Kentucky's Wonderful Commonwealth of Water:

A Standards Based, Integrated Curriculum for Teaching Water Quality Issues in Kentucky

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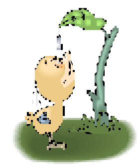
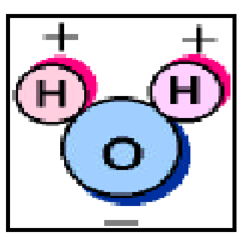


Looking at water, you might think that it's the most simple thing around. Pure water is colorless, odorless, and tasteless. But it's not at all simple and plain and it is vital for all life on Earth. Where there is water there is life, and where water is scarce, life has to struggle or just "throw in the towel." So what is it about water that makes it so important to us? And what is it about water that makes it water? This section explores the physical and chemical properties of water and why water is so critical to living things.

Water Properties

Water's Chemical Properties

You probably know water's chemical description is H_2O. As the diagram below shows, that is one atom of oxygen bound to two atoms of hydrogen. The hydrogen atoms are "attached" to one side of the oxygen atom, resulting in a water molecule having a positive charge on the side where the hydrogen atoms are and a negative charge on the other side, where the oxygen atom is. Since opposite electrical charges attract, water molecules tend to attract each other, making water kind of "sticky." (If the water molecule here looks familiar, remember that everyone's favorite mouse is mostly water, too).



Water’s physical properties

- Water is unique in that it is the only natural substance that is found in all three states -- liquid, solid (ice), and gas (steam) -- at the temperatures normally found on Earth. Earth's water is constantly interacting, changing, and in movement.
- Water freezes at 32° Fahrenheit (F) and boils at 212° F (at sea level, but 186.4° at 14,000 feet). In fact, water's freezing and boiling points are the baseline with which temperature is measured: 0° on the Celsius scale is water's freezing point, and 100° is water's boiling point. Water is unusual in that the solid form, ice, is less dense than the liquid form, which is why ice floats.
- Water has a high specific heat index. This means that water can absorb a lot of heat before it begins to get hot. This is why water is valuable to industries and in your car's radiator as a coolant. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.
- Water has a very high surface tension. In other words, water is sticky and elastic, and tends to clump together in drops rather than spread out in a thin film. Surface tension is responsible for capillary action, which allows water (and its dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies.
- Here's a quick rundown of some of water's properties:
  - Weight: 62.416 pounds per cubic foot at 32°F
  - Weight: 61.998 pounds per cubic foot at 100°F
  - Weight: 8.33 pounds/gallon, 0.036 pounds/cubic inch
  - Density: 1 gram per cubic centimeter (cc) at 39.2°F, 0.95865 gram per cc at 212°F

By the way:
1 gallon = 4 quarts = 8 pints = 128 ounces = 231 cubic inches
1 liter = 0.2642 gallons = 1.0568 quart = 61.02 cubic inches
1 million gallons = 3.069 acre-feet = 133,685.64 cubic feet

Common water measurements

The U.S. Geological Survey has been measuring water for decades. Millions of measurements and analyses have been made. Some measurements are taken almost every time water is sampled and investigated, no matter where in the U.S. the water is being studied. Even these simple measurements can sometimes reveal something important about the water and the environment around it.

Taking a single measurement of a water's properties is actually less important than looking at how the properties vary over time. For example, if you take the pH of the creek behind your school and find that it is 5.5, you might say "Wow, this water is acidic!" But, a pH of 5.5 might be "normal" for that creek. It is similar to how my normal body temperature (when I'm not sick) is about 97.5 degrees, but my third-grader's normal temperature is "really normal" -- right on the 98.6 mark. As with our temperatures, if the pH of your creek begins to change, then you might suspect that something is going on somewhere that is affecting the water, and possibly, the water quality. So, often, the ***changes*** in water measurements are more important than the actual measured values. pH is only one measurement of a water body's health; there are others, too.

Water temperature

Water temperature is not only important to swimmers and fisherman, but also to industries and even fish and algae. A lot of water is used for cooling purposes in power plants that generate electricity. They need cool water to start with, and they generally release warmer water back to the environment. The temperature of the released water can affect downstream habitats. Temperature also can affect the ability of water to hold oxygen as well as the ability of organisms to resist certain pollutants.

pH

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidity/basicness of the water. Water with a pH of 5 is ten times more acidic than water having a pH of six.
Pollution can change a water's pH, which in turn can harm animals and plants living in the water. For instance, water coming out of an abandoned coal mine can have a pH of 2, which is very acidic and would definitely affect any fish crazy enough to try to live in it! By using the logarithm scale, this mine-drainage water would be 100,000 times more acidic than neutral water -- so stay out of abandoned mines.

Specific conductance

Specific conductance is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water. Pure water, such as distilled water, will have a very low specific conductance, and sea water will have a high specific conductance. Rainwater often dissolves airborne gasses and airborne dust while it is in the air, and thus often has a higher specific conductance than distilled water. Specific conductance is an important water-quality measurement because it gives a good idea of the amount of dissolved material in the water. Probably in school you've done the experiment where you hook up a battery to a light bulb and run two wires from the battery into a beaker of water. When the wires are put into a beaker of distilled water, the light will not light. But, the bulb does light up when the beaker contains salt water (saline). In the saline water, the salt has dissolved, releasing free electrons, and the water will conduct an electrical current.

Turbidity

Turbidity is a measure of the cloudiness of water. It is measured by passing a beam of light through the water and seeing how much is reflected off particles in the water. Water cloudiness is caused by material, such as dirt and residue from leaves, that is suspended (floating) in the water. Crystal-clear water, such as Lake Tahoe (where they work hard to keep sediment from washing into the lake) has a very low turbidity. But look at a river after a storm -- it is probably brown. You're seeing all of the suspended soil in the water. Lucky for us, the materials that cause turbidity in our drinking water either settle out or are filtered before the water arrives in our drinking glass at home. Turbidity is measured in nephelometric turbidity units (NTU).

Dissolved oxygen

Although water molecules contain an oxygen atom, this oxygen is not what is needed by aquatic organisms living in our natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. This dissolved oxygen is breathed by fish and zooplankton and is needed by them to survive.
Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, while stagnant water contains little. The process where bacteria in water helps organic matter, such as that which comes from a sewage-treatment plant, decay consumes oxygen. Thus, excess organic material in our lakes and rivers can cause an oxygen-deficient situation to occur. Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material in it, especially in summer, when dissolved-oxygen levels are at a seasonal low.

Hardness

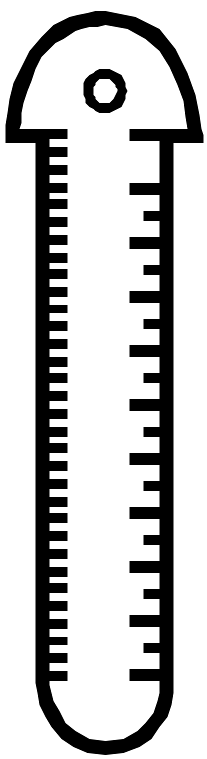
The amount of dissolved calcium and magnesium in water determines its "hardness." Water hardness varies throughout the United States. If you live in an area where the water is "soft," then you may never have even heard of water hardness. But, if you live in Florida, New Mexico, Arizona, Utah, Wyoming, Nebraska, South Dakota, Iowa, Wisconsin, or Indiana, where the water is relatively hard, you may notice that it is difficult to get a lather up when washing your hands or clothes. And, industries in your area might have to spend money to soften their water, as hard water can damage equipment. Hard water can even shorten the life of fabrics and clothes! Does this mean that students who live in areas with hard water keep up with the latest fashions since their clothes wear out faster?

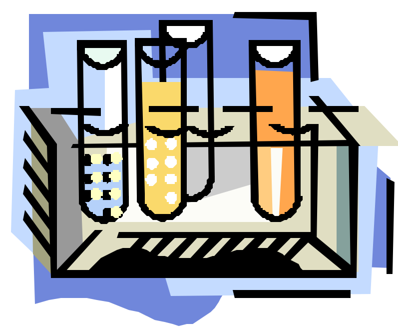
Suspended sediment

Suspended sediment is the amount of soil moving along in a stream. It is highly dependent on the speed of the water flow, as fast-flowing water can pick up and suspend more soil than calm water. During storms, soil is washed from the stream banks into the stream.

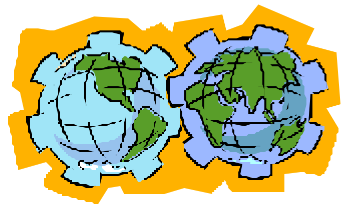
The amount that washes into a stream depends on the type of land in the river's drainage basin and the vegetation surrounding the river. If land is disturbed along a stream and protection measures are not taken, then excess sediment can harm the water quality of a stream. You've probably seen those short, plastic fences that
builders put up on the edges of the property they are developing. These silt fences are supposed to trap sediment during a rainstorm and keep it from washing into a stream, as excess sediment can harm the creeks, rivers, lakes, and reservoirs.

Sediment coming into a reservoir is always a concern; once it enters it cannot get out - most of it will settle to the bottom. Reservoirs can "silt in" if too much sediment enters them. The volume of the reservoir is reduced, resulting in less area for boating, fishing, and recreation, as well as reducing the power-generation capability of the power plant in the dam.





Water on Earth



Where is Earth's water?

The Earth is doing a balancing act with its water*!* Water is continually moving around, through, and above the Earth as water vapor, liquid water, and ice. In fact, water is continually changing its form. The Earth is pretty much a "closed system," like a terrarium. That means that the Earth, as a whole, neither gains nor loses much matter, including water. Although some matter, such as meteors from outer space, are captured by Earth, very little of Earth's substances escape into outer space. This is certainly true about water. This means that the same water that existed on Earth millions of years ago is still here. Thanks to the water cycle the same water is continually being recycled all around the globe. It is entirely possible that the water you drank for lunch was once used by a Mama Brontosaurus to give her baby a bath.

As you know, the Earth is a watery place. About 70 percent of the Earth's surface is water-covered. But water also exists in the air as water vapor and in the ground as soil moisture and in aquifers. Thanks to the water cycle our planet's water supply is constantly moving from one place to another and from one form to another. Things would get pretty stale without the water cycle!

When you take a look at the water around you, you see water in streams, rivers, and lakes. You see water sitting on the surface of the earth. Naturally, this water is known as "surface water." Your view of the water cycle might be that when rain falls it fills up the rivers and lakes. But, how would you account for the flow in rivers after weeks without rain? In fact, how would you account for the water flowing down your driveway on a day when it didn't rain? The answer is that there is more to our water supply than just surface water, there is also plenty of water beneath our feet.

Even though you may only notice water on the Earth's surface, there is much more water stored in the ground than there is on the surface. In fact, some of the water you see flowing in rivers comes from seepage of ground water into river beds. Water from precipitation continually seeps into the ground to recharge the aquifers, while at the same time water from underground aquifers continually recharges rivers through seepage.

Humans are happy this happens because people make use of both kinds of water. In the United States in 1995, we used about 321 billion gallons per day of surface water and about 77 billion gallons per day of ground water. In a way, that underestimates the importance of ground water, since not only does ground water help keep our rivers and lakes full, it also provides water for people in places where visible water is scarce, such as in the desert towns of the Western United States. Without ground water, people would be sand-surfing in Palm Springs, CA. instead of playing golf!

Just how much water is there on (and in) Earth? Here are some numbers.

- The total water supply of the world is 326 million cubic miles (a cubic mile is an imaginary cube (a square box) measuring one mile on each side). A cubic mile of water equals more than one trillion gallons.
- About 3,100 cubic miles of water, mostly in the form of water vapor, is in the atmosphere at any one time. If it all fell as precipitation at once, the Earth would be covered with only about 1 inch of water.
- The 48 contiguous United States receive a total volume of about 4 cubic miles of precipitation each day.
- Each day, 280 cubic miles of water evaporate or transpire into the atmosphere.
- If all of the world's water was poured on the United States, it would cover the land to a depth of 90 miles.
- Of the freshwater on Earth, much more is stored in the ground than is available in lakes and rivers. More than 2,000,000 cubic miles of fresh water is stored in the Earth, most within one-half mile of the surface. Contrast that with the 60,000 cubic miles of water stored as fresh water in lakes, inland seas, and rivers. But, if you really want to find fresh water, the most is stored in the 7,000,000 cubic miles of water found in glaciers and icecaps, mainly in the polar regions and in Greenland.

Follow a drip through the water cycle

You may be familiar with how water is always cycling around, through, and above the Earth, continually changing from liquid water to water vapor to ice. One way to envision the water cycle is to follow a drip of water around as it moves on its way. I could really begin this story anywhere along the cycle, but I think the ocean is the best place to start, since that is where most of Earth's water is.

If the drip wanted to stay in the ocean then it shouldn't have been sunbathing on the surface of the sea. The heat from the sun found the drip, warmed it, and evaporated it into water vapor. It rose (as tiny "dripettes") into the air and continued rising until strong winds aloft grabbed it and took it hundreds of miles until it was over land. There, warm updrafts coming from the heated land surface took the dripettes (now water vapor) up even higher, where the air is quite cold. When the vapor got cold it changed back into it a liquid (the process is condensation). If it was cold enough, it would have turned into tiny ice crystals, such as those that make up cirrus clouds. The vapor condenses on tiny particles of dust, smoke, and salt crystals to become part of a cloud.

precipitation. Earth's gravity helped to pull it down to the surface. (Maybe it would land on a leaf in a tree, in which case it would probably evaporate and begin its process of heading for the clouds again. If it misses a leaf there are still plenty of places to go.)

The drop could land on a patch of dry dirt in a flat field. In this case it might sink into the ground to begin its journey down into an underground aquifer as ground water. The drop will continue moving (mainly downhill) as ground water, but the journey might end up taking tens of thousands of years until it finds its way back out of the ground . Then again, the drop could be pumped out of the ground via a water well and be sprayed on crops (where it will either evaporate, flow along the ground into a stream, or go back down into the ground). Or the well water containing the drop could end up in a baby's drinking bottle or be sent to wash a car or a dog. From these places, it is back again either into the air, down sewers into rivers and eventually into the ocean, or back into the ground.

But our drop may be a land-lover. Plenty of precipitation ends up staying on the earth's surface to become a component of surface water. If the drop lands in an urban area it might hit your house's roof, go down the gutter and your driveway to the curb. If a dog or squirrel doesn't lap it up it will run down the curb into a storm sewer and end up in a small creek. It is likely the creek will flow into a larger river and the drop will begin its journey back towards the ocean.
If no one interferes, the trip will be fast (speaking in "drip time") back to the ocean, or at least to a lake where evaporation could again take over. But, with 250+ million people here needing water for most everything, there is a good chance that our drop will get picked up and used before it gets back to the sea.

A lot of surface water is used for irrigation. Even more is used by power-production facilities to cool their electrical equipment. From there it might go into the cooling tower to be evaporated. Talk about a quick trip back into the atmosphere as water vapor -- this is it. But maybe a town pumped the drop out of the river and into a water tank. From here the drop could go on to help wash your dishes, fight a fire, water the tomatoes, or (shudder) flush your toilet. Maybe the local steel mill will grab the drop, or it might end up at a fancy restaurant mopping the floor. The possibilities are endless -- but it doesn't matter to the drip, because eventually it will get back into the environment. From there it will again continue its cycle into and then out of the clouds, this time maybe to end up in the water glass of the President of the United States.

The Water in You

Think of what you need to survive, really just survive. Food? Water? Air? Naturally, we are going to concentrate on water here. Water is of major importance to all living things; in some organisms, up to 90 percent of their body weight comes from water. Up to 60 percent of the human body is water, the brain is composed of 70 percent water, blood is 82 percent water, and the lungs are nearly 90 percent water.

There just wouldn't be any you, me, or Fido the dog, without the existence of an ample water supply on Earth. The unique qualities and properties of water are what make it so important and basic to life. The cells in our bodies are full of water. The excellent ability of water to dissolve so many substances allows our cells to use valuable nutrients, minerals, and chemicals in biological processes. Water's "stickiness" (from surface tension) plays a part in our body's ability to transport these elements all through ourselves. The carbohydrates and proteins that our bodies use as food are metabolized and transported by water in the bloodstream. No less important is the ability of water to transport waste material out of our bodies.

Surface Water

About 80 percent of all the water we use in everyday life comes from surface-water sources such as rivers, streams, lakes, and reservoirs. The other 20 percent comes from ground-water. It is only natural that we heavily use our surface-water resources. After all, it is a lot easier and cheaper to get water out of a river than it is to drill a well and pump water out of the ground. Also, rivers are more accessible to us -- we generally build our towns and cities next to a river or lake.

For certain purposes, such as irrigation and supplying towns and cities with water, the United States relies heavily on surface water. Other users, such as mining and livestock industries rely more on ground water.

Rivers and streams

Rivers? Streams? Creeks? They are all names for water flowing on the Earth's surface. As far as this site is concerned, they are pretty much interchangeable. I tend to think of creeks as the smallest of the three, with streams being in the middle, and rivers being the largest.

A river is nothing more than surface water finding its way over land from a higher altitude to a lower altitude, all due to gravity. When rain falls on the land, it either seeps into the ground or becomes runoff, which flows downhill into rivers and lakes, on its journey toward the seas. In most landscapes the land is not perfectly flat -- it slopes downhill in some direction. Flowing water finds its way downhill initially as small creeks. As small creeks flow downhill they merge to form larger streams and rivers. Rivers eventually end up flowing into the oceans. If water flows to a place that is surrounded by higher land on all sides, a lake will form. If man has built a dam to hinder a river's flow, the lake that forms is a reservoir.

Runoff: Point and Nonpoint Source Pollution

When rain or snow falls onto the earth, it just doesn't sit there -- it starts moving according to the laws of gravity. A portion of the precipitation seeps into the ground to replenish Earth's ground water. Most of it flows downhill as runoff. Runoff is extremely important in that not only does it keep rivers and lakes full of water, but it also changes the landscape by the action of erosion. Flowing water has tremendous power -- it can move boulders and carve out canyons (check out the Grand Canyon. It was made by water!) Special terms are used to describe the types of runoff pollution that occurs. These terms are nonpoint source pollution and point source pollution. Nonpoint source pollution means that the pollution is coming from many sources at once. An example of this would be runoff from lawn chemicals throughout a neighborhood or town. Point source pollution comes from a particular place or point. An example of point source water pollution would be a large trash dump that was leaking chemicals into a stream. Sewer pipes that discharge directly into streams are considered nonpoint source pollution because they are so numerous and so difficult to find.

Rivers and sediment

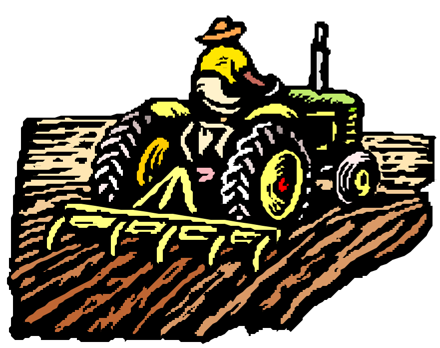
Rivers and streams are hardly ever crystal clear. As the rivers move they are carrying soil, sand, and sediment along with them. The sediments that rivers transport actually play quite an important role in shaping the environment and even in our own lives.

When it rains, soil and debris from the surrounding land are eroded and washed into streams. From there, sediment particles from as small as clay to as large as boulders flow along with the water. Fast-moving water can pick up, suspend, and move larger particles more easily than slow-moving waters. This is why rivers are more muddy-looking during storms -- they are carrying a **LOT** more sediment than they carry during a low-flow period. In fact, so much sediment is carried during storms that well over one-half of all the sediment moved during a year might be transported during a single storm period.

The U.S. Geological Survey does quite a lot of work measuring how much sediment is transported by streams across the country. To do this, both the amount of water flowing past a site (streamflow or flow) and the amount of sediment in that water (sediment concentration) must be measured. Both streamflow and sediment concentration are continually changing. A river discharge measurement is performed to measure streamflow. As streamflow goes up and down during a storm, hydrologists take measurements of how much sediment is in the water at different streamflows. Once we know how much water is flowing and the amount of sediment in the water at different flow conditions, we can compute the tonnage of sediment that moves past the measurement site during a day, during the storm, and even during the whole year.

So what does this have to do with people? On the plus side, sediment deposited on the banks and flood plains of a river is often mineral-rich and makes excellent farmland. The Nile in Egypt and the Mississippi River here in the United States are good examples. On the negative side, when rivers flood, they leave behind many tons of wet, sticky, heavy, and smelly mud -- not something you would want in your basement. You may recall the disastrous effects of the Midwest flooding of 1995 and 1997. Sediments can also harm dams and reservoirs. When a river is dammed and a reservoir is created, the sediments that used to flow along with the relatively fast-moving river water are, instead, deposited in the reservoir. This happens because the river water flowing through the reservoir moves too slowly to keep sediment suspended -- the sediment settles to the bottom of the reservoir. Reservoirs slowly fill up with sediment and mud, eventually making them unusable for their intended purposes.

Even more important, sometimes the sediment that washed away is soil we need to grow crops. The government agency known as the Natural Resource Conservation Service was once known as the Soil Conservation Service. It was established specifically to help people understand how important it is to conserve soil. Once soil is washed away, it takes thousands of years for nature to replace it.

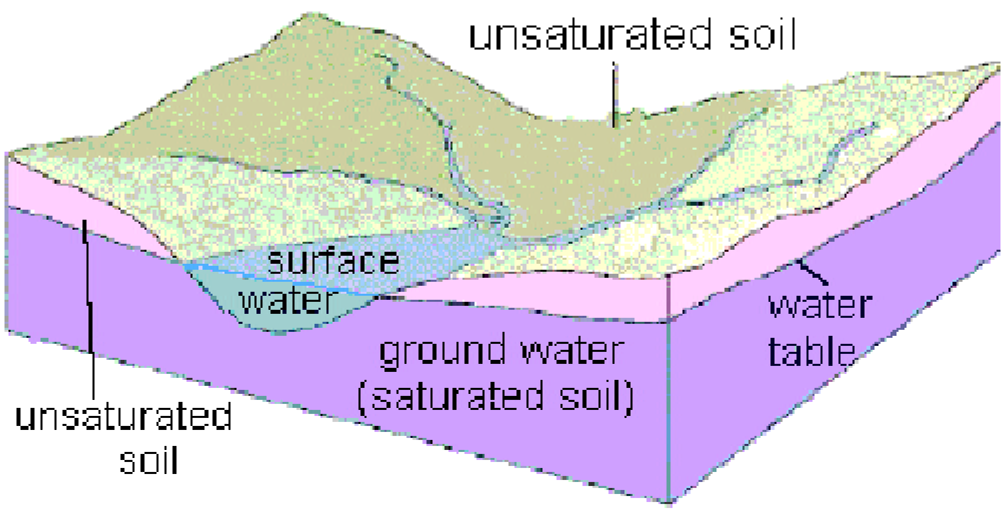


Ground water

What is ground water?

Ground water is the part of precipitation that seeps down through the soil until it reaches rock material that is saturated with water. Ground water slowly moves underground, generally at a downward angle (because of gravity), and may eventually seep into streams, lakes, and oceans.

Here is a simplified diagram showing how the ground is saturated below the water table. The ground above the water table may be wet to a certain degree, but it does not stay saturated. The dirt and rock in this unsaturated zone contain air and some water and support the vegetation on the Earth. The saturated zone below the water table has water that fills the tiny spaces (pores) between rock particles and the cracks (fractures) of the rocks.



Why is there ground water?

A couple of important factors are responsible for the existence of ground water:

(1) Gravity

Nothing surprising here - gravity pulls water toward the center of the Earth. That means that water on the surface will try to seep into the ground below it.

(2) The Rocks Below Our Feet

The rock below the Earth's surface is the bedrock. If all bedrock consisted of a dense material like solid granite, then even gravity would have a hard time pumping water downward. But Earth's bedrock consists of many types of rock, such as sandstone, granite, and limestone. Bedrocks have varying amounts of void spaces in them where ground water accumulates. Bedrock can also become broken and fractured, creating spaces that can fill with water. And some bedrock, such as limestone, is dissolved by water -- which results in large cavities that fill with water.

In many places, if you looked at a vertical cross-section of the earth you would see that rock is laid down in layers, especially in areas of sedimentary rocks. Some layers have rocks that are more porous than others, and here water moves more freely (in a horizontal manner) through the earth. Sometimes when building a road, the layers are revealed by road cuts, and water can be seen seeping out through the exposed layers.

Try as it might, gravity doesn't pull water all the way to the center of the Earth. Deep in the bedrock there are rock layers made of dense material, such as granite, or material that water has a hard time penetrating, such as clay. These layers may be underneath the porous rock layers and, thus, act as a confining layer to retard the vertical movement of water. Since it is more difficult for the water to go any deeper, it tends to pool in the porous layers and flow in a more horizontal direction across the aquifer toward an exposed surface-water body, like a river.

