	w	a	t	e	r	a	o	a	e	o	x	t
n	e	b	a	v	l	o	n	m	n	a	o	i
b	a	c	t	o	n	b	a	c	t	t	e	o
s	e	d	i	m	e	n	t	a	t	i	o	n
a	e	l	r	o	u	s	m	f	g	o	n	t

PUDDLE PICTURES

PUDDLE PICTURES RULES

Teams: Teams consist of three students who will alternate drawing and guessing a water-related word.

Equipment: timer, watch or clock; chalkboard, wipe-off board or paper; chalk, markers or pencils

The following are rules for a "Puddle Pictures" tournament at the Festival, please adapt them for your classroom setting:

Each tournament session will last 25 minutes and will consist of four teams of three students. The games will be played in a bracket-type contest; in Round 1, Team A plays Team B; in Round 2, Team C plays Team D. Each preliminary round is 6 minutes long. The winner of the A-B round plays the winner of the C-D round in a 5-minute play-off to determine the "grand champion". Each student will receive something for playing and the winning team will receive a prize package.

The two teams will sit on chairs on a stage. An emcee, a timekeeper and a scorekeeper will run the game. A wipe-off board and markers will be used for the drawings.

To begin, the emcee will flip a coin to determine which team will go first. The emcee will show the first contestant from Team A a word. The contestant will have 1 minute to make a drawing that represents the word. Teammates may shout out possible answers. If the team answers correctly, they receive 2 points. If they do not know the answer, Team B has an opportunity to give an answer. If they answer correctly, they receive 1 point. If neither team can answer the question, the emcee reveals the answer and the turn is given to Team B. Students should take turns drawing on subsequent "turns".

Puddle Pictures words are included in this packet. However, the emcee will also use words that are not in the packet. (Note: in previous years, students have memorized all the words in the packet and then shouted out nearly every word listed, hoping to "get it" by chance. These other words will relate to water and the environment.) We want the contest to be FUN and challenging at the same time.

THE AUDIENCE - Students are encouraged to cheer for their classmates, but words will be thrown out if any answers are called or whispered from the audience. Booing of the other team is not allowed!

If you are bringing students older than 6th grade, they may not participate in the games.

Due to the complicated process in scheduling students into Festival activities, 4th grade students may be competing against 5th or 6th grade students. We hope this will not be a problem. In past years, some 4th grade students have competed equally with 6th graders.

PUDDLE PICTURES WORDS

• Irrigation	Landfill	Reservoir
• Run off	Evaporation	Rain
• Transpiration	River	Condensation
• Clay	Ship	Gravel
• Flow	Stream	Spash
• Canoe	Shower	Whirlpool
• Diving	Tide	Lake
• Tidal	Wave	Rain Gauge
• Waterfall	Dam	Rapids
• Hydroelectricity	Wave	Sea
• Surf	Ocean	Geyser
• Pipes	Tributary	Faucet
• Brook	Gallons	Watermelon
• Stream	Drink	Creek
• Watercolor	Liquid	Waterbed
• Cloudburst	Waterbug	Swimming
• Waterfowl	Fishing	Waterheater
• Skiing	Wash	Skating
• Wastewater	Moisture	Acid Rain
• Mist	Erosion	Vapor
• Fish	Thunderstorm	Fresh Water
• Sprinkler	Sea	Water
• Spray	Swamp	Bath Pond