Visualize it this way: get two sponges and lay one on top of the other. Pour water (precipitation) on top and it will seep through the top sponge downward into the bottom sponge. If you stopped adding water, the top sponge would dry up and, as the water dripped out of the bottom sponge, it would dry up too. Now, put a piece of plastic wrap between the sponges, creating your "confining layer" (making the bottom sponge an impermeable rock layer that is too dense to allow water to flow through it). Now when you pour water on the top sponge, the water will seep downward until it hits the plastic wrap. The top sponge will become saturated, and when the water hits the plastic wrap it won't be able to seep into the second sponge. Instead, it will start flowing sideways and come out at the edges of the sponge (horizontal flow of ground water). This happens in the earth all the time -- and it is an important part of the water cycle.

Groundwater use

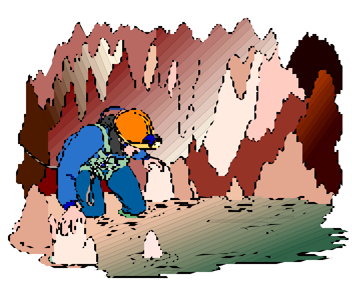
When we talk in terms of the source of the water we use everyday, we consider if the water comes from a surface-water source (river, lake, etc.) or from a ground-water source (from a well or spring). In 1990, about 20 percent of our nation’s water withdrawals were from ground-water sources and about 80 percent were from surface water.

You might think 20 percent is not very much, but ground water is important for many of our uses. For some water-use categories, ground water plays a larger role. For instance, for the 43 million of Americans who supplied their own water at home in 1990, almost 99 percent used ground water.

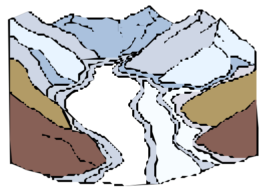
Just because you have a well that yields plenty of water doesn't mean you can go ahead and just take a drink. Because water is such an excellent solvent it can contain lots of dissolved chemicals. And since ground water moves through rocks and subsurface soil, it has a lot of opportunity to dissolve substances as it moves. For that reason, ground water will often have more dissolved substances than surface water will. Even though the ground is an excellent mechanism for filtering out particulate matter, such as leaves, soil, and bugs, dissolved chemicals and gases can still occur in large enough concentrations in ground water to cause problems. Underground water can get contaminated from industrial, domestic, and agricultural chemicals from the surface. This includes chemicals such as pesticides and herbicides that many homeowners apply to their lawns.

Contamination of ground water by road salt is of major concern in some areas of the United States. Salt is spread on roads to melt ice, and, with salt being so soluble in water, excess sodium and chloride is easily transported into the subsurface ground water. The most common water-quality problem in rural water supplies is bacterial contamination from septic tanks, which are often used in rural areas that don't have a sewage-treatment system. Effluent (overflow and leakage) from a septic tank can percolate (seep) down to the water table and maybe into a homeowner's own well. Just as with urban water supplies, treatment may be necessary to kill the dangerous bacteria.

The subject of ground water is not a simple one, and a discussion of it will not fit on these pages! There are people who make their careers studying ground water, trying to model where it exists, how it moves underground, and analyzing how ground water can carry possible contaminants. By the way, it's a myth that all our ground-water supplies are really rivers flowing underground -- except in the case of caves that exist in limestone rock. These caves can have flowing streams in them. Kentucky has many such caves.



Glaciers and icecaps: Storehouses of fresh water



Even though you may never have seen a glacier, they are a big item when we talk about the world's water supply. Almost 10 percent of the world's land mass is currently covered with glaciers, mostly in places like Greenland and Antarctica.

In a way, glaciers are just frozen rivers and they "flow" downhill. Glaciers begin life as snowflakes. When the snowfall in an area far exceeds the melting that occurs during summer, glaciers start to form. The weight of the accumulated snow compresses the fallen snow into ice. These "rivers" of ice are tremendously heavy, and if they are on land that has a downhill slope the whole ice patch starts to slowly grind its way downhill. These glaciers can vary greatly in size, from a football-field sized patch to a river a hundred miles long.

Glaciers have had a profound effect on the topography (lay of the land) in some areas, as in the northern U.S. You can imagine how a billion-ton ice cube can rearrange the landscape as it slowly grinds its way overland. Many lakes, such as the Great Lakes, and valleys have been carved out by ancient glaciers.

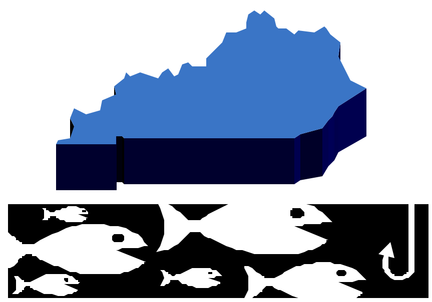
Because the earth is getting warmer, many glaciers and icecaps are melting. Some scientists think the release of this fresh water into the oceans may eventually cause changes in the climate.

Water Quality

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. Although scientific measurements are used to define a water's quality, it's not a simple thing to say that "this water is good," or "this water is bad." After all, water that is perfectly suited to wash a car may not be good enough to serve as drinking water at a dinner party for the President! When the average person asks about water quality, they probably want to know if the water is good enough to use at home, to play in, to serve in a restaurant, etc., or if the quality of our natural waters are suitable for aquatic plants and animals.

More and more nowadays we are hearing about situations where the quality of our water is not good enough for normal uses. Bacteria and microorganisms have gotten into drinking-water supplies, sometimes causing severe illness in a town; chemical pollutants have been detected in streams, endangering plant and animal life; sewage spills have occurred, forcing people to boil their drinking water; pesticides and other chemicals have seeped into the ground and have harmed the water in aquifers; and, runoff containing pollutants from roads and parking lots have affected the water quality of urban streams.

Yes, water quality has become a very big issue today, partly because of the tremendous growth of the Nation's population and urban expansion and development. Rural areas can also contribute to water-quality problems. Inappropriate use or disposal of animal feed, fertilizer, and manure, creates more nitrogen and phosphorus than can be used by crops or animals. These excess nutrients have the potential to degrade water quality if incorporated into runoff from farms into streams and lakes. All this growth puts great stress on the natural water resources, and, if we are not diligent, the quality of our waters will suffer.



Kentucky Water Facts

(From the Kentucky Division of Water)

Average annual rainfall	40-50 inches
Maximum rainfall period	winter and spring
Minimum rainfall period	late summer and fall
Miles of rivers and streams	89,431
Miles of rivers bordering other states	849
Acres of wetlands	637,000
Number of reservoirs over 1000 acres in size	18
Acres of publicly owned lakes and reservoirs	228,385

List of Enviroscape Models Available for Loan in Kentucky

(There may be others – Check with your local Extension Office or Conservation District)

STATEWIDE

Cumberland Valley RC+D
Division of Pesticide Regulation
Division of Water Nonpoint Source Section
East Kentucky Science Center
Eastern Kentucky PRIDE
ENRI Task force-CES-UK
Green River RC+D
Kentucky Ag and Environment in the classroom
Kentucky Heritage RC+D
Kentucky Waterways Alliance
Mammoth Cave National Park
Northern Kentucky University
Pennyrile RC+D
Upper Cumberland River Watershed Watch
WKU Center for Water Resource Studies
WKU Center for Math, Science & Environmental Edu.

County Level

Adair Cooperative Extension Service
Allen County Conservation District
Anderson Conservation District
Bell County Cooperative Extension Service and Conservation District
Boone County

- Cooperative Extension Service
- Conservation District
- Sanitation District #1
- Ockerman Elementary

Bourbon Conservation District
Boyd County Natural Resources Conservation Service
Boyd County Middle School
Boyle County Cooperative Extension Service and Conservation District
Bracken County Cooperative Extension Service and Conservation District
Bullit County – contact Jefferson County
Butler Conservation District
Caldwell Conservation District
Calloway Conservation District
Calloway County: Murray Middle School
Campbell Cooperative Extension Service, Conservation Dist, Sanitation District#1

Carroll Conservation District
Enviroscapes models availabel for schools to borrow (cont.)

Carter Conservation District
Christian Conservation District
Clark Conservation Dist
Clay County High School
Crittenden Conservation District
Cumberland Natural Resources Conservation Service
Daviess County - Utica Elementary School
Elliot County Cooperative Extension Service
Estill County Conservation District
Fayette County

- Bluegrass PRIDE
- Conservation District
- UK Landscape Architecture Department

Fayette County Schools

- Stonewall Elementary
- Winburn Middle School

Fleming County Cooperative Extension Service and Conservation District
Floyd County Extension Service
Franklin County Conservation District
Franklin County KY Div. of Water Management Field Office
Garrard County Conservation District
Graves County Conservation District
Grayson County Extension Service
Greenup County Natural Resources Conservation Service
Hancock County Conservation District
Hardin County Conservation District
Harlan County Conservation Dist
Hopkins County KY Div. Of Water Madison Field Office
Hopkins County Extension Service and Conservation District
Hopkins County Schools

- Jesse Stuart Elementary
- Grapevine Elementary

Jackson County Extension Service
Jefferson County

- Natural Resources Conservation Service
- Hawthorn Elementary
- Seneca High School
- Kennedy Montessori School
- Blackacre State Nature Preserve

Johnson County Extension Service
Kenton County

- Extension Service
- Conservation District

Enviroscape models available for loan to schools (cont.)

Knott County

- Extension Service
- Natural Resources Conservation Service
- Jones Fork Elementary

Knox County Extension Service and Union College Graduate Program
LaRue County Conservation District
Leslie County Extension Service and Conservation District
Letcher County Conservation District
Lewis County Conservation District
Lincoln County Conservation District
Madison County - Berea Community Elementary School
Magoffin County High School
Martin County - Warfield Elementary
Nelson County - Cox's Creek Elementary
Nicholas County - Ryle High School
Oldham County - Buckner Elementary or contact Jefferson County
Pike County - John's Creek Elementary
Pulaski County - Southwestern High School
Rowan County - Tilden Hogg Elementary
Spencer County – contact Jefferson County
Todd County - North Todd Elementary School
Warren County - Lost River Elementary

Kentucky’s Wonderful
Commonwealth of Water

Primary Unit

Be a Water Explorer

Kentucky's Wonderful Commonwealth of Water
Primary Unit

UNIT SUMMARY

This unit addresses the basics. What is water? What forms can it take? How does it behave? Why is it important to us? It culminates with students learning the best ways to conserve water and then teaching their families the same skills.

Some of the big ideas in this unit include the following.

- Water is all around us.
- Water comes in three "states" - liquid, solid and gas.
- Water has specific physical properties.
- Water cycles through the earth's atmosphere and crust.
- Various objects float or sink in water according to their density.
- All living things need water to survive.
- Certain human activities can pollute water.
- Certain human activities can prevent water pollution.
- There are simple and effective ways to conserve water.

Suggested Open Response Question - Your community is experiencing a severe drought. It has not rained in three months. Describe two problems this might cause in your community and how they might be solved.

Portfolio Suggestions - Expand on the "Freddy the Fish" activity by asking students to write a newspaper account of how Freddy got sick and how the community worked to save him. Have students write a lab report outlining their findings in the "What Makes Water, Water" activity.

Technology Extensions

- Have students take (or draw) pictures of different water features in your community. Scan the pictures onto a computer disk and have students create a PowerPoint presentation using the photos and drawings. (Note: digital cameras can be used if they are available.)
- Have students use water testing kits to assess water quality in a nearby stream or pond, then use computers to graph their findings.
- Have students write poems or stories about water and use word processing software to type and illustrate them.

Kentucky's Commonwealth of Water—Be a Water Explorer
Primary

Essential Question: What is water and why is it important?

Standards

Science

Science SC-E-2.1.1, Students will understand that earth materials include solid rocks and soils, water, and the gases of the atmosphere.
Science S C-E-1.1.1, Students will understand that materials have many observable properties such as size, mass, shape, color, temperature,...and the ability to react with other substances.
Science SC-E-1.1.2, Students will understand that properties (e.g., size, shape) of materials can be used to describe, separate, or sort objects.
Science SC-E-1.1.3, Students will understand that materials can exist in different states and some common materials, such as water, can be changed from one state to another by heating and cooling.
Science SC-E-3.1.2, Students will understand that organisms have basic needs (e.g., air, water, nutrients, light) and can only survive when those needs are met.
Science SC-E-3.3.3, Students will understand that all organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms, other changes are beneficial.

Arts and Humanities

Arts and Humanities AH-E-4.1.4, Students will create artwork using the elements of art and principals of design.
Arts and Humanities AH-E-2.1.12, Students will create movement patterns using locomotor and non-locomotor movement.

Social Studies

Social Studies SS-E-4.1.1, Students will use tools (e.g. maps, globes, charts, graphs, compasses) to understand surroundings.
Social Studies SS-E-4.4.2, Students will recognize that people depend on, adapt to, or modify the environment to meet basic needs.

Practical Living

Practical Living PL-E-3.1.5, Students will understand that there are consumer decisions (e.g., reducing, recycling and reusing) that have positive impacts on the environment.

Kentucky's Commonwealth of Water—Be a Water Explorer
Primary

Practical Living (cont.)

Practical Living: PL-E-3.3.2, To protect all citizens, there are community guidelines (e.g., school inspections, trash collection, water treatment, waste treatment, animal control, immunization) that promote healthy living environments in the community.

Reading

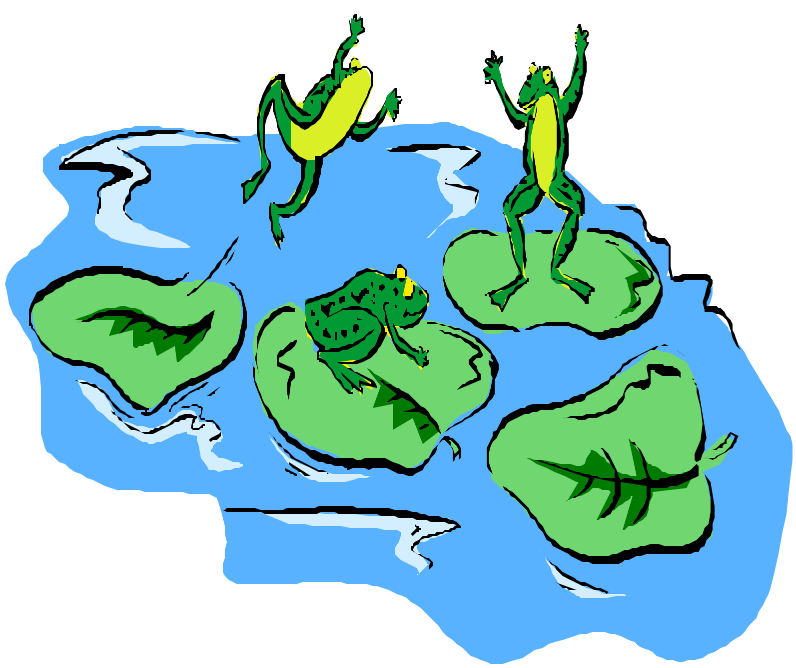
Reading: R D-E-4.0.6, Students will read a variety of materials to accomplish authentic purposes including reading for enjoyment, to locate information, and to complete tasks.

Math

Math: MA-E-3.2.1, Students will pose questions, collect, organize, and display data.

Writing

Writing: WR-E-1.4, Students will write an informative and persuasive letter for an authentic audience to accomplish realistic purposes.



Unit Overview

Lesson	Title and Description of Activities, Essential and Guiding Questions and Standards
#1	**"Let's Take a Water Walk"**-Students will go for a walk outside and use their senses to observe and record sources of water and how it is affecting the surrounding area. They will also paint pictures showing where water can be found and create water logs. **Standards:** Arts and Humanities AH-E-4.1.4 **Essential Question:** What is water and why is it important? **Guiding Question:** • Where do you see signs of water being used in our community? • How is our immediate environment affected by water?
# 2	**"So Much ...Yet so Little"**-Students will use globes, maps and "apples" to explore the amount of land and water found on Earth. **Standards:** Science SC-E-2.1.1 and Social Studies SS-E-4.1.1 **Essential Question:** What is water and why is it important? **Guiding Question:** • How much of our world is water? • How much of this water is fresh water?
# 3	**"What Makes Water Water?"**-Students will explore the physical characteristics of water by comparing water with other clear liquids. **Standard:** Science S C-E-1.1.1 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What are some of the properties of water? • What is a liquid?
# 4	**"Tense Water Droplets"**- Students will continue to learn about the physical characteristics of water as they explore water surface tension. **Standard:** S C-E-1.1.1 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What is surface tension? • Why is surface tension important?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 5	**“H2O-Overpowering the Opponents!”-** Students will be introduced to the concepts of cohesion, absorption and flow as they further explore water in its liquid state and participate in water races. **Standards:** Science S C-E-1.1.1 and Science SC-E-2.1.1 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What is a water molecule? • Why is cohesion important in the flow of water? • Why is surface tension important to the flow of water? • What role does gravity play in the flow of water?
# 6	**“Water Ups and Downs”-** Students will explore water density by using common objects to design floating and sinking experiments. **Standard:** Science SC-E-1.1.2 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What is density? • Why do some objects float and other objects sink in water? • How does salt affect the density of water?
# 7	**“What’s the Matter?’-** Students will explore water as a liquid, solid and gas. **Standard:** Science SC-E-1.1.3 **Essential Question:** What is water and why is it important? **Guiding Questions:** • Water can exist in what three forms of matter? • What causes water to change its form? • Why is it important for water to be able to change forms?
# 8	**“Constantly Changing Water Molecules”-**Students will explore water as a liquid, solid and gas through movement. **Standards:** Arts and Humanities AH-E-2.1.12 and Science SC-E-1.1.3 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What three forms of matter can water become? • What causes water to change its form?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 9	**"Where Does All the Water Go?"-** Students will make puzzles showing the water cycle at work to share with their classmates and families. **Standards:** Arts and Humanities AH-E-4.1.4 and Science SC-E-1.1.3 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What 3 forms of matter can water become and how does it relate to evaporation, condensation, and precipitation? • How does water travel around the Earth? • Where does all of this water come from?
# 10	**"A Journey Through the Water Cycle"-** Students will journey through the water cycle as clouds in this interactive lesson. **Standard:** Science SC-E-1.1.3 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What 3 forms of matter can water become and how does that relate to evaporation, condensation, precipitation, accumulation and transpiration? • How does water travel around the Earth?
# 11	**"To See is to Believe"-** Students will make a mini-model of the water cycle using 2-liter soda bottles in order to observe evaporation, transpiration, condensation, precipitation and infiltration taking place. **Standards:** Science SC-E-1.1.3 and Science SC-E-3.1.2 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What are the signs of the hydrologic cycle in the real world? • How does the model show what happens in the hydrologic cycle?
#12	**"Survival Needs"-** Through observation, discussion and research, students will report on the needs of plants and animals. **Standards:** Science SC-E-3.1.2 and Reading RD-E-4.0.6 **Essential Question:** What is water and why is it important? **Guiding Questions:** • What do plants and animals need to survive?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 13	**" A Fishy Tale"-** Students will be introduced to point and nonpoint sources of pollution as they take a trip with a pretend fish in a pretend river during this simulation activity. **Standards:** Science SC-E-3.1.2 and Science SC-E-3.3.3 **Essential Questions:** What is water and why is it important**?** **Guiding Questions:** • What happened in this activity to change the fish's environment? • In our community what might pollute water? • What can we do to clean up the water before disposing of it?
#14	**" Filtering Away Pollutants"-** Students will discover ways to filter "polluted" water, then learn about natural filters in the environment, and wastewater treatment plants. **Standards:** Science SC-E-3.3.3 , Social Studies SS-E-4.4.2 and Practical Living PL-E-3.3.2 **Essential Questions:** What is water and why is it important? **Guiding Questions:** • Where do we get the water we use for personal consumption? • How can dirty water be cleaned? • How do we know water in our community is purified and safe to drink?
# 15	**" The Water Patrol"-** Students will mark the places where water is used on a school map, discuss the different uses of water in the building, estimate the amount of water used daily to flush toilets in one student restroom, collect data for a predetermined amount of time and analyze that data. **Standards:** Math MA-E-3.2.1, and Social Studies SS-E-4.1.1 **Essential Question:** What is water and why is it important? **Guiding Questions:** • How much water do you think is used at school during a typical day? • Why is water conservation important?

Unit Overview	
Lesson	**Title and description of Activities, Essential and Guiding Questions and Standards**
#16	**"Concerned About Conserving Water" -** Students will develop a survey to use to collect and analyze information about how much water their families use during a typical day at home. **Standards:** Math: MA-E-3.2.1 and , Practical Living: PL-E-3.1.5 **Essential Question:** What is water and why is it important? **Guiding Questions:** • How much water do you think is used at home during a typical day? • How can we find out this information? • What can you and your family do to conserve water?
#17	**"Water" You Gonna Do About It?"-** Students will review information covered during the water unit and use some of that information to write a letter to family members telling what they learned about water and suggesting ways to conserve water at home. **Standards:** Practical Living PL-E-3.1.5 and Writing WR-E-1.4 **Essential Questions:** What is water and why is it important? **Guiding Questions:** • What are the most important things about water you want to remember? • Why is it important to conserve water? • What, specifically , can you and your family do to conserve water? 

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

Let's Take a Water Walk

Standards

Arts and Humanities: AH-E-4.1.4, Students will create artwork using the elements of art and principles of design.

Activity Description

Students will go for a walk outside and use their senses to observe and record sources of water and how it is affecting the surrounding area. They will also paint pictures showing where water can be found and create water logs.

Materials

- Water learning logs for each student
- Poster board or drawing paper
- Clipboards (optional)
- Art supplies
- Pencil for each student

Length of Lesson

2 days, approximately one hour each day

Vocabulary Word

<u>Environment</u>—the external conditions that influence the development and survival of an organism or population; usually refers to air, water, land, plants and animals.

Essential Question

What is water and why is it important?

Guiding Questions

- Where do you see signs of water being used in our community?
- How is our immediate environment affected by water?

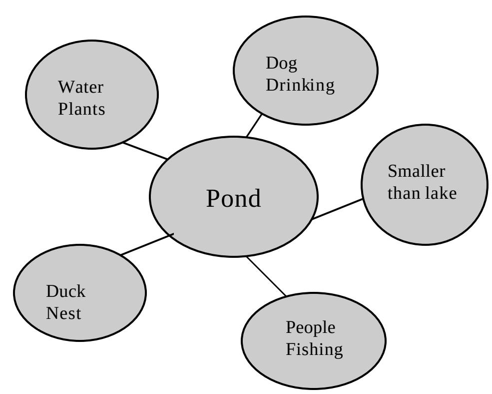
Skills Used

Observe	Record	Write
Draw	Discuss	Analyze

****

Activity

Step 1: Before beginning this unit, prepare water learning logs for students to use to write observations, thoughts, predictions and reflections. Students may wish to decorate the water learning logs prior to their first use.



Day 1

Step 2: Explain to students that the class is going to be studying about water and will begin the unit by going for a walk outside in order to look for signs of water and its effects on the surrounding environment.

Let's Take a Water Walk, *continued*

Step 3: Tell students that they will be using their senses to make observations of water at work (example: puddle, downspout, sewer, garden hose, pool, dew, etc.). Each sign of water should be recorded, using words and/or pictures, along with how the water source is affecting the environment. Students may wish to organize this information by using individual thought webs. Distribute water learning logs and pencils.

Step 4: Return to the classroom and invite students to share their findings. As each student gives examples of sources of water found outside, record the basic ideas on pre-cut water droplets. Students should also be encouraged to share information they know about water at this time, including places around the world where water can be found. This is the beginning of the KWL (What I Know, What I Want to Learn, and What I Have Learned) Chart. As the unit progresses, the number of water droplets posted on the wall in the classroom will increase.

Step 5: Record on sentence strips any questions that arise during the discussion. Post these strips in the classroom for future exploration and study. This should continue throughout this unit of study.

Step 6: Give students an opportunity to record any reflections or "Ahaas" (new things learned about water) in their new learning logs at the conclusion of this lesson.

Primary Unit

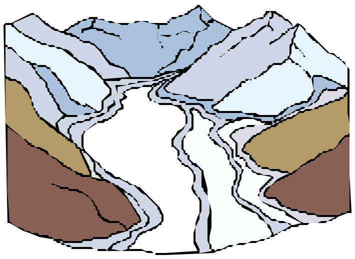
Day 2

Step 1: Review water sources discussed yesterday. Have students choose one water source found in their water learning logs, or on the water droplets hanging on the wall, to illustrate and label on a piece of poster board or large sheet of construction paper. Encourage students around the classroom to choose different water sources and to add many details to their drawings. Color and decorate the posters.

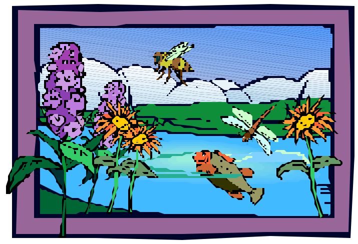
Step 2: After the posters have been completed, display them in the classroom or hallway until they are needed in a later lesson.

Primary Landscape Poster Examples

Use with students who have difficulty visualizing scenes to draw.

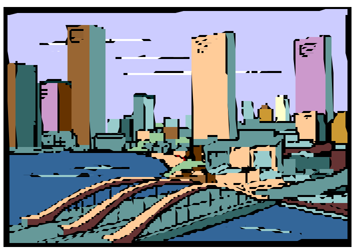


Glacier

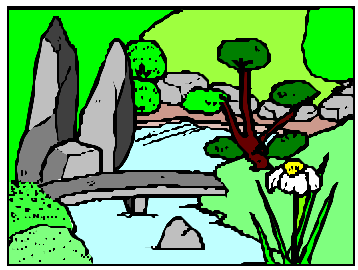


Lake

Waterfall



City

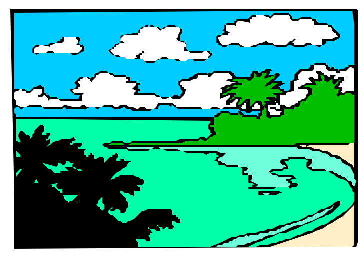


Stream or Creek

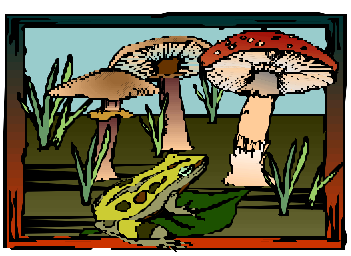
Farm

Neighborhood

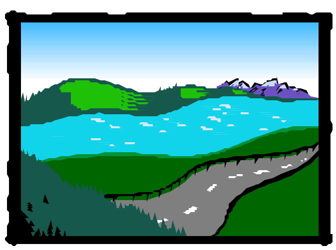
Iceberg



Ocean

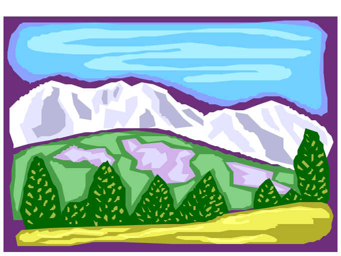


Wetland, Marsh

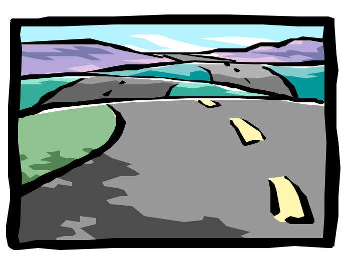


River

Snowy Hillside



Mountains



Puddle

Field, Meadow

Kentucky’s Commonwealth of Water – Be a Water Explorer
Primary

So Much . . . Yet So Little

Standards	**Science: SC-E-2.1.1,** Students will understand that earth materials include solid rocks and soils, water, and the gases of the atmosphere. **Social Studies: SS-E-4.1.1**, Students will use tools (e.g. maps, globes, charts, graphs, compasses) to understand surroundings.
Activity Description	Students will use globes, maps and “apples” to explore the amount of land and water found on Earth.
Materials	• Globes, maps and/or atlases • Apples (the number needed depends on how the lesson is structured) • Plastic knives for children, or one knife for teacher
Length of Lesson	30 minutes
Vocabulary Words	**Topography map**—map that shows the land and water contours and elevations, and is reproduced from satellite pictures. **Fresh water—**inland water that has a low concentration of minerals, salts, and dissolved solids found as surface water or ground water.
Essential Question	**What is water and why is it important?**
Guiding Questions	• How much of our world is water? • How much of this water is fresh water?
Skills Used	Observe Visualize Compare Communicate

****

Activity

Step 1: Distribute globes, maps (including **topography maps** of your area if you have them), and atlases. Explore and discuss the water and land masses. Encourage students to share insights about discoveries.
*Use the Internet sites, such as **http://www.ngdc.noaa.gov/seg/topo/state.shtml** , **http://www.usgs.org/** or **http://www.kygs.org** .for access to topography maps. Students will be delighted to see all of the hills and water sources in their own communities.

Step 2: Distribute apples and plastic knives to partners (or the teacher may do this activity as a demonstration for very young students). Explain to students that they will not be eating these apples, but using them for a class activity. (Let students know if there will be extra apples for eating later.)

So Much . . . Yet So Little, *continued*

Step 3: Ask students how the apple is like a globe. Once the connection of the apple being a model of the globe is made, have students divide the apple in half, then in half again, creating quarters. Explain that three of the slices are the blue on our map that represents salt water. One slice represents the land and its freshwater. (At this point of the lesson we want to make sure that the students understand there is a lot more water than land.) Put the three slices representing salt water aside.

Step 4: Concentrate on the fourth remaining piece of the apple that represents land and its water. In an attempt to help students discover that not all of the land on Earth is inhabitable, cut the land piece in half and explain that half of the land is too dry, too wet, too cold or too hot for people (e.g. mountains, deserts, etc.). Lay one of these two pieces of the apple aside.

Step 5: Slice the remaining 1/8 piece of apple into 4 equal pieces. Set aside three of the pieces, explaining to students that only 1/4 of the remaining apple represents land on which we grow food.

Assessment

Class discussion:

You have heard people talk about the large amount of water on Earth, but you have also heard people talk about not wasting water? Why should we not waste water if we have so much?

Step 6: Using the remaining 1/32 piece of apple to show the land on earth that can be used to grow food, instruct students to take their knives and shave off a paper-thin slice of apple (approximately 1/3200). Explain that this sliver represents usable **fresh water**.

Step 7: Ask students for suggested facts or discoveries to add to the water droplets that are displayed in the classroom. If there are any questions, add them to sentence strips to post on the classroom wall.

Step 8: Give students an opportunity to reflect on their learning in their water learning logs. Pass out pieces of apples for the students to eat as they write in their learning logs.

Extensions

1. Visit http://wwwga.usgs.gov/edu/mearth.html to find web pages to bookmark for students to use for further investigations about fresh water on Earth.
2. Encourage students to begin thinking about why it is so important to conserve water instead of wasting it.
3. For a lesson in probability, use an inflatable plastic globe and toss it from student to student. Keep a tally of what the right thumb touches each time the globe is caught — LAND or WATER. Graph the results. Discuss why the right thumb landed on water more frequently than on land.

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

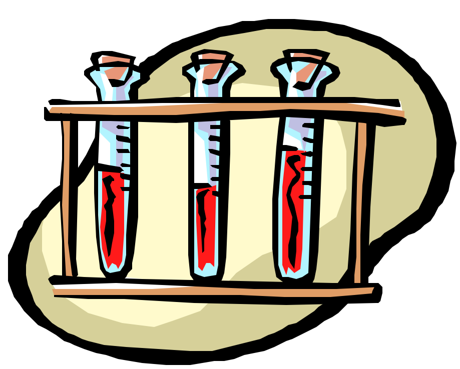
What Makes Water ,Water?

Standard	**Science: SC-E-1.1.1**, Students will understand that materials have many observable properties such as size, mass, shape, color, temperature, . . . and the ability to react with other substances.
Activity Description	Students will explore the physical characteristics of water by comparing water with other clear liquids.
Materials	• Water • Glycerin or mineral oil • Clear containers with lids to hold liquids • Water learning log Isopropyl alcohol Toothpicks Wax paper Pencil
Length of Lesson	Approximately 45 minutes
Vocabulary Words	**<u>Liquid</u>**—a free flowing substance that takes the shape of its container. **<u>Property</u>**—a characteristic of a material or object: something that you can observe such as color, smell, or taste. **<u>Water</u>**—a colorless, odorless, tasteless liquid that is essential to plant and animal life.
Essential Question	**What is water and why is it important?**
Guiding Questions	• What are some of the properties of water? • What is a liquid?
Skills Used	Observe, Analyze, Organize, Compare Communicate, Graph, Write, Experiment

****

Activity

Step 1: Prior to beginning this lesson, gather the materials listed above. Label each container to show the liquid it contains. It is recommended that this activity be done in small groups, with a set of liquid samples for each table of students. This type of experiment allows students to make discoveries on their own. This activity can also be conducted as one large group, with the teacher demonstrating while students watch, if supplies are limited. (**Teacher Fact Sheets** contain background information on water characteristics.)



What Makes Water, Water, *continued*

Step 2: Explain to students that they will be observing the physical properties of the liquids in the different containers by dropping small amounts onto pieces of wax paper. Explain that each student will be recording observations in their water learning logs, and comparing the properties using a Venn Diagram model. (Review a Venn Diagram, if necessary, with older students. Do the diagram as a whole group activity with younger students.)

Step 3: Give students an opportunity to discuss their findings. Ask students for discoveries about water to add to the water droplets that are displayed in the classroom.

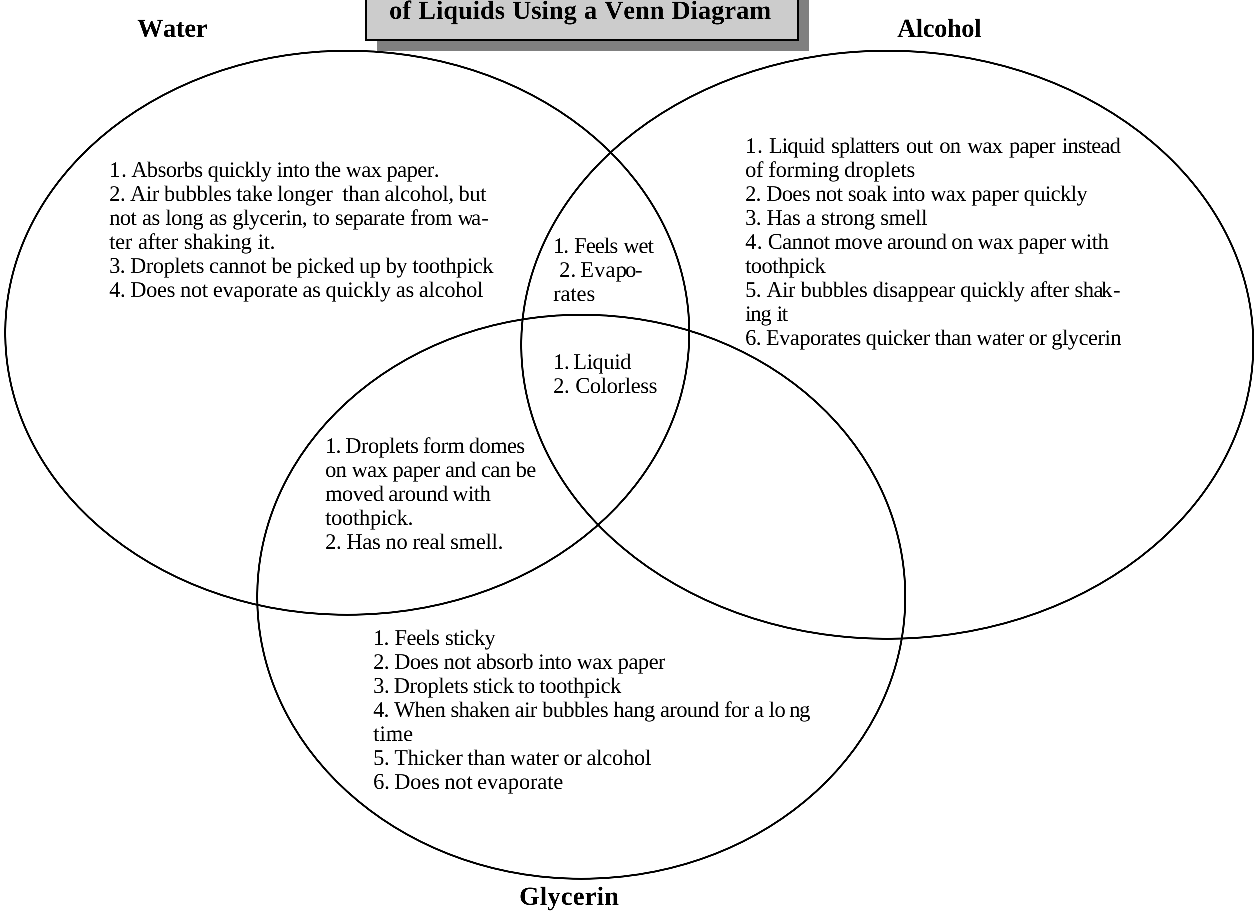
Assessment

Check student's water journals to be sure they have participated in this activity and are beginning to understand the properties of water.

Extensions / Variations

1. Give students who are interested in taking this experiment further, opportunities to compare water to other clear liquids.
2. If working with younger students, try using only two of the liquids (water and glycerin or water and mineral oil).

Comparing the Physical Properties of Liquids Using a Venn Diagram



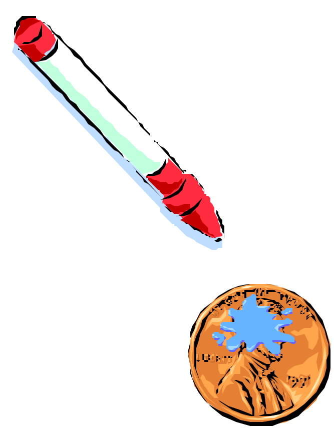
Tense Water Droplets

Standards	**Science: SC-E-1.1.1**, Students will understand that materials have many observable properties such as size, mass, shape, color, temperature, . . . , and the ability to react with other substances.
Activity Description	Students will continue to learn about the physical characteristics of water as they explore water surface tension.
Materials	• Clean water • Class set of pipettes or water droppers • Water learning log One penny per student Class set of hand lenses Pencil
Length of Lesson	Approximately 30 minutes
Vocabulary Word	**Surface Tension**—the skin-like surface on water (and other liquids) that pulls it together into the smallest possible area (sphere).
Essential Question	**What is water and why is it important?**
Guiding Questions	• What is surface tension? • Why is surface tension important?
Skills Used	Observe, Discuss, Predict, Experiment, Write, Analyze

****

Activity

Step 1: Gather and prepare the materials needed prior to beginning this lesson. (Refer to **Teacher Fact Sheets** for background information on characteristics of water.) At the beginning of this lesson each student should have their water learning logs and a pencil, one clean penny, access to a small container of clean water and one pipette or water dropper.



Step 2: Ask students to think about what the water did when a small amount was dropped onto wax paper in "What Makes Water, Water?", if this lesson was used. If lesson 3 has not been used yet, then ask students to predict what they think might happen as a small droplet of water is placed on the penny. Encourage students to share their predictions with class members.

Tense Water Droplets, *continued*

Step 3: Instruct students to squeeze one small drop of water onto the penny. Using hand lenses, ask students to closely observe the drop of water and discuss what they see. Explain to students that the water droplets are rounded like little domes because of the bonding between the molecules of water where its surface meets the air. This is known as ***surface tension*****.** Also explain that without gravity, water would form perfect spherical shaped droplets, since the sphere is the geometric shape with the smallest surface-to-volume ratio.

Step 4: Tell students that the objective of this lesson is to teach them more about water surface tension. Ask students to estimate how many small droplets of water the surface of the penny might be able to hold and write that estimation in their water learning logs.

Step 5: Explain to the students that they will be counting the number of water droplets they each place on top of their own penny. Once the surface tension of the water is broken and the water "spills" across the penny this experiment is completed and the results should be recorded in the water learning logs. Instruct students to stay focused on their penny since they each need to be responsible for counting their droplets of water as accurately as possible. Do not say anything to students at this time about how to squeeze the pipette or how to position the pipette in proximity to the penny. This should allow for a wide variety of results among the students and some lively discussions and observations. (If the pipette is held far away from the penny as the droplets of water are released, the droplets will land with more "force". This may cause the surface tension to break after only a few droplets of water have been placed on the penny. Also, results will vary depending on the pressure used by each student as the pipette is squeezed. More pressure might produce larger droplets of water.)

Step 6: Once all students have completed their experiment give students an opportunity to discuss their findings as a large group. Ask students to think about what variables could have been present during the experiment to cause the wide variety of results (dirt on surface of pennies, different sides of pennies used, pipette squeezed with different amounts of pressure, pipette held different distances from penny, shaking hands, . . .). Give students time to add discoveries to their learning logs and questions to their question strips at the conclusion of this lesson.

Extensions / Variations

1. If working with younger students, working in pairs may be easier, since one student can count as the other student squeezes the water droplets onto the penny. Once the surface tension is broken and the actual amount of drops is recorded, the students can switch roles.
2. Set up an area in the classroom with materials available for students to redo this experiment, using different variables. Encourage students to keep specific notes on how the variables were changed each time and post the results in the center for others to read.
3. If there is enough time, make a solution by adding a squirt of liquid soap to the water students are using and have students try the experiment again. (The soap makes it very difficult for the water to maintain its surface tension.)
4. Add clean water to a shallow pan. Sprinkle pepper onto the surface of the water. The surface tension remains unbroken. As students gather around to watch, squirt some liquid soap into the center of the pan. The soap breaks the surface tension as it mixes with the water, and causes the pepper to quickly "scatter".

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

H 2 O-verpowering the Opponents!

Standard

Science: SC-E-1.1.1, Students will understand that materials have many observable properties such as size, mass, shape, color, temperature, . . . and the ability to react with other substances.
Science: SC-E-2.1.1, Students will understand that earth materials include solid rocks and soils, water, and the gases of the atmosphere.

Activity Description

Students will be introduced to the concepts of cohesion, absorption and flow as they further explore water in its liquid state and participate in water races.

Materials

- Clear beakers in different sizes
- Wax paper
- Class set of pipettes or water droppers
- Shallow trays or cookie sheets
- 10 ml graduated cylinders (1 for each group)

Water in opaque container
Class set of plastic straws
Water learning log and
Toothpicks

Length of Lesson

Approximately 60 minutes

Vocabulary Words

Absorb—movement of water into another material.
Cohesion—the force by which molecules of the same kind or the same body are held together.
Flow—movement of water over another material.
Molecule—the smallest particle of a compound that can exist in the free state and still retain the characteristics of a compound.

Essential Question

What is water and why is it important?

Guiding Questions

- What is a water molecule?
- Why is cohesion important in the flow of water?
- Why is surface tension important to the flow of water?
- What role does gravity play in the flow of water?

Skills Used

Observe	Discuss	Experiment	Compare
Communicate	Write	Analyze	Reflect

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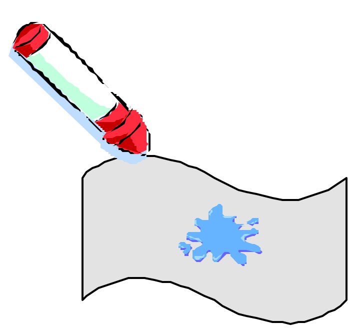


H2O-verpowering the Opponents!, *continued*

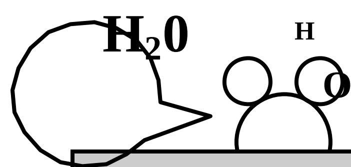
Activity

Step 1: Hold up an opaque container of water. Tell students that the container is filled with one of earth's materials — WATER! Ask students to share what they know about water, as a quick review. Write any new water facts not yet recorded onto pre-cut raindrops. Hang these raindrops on the wall with the collection that has been growing since the first lesson of this unit. (Also, remember to keep writing unanswered questions on sentence strips to add to the wall as reminders for further investigations.)

Step 2: Pour the water into a clear beaker. Ask students to describe what they observed. (The water took on the shape of the new container.)

Step 3: Once again, pour the water from the clear beaker into a totally different shaped beaker, or container. Ask students to share observations. Explain that a liquid is a substance that takes on the shape of the container into which it is stored.

Step 4: Give each student a small piece of scrap paper. Ask the students to tear the scrap paper in half over and over again until it gets too small to tear anymore. Allow time for students to get the scrap paper torn into tiny, tiny pieces. Then explain that one molecule of water is the smallest particle of water possible, even too small to be seen unless using a powerful microscope. Explain that one water molecule is made up of one atom of oxygen bonded (or stuck) to two atoms of hydrogen, gases that are found naturally in our atmosphere. (Refer to **Teacher Fact Sheets** for theories about how water came to be a part of our world.) Draw a model of a water molecule on the board for students to visually study. Tell students that they will be learning more about how water molecules cohere, or "stick together" in this lesson..



Simple Illustration of a Water Molecule

Step 5: Next, give each group of four students a 12 inch by 12 inch piece of wax paper. Ask a student from each group to cut the wax paper into fourths so each student has a piece to use. (Explain that wax paper is a good surface on which to observe water because the fibers in the wax paper are so close together that water **flows** across the paper instead of being **absorbed** into the fibers like materials such as paper towels, whose fibers have larger spaces between them.) Place small containers of water on each table, along with a pipette, or eyedropper, for each student. (It is a good idea to have extra pieces of wax paper available for students to use since the wax paper tears, or the water is absorbed once some of the wax is scraped off the paper.)

Step 6: Ask students to use the pipette to place several drops of water onto the wax paper. Encourage students to observe the water droplets closely as each student tries to maneuver the droplets around on the wax paper. Suggest that students try working with a straw, toothpick and fingers to see which works best with the water on the wax paper. Also suggest to students, if this does not happen naturally, that they try separating the larger drops into smaller droplets, then blow them back together. This introduces the concept of **cohesion**, the way molecules are drawn together, in a natural setting.

H2O-verpowering the Opponents!, *continued*

Step 7: While students are busy observing and experimenting with their water on wax paper, ask them to try to pull their drops of water across the paper. Discuss what happened. (Cohesion held the water molecules together so the water could be pulled.) Then ask them to try to push the drops of water across the paper. Discuss what happened. (Since water is a liquid, the straw, finger, or toothpick traveled through the water and was unable to push the water molecules across the paper.)

Step 8: After students have been given about 10 to 15 minutes just to experiment with and observe the water, ask students to move away from their work stations to a different area of the classroom to discuss any new discoveries about water. (Have water droplets and paper strips ready to add any new water facts or questions.)

Step 9: After students are finished talking about how their water "behaved", announce that it is time to prepare for water races! Explain that the water races will take place at each work station. Each student will be given the same amount of water to move along a new piece of 12-inch by 12-inch wax paper. Two students will race at the same time, with the two winners from each group of four students competing in the final race to determine the group winner. Let students decide on their own how they want to move their drop of water down the race track (by blowing, using a straw or toothpick, etc.). Designate the amount of water each student should place on the new piece of wax paper prior to the start of the water races. (2 or 3 ml works well, if 10 ml graduated cylinders are available to use as measuring tools.) Stand back and let the races begin!

Step 10: Monitor the small group races as preparation for the closing large group activity is taking place (shallow pan lined with wax paper is needed). Once the small group races are over, call students together for a large group demonstration.

Step 11: Ask students how the water races went. Was it easy to get the water to move across the wax paper together as one unit, or was it difficult to keep all of the water molecules moving together? Ask students for suggestions on ways to make the water races easier.

Step 12: Show students the shallow pan lined with wax paper. Prop one end of the pan on a book. Ask students what they think will happen when a drop of water is placed at the higher end of the pan. (Gravity will pull it down to the bottom.) Explain to students that they have been racing water on a flat surface, but that they will now get to experiment with it on a sloped, or inclined, surface.

Step 13: If pans are limited, explore water on a slope as a large group activity. If there are enough pans available for each group of four to six students to have one, send students back to their small groups to experiment with racing water down the slope. Have paper towels available for students to use to dry the surface after each race, if students decide to hold a second round of races. Help students arrive at a better understanding of the role gravity plays in how water flows down hillsides and into rivers.

Step 14: After about 10 to 15 minutes with the pans, give students time to reflect on and write in their water learning logs about what they learned from these water explorations, and previous ones that helped them perform well in the water races. Ask students to think about and answer this question: Is river water going to move faster on a steep slope or a gentle slope? Why? Have students record questions on question strips.

Step 15: Go outside. See how water would flow if poured on a school site.

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

Water Ups & Downs

Standard	**Science: SC-E-1.1.2**, Students will understand that properties (e.g., size, shape) of materials can be used to describe, separate, or sort objects.
Activity Description	Students will explore water density by using common objects to design floating and sinking experiments.
Materials	• The book **Who Sank the Boat**, by Pamela Allen, Sandcastle, 1982 • Common classroom objects. Clear containers of water • Salt and spoons Learning logs and pencils • Class set of worksheets found at end of activity (optional)
Length of Lesson	30 – 45 minutes
Vocabulary Words	**Density**—a measure of the compactness of matter; defined as the amount of matter per unit of volume. Density is sometimes thought of as the "lightness" or "heaviness" of a substance. **Solution**—a mixture formed by dissolving one or more substances, whether solid, liquid, or gaseous, in another substance.
Essential Question	**What is water and why is it important?**
Guiding Questions	• What is density? • Why do some objects float and other objects sink in water? • How does salt affect the density of water?
Skills Used	Observe, Compare, Experiment, Organize Record, Discuss, Communicate, Predict

****

Activity

Step 1: Read and discuss the book, **Who Sank the Boat**, by Pamela Allen, or another book that deals with floating and sinking objects.

Step 2: Prepare clear containers of water, approximately the size of a small aquarium if available, and gather common classroom objects for students to share during this experiment. Make copies of the accompanying activity sheet, if desired. (Activity Sheet 1, which is found at the end of this lesson, has been designed for use by younger students. Activity Sheet 2, which is found at the end of this lesson, has been designed for use by older students.)

Water Ups & Downs, *continued*

Step 3: Before conducting this experiment, ask students to define floating and sinking. Tell students that they will be experimenting with different objects to discover if they will float or sink in water. Instruct students to first make a prediction as to whether they think the object will float or sink.

Step 4: After completing the prediction column on their paper (or in the learning log, if you choose to record results in that fashion) give students enough time to conduct the experiment. While students are conducting the experiments, walk around the room and encourage discussion.