APPENDIX

Other Ideas and Activities

- Prepare a bulletin board with some of the students' works during this unit. Or you may want a board displaying the uses of water, a section with newspaper and magazine clippings of water issues, photos of how water and living thing are related, or the one about water cycle.
- Have an art activity using water-based paints and sponges.
- Have the class put together a shadow box or diorama about water
- Have them write and perform a water play or puppet show for younger students.
- Take an erosion hike and spot examples of water damage, either natural or human made.
- Study water myths of the Native Americans or from other lands.
- Have the class develop their own classroom water laws and penalties - forgetting to turn off water, lose a recess period, letting the water get cold before drinking, write a conservation poem, etc.
- Have the class put together a saving water resolution and have it signed by the principal.
- Set up a display in the school cafeteria showing how water can be conserved by even the youngest students.
- Have a poster contest on saving water or with rules fro the pioneers to follow.
- Have the students study the source of their water supply, Is it in danger of being polluted? Study any polluted lakes, rivers, steams in your area. What are the effect that can be seen? What about those we don't see?
- Have a PR campaign with the students sending in letters to the editor, designing posters and bumper stickers, writing news stories about a water topic.
- See about volunteering as a class at a local lake or recreation area to do cleanup, etc.
- Write a letter to the city official in a major metropolitan area that uses groundwater as its major supply of water - Miami, Honolulu, San Antonio, Mexico City are a few. Study groundwater sources in other parts of the world.
- Study water pollution and the types of pollution - disease carrying agents, inorganic and organic chemicals, plant nutrients, sediment, heat, radioactive substances, oxygen demanding waste, synthetic organic chemicals.
- Develop an environmental and/or water textbook of clippings from newspapers, magazines, etc. Keep them in a loose leaf notebook (Don't forget cartoons!). Be sure articles are labeled with the newspaper, date, and page number. Have the students write a summary or interpretation of the articles.
- Make a sediment dam in a bottle with an empty pop bottle. Pour in a few tablespoons of soil and the rest with tap water. Shake the bottle to show how sediment mixes with water, but when left alone for several hours, the sediment will setting to the bottom of the bottle just like it does in a sediment dam.
- Get some maps of the watershed your school is located from www.epa.gov/surf/.
- Have an engineer visit and discuss how and why dams are built. Ask for a cross-section of a dam.
- Get a floodplain map of your town from www.ci.huntsville.al.us/maps/.
- Display the included water quotes around your classroom. Can the students make up some quotes of their own of find others?
- Set up a learning center using the worksheets in this text.

Water Drops

Science Fun for Kids in the Water Environment — Fall 1996

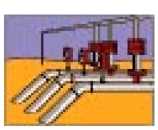
WATER POLLUTION

What is it? Have you ever walked by a stream or lake and seen trash floating on top of the water? Have you sometimes wondered what it was and where it came from? If you have, then you have seen water pollution. Water pollution is any substance introduced into a river, stream, lake, or ocean that harms the natural resources found in those environments. Sometimes water pollution is visible man-made objects such as plastic bags, plastic soda rings, fishing lines, balloons, and even shoes. Other times water pollution is invisible. Fertilizers from farms and chemicals from factories are two causes of water pollution which are hard to see. Sometimes, everyday activities such as flushing the toilet, washing dishes, washing our cars, or watering our lawns, also cause water pollution.

Where does it come from? Water pollution comes from several sources and is connected to the water cycle. Water pollution can come from direct human activities such as dumping trash and chemicals into the water, or it can be picked up through the water cycle. Imagine the path taken by a drop of rain from the time it hits the ground to when it reaches a river, ground water, or the ocean. As water runs over land it picks up pollutants from farms, streets and lawns. As it moves through the ground it may come in contact with pollutants that have leaked from landfills, illegal dumps or chemical spills. Also, water can pick up pollutants that were discharged directly into streams, rivers, or lakes by some businesses and manufacturing facilities. In the atmosphere, water vapor may form around pollutants from cars, factory smokestacks, and other pollution sources. When this water falls to Earth any pollutant that it picked up along the way can become part of the water pollution problem.

COMMON SOURCES OF WATER POLLUTION

Can you name them?

1.


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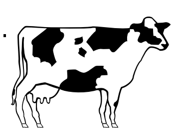
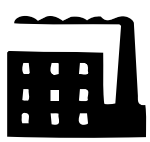


3.


4.


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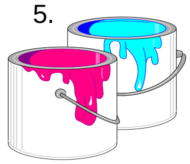
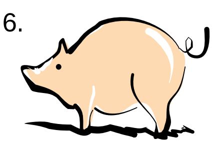


6.


7.


8.


YOU AND PLANET EARTH

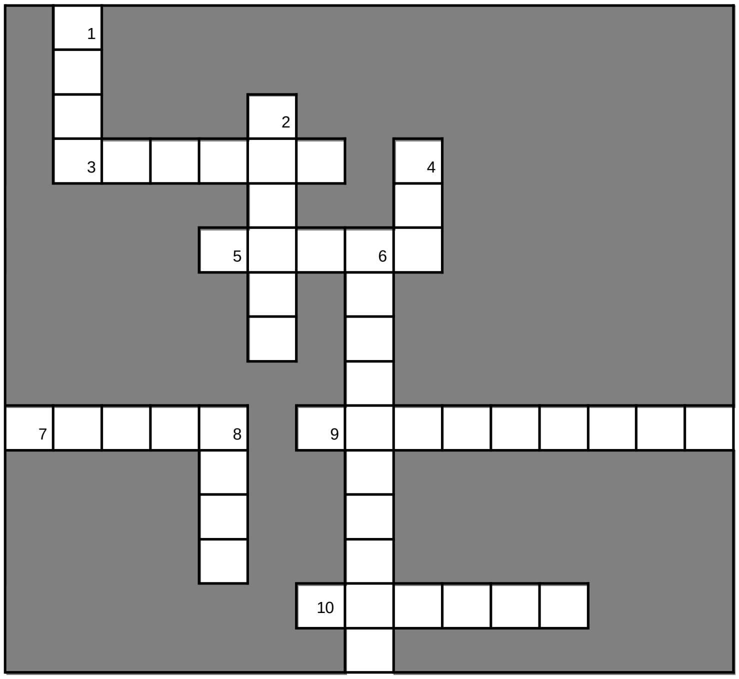
All living things - people, plants, and animals - depend on water. It is up to all of us to help keep our water clean. If we don't, our waters can become unsafe for swimming, fishing, and drinking. There is an abundance of water on Earth, but all the water in the world won't benefit us unless it is clean.

There are many ways to keep our waters clean. For example, planting plants and trees along streams and riverbanks, disposing of household chemicals properly, conserving water whenever possible, recycling, and properly disposing trash can help keep our waters clean. Communities and businesses help keep our water clean by building wastewater treatment plants in our home towns and at factories. These plants treat water by killing germs and bacteria and removing harmful chemicals.

So, the next time you wash a car, play near a stream, or take a bath, think about what is going to happen to the water that you are using right now. The water that you use today will be the same water that someone else will use tomorrow. Therefore, we must all do our part to keep our supply of water clean.

POLLUTION PUZZLE

How many clues can you figure out?



by Kyle Harrington

ACROSS

3. Wood comes from a _________.
5. Two-thirds of the earth is covered with ___________.
7. A __________ is formed when water evaporates.
9. __________ destroys oceans, kills plants and wildlife, and is bad for our earth.
10. The Sahara is a famous ________.

DOWN

1. A __________ between two cultures.
2. A piece of land surrounded by water on all sides is an __________.
4. A lark flew into the __________.
6. When water on earth returns to the atmosphere, it ___________.
8. Soil is another word for ________.

WORD FIND...

Words about water pollution are hidden in the block below. Words are hidden vertically, horizontally, or diagonally. See if you can find them.