Step 5: Once the first part of this experiment has been completed, ask students if they can explain why some objects float while others sink. Explain that **density** refers to how tightly particles are compacted together. The tighter the particles, the heavier the substance or object and the greater the pull of gravity on the substance or object.

Step 6: Ask students if they have ever been to the ocean. Call on students to describe ocean water (salty taste). Tell students that they will be given a specific amount of salt to add to their water. **In order to compare the results from different tables, give different amounts of salt to each table, beginning with 1/2 cup of salt at the first table and increasing by 1/4 cup at each of the other tables.** Instruct students to redo the experiment a second time, remembering to mark the predictions first. Discuss the results. Did salt change the water density? How can we tell?

Step 7: Give students time to use their water learning logs to record thoughts and questions as they reflect on and write about density and why things float or sink in water. Add questions to question strips.

Extensions

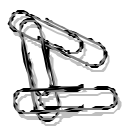
1. For students who would like to take this experiment to a higher level, give them an opportunity to make a density float. They will need a tall clear container, corn syrup, glycerin, colored water, and corn oil. Carefully pour about 3 centimeters of each substance, in the order they are listed, into the container. Once this has been done, carefully add a metal object, a solid rubber ball, a plastic object, and a piece of balsa wood. These objects should settle at different levels in the container. (Students may need to experiment with the plastic and rubber objects in order to find ones having the correct density to float at different levels..)
2. Ask students to predict the density of other liquids such as cooking oil, molasses, rubbing alcohol and milk, as compared to water. After making predictions, ask students how they might test their predictions to see if they are correct.

Side-Tracking

In a flat container, such as a pie tin, evaporate some of the leftover salt solution. Many interesting crystals will remain. Students may question why ocean water is not ridded of its salt in the same way to create drinking water. Explain that some "desalination" water plants have been built during times of water shortages due to droughts in the western United States, but it is a very expensive way to remove salt from ocean water. It is more economical to take care of the fresh water we have available as surface and ground water.

Name______________________________ Date____________________

Water Ups & Downs

	Without Salt in Water				With Salt in Water			
	Prediction Float / Sink		Actual Answer Float / Sink		Prediction Float / Sink		Actual Answer Float / Sink	
 Paper clips								
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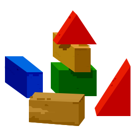
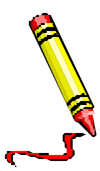
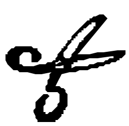
 Blocks								
 Crayons								
 Scissors								
 Paintbrush								

- **Remember to mark your prediction before you conduct the experiment.**
- **Try the experiment a second time, but add salt to your water prior to conducting the experiment. Do any of the results change? If not, keep adding more salt.**
- **Think about this experiment and write about what you observed in your learning long.**

Name______________________ Date_______________

Water Ups & Downs

Objects	Without Salt in Water: Prediction Float / Sink		Without Salt in Water: Actual Answer Float / Sink		With Salt in Water: Prediction Float / Sink		With Salt in Water: Actual Answer Float / Sink	
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- **Remember to mark your predictions before you conduct the experiment.**
- **Try the experiment a second time, but add salt to your water prior to conducting the experiment. Do any of the results change? If not, keep adding more salt.**
- **Think about this experiment. Write about what you observed in your learning log.**

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

What's the Matter?

Standard

Science: SC-E-1.1.3, Students will understand that materials can exist in different states and some common materials, such as water, can be changed from one state to another by heating and cooling.

Activity Description

Students will explore water as a liquid, solid and gas.

Materials

- The book **Water, My First Nature Book**, by Adrienne Sotter-Perrot, 1993 (or another suitable book)
- A clear plastic cup for each group
- Permanent markers
- Digital camera (optional)
- Computer software to create time-lapsed digital imagery (optional)
- Measuring tools (optional)

Water
Water learning log
Pencil

Length of Lesson

Approximately 20 minutes, with experiment lasting throughout the day

Vocabulary Words

Atmosphere—the body of gases surrounding Earth.
Gas—a form of matter having extreme molecular mobility and capable of diffusing and expanding rapidly in all directions.
Liquid—a free flowing substance that borrows the shape of its container.
Matter—that which makes up the substance of anything, occupies space and is perceived by the senses.
Solid —a state of matter characterized by definite shape and volume.

Essential Question

What is water and why is it important?

Guiding Questions

- Water can exist in what 3 forms of matter?
- What causes water to change its form?
- Why is it important for water to be able to change forms?

Skills Used

Analyze	Observe	Communicate	Write
Compare	Experiment	Discuss	Predict

Technology, if digital photography is used

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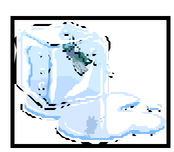
Activity

Step 1: Prior to beginning this lesson, gather the materials listed above. Also, check the **Teacher Fact Sheets** for background information on the characteristics of water.

NOTE: This experiment will achieve better results if it is started early in the morning.



What's the Matter?, *continued*

Step 2: Prepare the clear plastic cups for each group of students. If working with younger students, it may be easier to mark the cups with group names and the half-way mark prior to beginning the lesson. If working with older students, you may wish to have each group measure out a specific amount of water, then mark the level of the water on the side of the cup. Measuring tools will need to become a part of the materials list if students are required to measure out the specified amount in milliliters or ounces.

Step 3: Read and discuss the book, **Water, My First Nature Book**, by Adrienne Soutter-Perrot, with the students. (Any book that talks about the characteristics of water in its three states will work well as an introduction to this lesson.)

Step 4: Divide students into small groups and distribute a plastic cup and water to each group. Depending on how the lesson is organized, instruct students to add water to the cups (either up to the line that has already been marked, or a specific amount, then mark the level). Ask students to choose a place in the school to put their cups. (Some students may choose the window sill, freezer, refrigerator, closet, etc.)

Step 5: If a digital camera is available, take a picture of the cups of water immediately after they have been placed throughout the school building. Also, if possible, take pictures each time the cup of water is checked so the information can be visually viewed at a later time. ("Timeliner" software, a Tom Snyder product, or any similar product, can be used, along with HyperStudio or PowerPoint) to sequence the pictures to create a visual presentation of matter changing states.)

Step 6: After the cups are in place, give students time to record predictions in their water learning logs as to what they think will happen to their cups of water.

Extensions / Variations

1. For students who need to see faster results, use small pieces of laminated graphing paper. Place the desired amount of water directly onto the graphing paper after the laminated paper has been placed in designated locations. Determine the area of the drop of water on each piece of graphing paper by counting the square units it covers. Record the size. When each observation is made, the size of the water drop will need to be figured and recorded.
2. As a language arts assignment, encourage students to write a fictional story about the mystery of the changing water. Poetry and songs are another great avenue for students to use. Refer to Resource List at the end of this unit for suggested books. Songs about water can be found at the end of the Interme-

Step 7: Allow students time to check the amount of water in relation to the line on the cup every hour. If changes are taking place, these changes should be recorded in the learning logs. (Students should be given time and encouraged to record discoveries in their water learning logs throughout this experiment as well as add question strips to the bulletin board.)

Step 8: At the end of the day, have each group of students present their findings. Encourage students to share insights or questions they may have about the changes they witnessed. (Some of the water levels may not show much change if the cup of water was not placed in direct sunlight, close to a heat source, or in a freezer. It may take two days to get more dramatic results, so be patient!)

Step 9: Once the experiments are finalized, help students prepare visual presentations about their findings.

Constantly Changing Water Molecules

Standard	**Arts and Humanities: AH-E-2.1.12,** Students will create movement patterns using locomotor and non-locomotor movement. **Science: SC-E-1.1.3**, Students will understand that materials can exist in different states and some common materials, such as water, can be changed from one state to another by heating and cooling.
Activity Description	Students will explore water as a liquid, solid and gas through movement.
Materials	Script for teacher (included in lesson plan)
Length of Lesson	Approximately 15 minutes
Vocabulary Words	**Matter**, **Gas**, **Liquid**, **Solid** (Review from previous activity)
Essential Question	**What is water and why is it important?**
Guiding Questions	• What 3 forms of matter can water become? • What causes water to change its form?
Skills Used	Listen, Follow Directions, Interpret, Create

****

Activity

NOTE: This is a simple movement activity that works well when students become restless and need to move around for just a few minutes, while reviewing previous learning.

Step 1: Review concepts of the water molecule and the three states of matter that were covered in previous lessons.

Step 2: Explain to students that water molecules react in predictable ways when they are subjected to hot or cold conditions. Tell students that this lesson requires them to pretend to be a water molecule as they change their states of matter from a **solid** to a **liquid** and then a **gas.**

Constantly Changing Water Molecules, *continued*

Step 3: Ask students to stand up and move to an open area in the classroom. (This activity can be done in a hallway or outside, also.) Instruct students to listen to the script read by the teacher so they will understand what they are supposed to do. Read: "You were poured into an ice tray and placed in the freezer earlier in the day so there would be enough ice cubes to use in drinks at dinner. You are now a frozen ice cube. Water molecules slow down as they get colder and colder, and finally quit moving when they become a solid. Squeeze tightly against your neighbor to show you are a solid." (Tell your "molecules" that you are checking to see if they are all frozen as they try to stand perfectly still.)

Step 4: Read the following script: "Oops! I took the tray of ice cubes out of the freezer and left the tray setting on the kitchen countertop. The ice cubes are beginning to melt. I see water molecules slowly moving apart and changing from a solid to a liquid." Tell students that their bodies should still be close together, but not squeezed so tightly, because the water molecules are still stuck together in the ice cube tray as a liquid. (Make a big deal about checking your "molecules" once again to see if they are warming up and melting.)

Step 5: Read the following script: "Oh, dear! The sun was shining through the window onto the ice tray! About half of the water that was in the tray has disappeared! Some of the water molecules have escaped as they changed from a liquid to a gas!" Encourage students to begin to move, or even hop, around as they separate and move into the surrounding atmosphere. (Check the "molecules" to see if they are separating and changing from a liquid to a gas.)

Step 6: Explain to students that this is a demonstration of how water molecules react to cold and heat in real life situations. Reinforce the idea that water never totally disappears (in the sense of going away never to return). Explain that as the molecules disperse into the air (evaporation), they will eventually condense, or reunite with other water molecules and change back into a liquid as they cool. Explain that water molecules are in a constant state of motion, we just usually do not pay any attention to the change taking place because it is such a normal part of daily living.

Step 7: (Optional) Conclude this activity by asking students to write about how water makes them feel in different settings: the beach, a lake, a pond, a river, a fountain, snow, rain, ...

Extensions / Variations

1. At different times throughout the school year, a variation of this activity can be used as a simple movement activity in the classroom, but also as a valuable way to review information learned about the water molecule. Change the story each time to a different setting to create different visual stimulation for the students. As students become familiar with the pattern of this activity, call on volunteers to make up the stories. This is a simple way to check for comprehension.

2. When feeling in a really crazy mood, stand the students up and just call out "liquid", "solid" or "gas". Observe the students to see how quickly they can react to the cue to turn into a water molecule.

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

Where Does All the Water Go?

Standards

Arts and Humanities: AH-E-4.1.41, Students will create artwork using the elements of art and principles of design.
Science: SC-E-1.1.3, Students will understand that materials can exist in different states and some common materials, such as water, can be changed from one state to another by heating and cooling.

Activity Description

Students will make puzzles showing the water cycle at work to share with their classmates and families.

Materials

- Art supplies
- Tag or white poster board

Art paper (if using tag board)
Glue (if using tag board)

Length of Lesson

Approximately 60 to 90 minutes (May be divided into two lessons)

Vocabulary Words

Accumulation—the collecting of surface water after precipitation.
Condensation—the process of changing a gas or vapor to a liquid, as in the formation of water droplets.
Evaporation—the process by which liquid water is heated to the point it changes into water vapor, a gas, and rises into the atmosphere.
Ground water—water that infiltrates (soaks into) the earth and is stored in porous spaces of soil and rock below the earth's surface, within the zone of saturation.
Hydrologic cycle—the circulation of water in and on the earth and through earth's atmosphere through evaporation, condensation, precipitation, run-off, ground water storage and seepage, and re-evaporation into the atmosphere. (Also called the **Water Cycle**.)
Infiltration—the process in which moisture soaks into the ground, where it is either taken up by plants or sinks below plant roots into the ground water.
Precipitation—water that falls to the earth as rain, sleet, snow or hail.
Runoff—water, usually from precipitation, that flows across the ground—rather than soaking into it—and eventually flows to oceans or interior basins, like lakes or ponds.
Surface water—all the water on the surface of the earth, including snow and ice.
Transpiration—the process in which plants give off moisture (water vapor) as a by-product of photosynthesis.
Water vapor—the gaseous state of water.

Essential Question

What is water and why is it important?

Guiding Questions

- What 3 forms of matter can water become and how does that relate to evaporation, condensation, and precipitation?
- How does water travel around the earth?
- Where does all of this water come from?

Skills Used

Draw Analyze Connect Explain

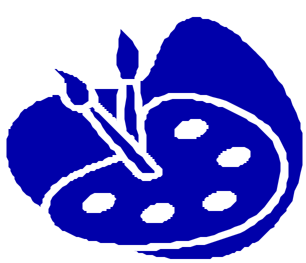
Where Does All the Water Go?, *continued*

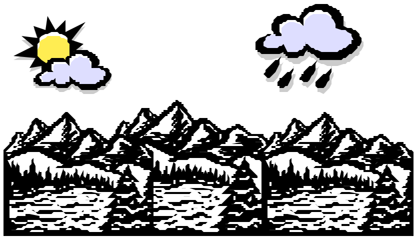
Activity

Step 1: Review the three forms of water (liquid, solid and gas). Ask students to think about and discuss how they think water moves from one point to the next. Emphasize during this discussion the idea that water evaporating from a puddle or pond close to the school does not hang in the air around school. Instead it rises into the air and is blown around in the earth's atmosphere by wind. Explain that we reuse the water found on Earth over and over again, but that this water travels all around the earth. (A weather satellite picture from the Internet that shows cloud movement might help illustrate this concept better than verbal explanations. See: www.weather.com.)

Step 2: Ask students what types of precipitation fall to Earth (rain, sleet, snow and hail) and list these on chart paper or the board. Discuss and list the form water takes once it falls back to Earth and becomes ground water and surface water (lakes, streams, ponds, puddles, glaciers, rivers, oceans, etc.).

Step 3: Tell students that they will be creating a picture of the water cycle, but they must choose one water source (surface water) and a form of precipitation (e.g., rain and a pond or snow and a glacier) to show in their art work. Give students a variety of art materials to use (crayons, colored pencils, pastels, watercolors), but remind them that the picture must include evidence of **evaporation, condensation, precipitation** or **accumulation** taking place. (Post these words and review to make sure students understand their meaning before the students begin working on their pictures.)





Step 4: Once students think their pictures have been completed, have them team up with a classmate and explain how the water cycle works in their illustration. (This will give students the opportunity to review the water cycle concept as they check to make sure they have included everything they need in their art work.)

Step 5: Next, have students cut apart their pictures and store the pieces in envelopes. (It will help to remind students to cut the pictures into large, puzzle-shaped, pieces, instead of small slices. Demonstrate this step for younger students.) Also, ask each student to count the number of puzzle pieces their envelope contains, and write that number on the outside of the envelope, so the student using the puzzle can make sure all of the pieces are returned to the envelope. Students should also write their names on their envelope.

Step 6: Once several students have completed their puzzles, have students work in pairs to exchange their envelopes and put together the puzzles created by other students. Remind each student to look for the way their classmates chose to show the water cycle once the puzzle has been reassembled.

Step 7: Allow time, as students are completing puzzles, to review the information that has been written on raindrops posted around the classroom. If students have any more information to include on the raindrops, add this to the information already posted. Also, give students time to reflect in their learning logs at the conclusion of this lesson.

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

A Journey Through the Water Cycle

Standard

Science: SC-E-1.1.3, Students will understand that materials can exist in different states and some common materials, such as water, can be changed from one state to another by heating and cooling.

Activity Description

Students will journey through the water cycle as clouds in this interactive lesson.

Materials

- Posters created in "Water Walk" activity
- Bowls of water at each station
- Class set of cloud-shaped sponges
- Continent name tags (optional)

Pencil
Water learning log

Length of Lesson

Approximately 45 minutes

Vocabulary Words

Review vocabulary introduced in previous lesson.

Essential Question

What is water and why is it important?

Guiding Questions

- What 3 forms of matter can water become and how does that relate to evaporation, condensation, precipitation, accumulation and transpiration?
- How does water travel around the earth?

Skills Used

Interact Follow directions Recall Connect

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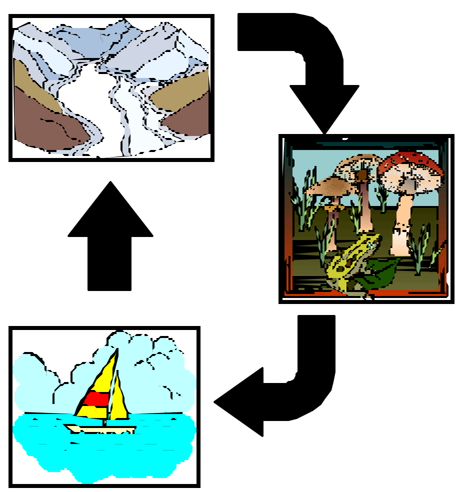
Activity



Step 1: Review information about the water cycle that has been previously covered in class. Take out cold, metal spoons and blow on them. Ask students to explain how this relates to what they drew in the previous lesson "Where Does All the Water Go?" **(condensation)** Have students lick a finger then wave it in the air. When the saliva "disappears" ask students to relate this to what happens during the water cycle. **(evaporation)** Using a hot plate as a heat source, boil water in a glass pan, if available. Place ice in a glass bowl. Hold the bowl over the boiling water so it "catches" the escaping water vapor that is evaporating from the boiling water. As the water condenses on the sides of the cold bowl, the students will see precipitation begin to fall in the form of droplets of water cascading back down to the pot. Ask students how this relates to the water cycle. **(precipitation)**

A Journey Through the Water Cycle, *continued*

Step 2: Remind students of "Water Walk" when they made the posters showing where water can be found. Tell students that they will be using those posters in this lesson as they pretend to be clouds, traveling all around the world, collecting evaporating water. Use the overhead projector or board to show a list of the different scenes shown on the posters from "Water Walk". Give each student a card, or recycled paper, to write ten water sources they would like to visit as they gather their water. While students are deciding which locations to visit, begin placing the posters around the classroom. Beside each poster, place a bowl of water and a plastic spoon.

Step 3: Once the posters, water and spoons have been placed around the classroom, give each student a sponge cut in the shape of a cloud. Explain that as clouds, they must collect the "evaporating water" from each water source they visit around the room by adding one spoon of water to their sponge at each station.

NOTE: To make this lesson more geography-based, the posters showing the water sources may be organized on different "continents" around the classroom. This will reinforce the idea that evaporated water collects and travels all around the world, rather than making a circular motion over one area, as most water cycle diagrams show.

Step 4: Once the posters and bowls of water have been placed around the classroom, instruct students to begin visiting the water sources they have written on their cards. Remind students to take one spoon of water at each station and carefully pour it onto their sponge. Explain that they are simulating what happens as water condenses (changes from a gas to a liquid) and becomes clouds. Tell students that as the sponge becomes saturated with the condensed water, and starts dripping, each student should decide on which continent or water source they would like to "precipitate". (Students will squeeze water back into one of the bowls to make precipitation.)

Step 5: Continue this water cycle simulation activity until all students make it through their ten pre-selected water stations. Stress the point that when water vaporizes, it cannot be seen, but the molecules of water are suspended in the air around us as they make their journey through the water cycle. Also, reinforce the idea that it takes heat for evaporation to occur and cool air high in the atmosphere for condensation and precipitation to occur.

Step 6: As a conclusion for this lesson, ask students to reflect on the experience in their learning logs and write about any new insights they may now have about the water cycle and how it works. Make sure they add any questions to question strips.

Assessment

Give students the following writing prompt as an assessment on what they have learned. "You have just washed your hands before going to lunch. Thinking about what you have learned about the water cycle, what are at least three different ways you can think of to dry your hands? In your answer, explain what happens to the water that was on your hands."

To See is to Believe!

Adapted from "What Goes 'Round Comes "Round" found in *Splash Water Resource Education*, Southwest FL Water Management District

Standards

Science: SC-E-1.1.3, Students will understand that materials can exist in different states and some common materials, such as water, can be changed from one state to another by heating and cooling.
Science: SC-E-3.1.2, Students will understand that organisms have basic needs (e.g., air, water, nutrients, light) and can only survive when these needs are met.

Activity Description

Students will make a mini-model of the water cycle using 2-liter soda bottles in order to observe evaporation, transpiration, condensation, precipitation and infiltration taking place.

Materials

Supplies needed for one model:

- Three 2-liter plastic soda bottle — Hair dryer
- Three plastic bottle caps — Soil
- Two feet of heavy cotton string (wick) — Tape
- Scissors, hammer, nail, sharp knife — Water and ice
- Digital Camera (optional) — Learning logs and pencil
- Plant seeds (Chinese cabbage, radish, etc.), or small plants

Length of Lesson

Approximately 30 minutes to discuss, put models together, and begin demonstration (Observations take place throughout the day.)

Vocabulary Words

Review terms learned in previous lessons about the hydrologic cycle.

Essential Question

What is water and why is it important?

Guiding Questions

- What are signs of the hydrologic cycle in the real world?
- How does the model show what happens in the hydrologic cycle?

Skills Used

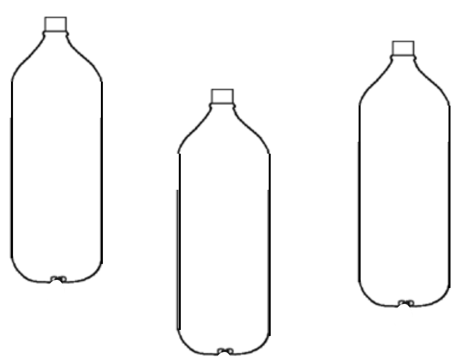
Observe	Experiment	Analyze	Construct
Communicate	Record	Discuss	Compare

Technology (if using digital camera)

****

Activity

Step 1: Prior to beginning this lesson with students, collect and prepare the plastic 2-liter bottles. (See next page for specific directions on how to prepare the bottles.) If plans are to only do one classroom demonstration model, only three 2-liter bottles will be needed. If plans are to have each student make a personal model to take home, then multiply the basic materials listed above by the number of students.



To See is to Believe!, *continued*

Step 2: Use a hair dryer on the lowest heat setting to soften the glue on the soda bottle labels so that they may be removed. Mark the bottles A, B, and C to tell them apart. Cut each bottle as shown in ***Diagram A*** on the next page.

Step 3: Poke a hole in the bottle cap on Bottle B. Insert a string/wick loop so that about 3 inches hang down from the cap. Place the cap with no hole on Bottle C. Tie the remaining 7 inches of string around the neck of Bottle C, so that it hangs down about 3 inches. (See ***Diagram A*** for illustration.)

Step 4: Assemble the bottles as in ***Diagram B:*** Bottle C fits into Bottle B, and Bottle B fits into Bottle A. Thoroughly wet both wicks. This will bring a constant source of water from a reservoir to the plant roots. Add about one pint (16 ounces) of water to Bottle A. This reservoir supplies water to the model's cycle. Fill Bottle B with enough pre-moistened soil to cover the top of the string loop. The string should not be pressed against the side of the bottle.

Step 5: Plant two or three seeds of a fast-growing plant, such as Chinese cabbage, carrot or radish inside the well of Bottle B. (Remove Bottle C from the other bottles when not performing a demonstration, so the air circulates, and the seeds can sprout and grow.) **NOTE: You may opt to place small green plants in this soil instead of planting seeds, if you like.**

Step 6: Place a plastic bottle cap on top of the soil in center of Bottle B, so that the wick from Bottle C drops into it. The bottle cap represents a water body and will collect water when the model "rains". **NOTE: Taking digital pictures of this demonstration will allow students to observe the process over and over again. See "What's the Matter" for previously mentioned suggestions.**

Extensions

1. Before demonstrating the hydrologic cycle the second time, or in the future, add a drop of food coloring inside the bottle cap. Place the bottle cap on the soil so it can catch the "precipitation", once the ice is added to the top bottle. When the rain fills the cap, the food coloring will have tainted the water. Explain that this is how pollution can contaminate water bodies.
2. (Visit http://brainpop.com/science/earth/water/index.wem/ to view a short movie about the water cycle and play water trivia games.)
3. Use the classroom hydrologic cycle model to demonstrate the needs of plants. Insert bottle C, or place plastic wrap on top to create a terrarium, which is an example of a closed system, similar to the system we operate within on Earth.

Step 7: Fill Bottle C with ice water. Tape the seams between bottles to seal them (***Diagram C)***. Observe the bottle cap after a few hours. The model's condensation should have filled the cap with water.

Step 8: Encourage students to discuss what they observe taking place inside their models. Also, instruct students to write the time each observation takes place and briefly describe in their learning logs what changes they see inside their models.

Step 9: After making observations, bring the students back together and ask questions (like the "Guided Questions" listed at the beginning of this lesson). Encourage students to explain, using terminology learned during the previous lessons, as well as their own words and pictures, how the water cycle works. Share this demonstration with other students, or parents, by using the models or showing the digital photographs. Continue to write questions on question strips.