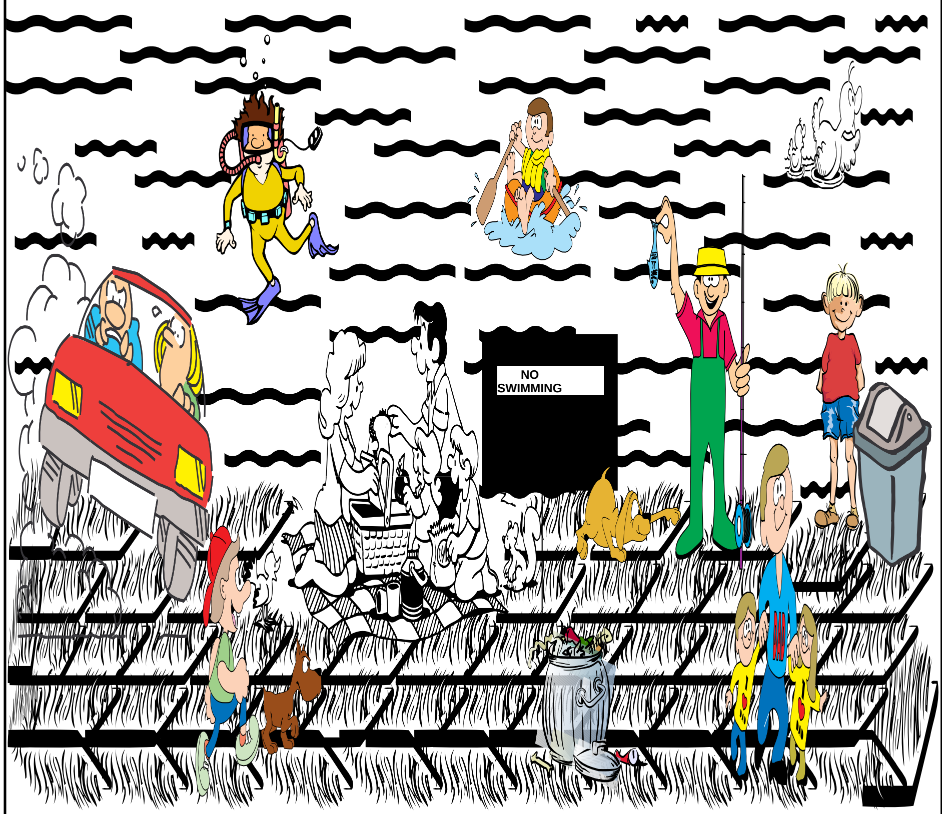
by Gregory Maheu

J	I	N	G	O	L	I	N	K	O	L	O	P	J	A	K	E	N	I	K	E	L
S	I	N	O	M	E	P	E	Y	G	S	O	O	C	E	A	N	N	O	T	I	N
D	K	O	N	E	F	I	N	N	K	Y	L	O	M	O	R	K	O	A	B	L	R
R	M	O	I	B	A	T	I	F	I	N	R	I	V	E	R	T	S	W	H	A	T
I	I	E	A	P	L	M	E	R	E	S	P	E	C	T	I	E	R	R	I	N	Y
N	R	S	R	E	M	A	L	W	A	T	E	R	L	Y	N	C	O	I	L	D	G
K	A	D	O	I	G	A	F	P	O	N	D	N	G	M	E	P	L	E	A	S	E
I	E	J	W	F	R	B	E	B	O	U	N	G	I	N	G	R	C	P	N	O	Q
N	S	S	M	O	E	A	H	A	N	D	L	A	K	E	E	I	R	E	A	L	L
G	S	T	I	P	E	I	N	G	B	L	A	H	H	T	R	I	C	K	F	L	O
P	O	N	M	S	E	Q	U	A	P	O	L	L	U	T	I	O	N	L	U	P	N
R	N	G	T	H	E	C	O	P	I	P	L	Q	L	A	M	O	M	O	L	I	N

Hidden Words: rain; ocean; water; drinking; sea; pollution; ice; swimming; river; lake; pond; respect

Games and Puzzles contributed by: *Students from the Aquinas Montessori School in Alexandria, Virginia.*

Can you identify three things wrong with this picture?