To See is to Believe!, *continued*

Hydrologic Cycle Model

Written directions for assembling these models are found on the previous page. This completed model can also be used to demonstrate pollutants. (See **Extensions**, on the previous page.)

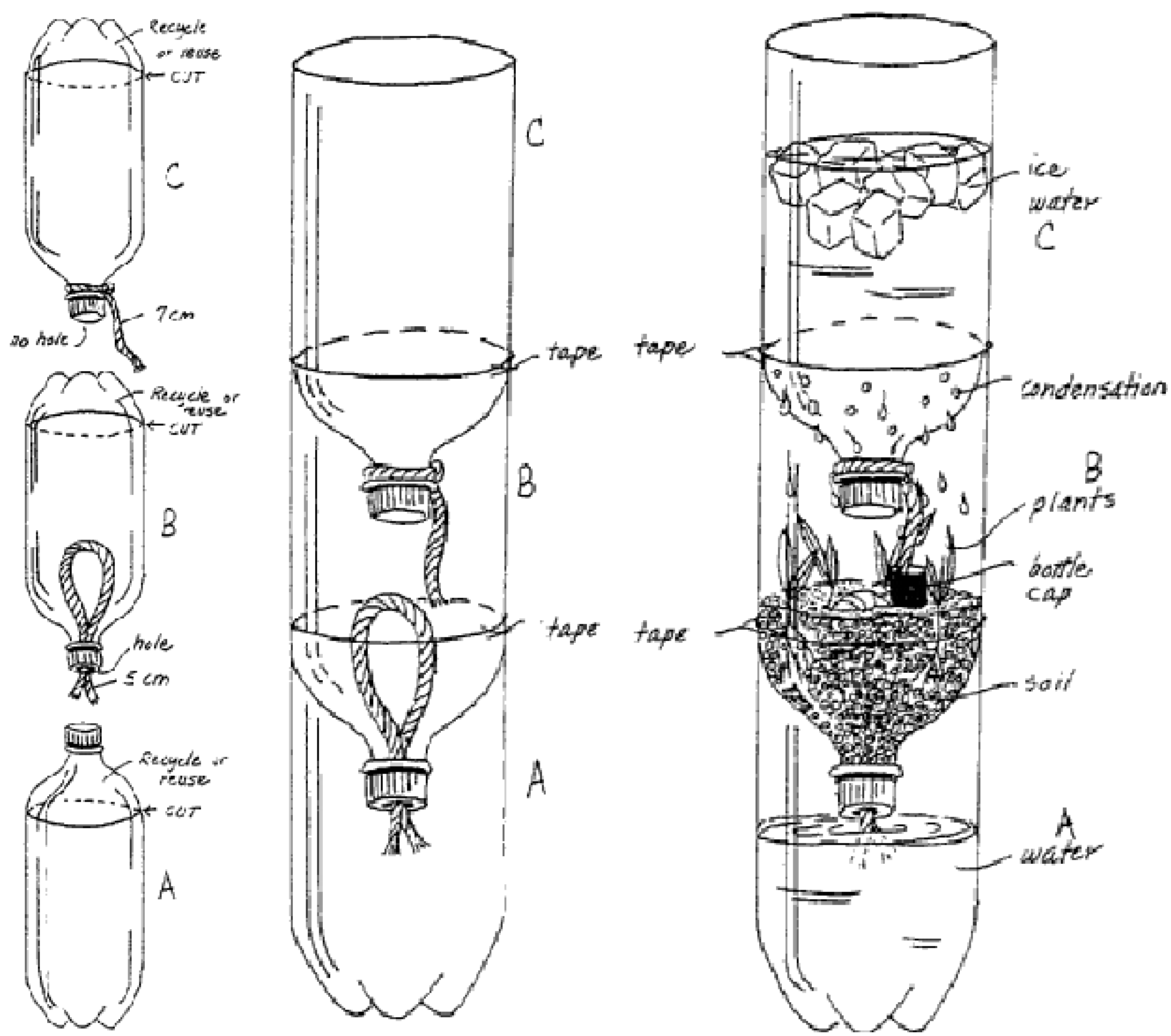


Diagram A **Diagram B** **Diagram C**

Diagrams downloaded from the following web site: **http://www.swfwmd.state.fl.us/infoed/educators/splash/hydcycwk.htm**.

Kentucky's Commonnwealth of Water – Be a Water Explorer
Primary

Survival Needs

Standards	**Science: SC-E-3.1.2**, Students will understand that organisms have basic needs e.g. (air, water, nutrients, light) and can only survive when these needs are met. **Reading: RD-E-4.0.6,** Students will read a variety of materials to accomplish authentic purposes including reading for enjoyment, to locate information, and to complete tasks.
Activity Description	Through observation, discussion and research, students will report on the needs of plants and animals.
Materials	• Digital Camera (optional) Learning logs and pencil • Computers (optional) • Collection of nonfiction books about plants and animals
Length of Lesson	Approximately 30 minutes for outside visit, with research and writing taking place during several language arts periods
Essential Question	**What is water and why is it important?**
Guiding Questions	What do plants and animals need in order to survive?
Skills Used	Observe Read Discuss Write Research Communicate Analyze Draw Technology (if using digital camera or computers)

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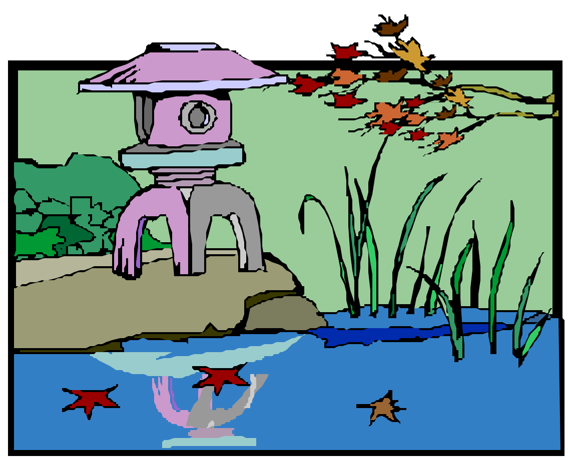
Activity

This activity looks at plants and animals in their native habitats. It is designed to show students the interdependence of water and all living things, while giving students a short break from working exclusively with water.

Step 1: Actively engage students in learning more about the importance of water in the lives of plants and animals by visiting a local body of water.

NOTE: If this is not possible, check your school library for a good video dealing with the needs of plants and animals, that shows living things in their natural habitats.



Survival Needs, *continued*

Step 2: Prior to taking the students outside, explain to students that they will be making a list of the plants and animals they see around the water. Tell students that they may do drawings, take digital pictures, or use words to record their ideas. Remind students to be animal trackers and search for animal tracks while outside, also. (You may wish to visit "**http://www.beartracker.com/guide.html**" to download an animal tracker's guide for students to take along on the outside adventure.)

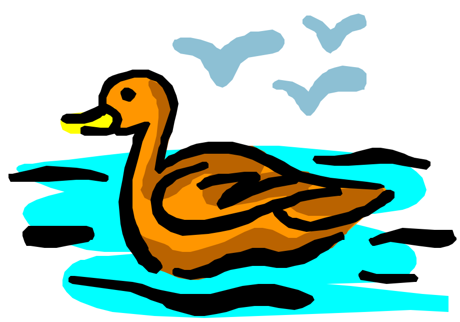
Step 3: Upon returning to the classroom, form expert groups to study the plants and animals observed. Students in each group will choose one animal or plant and create an idea web of the things it needs to survive.

Step 4: After completing **Step 3**, come back together as a group and compare the class webs. (**Kidspirations** and **Inspirations** are great software programs to help students organize thinking in a flowchart, or web, format see: www.piecesoflearning.com/publish/resource/write/ins002.htm/.) Have students reflect in their water learning logs on the importance of water to all living things.

Step 5: Prepare a collection of nonfiction literature for students to use for further investigations, transactive writings, presentations, or reading enjoyment. A trip to the Kentucky Technology Learning Network (KTLN) will allow students to share their findings with a wider audience through multimedia presentations (e.g. PowerPoint, Claymation, Hyperstudio, . . .).

Extensions

1. Invite a speaker from the local Conservation District or Cooperative Extension Service to speak to students about the needs of native Kentucky plants and animals found in the area.
2. Create a mural depicting Kentucky plants and animals in natural habitats.
3. Discuss food chains and the consequences if any part of the chain is disturbed (e.g. drought causes plants in a region to die).
4. Create an outdoor wetland area or small water pond, if there is not a close water source to school, in order to bring plants and animals closer to the school environment. The Daniel Boone National Forest has an excellent publication on vernal ponds. Call 606 784-6428 for more information.



A Fishy Tale

Adapted from "Freddy the Fish", found in *Instructional Models For Use With Enviroscapes*, KEEC, NKEEA, pages 1-3

Standards

Science: SC-E-3.1.2, Students will understand that organisms have basic needs (e.g., air, water, nutrients, light) and can only survive when these needs are met.
Science: SC-E-3.3.3, Students will understand that all organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms, other changes are beneficial.

The next standard is introduced in this activity.
Social Studies: SS-E-4.4.2, Students will recognize that people depend on, adapt to, or modify the environment to meet basic needs.

Activity Description

Students will be introduced to point and nonpoint sources of pollution as they take a trip with a pretend fish in a pretend river during this simulation activity.

Materials

• Large fishbowl or aquarium	7 small paper cups	Soil
• Sponge cut in shape of fish	String	Water
• Plant food /colored drink mix	Pencil or stick	Salt
• Punched out paper dots	Liquid detergent	Cooking oil
• Yellow and red food coloring	A weight or fishing sinker	
• Grass clippings or decaying plants		

Length of Lesson

Approximately 30 minutes

Vocabulary Words

<u>Point Source Pollution</u>— pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial or wastewater treatment plant)
<u>Nonpoint Source Pollution</u>—pollution that cannot be traced to a single point (e.g., outlet or pipe) because it comes from many individual sources or a widespread area (typically urban, rural and agricultural runoff).
<u>Nutrients</u>—food for living organisms. If more nutrients are applied to the land than the plants growing there can use, the excess can pollute water.

Essential Question

What is water and why is it important?

Guiding Questions

- What happened in this activity to change the fish's environment?
- In our community what might pollute water?
- What can we do to clean up the water before disposing of it?

Skills Used

Observe	Predict	Communicate	Listen
Analyze	Problem Solve	Connect	Discuss

A Fishy Tale, *continued*

Activity

Step 1: Gather the materials needed for this activity. Cut the sponge into the shape of a fish. Attach the weight to the bottom of the "fish" with the string. Suspend the fish in the fishbowl or aquarium by tying it to a pencil or stick suspended across the top of the container.

Step 2: Prepare "pollutants" for this activity by placing a small amount of soil in cup #1, colored drink mix or plant food for plant fertilizer in cup #2, grass clippings or decaying plants in cup #3, cooking oil in cup #4, salt in cup #5, paper dots in cup #6, and warm water with detergent in cup #7.

Step 3: Make a copy of the script (found on the next page) on tag board. Cut it apart for students to use during this activity.

Step 4: Assign ten students to read the script. As each scene is read, ask different students to pour the mentioned pollutant into "Buddy's river".

Step 5: Take the time during this activity to stop after each substance has been added to the river and discuss how Buddy feels. Encourage discussion about water pollution and its affect on plants and animals. Discuss with students possible point and nonpoint sources of pollution in your own area.

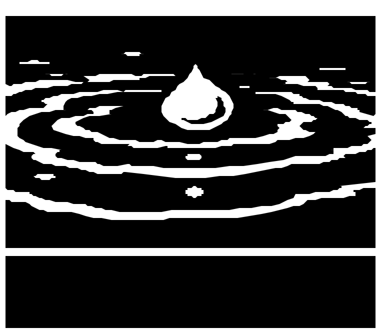
Step 6: At the end of the script, ask students what should be done with the container of polluted water. Help students gain in their understanding of why the water cannot be poured down the drain or dumped outside on the ground, since it could pollute fish or animals in local creeks or rivers.

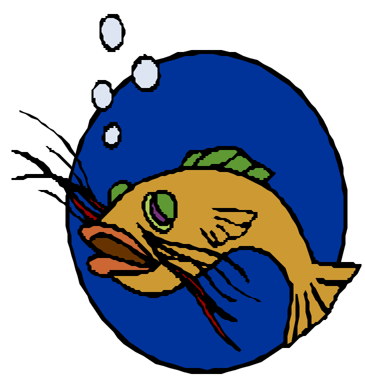
Step 7: Talk about how water is filtered both naturally and in water treatment facilities. Ask students to think about and discuss different types of filters they have seen used before.

NOTE: This discussion should automatically flow into the next activity in this unit, "Filtering Away Pollutants", so students can see that there are good solutions to water pollution..

Extension:

Borrow an Enviroscape tabletop model to show exactly how pollutants get into the water system. See Teacher Fact Sheets for where to borrow an enviroscape model near you.





Kentucky’s Commonwealth of Water – Be a Water Explorer
Primary

A Fishy Tale Script

1. Today we are going to imagine this container of water is a clean river flowing gently through the rolling hills of Kentucky. In this river lives a friendly little fish named Buddy. How do you think Buddy feels today as he is relaxing in his clean, beautiful river?

2. Buddy has lived in this part of the river with his family for his entire life. Today, though, he has decided that he is old enough for an adventure away from his mom and dad. Let’s join Buddy as he begins his adventure.

3. Buddy’s first part of his journey takes him into farm country. As he swims along, he passes a recently plowed riverbank. It begins to rain, and some of the soil from the riverbank erodes and washes into the river. ***(Pour soil into water.)*** How does Buddy feel?

4. Buddy swims close to a suburban neighborhood. Some fertilizer from the nearby lawns washed into the river a few months ago. ***(Pour plant food or colored drink mix into water.)*** This fertilizer made the plants in the river grow very dense. The river was unable to furnish these plants with all of the nutrients they needed, so they began to die and decay. ***(Pour grass clippings or decaying plants into water.)*** This decomposing process is using up some of Buddy‘s oxygen. How does Buddy feel?

5. Buddy swims under a bridge. Some cars traveling across the bridge are leaking oil. The rain is washing the oil into Buddy’s river. ***(Pour cooking oil into the water.)*** How does Buddy feel?

6. Last week when the weather turned very cold one night, the highway department had to spread salt on the bridge to keep it from freezing. The rain is now washing the rest of the salt off the bridge and into the river. ***(Pour salt into the water.)*** How does Buddy feel?

7. Buddy is now swimming past a city park. A few of the picnickers did not throw their trash into the cans. Instead, the wind has started blowing it into the river. ***(Sprinkle in paper dots.)*** How does Buddy feel?

8. Buddy is leaving the city and swimming toward some factories located in the county industrial park. Laws have been passed to keep factories from dumping pollutants into the river, but these factories are ignoring the laws. ***(Pour warm soapy water into the water.)*** How does Buddy feel?

9. Buddy is passing the city’s wastewater treatment plant and has discovered that some of the sewage from the plant is flowing into the river because the plant is not working properly. ***(Squirt 2 drops of yellow food coloring into water.)*** How does Buddy feel?

10. Finally, Buddy swims past a hazardous waste dump only to find the rusty barrels holding the harmful chemicals are leaking. The rain is washing these poisonous chemicals into the river. ***(Squirt one drop of red food coloring into water.)*** How does Buddy feel?

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

Filtering Away Pollutants

Standards

Science: SC-E-3.3.3, Students will understand that all organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms, other changes are beneficial.
Social Studies: SS-E-4.4.2, Students will recognize that people depend on, adapt to, or modify the environment to meet basic needs.
Practical Living: PL-E-3.3.2, To protect all citizens, there are community guidelines (e.g., school inspections, trash collection, water treatment, waste treatment, animal control, immunization) that promote healthy living environments in the community.

Activity Description

Students will discover ways to filter "polluted" water, then learn about natural filters in the environment, and wastewater treatment plants.

Materials

- Dirty water from "A Fishy Tale" Measuring cup
- Clear jars for each group Learning logs and pencils
- Cotton balls, paper towels, coffee filters, charcoal, cotton batting
- ***The Magic School Bus at the Waterworks***, by JoAnna Cole

Length of Lesson

Approximately 60 minutes

Vocabulary Words

- **Purify**—to clean.
- **Wastewater treatment plant**—a large facility that treat wastewater from homes and industry to a point that it can be safely discharged into the environment.

Essential Question

What is water and why is it important?

Guiding Questions

- Where do we get the water we use for personal consumption?
- How can dirty water be cleaned?
- How do we know water in our community is purified and safe to drink?

Skills Used

Compare	Experiment	Analyze	Investigate
Write	Discuss	Teamwork	Communicate

Filtering Away Pollutants, *continued*

Activity

Step 1: Even though this lesson can be taught separately, it is recommended that it follow "A Fishy Tale", since the dirty water left over from that lesson would lead into our study of water treatment facilities.

Step 2: Using the dirty water left in the fish bowl at the conclusion of "A Fishy Tale", ask students to think about ways they might be able to clean the dirty water in order to make it safe to throw away. (If that lesson has been skipped, begin this lesson with a gallon jug of dirty water.) List different suggestions made by students. If students have a difficult time thinking of ways to filter the water, ask them to think about filters that are used to clean water in fish tanks or pools. What materials are needed in order to filter the dirt from these water sources?

Step 3: Gather materials students think might be useful to clean Buddy's water. Divide students into small working groups. Give each group one cup of dirty water to try to clean and one small cup for each filter. Instruct students to select one person in each group to keep a written record of the materials and process they use to clean their cup of water. (This will be helpful when the group reports to the class the results of their experiment at the end of the lesson.)

Step 4: Explain how to conduct experiments more precisely by doing such things as:
- Stirring the dirty water each time to make sure each sample has similar dissolved solids.
- Use the same amount of water to pour through each filter.
- Allow the same amount of time for each filter to work.

Step 5: Allow sufficient time for each group to try to clean their water. Then ask each group to share their process and results with the rest of the class. This can be done in a large group setting at the front of the room, or by taking a mini field trip to

Step 6: After sharing test results, ask students if the water now looks clean enough to drink. If some answer "yes", ask if it is safe to drink. Emphasize to students that even when water looks clean, it may not necessarily be safe to drink.

Step 7: Read ***The Magic School Bus at the Water Works,*** by Joanna Cole, to give students a general idea of how water is treated to make it safe for human consumption.

Day 2

Step 1: If possible, take students to an outdoor stream to observe how nature filters water in a natural setting. Point out how the rocks are used to trap dirt and trash found in the water, as gravity pulls the water in the smaller stream toward the next larger water source. If there has been a recent rain, explain that the water runoff from the hillside has caused the water to be muddy. If the sediment has fallen to the bottom of the stream and the water is fairly clean, use a clear container to take a sample of the water from the stream. Hold up the container of water and ask students if the water looks clean enough to drink, and if it is safe to drink. Stress to students that water should never be taken directly from an outdoor stream or water hose to drink because of the unseen impurities in it.

Step 2: Upon returning to classroom, give students time to compare how nature cleans water with how people clean water in their learning logs.

Extensions / Variations

Students who might benefit from seeing a visual representation of a water treatment facility could visit the following web site sponsored by the Environmental Protection Agency: http://www.epa.gov/safewater/kids/treat.html

Protecting Kentucky's Water – Be a Water Explorer
Primary

The Water Patrol

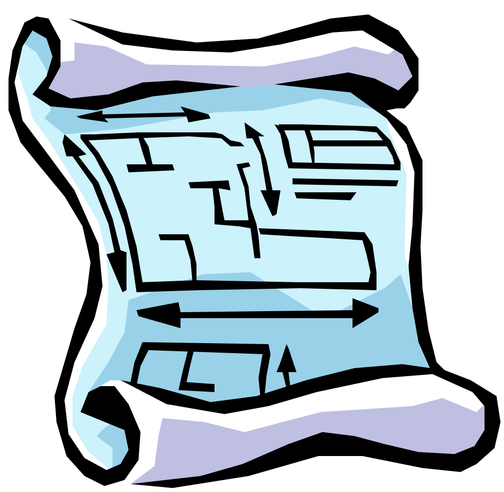
Standards	**Math: MA-E-3.2.1,** Students will pose questions, collect, organize, and display data. **Social Studies: SS-E-4.1.1,** Students will use tools (e.g., maps, globes, charts, graphs, compasses) to understand surroundings.
Activity Description	Students will mark the places where water is used on a school map, discuss the different uses of water in the building, estimate the amount of water used daily to flush toilets in one student restroom, collect data for a predetermined amount of time and analyze that data.
Materials	• Diagram of school layout (or students may draw a school map • Timer • 2 copies of data collection sheet (found at end of lesson)
Length of Lesson	30-45 minutes on first and third day Students should be scheduled to collect data throughout the second day
Vocabulary Word	**Conservation**—the protection or wise use of natural resources that ensures their continuing availability to future generations.
Essential Question	**What is water and why is it important?**
Guiding Questions	• How much water do you think is used at school during a typical day? • Why is water conservation important?
Skills Used	Record, Analyze, Compute, Graph Discuss, Display, Organize, Technology

****

Activity

Step 1: This lesson may be presented in different ways, depending on the needs of your students. If working with younger students, obtain a map of the building, like the one used to mark fire escape exits. Create a transparency to use on the overhead projector. Explain the map to the students. Ask students to think about and help locate places throughout the school building where water is used. Mark those places on the map with water droplets, and keep of list of how water is used..

If teaching map skills to older students, assign different areas of the school building to different groups of students. Ask students to study their assigned section of the building, draw a map of that section, and mark the places where water is used.



The Water Patrol, *continued*

Step 2: Ask students to estimate how much water might be used to flush toilets in one student restroom for one day. Ask for suggestions on how the class might find out how much water is used. Share with students that it takes approximately 5 gallons of water when one toilet is flushed. Explain that they will be collecting information on how much water is used in the restroom closest to their classroom. Tell students they will begin collecting data on the next school day.

Step 3: Prior to the start of the next school day, prepare a schedule for students to follow that will allow two students to sit outside a student restroom in 15 minute intervals to count the number of toilet flushes. The schedule should cover the start of the school day, and end approximately 15 minutes before school is dismissed. **(Use teacher discretion about whether "breaks" are needed from this or if an attempt will be made to record data without interruptions for an entire day.)**

Step 4: Place two chairs outside the closest student restroom. To make it look more official, post a sign above the chairs stating "***Water Patrol at Work — Please Do Not Disturb".*** Also, post a schedule in the classroom showing when students are assigned to go to the restroom to record the number of times each toilet in the designated student restroom is flushed.

Day 2

Step 1: Explain that each pair of students will take a clipboard, data collection sheet (found on the next page) and pencils with them to use as they record the data outside the restroom. Tell students that it is very important to make the information as accurate as possible by making sure they place a tally mark inside one box each time they hear a toilet flush.

Step 2: Designate responsible students to keep the timer set, mark the data collection sheets with the time each pair of new students leave the classroom (if information will be graphed based on the time and number of flushes) and catch the students up on classroom work as they reenter the classroom. This should keep the number of times instruction is disturbed throughout the day to a minimum.

Step 3: Begin collecting the data.

Day 3

Step 1: Model the use of a spreadsheet or calculator to compute the water used during the previous school day in the designated student restroom.

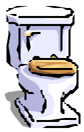
Step 2: Take this total and multiply it by the total number of student restrooms in the school to find an estimated amount of water used to flush toilets in all of these restrooms. Try to help students understand that this is only the flushes. Water was also being used to wash hands, drink, cook and clean throughout the day. WOW! What a lot of water to try to patrol!

Step 3: Remind students of the first lesson on the small amount of usable water on Earth. Ask if they are beginning to better understand why it is important to conserve the amount of water used.

Step 4: Use water learning logs to reflect on this experience.

Extensions

1. E-mail the office manager to find out who to contact to check on how many gallons of water were used at school during the previous month.
2. Graph toilet flushes and the time increments the data was collected to determine the time of day the most water was used.



The Water Patrol

Number of Toilet Flushes

Time of Data Collection	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Concerned About Conserving Water

Standards

Math: MA-E-3.2.1, Students will pose questions, collect, organize, and display data.
Practical Living: PL-E-3.1.5, Students will understand that there are consumer decisions (e.g. reducing, recycling, and reusing) that have positive impacts on the environment.

Activity Description

Students will develop a survey to use to collect and analyze information about how much water their families use during a typical day at home.

Materials

- Computer (to create survey, unless using the included survey)
- Computers and graphing program (optional)
- Class set of survey forms

Length of Lesson

Approximately 60 minutes on at least two days, plus homework

Vocabulary Words

Consumption—the amount of any product or resource used in a given time by a given number of consumers.

Essential Question

What is water and why is it important?

Guiding Questions

- How much water do you think is used at home during a typical day?
- How can we find out this information?
- What can you and your family do to conserve water?