Nature

Nature is a home for most animals.
Nature has clean water for animals to live.
Nature is a cheerful place, quiet and sweet.
Nature had become a destroyed place.
Nature has been hunted a lot and animals shot.
Nature is a place you can love.
Help nature be a place with no trash.
Nature can be pretty, help please.
That was nature talking to me.
Listen to nature and help.
Nature can have beauty.

by Jennifer Metcalf

Trash Hurts Animals

Animals can be harmed by water pollution. Sometimes animals get entangled in trash found in oceans, lakes, and streams. Entanglement can impair an animal's ability to swim, which can cause drowning or difficulty in moving about, finding food, and escaping predators. Animals, like sea turtles and fish, often mistake trash items for food. Once eaten, items such as plastic bags, balloons, and plastic resin pellets can interfere with feeding habits and digestion.

Chemicals and other toxic pollutants are also considered trash. Chemicals dumped by man into rivers, lakes, streams, and oceans harm animals by polluting the habitat in which these creatures live. As a result, animals may not be able to find clean water to drink or get clean oxygen from the water to breath.

You can help nature's creatures by helping to keep trash and other pollutants out of the water cycle. You can also get involved in local water clean-ups at your school or community. To help keep nature's animals safe, it is up to you to get involved and to take action to preserve our most precious resource - ***clean water***.

WHAT YOU CAN DO TO HELP KEEP OUR WATER CLEAN...

Take part in regional river, lake, or coastal cleanup campaigns.

Alternative or recyclable materials should be used when possible.

Keep trash with you when on a boat or beach, then dispose of it properly.

Educate yourself and others about water conservation issues.

Always throw unwanted fishing line in a trash can, not in the water.

Cut loops from six-pack soda rings before disposing of them.

Toilets are not to be used to dispose of trash of any kind.

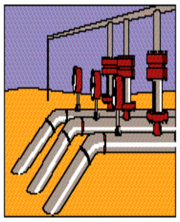
If your family and friends pollute, teach them how to properly dispose of trash.

Offer help to environmental and conservation groups and participate in community projects.

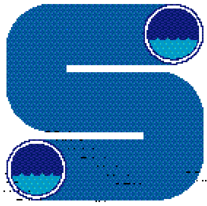
Notify your parents or the Coast Guard if you see boats dumping trash into the water.

Which of these items are part of the **Water Pollution Solution?** *Which ones are not?*

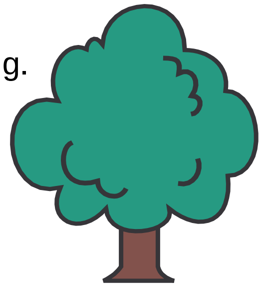
a.



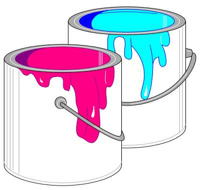
d.



g.



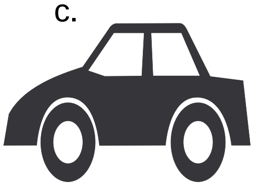
b.



e.

h.

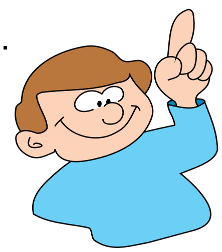
c.



f.

THINK GLOBALLY, ACT LOCALLY

i.



Answer Key:

Pollution Sources:
1. Manufacturing
2. Farming (Grazing)
3. Household Products
4. Factory
5. Paint
6. Farming
7. Littering
8. Car Exhaust

Word Find:

J	I	N	G	O	L	I	N	K	O	L	O	P	J	A	K	E	N	I	K	E	L
S	I	N	O	M	E	P	E	Y	G	S	O	O	C	E	A	N	N	O	T	I	N
D	K	O	N	E	F	I	N	N	K	Y	L	O	M	O	R	K	O	A	B	L	R
R	M	O	I	B	A	T	I	F	I	N	R	I	V	E	R	T	S	W	H	A	T
I	I	E	A	P	L	M	E	R	E	S	P	E	C	T	I	E	R	R	I	N	Y
N	R	S	R	E	M	A	L	W	A	T	E	R	L	Y	N	C	O	I	L	D	G
K	A	D	O	I	G	A	F	P	O	N	D	N	G	M	E	P	L	E	A	S	E
I	E	J	W	F	R	B	E	B	O	U	N	G	I	N	G	R	C	P	N	O	Q
N	S	S	M	O	E	A	H	A	N	D	L	A	K	E	E	I	R	E	A	L	L
G	S	T	I	P	E	I	N	G	B	L	A	H	H	T	R	I	C	K	F	L	O
P	O	N	M	S	E	Q	U	A	P	O	L	L	U	T	I	O	N	L	U	P	N
R	N	G	T	H	E	C	O	P	I	P	L	Q	L	A	M	O	M	O	L	I	N

Crossword:

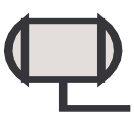
Across:
3. Forest
5. Water
7. Cloud
9. Pollution
10. Desert

Down
1. Gulf
2. Island
4. Air
6. Evaporates
8. Dirt

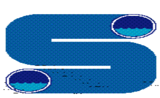
Water Pollution Solution:
a. No - Factory pollution
b. No - Household chemicals
c. No - Car exhaust
d. Yes - Sewage treatment
e. Yes - Recycle, reuse
f. Yes - Get Involved
g Yes - Plant trees to keep soil in place
h. Yes - Place litter in a trash can
i. Yes - You can make a difference

Picture Puzzle:
1. Car by the lake polluting the air
2. Overflowing trash can near the water
3. People swimming in a "No Swimming" area

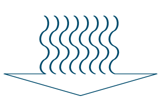
How Does Wastewater Get Clean?



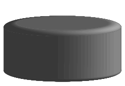
Sanitary Sewer System. Wastewater from homes, stores, and businesses runs through a large pipe that connects drain pipes to a large main sewer. This system collects waste water from all parts of the city and sends it to a wastewater treatment plant for cleaning and disposal.



Screening Process. A large screen placed in a screening tank removes large solids such as sticks, rags, and cans from the water as it moves through the screening chamber.

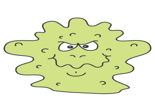


Grit Chamber. Particles such as gravel, seeds, and small stones settle to the bottom of this tank and are removed.

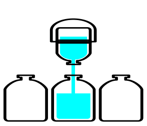


Settling Tank. Smaller solids are given time to sink to the bottom where they form primary sludge which is sucked out and sent to a sludge digester.

Aeration Tank. In this tank, oxygen and bacteria are added to the water to destroy any remaining wastes.



Clarifier. Another large tank where the well-fed bacteria from the aeration tank sink to the bottom as secondary sludge. Sludge is treated and converted to biosolids used for fertilizers and soil conditioners.



Disinfection Treatment. At this point, water is disinfected with chlorine or other chemicals. The treated wastewater is then either sent to advanced treatment or is discharged into seas, rivers, or the ground. The primary sludge is then dried out and composted for use as fertilizer or soil conditioner.

More Than Just A Swamp — Grade 4-5

Activity Description
To facilitate an understanding of wetlands by reading information on wetlands and completing puzzle. Grades 4-5

Introduction:
Wetlands are very important to the well-being of many plants and animals, including people. But what are these areas, and what do they do? A Wetland is the area between dry land and open water. It is sometimes covered with a shallow layer of water, but there are also wetlands which can be dry for part of the year. The plants and animals which live there are adapted to this watery environment. There are many different types of wetlands.

Wetland Types

Swamp - Wetland where trees and shrubs grow which are flooded and rivers that experience both wet and dry periods during the year. They are often forested.

Marsh - Marshes are the wet areas filled with a variety of grasses and rushes. They can be found in both freshwater areas and in the saltwater areas near our coast.