Skills Used

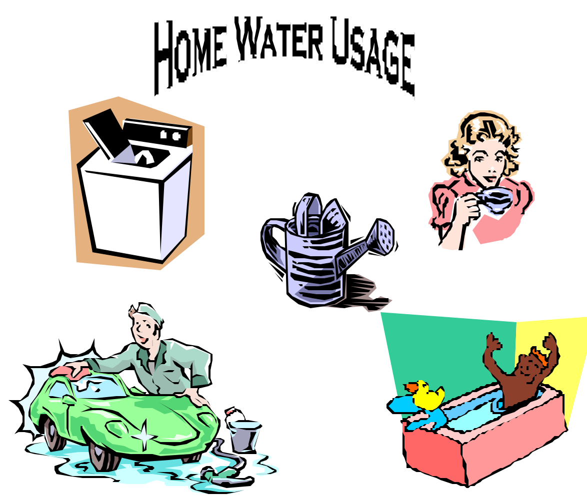
Analyze	Collect	Compute	Describe
Estimate	Identify	Observe	Graph
Compare	Discuss	Technology	Communicate

****

Activity

Step 1: Explain to students that, as a group, they will be compiling a survey to take home and use to find an estimate of how much water is used by their families in one day. Ask students to brainstorm how water is used in their homes. Make a list on chart paper or the board.

Step 3: Once the list has been compiled, show students how to set up a chart to collect their data. (If working with younger students, or if there is a time constraint, this step may be skipped and the chart at the end of this lesson may be used.)



Concerned About Conserving Water, *continued*

Step 3: Once the chart is ready to send home, explain it to the students, if they were not a part of the development process. Be sure to point out the "conservative" ways listed to use water on the chart. Be ready to give out question strips.

Step 4: Ask students to estimate how many gallons of water they think their family uses in one day. Ask students to write their estimate in the water learning logs, so it can be compared to the actual amount when the homework is returned to school. Send the chart home with students. Explain to students that the chart needs to be completed with the help of family members and returned to school the next day. Send survey home. You may want to assign this on Friday to give students time to investigate.

Day 2

Step 1: Bring students together the next school day to discuss the results of their home investigations dealing with water usage. Compare the estimate written in the learning logs on the previous day with the actual amount of water used. Ask students if any family members tried to change the way they normally use water at home to the conservation ideas listed on the chart. If so, applaud the efforts made to save water usage!

For parents who have Internet access, encourage them to visit ***http://www.h2ouse.org/*** to discover ways to conserve water at home.

Step 2: If the students have access to a computer lab, set up a time to allow students to enter their collected data on *Excel* or another graphing program in order to visually compare the amounts of water used for different activities at home. If a computer lab is unavailable, but each classroom has computers, try teaming primary students with older students in other classrooms in the school to individually help them enter the data and create graphs.

Step 3: As the graphs are printed, compare water usage and create a display to share with the rest of the school. Challenge students to work with families to decrease the amount of water used at home by using the conservative methods mentioned on the chart.

Step 4: Give students time to reflect, either by themselves in their learning logs, or in a group, about this activity. Encourage them to think about how they have used water in the past, and changes they will try to make in the future to conserve water. Spend some time recording student questions on question strips.

Extensions / Variations

1. **Using the same basic format, this lesson can take on a different twist by sending the first collection data sheet home with the "conservative water usage" column removed. Tally and graph the results. One week later, send the data sheet home with the conservative usage included. Send a note encouraging families to use the conservative method, if possible, the second time. Tally, graph and compare the results with the previous homework.**
2. **Create posters to display at school, or in the community, showing how much water can be saved if people make the choice to conserve water when doing daily home activities.**
3. **Create infomercials for the school news program or a local television station showing ways water can be conserved.**
4. **Use a calculator to total the amount of water used by all students' families for one day. Multiply by 365 to obtain a yearly estimate.**

Water Used at Home

Name______________________________ **Date**____________________

Directions: Work at home, with family members to complete this chart, based on water used during one typical day. Please return this completed chart to school tomorrow. Thank you!

ACTIVITY	**Total Number of Times**	**Estimated Gallons of Water Used With Normal Usage**	**Estimated Gallons of Water Used With Conservative Usage**	**Total Gallons of Water Used**
Brush teeth		Water running 2 gallons	Water turned off 1/4 gallon	
Take a bath		Full tub 40 gallons	Low water 10 gallons	
Take shower		Standard shower head 50 gallons	Low flow shower head 25 gallons	
Shave		Water running 15 gallons	Plug & fill basin 1 gallon	
Flush toilet		Standard flow toilet 5 gallons	Low flow toilet 1 1/2 gallons	
Get a drink		Run water to cool 1 gallon	Keep water in fridge 1/16 gallon	
Wash hands or face		Water running 2 gallons	Plug and fill basin 1 gallon	
Cook a meal		Water running to wash vegetables: 3 gallons	Wash vegetables in bowl: 1 gallon	
Wash dishes by hand		Water running 30 gallons	Wash & rinse in sink: 5 gallons	
Run a dishwasher		Full cycle 16 gallons	Short cycle 7 gallons	
Do a load of laundry		full cycle / top water level 60 gallons	short cycle/ low water level	
Watering lawn		300 gallons	Early,, shorter watering 150 gallons	
Washing car		50 gallons	Rinse less often 25 gallons	
			Total Water Used	

Please compute the total amount of water used at home before returning it to school tomorrow. Thank you!

Primary Unit

Kentucky's Commonwealth of Water – Be a Water Explorer
Primary

"Water" You Gonna Do About It?

A Culminating Performance Task

Standards	**Practical Living: PL-E-3.1.5,** Students will understand that here are consumer decisions (e.g. reducing, recycling, and reusing) that have positive impacts on the environment. **Writing: WR-E-1.4,** Students will write an informative and persuasive letter for an authentic audience to accomplish realistic purposes.
Activity Description	Students will review information covered during the water unit and use some of that information to write a letter to family members telling what they learned about water and suggesting ways to conserve water at home.
Materials	• Paper and pencil • Assessment rubric
Length of Lesson	One to two writing periods
Vocabulary Words	All words in the unit
Essential Question	**What is water and why is it important?**
Guiding Questions	• What are the most important things about water you want to remember? • Why is it important to conserve water? • What, specifically, can you and your family do to conserve water?
Skills Used	Organize Reflect Write Communicate

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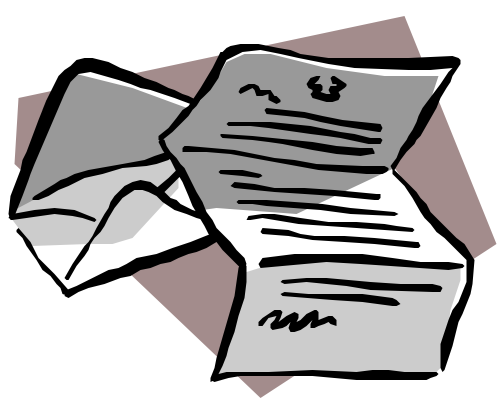
Activity

Step 1: Prior to beginning this culminating activity, develop an assessment rubric to fit the needs of the students who are participating in this activity. A sample rubric is shown on the next page. A copy of the completed rubric should be given to each student once the assignment has been explained in **Step 4**.

Step 2: Tell students to look at all the rain droplets that have been added to the wall throughout this study of water. Ask them to suggest ways the droplets may be sorted. (For example, characteristics of water, animals and plants that live in water, etc.) Begin sorting the droplets and place labels over the different groups.



"Water" You Gonna Do About It?, *continued*

Step 3: After the droplets have been sorted, ask students to think about how the word groups are related to paragraphs. (By adding a topic sentence or by forming a question and adding a concluding sentence, paragraphs can be formed.) Call on different students to show how the droplets can be turned into paragraphs for transactive writing pieces about water.

Step 4: Explain to students that they will be writing a letter to their family telling them the most important things they have learned about water. The letter should tell why students feel the points covered are important and it should also attempt to persuade family members to conserve water usage at home by listing specific suggestions for water conservation. Tell students that the letter should also include reasons why water conservation is important. Remind students that they may use any information from their water learning logs, the water droplets on display in the room and the posters or other art work created during this unit for help with ideas.

Step 5: Pass out copies of the scoring rubric so students have a clear idea of teacher expectations on this final assignment.

Step 6: Give students ample time to reflect on and complete this activity. As the letters are completed, score them, according to the rubric that is being used, make a copy of the letter to place in student writing folders, and send the original letters home for students to share with family members.

Step 7: Pass out water certificates (found on the next page) to students for a job well done!

Step 8: Place water droplets and sentence strips that have been displayed on the classroom wall in a manila envelope labeled "WATER" for students to use throughout the school year to spell the words, for sentence building and for continuing transactive writings.

Step 9: If time allows, encourage students to visit **"http://www.campbell.k12.ky.us/links webquest/earth/water.html"** to do an independent study using the Web Quest, "Water, Water Everywhere".

Letter to Family Rubric

1	2	3	4	Score
May or may not have all 5 parts of a friendly letter, does not recognize purpose or audience.	Letter shows all 5 parts of a friendly letter, recognizes family as audience, shows purpose is to convince family to conserve water, includes no supportive examples from research.	Letter shows all 5 parts of a friendly letter, recognizes family as audience, shows purpose is to convince family to conserve water, includes a few supportive examples from research.	Letter shows all 5 parts of a friendly letter, recognizes family as audience, shows purpose is to convince family to conserve water, and provides at least 4 supportive examples from research.	

This is to certify that

____

is now an official

Kentucky Water Explorer and

protector of one of Earth‘s most precious natural

resources — WATER!

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This is to certify that

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Kentucky Water Explorer and

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Kentucky's Commonwealth of Water – Be a Water Explorer
Primary*

Primary Water Unit Reading Resource List

A Drop of Water	By Walter Wick
All About Rivers	By Jane Emil
All About Water	By Melvin Berger
A River Ran Wild	By Lynne Cherry
Around the Pond	By Lindsay Barrett George
Beavers and Their Homes	By Deborah Chase Gibson
Box Turtle at Long Pond	By William T. George
Canoe Days	By Gary Paulsen
Come a Tide	By George Ella Lyon
Come Back, Salmon	By Molly Cone
Daddy and Me	By Catherine Dalyl-Weir
Dawn	By Uri Shulevitz
Drip! Drop! How Water Gets to Your Tap	By Barbara Seuling
Gone Fishing	By Earlene Long
Fishing at Long Pond	By William T. George
Frogs, Toads, Lizards and Salamanders	By Nancy Parker and Joan Richard Wright
I Am Water	By Jean Marzollo
Keeper of the Sea	By Kimberley Smith Brady
Letting Swift River Go	By Jane Yolen
Listen to the Rain	By Bill Martin, Jr.
Little Cloud	By Eric Carle
My River	By Shari Halpern
On a Wintry Morning	By Dori Chaconas
Ponds and Streams	By John Stidworthy
Pond Year	By Kathryn Lasky
Rain	By Peter Spier
Rain	By Manya Stojic
Red Rubber Boot Day	By Mary Lyn Ray
River Life	By Barbara Taylor
River Story	By Meredith Hooper

 * Please note that not all books on this list are included in the PRIDE list approved for purchase. See http://www.kypride.org/ for that list.

Primary Water Unit Resource Reading List, *continued*

Rosie's Fishing Trip	By Amy Hest
Salamander Rain, A Lake and Pond Journal	By Kristin Joy Pratt-Serafini
Snow	By Uri Shulevitz
Swift Rivers	By Cornelia Meigs
Tale of a Tail	By Judith Z. Bodnar
The Caterpillar and the Polliwog	By Jack Kent
The Clean Brook	By Margaret Farrington Bartlett
The Cloud Book	By Tomie DePaola
The Drop in My Drink: The Story of Water	By Meredith Hopper
The Lost Lake	By Allen Say
The Magic School Bus at the Waterworks	By JoAnna Cole
The Raft	By Jim LaMarche
The River	By David Bellamy
The Salamander Room	By Anne Mozer
The Water's Journey	By Eleonore Schmid
Three Days on a River in a Red Canoe	By Vera Williams
Trout Summer	By Jane Leslie Conly
Water Dance	By Thomas Locker
Water Music: Poems for Children	By Jane Yolen
Water, My First Nature Book	By Adrienne Soutter
Water's Way	By Lisa Westberg Peters
Water, Water Everywhere	By Melvin Berger and Gilda Berger
Where Fish Go in Winter	By Amy Goldman Koss
Where the River Begins	By Thomas Locker
Who Sank the Boat	By Pamela Allen

Songs for Primary Water Unit

Keep It Clean
(tune: "**Bingo**")

We use water every day
In many different ways.
W-A-T-E-R
W-A-T-E-R
W-A-T-E-R
We need to keep it clean

Repeat, substituting a handclap for the W, then the W-A, etc.
Reprinted from Earth Children 2000 by Kathryn Sheehan and Mary Waldner, Ph.D., Council Oak Books

Did You Ever See a Goldfish
(tune: "**Did You Ever See a Lassie** ")

Did you ever see a goldfish, a goldfish, a goldfish,
Did you ever see a goldfish go this way or that?
Go this way or that way or that way or this way,
Did you ever see a goldfish go this way or than?

(substitute other fish for goldfish in additional verses)
by Monica Edwards

Rain Song
(tune: "**If You're Happy and You Know It**")

First a little drop of rain hits the ground (tap, tap)
Then another drop of rain hits the ground (tap, tap)
Then another and another and another and another
And pretty soon we heard a different sound (splash, splash)

Http://www.childfun.com

The Water Cycle Song
(tune: **"Clementine"**

Evaporation, Condensation, Precipitation is what I say.
It is called the water cycle and it happens every day.

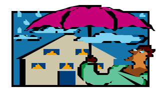
Kentucky's Wonderful Commonwealth of Water

Intermediate Unit

Be a Water Historian

Kentucky's Wonderful Commonwealth of Water
Intermediate Unit

UNIT SUMMARY



While this unit helps students review watersheds and erosion, its main theme is how people have affected water in the Commonwealth throughout history and how all living things (including people) are connected with, and through, water. This connection is placed in the historical context of Kentucky's human populations.

In this unit students will learn the follow big ideas.

- Pollution causes problems for aquatic life and other life as well
- All life is connected
- Some human activities cause erosion, pollution and other changes in the water cycle and human activities can stop it as well
- Throughout Kentucky's history, humans have affected water and water organisms
- Water has always been very important to the people of Kentucky
- People in Kentucky, including prehistoric Indians, early settlers, older people who are still living today, and our own families have used water in very different ways throughout the years.
- Water was once a major form of transportation in Kentucky
- We control water much more today than we ever have before.

In the culminating activity of this unit, students create a time capsule using work completed during the unit. The capsule contains old photographs, oral histories and other sources of historical data, as well as projections for how people might use and protect water in the future.

Suggested open response question - For thousands of years, humans have been using and affecting water in the part of the world we now call Kentucky. Give an example of how people have affected water here and explain how this change has been both good and bad for life in Kentucky.

Portfolio suggestion – Ask students to pretend they are a person living in Kentucky at least 75 years ago or at least 50 years from now. (They may choose the time period and the kind of person they wish to play.) Have each student write a diary that would describe that person's life for a two-week period, including how he or she related to water on a day-to-day basis. Be sure students do research so what they describe is as accurate as possible. Publish excerpts from the diaries as a water history book to place in the time capsule.

Technology Extensions— Have students use desktop publishing software to "illustrate" their diaries. Introduce students to GIS by mapping your local watershed. Assign students different cultures or time periods and have them do a web search of how the people of that time and/or place used water.

Kentucky's Commonwealth of Water– Be a Water Detective
Intermediate

Unit Essential Question: How has our relationship with water changed over time?

Standards

Social Studies

Social Studies SS-E-4.3.2, Students will understand that humans usually settle where there are adequate resources to meet their needs (e.g., areas with water, fertile land, protected land, different modes of transportation).
Social StudiesSS-E-4.4.3, Students will understand that the physical environment both promotes and limits human activities (e.g., mountains as barriers or as protection, rivers used as boundaries or transportation routes)
Social Studies SS-E-5.5.3, Students will understand that the way we live has changed over time in both Kentucky and America because of changes in many areas (e.g., communications, innovations/inventions, homes, recreation, traditions, education)
Social Studies SS-E-5.1.1, Students will understand that the accounts of historical events are influenced by the perceptions of people and passing of time.
Social Studies SS-E-5.2.3, Students will understand that the way we live has changed over time for both Kentuckians and Americans because of changes in many areas (e.g., communication, innovations/inventions, homes, recreation, traditions, education).
Social Studies SS-E-4.1.5, Students will understand that different factors in one location can have an impact on another location (e.g., natural disasters, damming a river).
Social Studies SS-E-2.1.1, Students will understand that language, music, art, dress, food, stories, and folk tales help define culture and may be shared among various groups.
Social Studies SS-E-5.1.2, Students will understand that history can be understood by using a variety of primary and secondary sources and tools (e.g., artifacts, diaries, time lines).

Science

Science S-4-SI-3, Students will use evidence (e.g., descriptions) from simple scientific investigations and scientific knowledge to develop reasonable explanations.
Science SC-E-1.2.2, Students will understand that the position and motion of an object can be changed by pushing or pulling. The amount of change in the position or motion is related to the strength of the push or pull.
Science SC-E-2.3.1, Students will understand that the surface of the Earth changes. Some changes are due to slow processes such as erosion or weathering. Some changes are due to rapid processes such as landslides, volcanic eruptions, and earthquakes.
Science SC-E-3.3.3, Students will understand that all organisms, including humans cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms; other changes are beneficial (e.g., dams built by beavers benefit some aquatic organisms but are detrimental to others).

Kentucky's Commonwealth of Water– Be a Water Detective
Intermediate

Writing

<u>WritingWR-E-1.4,</u> Students will write an informative and persuasive piece for an authentic audience to accomplish realistic purposes.

Arts and Humanities

<u>Arts and Humanities AH-E-3.1.4,</u> Students will create and perform using creative dramatics improvisation, mimicry, pantomime, role playing, and story telling.

Practical Living

<u>Practical Living PL-E-3.3.2,</u> Students will understand that to protect all citizens, there are community guidelines (e.g., water treatment, waste treatment, etc.) that promote healthy living environments in the community.

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 1	**The Runoff Water Mystery"-** Students will learn about watersheds and the interrelationships between people living within a watershed by studying maps of their local watershed, building a watershed model and exploring a micro-watershed on school property. **Standards:** Science SC-E-3.3.3 and Social Studies SS-E-4.1.5 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • What is a watershed? • What are the physical characteristics of our local watershed?
# 2	**"We All Live in a Watershed"-**This activity involves students using an enviroscape model or the watershed and/or stream table models built earlier in this unit to explore how the actions of everybody in a watershed have a impact on other living things, including humans. **Standards:** Science SC-E-3.3.3 and Social Studies SS-E-4.1.5 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions** • How are the actions of humans within a watershed interrelated with other living things?
# 3	" **The Mysterious Drop in the Drainpipe"-**This activity develops a better understanding of how drinking water gets into our homes, and where it goes once it leaves our homes. It also explains how this all fits into the water cycle. **Standards:** Practical Living PL-E-3.3.2 and Social Studies SS-E-5.2.3 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • How do we get water into our homes? • Where does wastewater go when it leaves our homes? 

Unit Overview

Lesson	Title and Description of Activities, Essential and Guiding Questions and Standards
# 4	**" Where Have All the Settlers Gone?"-** Students will investigate early European settlements in their area to find out how close they were to bodies of water. **Standards:** Social Studies SS-E-4.3.2 and Social Studies SS-E-4.4.3 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • Where were the early settlements in our area of Kentucky located? • Were these settlements near rivers, streams or springs?
# 5	**"Heavy Water"-** Students will carry water in buckets to simulate how early settlers had to carry nearly all the water they used. **Standards:** Social Studies SS-E-5.5.3 **Essential Question:** How has our relationship with water changed over time ? **Guiding Questions:** • How do we get drinking water into our homes? • Where does waste water go when it leaves our homes?
# 6	**" Adapted, with permission, from "Water Crossings" in Project WET"-** Students participate in a water crossing contest in which they must move their possessions (represented by a hard boiled egg) across a span of water (a cake pan). **Standards:** Social Studies SS-E-4.4.3 and Science S-4-SI-3 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • How did pioneers travel long distances and /or move goods? • What types of water transportation did early settlers use in Kentucky?
# 7	**" Of Time and the River"-** In this activity students will read a diary account from a young river worker in 1806, then compare river travel today to river travel 200 years ago. **Standards:** Social Studies SS-E-5.1.1 and Social Studies SS-E-5.2.3 **Essential Questions:** How has our relationship with water changed over time? **Guiding Question:** • How has Kentucky's water travel changed in the past 300 years?

Unit Overview

Lesson	Title and Description of Activities, Essential and Guiding Questions and Standards
# 8	**"Water Craft"-**In this activity, students will investigate different crafts used in early water transportation in Kentucky, then construct models of these vessels. **Standards:** Social Studies SS-E-5.2.3 and Science SC-E-3.3.3 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • How did pioneers travel long distances and/or move goods? • What types of water transportation did early settlers use in Kentucky?
# 9	**"The Ohio River Mussel Mystery"-** In this activity, students will learn about the importance of the mussel industry in Kentucky's history, as well as the invasion of the zebra mussel. **Standards:** Social Studies SS-E-5.2.3 , SS-E-4.1.5 and Science SC-E-3.3.3 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • How have people used Kentucky's resources in the past? • How do organisms change Kentucky's environment?
# 10	**" The Mystery Surrounding Kentucky's Dams"-** This activity involves students conducting research to find out about the history of a nearby dam and how it changed life in the area. **Standards:** Social Studies SS-E-4.1.5 **Essential Question:** How has our relationship with water changed over time? **Guiding Question:** • How are the actions of humans within a watershed interrelated with other living things?
#11	**" Capturing a Moment in Time: A Culminating Activity"-** Using photographs, interviews, surveys, stories, etc. collected throughout this unit of study about water, students will create a time capsule to present to the local historical society, or school, to be kept safe for a specified number of years. **Standards:** Social Studies SS-E-5.1.2 and Writing WR-E-1.4 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • How has water been used in my community? • How can we preserve information for future generations to view?

- What is source and nonpoint source pollution?
- How can people help prevent water pollution?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 12	**"Investigating The History of Water Through Music"-** After creating a timeline of historical events surrounding water in the local county and/or state, the music teacher will help students compile and perform a collection of songs and stories about the history of how water has been used (and abused). **Standards:** Arts and Humanities AH-E-3.1.4 and Social Studies SS-E-2.1.1 **Essential Question:** How has our relationship with water changed over time? **Guiding Questions:** • What are some important historical water events in our area or state? • Who can help us collect water songs? 

Making The Unit More Inquiry-Based

Nearly all the activities in this unit are designed to help students ask questions and do some basic research on topics related to water quality in our state. However, a simple exercise woven throughout the unit can increase the numbers of questions asked by the students and make them your partners in finding answers to those questions. Here is how it works.

At the beginning of the unit, make (or have students make) about 100 wavy strips of colored paper long enough on which to write a question. (Strips should look like a stream or river) Also make (or have students make) about 100 drops of water on colored paper. These should be large enough on which to write an answer or fact. Also, designate a bulletin board or wall in the classroom as your "Water Discovery Area". Place the paper in two boxes near the water discovery area. Label the two boxes, "question strips" and "answer drops".

Encourage students to both ask questions in class and to write any questions they have on one of the question strips. They should then attach these to the water discovery area. Also tell students that each time they learn something new about water they are to write that new knowledge on an answer drop. (Students may need a little guidance at first.)

Throughout the unit pause occasionally to match question strips with answer drops. Explain to students that gaining knowledge is similar to the water cycle. It really never ends because each new question needs an answer and, very often, each new answer raises a new question. Also explain that, just as water changes forms, the answers to questions change as we gain new knowledge through science and inquiry.

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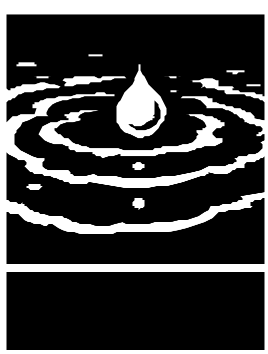

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Kentucky’s Commonwealth of Water – Be a Water Historian
Intermediate

The Runoff Water Mystery

Adapted from “Shedding Light on Watersheds”, *Water Sourcebook, Grades 3-5,* EPA

Standards

Science SC-E-3.3.3, Students will understand that all organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms; other changes are beneficial (e.g., dams built by beavers benefit some aquatic organisms but are detrimental to others).
Social Studies: SS-E-4.1.5, Students will understand that different factors in one location can have an impact on another location (e.g., natural disasters, damming a river).

Activity Descrip-

Students will learn about watersheds and the interrelationships between people living within a watershed by studying maps of their local watershed, building a watershed model and exploring a micro-watershed on school property.

Materials

- Ingredients for salt dough (see activity sheet at end of lesson)
- 9 x 13 x 2 inch cake pan (for each watershed model)
- Hot plate, pan and food coloring (optional)
- Colored picture of a river (any will do)
- Laminated topography maps of local watershed (1 per student)
- Watershed transparency (picture included) and overhead projector
- 5-gallon buckets of water (for outside watershed demonstration)
- Art supplies and waterproof paint or clear shellac to seal the models
- Sprinkling can or spray bottle to create “rain” over models
- Enviroscape Model

Length of Lesson

30 – 60 minutes for at least 3 days

Vocabulary Words

Watershed—land area from which water drains to a particular water body.
Basin—a low lying area where surface water flows, such as a river basin.