Pocosin - These are the wet areas with evergreen trees and shrubs growing on peat or sandy soils. Peat is a spongy-feeling material made up of decaying plants. The word pocosin comes from the Algonquin Indian word meaning "swamp on a hill."

Wetland Functions

Flood Control - Excess water from heavy rains is slowed by wetland plants and stored in the low-lying areas of wetlands, preventing the waters of nearby rivers and streams from overflowing and damaging property.

Storm Buffer - Along our coast, wetlands take a beating from high winds and waves, yet remain intact. The thick vegetation buffers the forces of storms and protects the land from erosion.

Water Banks - Wetlands hold water during the wet season. This water seeps through the soil and into our underground water supplies.

Water Filter - Wetlands help purify runoff waters which carry pollutants. Silt and soil, which choke aquatic life, settle out. Wastes are broken down and absorbed by aquatic plants, as are many harmful chemicals.

***Nurseries* -** Many fish and animals use wetlands as nurseries. They provide an abundant supply of food and shelter for they young.

***Home Sweet Home* -** Wetlands are home to many animals. A thriving wetland probably has more life in it than any other kind of habitat.

***Wildlife Pantry* -** Wetlands are so productive, many animals depend on them for food. Many migrating birds stopover in wetlands each spring and fall to rest and feed before continuing their trip, and some will spend the winter in the wetlands.

***Recreational Opportunities* -** Wetlands provide us with places to watch birds and animals, and to fish, boat, and hunt.

***Economics* -** Commercial fisherman depend on the wetlands to supply us with crabs and many other types of seafood.

Wetlands in Danger!

More than half of the U.S. wetlands have been lost since the 1600's. They have been drained to make farm fields, or filled for developments or dredged for waterways. Wetlands become “drylands” when people fill them, build dams, or divert the water that feeds these areas.

In the past wetlands were considered useless wastelands. Now we know that they are very valuable to people and wildlife. Changing opinions are resulting in new laws to help save wetlands, but there is still much work to be done to stop the destruction and to restore our wonderful wetlands.

Wetland's Crossword

Name:____

Test your wetlands knowledge by completing this wetlands crossword puzzle.