Essential Question

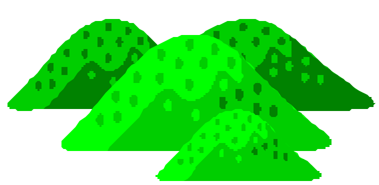
How has our relationship with water changed over time?

Guiding Questions

- What is a watershed?
- What are the physical characteristics of our local watershed?

Skills Used

Analyze	Observe	Communicate	Describe
Discuss	Identify	Collaborate	Interpret
Infer	Write	Apply	Critique



The Runoff Water Mystery, *continued*

Activity: Part 1

Step 1: Prior to this activity, gather materials needed to build a salt relief model of a watershed. (The recipe for salt dough and directions are included at the end of this activity.) Also, send a note home by students asking parents to send in an aluminum 9 x 13 x 2 inch cake pan or comparable container to use for their watershed model. Locate maps of the local watershed area. Obtain one per student. Make a transparency of the watershed shown at the end of this activity in the picture below the salt dough recipe.

NOTE: For state and local topography maps, contact the KY Geological Survey, the local water department, the state agricultural department, the local conservation district office or the department of geology at the nearest college or university. Aerial and topographic maps that can be downloaded may also be found at **http://terraserver.homeadvisor.msn.com/default.aspx.**

Step 2: Before students arrive at school, set out buckets of water by the parking lot (if it is paved and has storm drains installed that lead to a drainage area downhill on the property) and at least one other place on the school property where the lay of the land will allow for water to drain downhill. (This is done in preparation for students to learn more about how the local micro-watershed works. If it happens to be raining, just put on the rain gear and take students out to watch part of the water cycle in action!)

Step 3: At the beginning of class time tell students that they will be traveling outside on school property to see if they can help solve the mystery of where the runoff goes when it rains. Explain that before they can work on solving the mystery, they need some background training, so they need to listen carefully.

Step 4: Show students a colored picture of a river and the surrounding lands. Explain that the area immediately adjoining the river is called the **riparian area.** Ask students where the water came from to create the river. Write their responses on the board or chart. Explain that most of the water in our rivers comes from water that has drained off surrounding land.

Step 5: Ask students to think about how water flows downhill when it rains. Explain that the area of land that drains into a body of water is known as a watershed, and that watersheds come in all different sizes, ranging from a small hill on the playground, to a local creek, pond or lake, on to a nearby river, and even, on a much larger scope, to the Mississippi River Basin. (Explain that a river basin is the low lying area where surface water flows.)

Step 6: Show students a transparency or photocopy of the "Watersheds" picture found at the end

Dear Parents,

We are very excited about a project we are going to be doing at school this week. We will be building watershed models. Each student will need a 9 x 13 x 2 inch cake pan for this project. (An old pan will work great, or a disposable one will be fine.) If you have any small cans of enamel paint stored around the house that you do not plan to be using, we could use that, too (especially green and brown). I would like to thank you so much for the support you give to our school program!

The Runoff Water Mystery, *continued*

of this activity. Ask students to talk about and discuss what they see in the picture. Point out that the picture shows two different watersheds, if students do not bring this up on their own. Use the picture to teach concepts of valley, hill, mountain, etc. Also, teach the concept of the **crest** of the hill being the point where water flows downhill in all directions. (This will help when students are taken outside to look for a micro-watershed on the school property.)

Step 7: Give each student a copy of the local watershed map, or any map showing topography of your local area, including the school. Explain to students how to read a topographic map, if this is the first time one has been used. Instruct students to study the map closely and use their fingers to trace some of the paths water takes to get from different parts of the watershed area to the streams, rivers, ponds and lakes. Give students a few minutes to study the maps and discuss findings with neighbors. Circulate around the room and listen to discussions taking place. Ask students to share insights as you hear learning taking place within the small groups. Provide opportunities for writing question strips.

Step 8: If your local watershed, or topographic map, shows a prominent stream, ask students where they think the creek or river will eventually take the water collected from the local watershed area. Discuss. Also, reference the topographic map, if it shows the school property, and have students look for the highest elevations on the property.

Step 9: Tell students that they now have enough information to work toward solving the mystery of the runoff water.

Step 10: Take students outside. Explain that they are going to be looking for the crest of a hill and watch water flow downhill. They will follow the water and watch to see what happens. Keep in mind that if it is a very dry time, the water will soak in the ground very quickly. (See the groundwater section in the Teacher Fact Sheets.)

Step 11: Give students time to explore the lay of the land in a specified area of the school property. Be there as a guide, if needed, to help them solve their mystery of trying to find the micro-watershed on the school property. Once they think they have located the crest of the hill in the watershed, confirm or reject their conclusion, and lead them toward a better understanding that it takes many small watersheds to feed into larger ones. This should also be a good time to talk about impervious surfaces (parking lots, sidewalks, etc.) and how they affect the watersheds through storm drains (as well as the pollutants that build up from leaking oil, salt, etc.)

Step 12: Collect student questions and post on bulletin board.

Assessment on Part 1

Once the students are settled back in the classroom after the adventure outside, review what they have learned about watersheds. Ask students to think and write about how a watershed and a river are interrelated. Ask students to include, as part of this assessment, a sketch of the immediate watershed that was located on the school property, showing how the water flows in the immediate micro-watershed.

The Runoff Water Mystery, *continued*

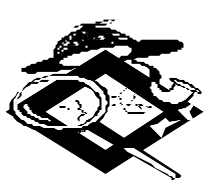
Part 2

Step 1: Explain to students that they will get to make their own watershed model. Give students the option of trying to replicate part of their local watershed or the one pictured on the transparency. Explain that they will need to include hills and valleys so they will be able to see the direction runoff will take when it "rains" on their model. At this point, either gather the ingredients and cook the dough, or take out dough that has been prepared in advance. (Cooking the dough will take a while if done at school, unless you have several adult volunteers, pans and hot plates at your disposal. The dough can be made in advance and stored in airtight containers.) Follow instructions on salt dough recipe. You may ask parents to make the dough and send it in on the day you are doing the project. Have students paint models with water resistant paint when they are fully dry.

NOTE: Ask students for suggestions on how to get the liquid from the salt dough to evaporate faster, once the models have been shaped and are ready to dry. (Use this as an opportunity to review the evaporation stage of the water cycle!)

Step 2: Once the models are ready, they may be used for a variety of demonstrations, such as how water flows toward a water body, or how the unwise actions of one person who lives in a watershed affects everybody who lives down river. Refer to "Let's Make a Watershed Model" in the Middle School Water Unit for further ideas.

NOTE: The watershed models can be used later in the "Mysterious Happenings in the Watershed" activity.



Step 3: While waiting on the watershed models to dry, the lesson can move forward in several directions, depending on the needs of the students. Some suggestions are listed below:

- Divide students into teams of four and give each team a map of the United States. Assign each team a particular area of the United States (New England, Southeast, etc.) and have them find and record the major rivers in that section of the country.
- Ask the teams to list states that are not part of the Mississippi River watershed.
- Instruct teams to find two rivers that do not empty into another river, but directly into the ocean. Explain to students that some rivers have very small watershed areas.
- Pass out world maps to each student group and have students trace and list a few rivers that flow into Africa's Congo River. Explain that the Congo is a major watershed river in Africa. Ask students to trace and list some of the rivers that flow into South America's Amazon River. Explain that the Amazon River is a major river for South America.

Extensions

1. Invite a geologist to class to explain how topographic maps are made. If possible, request they bring booklets that can be given to each student
2. Invite an expert from the fish and wildlife or conservation district office to talk about the local watershed.
3. Research information about the local watershed on the Internet. See Teacher Fact Sheets for a list of web sites to visit.
4. Borrow an Enviroscape table top model to help students understand exactly how water pollution occurs. See teacher fact sheets to find one near you.

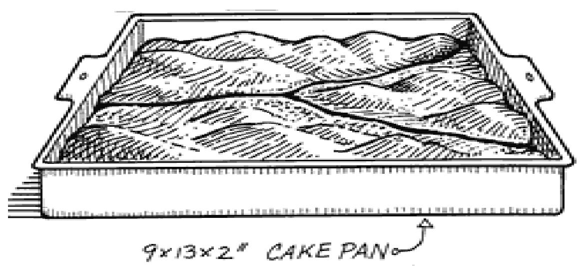
Salt Dough Relief Watershed Model

Salt Flour Dough (NOTE: This recipe 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.)

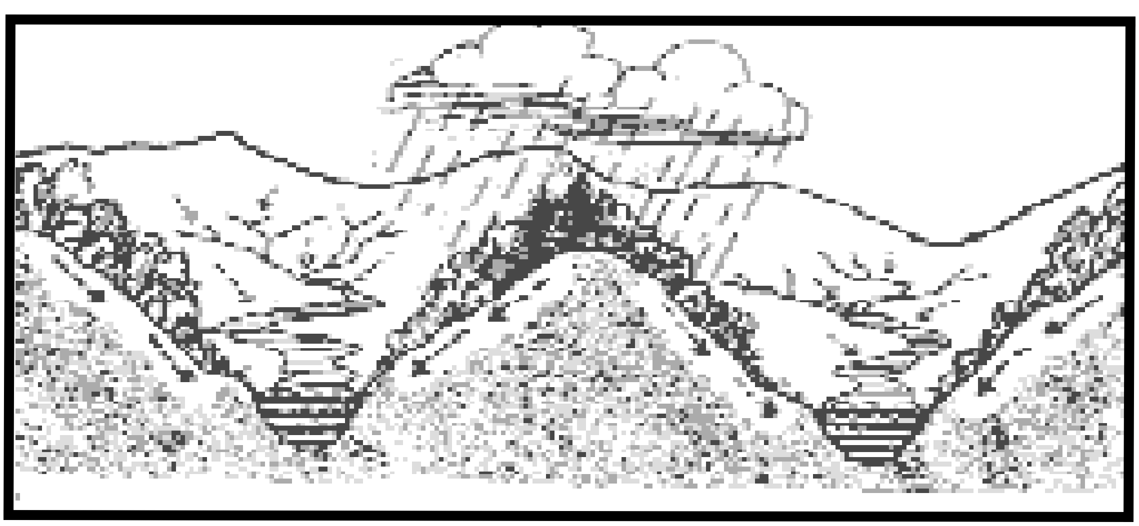
1 cup (250 mL) flour
½ (125 mL) salt
1 cup (250 mL) water
1 tablespoon (15mL) cooking oil
2 teaspoons (10mL0 cream of tarter

Mix and heat ingredients until a ball forms. Add a small amount of food coloring if desired. **NOTE: If the food coloring is added (half brown and half green) then the model will not have to be painted — just shellacked.**

To make model: Try to create a relief map similar to what is depicted on the teacher sheet. "Watersheds", or try to replicate the local watershed from one of the maps. 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. Paint it with waterproof paint, or apply a coating of clear shellac. Using waterproof paint or shellac protects the model so that it can be reused.



Watershed Transparency (Enlarge)



Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

We All Live in a Watershed

Standards

Science: SC-E-3.3.3, Students will understand that all organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms; other changes are beneficial (e.g., dams built by beavers benefit some aquatic organisms but are detrimental to others).
Social Studies: SS-E-4.1.5, Students will understand that different factors in one location can have an impact on another location (e.g., natural disasters, damming a river).

Activity Description

This activity involves students using an Enviroscape model or the watershed and/or stream table models built earlier in this unit to explore how the actions of everybody in a watershed have an impact on other living things, including humans.

Materials

- Enviroscape Groundwater Model (See **Resources** in **Teacher Fact Sheets** for schools and agencies who have models for loan.)
- Watershed models built earlier in unit
- Water and spray bottles
- Variety of powdered substances to use for pollutants (See activity.)
- Variety of materials to use to build dams, lagoons, levees, etc.

Length of Lesson

Two class periods, approximately 60 minutes each

Vocabulary Words

Best Management Practices (BMPs): effective ways to stop pollution.
Effluent—the discharge of a pollutant in a liquid form, often from a pipe into a stream or river.
Nonpoint source pollution: pollution that cannot be traced to a single point (e.g. outlet or pipe) because it comes from many individual sources or a widespread area (typically urban, rural, and agricultural runoff).
Point Source Pollution: pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial, wastewater treatment plant, and certain storm water discharges).

Essential Question

How has our relationship with water changed over time?

Guiding Questions

- How are the actions of humans within a watershed interrelated with other living things?
- What is source and nonpoint source pollution?
- How can people help prevent water pollution?

Skills Used

Research	Read	Write	Communicate
Discuss	Identify	Synthesize	Observe

We all live in a watershed, *continued*

Activity – Part 1

Step 1: If possible, locate an Enviroscape Groundwater Model to use to demonstrate source and nonpoint source pollution in Part 1 of this activity. (See **Teacher Fact Sheets, Resources,** for a list of schools and agencies with models for loan and also for background information on water pollution.) Gather a variety of materials such as powdered drink mix (different colors), cocoa, coffee, soil, pancake syrup, etc. to simulate pollutants. If you are planning to use the watershed model built during an earlier activity, or a stream table, proceed to **Step 2.**

Step 2: Gather students around the model and sprinkle some green powdered drink mix on a field. Explain that a local homeowner has applied too much fertilizer in an attempt to make the grass greener. Ask a student to spray clean water on the "lawn" while others observe to see what happens as it "rains". Explain the meaning of **source** and **nonpoint source pollution.** (Refer to vocabulary words.) Ask students which type of pollution the fertilizer represented (nonpoint source pollution).Encourage students to ask questions and record them on question strips.

Step 3: Ask students to brainstorm ways to try to decrease, or totally prevent the lawn fertilizer from polluting the closest body of water. (Possible student answers should include to decrease the amount of fertilizer used on the lawn or plant a buffer zone at the bottom of the hill.) Hand a sponge or porous shelf-liner to a student to place on the model. This will represent a buffer zone created by the roots of plants.

Step 4: Explain to students that as people become knowledgeable about the affects of pollution on other living things, they can also learn how to put **Best Management Practices (BMPs)** into place to help prevent water pollution..

Step 5: Continue to show the following examples of pollution taking place on the watershed model. After each type of pollution is shown, ask students to try to think of a **Best Management Practice (BMP)** that can be used to lessen or totally prevent the pollution from taking place. As students come up with ideas, hand them something with which to build their **BMP** (or pollution control) such as a piece of clay (for dams), sponges and bean sprouts (for roots of trees and plants), etc. Allow time for students to build their **BMPs** on the group model. If students have trouble coming up with ideas for **BMPs**, offer some of the following suggestions that might spur them to think in more divergent ways:

- Farm field (sprinkle soil on the model for erosion) – Build terraces of clay (parallel ridges) across the hill (not up and down).
- Cars and roads (squirt pancake syrup on model for oil) – Put sand or felt filter to catch oil.
- Bare spots on landscape (sprinkle cocoa or soil for erosion) – Cover with grass or trees (felt or sponges).
- Factory (sprinkle red powdered drink mix for effluent) – Build a little dam of clay to hold the effluent (waste disposal), pretend to treat it.
- Farm animals (sprinkle coffee for manure) – Build a lagoon (pond or pit) to hold manure.
- Anywhere – Pick up trash.
- Sink holes or illegal dumpsites (sprinkle yellow powdered drink mix to represent pollution) — Use sanitary landfills, that are lined to prevent seepage. Stop illegal dumping.

Assessment on Part 1

Ask students to reflect on and write about some of the things they have learned from observing and participating in this activity. Review the question strips and answer drops recorded so far.

We All Live in a Watershed, *continued*

Activity - Part 2

Step 1: Begin this activity by mentioning to students that water is a wonderful substance that has many uses. Give students an opportunity to think about the many ways water can be used. List the different ideas on a chart, board or water drop.

Step 2: Tell students that over the years, people have had to build dams to help prevent floods and create hydropower; levees to help keep river basins from flooding so the land could be used for farming; channels for irrigation, locks and dams so boats could navigate up and down the rivers, etc.

Step 3: Explain to students that they will be constructing the different "barriers" that were mentioned in **Step 2** on the river in their model to observe what happens to the flowing water as a result of the manmade objects obstructing, or redirecting, the flow of the water.

Step 4: If each student has a model that was built earlier in this unit to use, pass out materials, such as modeling clay, salt dough, small gravel, tongue depressors, etc. to represent different manmade barriers. Ask students to use the materials to try to manipulate the flow of water in their models. Encourage students to work together in groups of 3 or 4 as teams, with each model in the group used for a specific type of construction or use the Enviroscape model as a class. Tell students to observe the results carefully, and, just like real detectives, keep very good notes on their observations, so they will be able to report their findings to the rest of the class. Encourage discussion among students during this activity. Have them fill out question strips and water droplets as new questions come up and new facts are learned.

Step 5: Once "obstructions" are in place, give students recycled water bottles filled with water to create the rivers in their models.

Step 6: Give students time to explore and experiment individually, or in small groups. As the activity appears to be concluding, ask students to stop what they are doing and discuss, as a large group, some of the discoveries, or insights that occurred during the experiment as well as questions they may have. List on a chart or board.

Step 7: Ask students to think about bodies of water in Kentucky that they have personally seen in passing, or vacationed near in the past few years. List those named. Ask students if they think those bodies of water originated "naturally" or are manmade bodies of water that resulted from a dam or other water flow technique being created by humans. Explain to students that they will be doing further detective work in another activity to find out more about the dams that have been built in Kentucky.

Step 8: Conclude this activity by asking students to take the notes they made while experimenting with the models and write a brief summary of what they observed happening to the streams when the flow of water was disturbed. Add this information to water drops.

Assessment on Part 2

Explain to students that there are many manmade water systems in Kentucky. Ask students to write down ideas as to why they think Kentucky has so many manmade water areas and what some of the changes were that had to take place in Kentucky as a result of dams being built.

Protecting Kentucky's Water – Be a Water Historian
Intermediate

The Mysterious Drop in the Drainpipe

Adapted from , "Excuse Me, Is This The Way To The Drainpipe?" , ***The Water Sourcebooks,*** EPA , pages D-7 to D-18

Standards

Practical Living: PL-E-3.3.2, Students will understand that to protect all citizens, there are community guidelines (e.g., water treatment, waste treatment, etc.) that promote healthy living environments in the community.
Social Studies: SS-E-5.2.3, Students will understand that the way we live has changed over time for both Kentuckians and Americans because of changes in many areas (e.g., communication, innovations/inventions, homes, recreation, traditions, education.)

Activity Description

This activity develops a better understanding of how drinking water gets into our homes, and where it goes once it leaves our homes. It also explains how this all fits into the water cycle.

Materials

- Student copies of the story, "Excuse Me, Is This the Way to the Drainpipe?" found at the end of this activity
- Student copies of the survey questions developed in class
- Note to parents explaining the homework interview (optional)

Length of Lesson

Approximately one hour, followed by a homework assignment

Vocabulary Words

Pesticide—a chemical substance used to kill or control pests such as weeds, insects, fungus, mites, algae, rodents, and other undesirable agents.
Septic tank—an on-site wastewater treatment system, generally for single families, not connected to the wastewater treatment plant.
Sewage—waste and wastewater from people and animals.
Wastewater treatment plant—a large facility that treats wastewater from homes and industry to a point that it can be safely discharged into the environment.

Essential Question

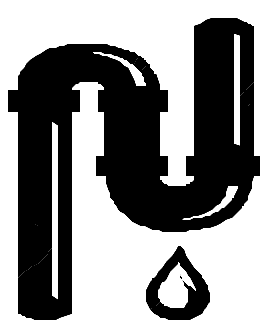
How has our relationship with water changed over time?

Guiding Questions

- How do we get drinking water into our homes?
- Where does wastewater go when it leaves our homes?

Skills Used

Research	Read	Write	Communicate
Discuss	Report	Synthesize	Interview



The Mysterious Drop in the Drainpipe, *continued*

Activity: Part 1

Step 1: Distribute copies of the story, "Excuse Me, Is this the Way to the Drainpipe?" Have students read the story on their own, or in small groups.

Step 2: Discuss the story. Ask students if the water that is piped into their homes comes from a well by their home (like the little girl in the story). If students do not have a well at their home, ask if they know where the water comes from that is piped into their homes. If students are unsure about the source of their drinking water, ask them for suggestions on how they might find out more about the local water supply. (Recommend that students ask parents or contact the local water company for more information.) Record student questions and water droplet facts.

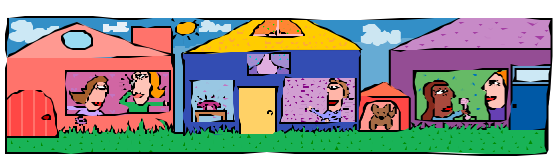
Step 3: Next, ask students where Martha Merriweather, the little girl in the story, lives — the city or the country. How do they know? Ask students if the waste water from their home goes to a septic tank in their yard, a wastewater treatment plant, or someplace else. Students may need to ask their families about this. (If plans are to graph this information, record the show of hands.) If living in a city, ask students where the water is cleaned to make sure it is safe enough to drink before being piped into homes, schools and businesses. Ask students where the dirty water travels to when it exits homes in the city.

Step 4: Call on several students to retell, in their own words, different parts of the route Willy Wetsworth traveled in the story.

Step 5: As a culminating activity to Part 1, ask students to create a "Willy Wetsworth Travel Book" as they follow a drop of water through the hydrologic cycle, into their own home, and all the way down the drainpipe to wherever it goes to next. (Remind students to be specific as to the form the drop of water is traveling in at each stage of the trip — liquid, solid or gas.) Give students different options on how the book may be completed, including electronic text or powerpoint. Assign a deadline for completion, then give students time to quickly share their creations with other class mem-

Extensions/Variations

1. When discussing the story, collect information about source of water supplies at home, and whether students have a septic system, straight pipe, or send their waste water to a wastewater treatment plant. Graph the information using the computer and a graphing program. Display and discuss the graphs.
2. Invite someone who works for the local water or wastewater department or a plumbing contractor to be a guest speaker and explain how water comes into and leaves homes, schools and businesses.
3. Investigate where the school gets its drinking water, and where it goes when it leaves school.



The Mysterious Drop in the Drainpipe, *continued*

Activity: Part 2

Step 1: Once Part 1 of this activity has been completed, and students have a better understanding of where their water comes from and goes to, ask students how they think people got their water and disposed of sewage before there were systems in place to do this task. List different ideas.

Step 2: Explain to students that they will be interviewing someone in their family or community who is over 75 years old, or who has lived in a rural area without running water or sewers, to find out where they got their drinking water when they were younger, and how they disposed of the waste water from their home.

Step 3: Ask students to think of some questions they might ask during the interview to learn more about how water was used long ago. Make sure they include the following questions in the survey if they are not included in their own questions.

- Where did you get the water used in your home? How did it get into your house?
- Approximately how much water did you and your family use every day?
- How did you dispose of the waste water created by you and your family?
- What are some of the differences in how water was used when you were my age and how water is used now?

NOTE: Explain to students that if they do not have a family member who is over 75 years old to interview, then they need to ask their parents for help in finding someone in their neighborhood to interview in person or by phone or e-mail. Also, advise students that they may wish to take a tape recorder or video camera along to use during the interview so they record accurate answers. (If students choose to do this, remind them to ask the person they are interviewing for permission to tape or video prior to beginning the interview.)

Step 4: As part of the assignment, ask students to write up a final report or powerpoint presentation comparing the use of water 60 – 70 years ago with how it is used now in their homes. Assign a deadline for completion of the project.

Assessment

Ask students to reflect on the interview and the comparisons they made between water usage 60 to 70 years ago and today in their written report. Then, ask students to write a short paragraph summarizing the most significant difference in water usage, or the most surprising thing they learned by completing this activity. Put these on water droplets

Dear Parents,

Each student has been asked to interview a family member, or somebody in the community, who is at least 75 years old to find out more about where they got water used in their homes as children, and how they disposed of the water once it was used.

Once the interview is completed, the students have been asked to write a paper comparing how water was used long ago with how it is used now.

As a class, we have compiled a list of questions to ask the person they choose to interview. The students have also been told they may wish to use a tape recorder or video camera to record the interview, if it is okay with the person they are interviewing.

This interview should prove to be a very exciting way for each student to gain a better understanding of what life was like in Kentucky before they were born.

Teacher BACKGROUND INFORMATION for "Excuse Me, Is This The Way to the Drainpipe?