Across

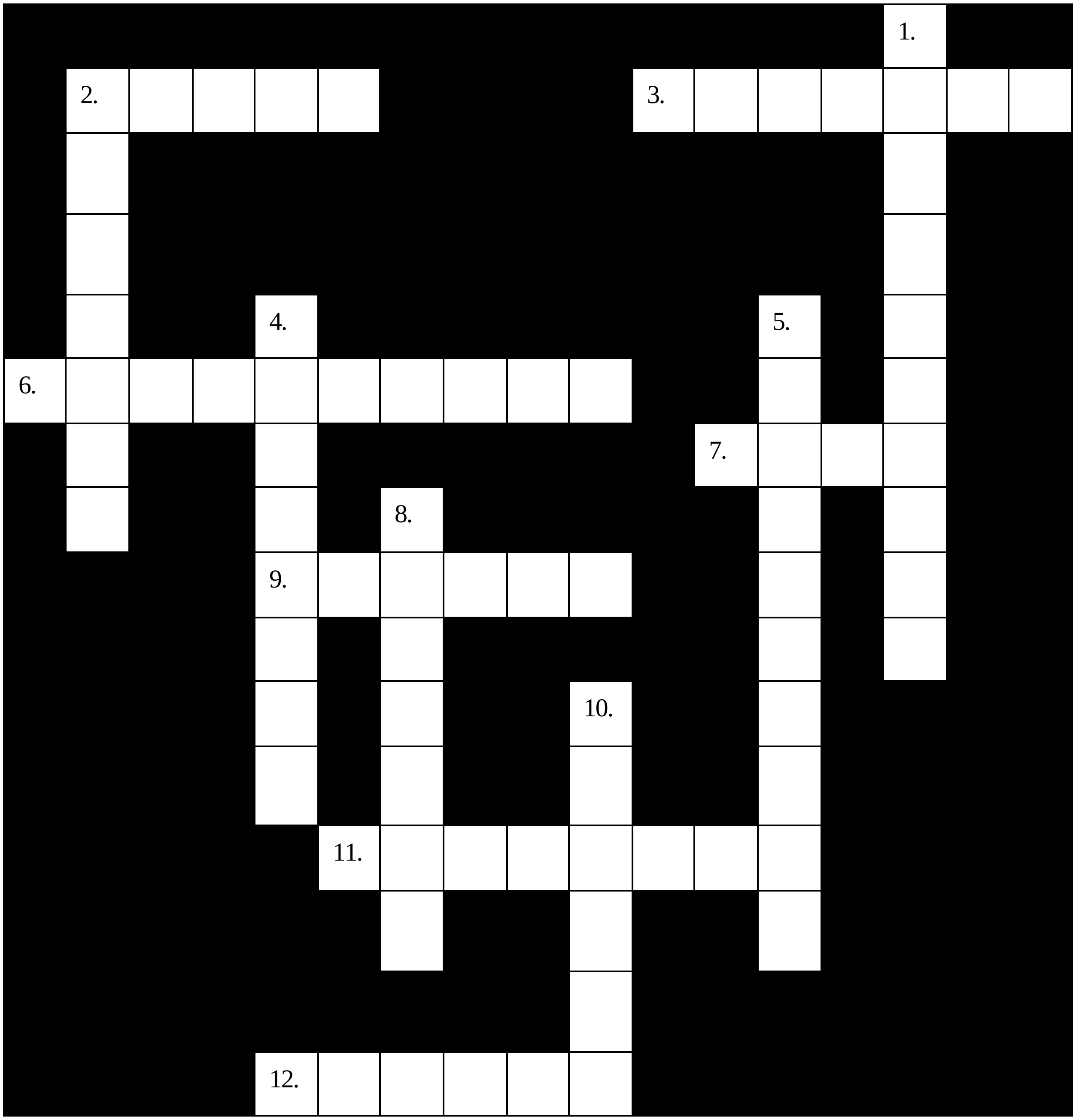
2.__________are wetlands that are flooded with water for most or all of the year, and are vegetated with trees and shrubs.
3. A use of wetlands for food and cover by young fish and other animals.
6. A wetland type found along streams and rivers. They are flooded for part of the year and dry for part of the year.
7. The type of soil often found in pocosin wetlands. It is made up of decayed plants.
9. Peat soil feels ____________.
11. Many kinds of __________use wetlands for sources of food, resting sites, and cover.
12. Wetlands along the coast may lesson the damage caused by storms, and protect land from erosion since they function as a _________.

Down

1. A use of wetlands by people.
2. Commercial fishermen depend on wetlands to supply us with _________to eat.
4. Bottomland wetlands are often ____________.
5. A ___________ marsh does not contain salty water.
8. A wetland type with evergreen trees and shrubs. This word means "swamp on a hill" to the Algonquin Indians.
10. Wetlands have the ability to remove, or ________ out, pollutants from water.

Wetland's Crossword

Name:____



Answers:

Across - 2.swamp; 3. nursery; 6. bottomland; 7. peat; 9. spongy; 11. wildlife; 12. buffer
Down - 1. recreation; 2. seafood; 4. forested; 5. freshwater; 8. pocosin; 10. filter

SAMPLE ACTIVITY

from

The Water SourceBook

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Please fill out the following questionnaire and return to:

Anne W. Burkett
Madison County Commission
Department of Planning and Economic Development
100 Northside Square
Huntsville, AL 35801-4820
532-3704 (fax)

1. What is your overall reaction to this packet?

____

____

____

2. Was it useful? Why or why not?

____

____

____

3. Were there any activities that were hard to understand, incomplete, or otherwise unusable? Which one(s) and why?

____

____

____

4. How could this packet be improved to better suit your needs?

____

____

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5. Other comments:

____

____

____