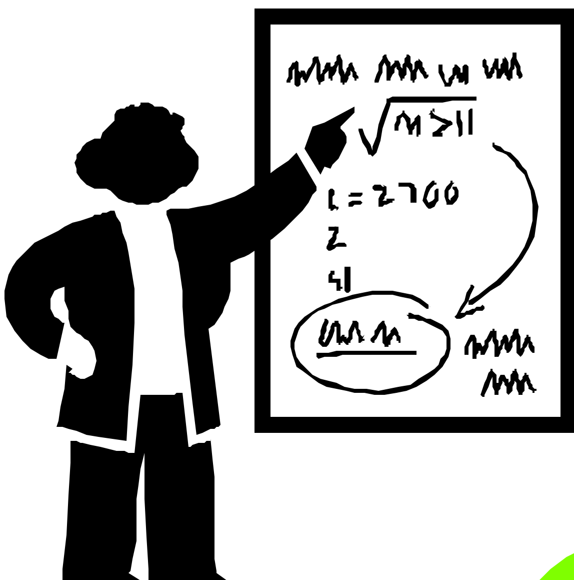
We seldom think about where the water we use in our homes or businesses comes from or where it goes once it disappears down the drain. The water we use everyday is very much a part of the earth's water cycle and is continually recycled. When we use water we are, essentially, detouring it from its natural cycle and then, in short order, returning it back to the environment. Water can dissolve, suspend, and transport many substances. Therefore, the quality of the water we drink has a lot to do with where it has been and what has been in contact with it. For this reason, our water supply sources are not always drinkable and may need treatment to remove natural or manmade contaminants. All drinking water must meet federal and state standards that were put in place to ensure that the water is safe to drink. Needless to say, protecting our water from harmful contaminants to begin with, is important.

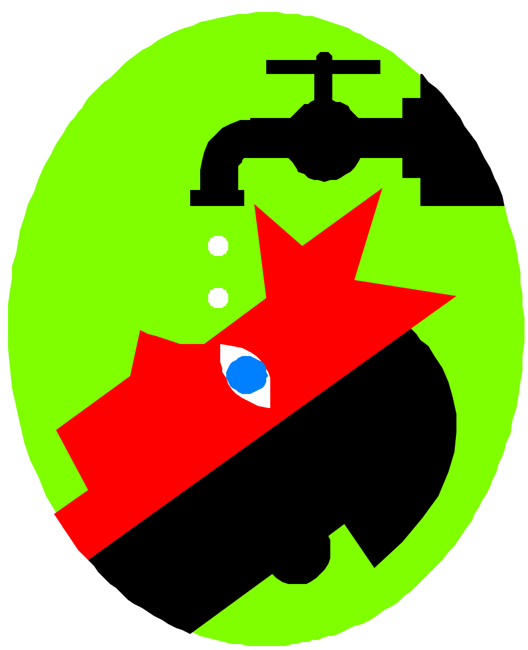
Our ***drinking water*** comes from either ground water (e.g., wells, springs) or surface water (e.g., rivers, lakes, manmade reservoirs). Ground water supplies are usually extracted by a pump, treated and disinfected when necessary, and delivered to homes and businesses through a network of pipes called a ***distribution system***. Many people who live in rural areas have individual, on-site ground water wells with very simple piping systems; many other people who depend on ground water, but live in more populated areas, receive their water from large water supply wells with more complicated distribution systems.

Surface water supplies are withdrawn from rivers, lakes, and reservoirs through large intake structures. The water is disinfected and often treated at a ***water treatment facility*** to remove impurities before entering the distribution system. Surface water supplies often travel through many miles of underground pipes before reaching the faucets of people's homes and businesses. Clean drinking water comes into our homes through one set of pipes and leaves our homes as ***wastewater*** through another set of pipes. The dirty wastewater that is flushed down the drain from our homes and businesses must be treated so that it can be safely and effectively recycled back to nature.

In rural areas, wastewater pipes are hooked up to small on-site sewage treatment and disposal systems, or ***septic systems***, that are buried in the ground. In these systems, wastewater generally flows by gravity through a pipeline that runs from the home to a septic ***tank***, where wastewater is partially treated before it flows onward to a ***leaching system***. As wastewater passes through the leaching system (a buried network of pipes with holes through which the water passes) it is further filtered and treated by the soil and the microorganisms in the soil. Eventually, the treated water seeps into the ground water. In more populated areas, wastewater in conveyed from the home into a network of sewer lines which lead to a ***wastewater treatment plant***. Here, wastewater is cleaned by mechanical, biological, and chemical processes before it is discharged into ground water or surface water. Water that is discharged from wastewater treatment facilities must meet stringent federal and state standards.

Both septic systems and large wastewater treatment systems rely on small, ***microscopic organisms*** (e.g., bacteria) to help clean up water. These organisms, nature's own built-in water purifiers, devour and digest organic waste material in the wastewater. The more efficiently the organic solids are digested, the cleaner the water. This is a big reason why it is important not to flush harmful substances, such as household hazardous wastes, paints, paint thinners, and drain cleaners, down the drain. These substances can kill natually-occurring bacteria, especially in septic systems, and cause the systems to function poorly.





Excuse Me, Is This The Way To The Drainpipe?

Martha Merriweather forgot to brush her teeth. She'd already said goodnight to her mom and dad, to Benji, her brother, and Lulu, her parakeet. She was all snug under her red polka dot blanket. In fact, she was pretty near asleep when she remembered about her teeth. It had been one of those days—one of those forgetting days. She forgot her lunch and had to borrow lunch money from Mrs. Johnson in the school office. She forgot her homework assignment and had to call her friend Terry to find out what it was. She'd even forgotten to feed Lulu until her mother reminded her. But Martha Merriweather did finally remember to brush her teeth. So she got out of bed, headed to the bathroom, turned on the light, picked up the toothbrush, picked up the toothpaste, put the toothpaste on the toothbrush. But, just as Martha was bringing the toothbrush with the toothpaste to her teeth, she noticed a drop of water that was just beginning to drip from the faucet—which isn't so very unusual. But this drop didn't drip and it didn't drop; instead, it seemed to get bigger...and bigger. Furthermore, it seemed to be waving to her. Yes, it was waving to her. In fact, it seemed to be speaking to her. Yes...yes, it was speaking to her. In fact, it was asking her a question.

"Excuse me, is this the way to the drainpipe?," the drop was asking as it pointed to the drain in the sink.

"Yes it is," answered Martha, her eyes wide open with amazement. "But...but....you're talking!"

"Yes," said the drop, "I often talk when I have a question, and, if you recall, I did have a question! You see," he said, "my travel book says that I should flow from the Merriweathers' ground water well, continue on up through the Merriweathers' water pipes, until I get to the Merriweathers' bathroom faucet. At that point, my travel book says, I should dive downward to the Merriweathers' drainpipe."

"Merriweather?," cried Martha, "Merriweather? That's my name—Martha Merriweather."

"And my name is Willy Wetsworth, a traveler and adventurer," said the drop. "Pleased to meet you."

"A traveler and adventurer?," whispered Martha gleefully.

"Yep," said Willy Wetsworth, "I spend my life traveling—in the clouds, in the sky, in the rivers, oceans, and streams, along the roadways, through the woodlands and grasslands, down in the soil, and between the rocks. Today, I'm traveling through water pipes—your water pipes. I was just pumped up into your house from the well in your backyard. It was a fun-foodling ride. Up, up, up, up, from the ground, then through this pipe and that pipe, until...well....here I am."

"Wow!," said Martha, trying to imagine what it would be like to travel in water pipes. She thought it might be "fun-foodling" if she were wearing a snorkel and flippers. She thought it might be like zooming through a water slide at the amusement park.

“Do you mean to say,” she asked, “that any time people brush their teeth, or wash their hands, or take a shower, or wash the dishes, or do the laundry, or flush the toilet, or water the flowers...that all that water has just had an exciting ride through the pipes?”

“Yep,” replied Willy.

“Do you mean to say that all the water that people use comes right from a well in their own backyard?,” asked Martha.

“Well...sometimes yes, and sometimes no,” replied Willy. “It says here in my travel book that some people, like the Merriweathers, live in the country where there are more trees than people, and where houses are spread apart. So when people who live in the country need water, they can usually get it from the water deep in the ground in their own backyard. But it’s different in the city—the city’s where there are more people than trees, and buildings are closer together. City water is usually piped in from a big well, or a lake, or a stream, or a reservoir that might be right near by or it might be many miles away. I have a friend who actually made the trip through city water pipes.”

“Really?,” asked Martha

“Yes,” said Willy, “he started out at a big reservoir. From there he went through a big pipe to a water treatment plant.”

“A water treatment plant?,” asked Martha. “What’s that?”

“According to my friend,” said Willy, “it’s a place where water is cleaned so it’s safe enough for people to drink.”

“You mean your friend isn’t safe to drink?” asked Martha.

“Well he probably is,” said the drop. “But, in our travels, we water drops never know what we’re gonna run into—or what’s going to run into us. Let’s face it, every living plant and animal on this earth needs us and uses us—people boil us, drink us, mix other stuff with us, throw their scumdiddle glunk in us. There are so many ways we can get dirty. Most days, mother nature can clean us up without anybody’s help. But sometimes mother nature can use some help and a water treatment plant does just that—it’s kind of like mother nature’s little helper. My friend said it was really weird going through the treatment plant, but he felt good as new by the time he got out of there. But then...,” continued the drop.

“But then what?,” asked Martha, who by now was trying to decide whether or not she would like it if *she* were a water drop.

“Then he took a wondrous, long, rip-snoodling ride through some great big pipes, and then some medium-sized pipes, and then some smallish pipes, right into an apartment house,” said Willy. “Other water drops went to other places like office buildings and stores and museums and libraries. And then...”

“And then what?,” gasped Martha, thinking that, indeed, it might be fun to be a water drop.

“Then,” said Willy Wetsworth, “the people who live and work in those buildings turned on their faucets and used their water for something or other—like brushing their teeth.”

“Oh,” said Martha, looking at the toothbrush and toothpaste she was still holding. “I was just about to brush my teeth when I met you."

"And I was just heading for the drain," said Willy.

"But you mustn't," blurted Martha, who had already grown rather fond of the drop. "I mean...down the drain? What on earth will happen to you?"

"Well, it says right here in my travel book that I'll wash down another set of pipes and end up in a septic tank that's buried in the Merriweathers' backyard."

"A septic tank?," exclaimed Martha. "I've heard of that. A man came to clean our septic tank a little while ago, and when I asked my mother what a septic tank was she told me that it was a big box that holds our dirty water after it goes down the drain. She said it helps make the water clean again. The dirty water stays in the septic tank for awhile and then goes into another pipe and then it goes into the ground." Martha thought for a moment and then asked Willy, "Are you sure you really want to go down the drain to a septic tank? It sounds yucky!"

"It's not so bad," said Willy. "My travel book says the Merriweathers take good care of their septic system, so it does a good job of cleaning us up. My book also says the Merriweathers don't throw all kinds of nasty scumdiddle glunk down the drain that might make my friends down in the septic tank sick."

"You have friends in the septic tank?," asked Martha.

"Yep," said Willy. "heaps and gobs of eency, beency, plump, and jolly bacteria —mother nature's little cleaner uppers. They live in the septic tank and love to eat the waste in your wastewater."

"Ick," thought Martha.

"They eat it and digest it and eat it and digest it," said the drop, "and, like magic, they change it from harm*ful* waste to harm*less* waste."

"Wow!," exclaimed Martha.

"But like I said," said the drop, "my bacteria buddies get sick when people throw nasty scumdiddle glunk down the drain."

"What kind of scumdiddle glunk?," asked Martha.

"Oh, like paint thinner or plastics or oils or pesticides," said the drop.

"Oh," said Martha, who was beginning to think that being a water drop might not be as much fun as she thought. "I can't say that I've ever thrown any glunk down my drain, and I know now—for certain—that I never will!"

"Hooray for you, Martha Merriweather!," shouted the drop. "As you know, I thrive on adventure, but I've heard there are some septic systems that even I wouldn't want to visit. Some people just don't take care of them and, after awhile, they clog up and bog down and then my bacteria friends are anything but jolly. And then, of course..." said Willy, his smiling face giving way to a deep, dark frown.

"And then, of course what?," asked Martha, almost afraid to hear the answer.

“Then, of course, we water drops stay dirty, dirty, dirty,” he answered with a shudder, “too dirty for anyone to drink...too dirty for brushing anyone’s teeth.”

“Oh,” sighed Martha.

“But I’m going down that drain Martha Merriweather,” Willy laughed and pointed to the drain. His face was once again lit up like the Fourth of July. “And if I get a little dirty and smelly in the septic tank, so what? Everybody gets dirty and smelly sometime. Down there in the septic tank, I’ll hang out with my friends for a while and then, like you said, I’ll float out of the tank and into a pipe—a pipe with holes in it,” he said. “It says right here in my travel book,” Willy began reading from his book, “You will float out of one of the holes in the pipe and sink down into a big gravely place. From there, just relax and enjoy your journey into the soil below. Here in the soil you will find yourself getting cleaner and cleaner and cleaner and cleaner. In time, you will find yourself back in the ground water, not far from where your little adventure began.” Willy smiled a big, wide smile and closed his book. Martha asked Willy if his friend in the city had gone into a septic tank when he went down the drain.

“Oh no,” replied Willy. “There’s no room for septic systems in cities. Your septic tank is only a short trip from your house, but in the city, all the dirty water that goes down the drains of all the apartment houses and businesses travels through oodles upon oodles of pipes—smaller-sized, then middle-sized, then biggersized pipes that are buried under the streets. All that dirty water ends up at a flumongous, magrungous wastewater treatment plant.”

“Another treatment plant?,” asked Martha.

“Another treatment plant,” replied the drop, “but this one is called a wastewater treatment plant. A wastewater treatment plant is a place where dirty water that’s flushed down drains and toilets gets cleaned up so that it’s clean enough to go back into a nearby river, lake, stream, or ocean. Yep, my friend flowed into the wastewater treatment plant. He flowed from one big, flumongous tank to another getting cleaner and cleaner.”

“Were there heaps and gobs of eency, beency, plump, jolly bacteria to help him get clean?,” asked Martha.

“As a matter of fact, there were, Martha Merriweather, jillions and scillions and gadrillions of them. They were eating and digesting and eating and digesting...they ate so much,” laughed Willy, “that after awhile they just sank to the bottom of the tank and took a nap.”

“Took an nap?,” giggled Martha.

“Yep,” laughed the drop. “And, guess what they did next?”

“What?..What?,” cackled Martha. “What did they do next?”

“They woke up and started eating and digesting all over again,” roared the drop, swinging gleefully from the faucet. Martha was laughing gleefully too—she couldn’t help it—although she wasn’t sure which was funnier, the thought of jillions and scillions of plump and jolly bacteria having a giant feast or seeing a drop of water named Willy laughing himself silly.

“And what happened to your friend?” asked Martha, trying to calm her giggles down.

“Then,” said the drop, trying to calm his giggles down, “then he splashed out of the treatment plant and into the Witchywatchy River. That’s where I met him—in the Witchywatchy River. We spent one cold January as icicles on the bank of the Witchywatchy River.”

“Icicles?,” shivered Martha. “Weren’t you cold?”

“Nah,” answered the drop. “We’re water. Sometimes we float and flow as a liquid, sometimes we freeze into ice, and sometimes the heat makes us evaporate into the air as a vapor. It’s fun-foodling Martha Merriweather...fun-foodling. But now,” checking his waterproof watch, “I really must be moving on down the drain, and I think you must be brushing your teeth.” He noticed a big, wet tear well up in Martha’s eye and slide slowly down her face.

“Hey, hey, Martha Merriweather, I see a friend of mine sliding down your face—Tina Teardrop’s her name. When I see Tina Teardrop I know somebody’s sad. Are you sad?”

Martha felt her cheek for Tina Teardrop, but Tina had already evaporated into the air. “Must you go?,” she asked. “I could keep you with me in a special, special little jar...” But Martha knew that a jar would be a very bad place for a traveler and adventurer. “Will I ever see you again?,” asked Martha.

“Of course you will,” smiled Willy. “Whenever you turn on your faucet, or catch a snowflake in your hand, or see the frost on your windowpane, or watch the mist rise from your spaghetti water, or swim in a swimming pool, or watch a flower grow—I’ll be there. I’m always here, Martha Merriweather. But if I were to become too dirty, even you wouldn’t want to have me around. So make sure you let your friends and family know that we water drops need to stay clean—for the sake of all the people and animals and flowers and trees in the whole wide world. So, S.Y.L., Martha Merriweather.”

“S.Y.L.?,” puzzled Martha.

“See Ya Later,” laughed Willy. “See Ya Later, Martha Merriweather,” he waved and winked.

“S.Y.L., Willy Wetsworth,” whispered Martha.

And, before her very eyes—right before her eyes—Willy got smaller and smaller until he was simply and purely a drop at the faucet. But, he’d left something behind. And what do you think it was? He left his travel book with all the pictures of pipes and wells and ground water and ponds and lakes and oceans and glaciers and raindrops and snow flakes and… Martha picked up the little book and opened it to the first page. And whatdo you think she saw? She saw a little message. It said, “To my friend Martha Merriweather. From your friend, Willy Wetsworth.” That’s what it said.

As Martha brushed her teeth, she watched the foamy water wash down the drain, knowing that Willy was on his way to another adventure. She turned the water off, put her toothbrush away, and returned to bed. She crawled under her polka dot blanket, then she took the travel book and tucked it carefully under her pillow. It had been quite a night...a FUN-FOODLING NIGHT!

Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

Where Have All the Settlers Gone?

Standards

Social Studies: SS-E-4.3.2, Students will understand that humans usually settle where there are adequate resources to meet their needs (e.g., areas with water, fertile land, protected land, different modes of transportation).
Social Studies: SS-E-4.4.3, Students will understand that the physical environment both promotes and limits human activities (e.g., mountains as barriers or as protection, rivers used as boundaries or transportation routes)

Activity Descrip-

Students will investigate early European settlements in their area to find out how close they were to bodies of water.

Materials

- E-mail access to contact Kentucky Historical Society **(http://www.kyhistory.org/Programs/Community_Services.htm)** or **http://www.rootsweb.com/roots-l/USA/ky.html**
- Access to phone to contact local historical society.
- Encyclopedias
- Local county maps (one for every 4 students)

Length of Lesson

Varies depending on how long the research takes

Essential Question

How has our relationship with water changed over time?

Guiding Questions

- Where were early settlements in our area of Kentucky ?
- Were these settlements near rivers, streams or springs?

Skills Used

Research	Read	Write	Communicate
Discuss	Report	Synthesize	Interview

Where Have All the Settlers Gone? *continued*

Activity

Step 1: Before starting this activity with students, visit the web sites listed in the "Materials" section on the previous page to familiarize yourself with, and bookmark, the different Internet resources available for student research.

Step 2: Read the book, ***Three Days on a River in a Red Canoe***. Ask students to think about and investigate why early settlements were built on or near water bodies. (Water was necessary for life and transportation.)

Step 3: Tell students that in this activity they will be learning more about early European settlements in their area of Kentucky. Explain that they will be interviewing local historians to find out where the first settlements were located in their county, and how close these settlements were to bodies of water. Students should be thinking of questions they want to ask and writing them on question strips.

Step 4: If students are unable to obtain the information listed in **Step 3** from a local historical society in the county where your school is located, have students visit the suggested web sites to locate information about the earliest settlements in their county **(http://www.kyhistory.org/Programs/Community_Services.htm** or **http://www.rootsweb.com/roots-l/USA/ky.html)**

Step 5: If there is a local historical society, ask students to help come up with a list of interview questions to ask the historical society's contact person about an early European settlement in the area. Questions should include:

- Where was the earliest known European settlement in your county?
- Why did people settle in that area?
- Was it close to water?
- How was the water of importance to these early settlers?
- Where was the first settlement in Kentucky?

Step 6: Using local county maps, assign students to work in small groups to locate towns and cities in their county. Ask students to check to see if these towns and cities are near water? If they are not, how do they get their water?

NOTE: Direct students to contact local water companies to find out where local drinking water comes from and how it gets to people's homes.

Step 7: Conclude this activity by asking students to write a short article describing how early settlements in Kentucky compare to present areas of development. Instruct students to try to find at least three ways that early settlements were like larger settlements of today, and three ways they were different. Accept any logical comparisons as correct in this assessment activity.

Extensions

1. Build models of what an early Kentucky settlement might have looked like. Display in an area of the school where others may view.
2. Interview older people in the community to find out what life was like for them and their parents (from stories heard growing up) when they were children. Make a collection of stories about life long ago in Kentucky from information collected during these interviews.
3. Check with the Kentucky Historical Society about borrowing a "traveling museum" with artifacts from the local area. (502 564-1792)
4. Plan a field trip to the Kentucky History Museum in Frankfort and arrange to participate in a program on early settlements in Kentucky.

Heavy Water

Standard

SS-E-5.5.3: Students will understand that the way we live has changed over time in both Kentucky and America because of changes in many areas (e.g., communications, innovations/inventions, homes, recreation, traditions, education)

Activity Description

Students will carry water in buckets to simulate how early settlers had to carry nearly all the water they used.

Materials

Several one-gallon buckets, two 20 gallon trash cans, a source of water, a large outdoor area near the water source.

Length of Lesson

About one hour

Vocabulary Words

Conservation and consumption

Essential Question

How has our relationship to water changed over time?

Guiding Questions

- How do we get drinking water into our homes?
- Where does waste water go when it leaves our homes?

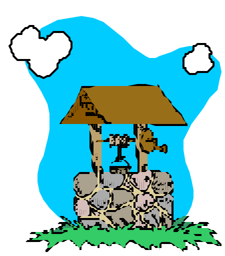
Skills Used

Predicting and estimating

****

Activity

Background: Ask students if any of them have ever been tent camping? If so, how did they get the water they needed? Ask whose responsibility it was to get water to the campsite. Where did they wash up, go to the bathroom, get drinking water while camping?



Heavy Water, continued

Background, cont.

Explain to students that in pioneer times, and even as late as the early part of the twentieth century, many people, especially in rural areas, did not have running water or indoor plumbing. In fact, in many parts of the world, people still do not have these luxuries. Also explain that in past times, and in many third world countries today, it was the job of the children to carry water to the house. (Note: There is much data on the relationship of water and poverty on the Internet but much of it is disturbing and should be viewed with teacher discretion.)

Activity

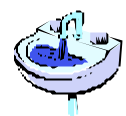
Step 1. Have on hand five to ten one gallon buckets plus at least two twenty gallon trash cans in which to place the water. Make sure to check with the school's maintenance folks before doing this activity since you may need help draining the water at the end of the activity. Set up the trash cans at least 150 feet from the water source. (note: If using a natural water source, you might want to have it checked for bacteria before allowing students to handle it.)

Step 2. Tell children they are going to pretend that it is the year 1820 in Kentucky. As it was then, it will be their job to bring water to the household. Have each child carry at least one bucket from the water source to the trash cans and pour the water into the cans. If they are children with special needs or very small children, assign them a partner to help with this activity, explaining that pioneer families always worked together to get things done.

Step 3: Once everyone has had a chance to carry the water, have children spend a few minutes in quiet reflection thinking about how it might have been to carry water like this several times a day everyday in all sorts of weather. Students may want to write about these feelings.

Step 4: Provide students with the following chart.

One toilet flush	5 gallons
Brushing teeth with water running	2 gallons
Dishwasher (one cycle)	20 gallons
Washing dishes by hand (with water running)	30 gallons
One load of laundry	40 gallons
One shower	5 gallons per min use



Ask each of them to use this chart to estimate how much water their families use each day. When they have a number, asked them to think how many trips it would take them each day to carry enough water to serve the needs of their families. Have a class discussion about whether students think people used as much water before it came into their homes automatically? What are some ways they might have saved water?

Assessment

Have students create a mural showing the side view of a house from 1820 and the side view of a house from 2003. Make sure they show all the water sources and uses in each house.

Kentucky's Commonwealth of Water - Be a Water Historian
Intermediate

Adapted, with permission, from "Water Crossings" in Project WET

Standards

SS-E-4.4.3: Students will understand that the physical environment both promotes and limits human activities.
S-4-SI-3: Students will use evidence (e.g., descriptions) from simple scientific investigations and scientific knowledge to develop reasonable explanations.

Activity Description

Students participate in a water crossing contest in which they must move their possessions (represented by a hard boiled egg) across a span of water (a deep pan).

Materials

Copies or overhead of The River West (included); Map of the U.S. or local map; state road maps; hard boiled eggs or tennis balls; student collected natural materials (such as leaves, twigs, reeds, bark, etc.); string or twine; water proof glue; large cake pan, bucket or dish pan.

Length of Lesson

Two, one hour class periods.

Essential Question

How has our relationship with water changed over time?

Guiding Ques-

- How did pioneers travel long distances and/or move goods?
- What types of water transportation did early settlers use in Kentucky?

Skills Used

Analyzing, applying and evaluating

****

Activity: Part One

Background: Ask students if they have ever taken long car trips? Did they cross rivers or streams? How did they know when they did so? Ask how pioneers might have crossed these same streams before bridges were built or there were ferries.

Water Crossings, continued

Background (cont.)

Have students read (or read to them) the excerpt from the book *The River West* by Frances Fuller (see the next page). The excerpt describes a crossing of the Yellowstone River by a group of trappers and traders in 1829.

Have a discussion about what factors students might take into consideration if they were doing this. (time of year, alternate routes, safety, building material, etc.)

Step 1. Have students study a map of the United States or their local region and identify several major cities located at river crossings. Why are river crossings often associated with towns? Help students list the positive and negative impacts of a crossing site on the development of a region.

Step 2: Using road maps, have students select a river or stream in Kentucky and count the number of bridges and/or ferries that cross it. Have students list what factors they think are likely to influence their number and location. Discuss this.

Step 3: Have students imagine what it would be like to get to a river and know you had to cross it on your own without a bridge or ferry. Have each student write a short fictional story about such an event. The stories should include how the river looks and what the character thinks as they approach the river, as well as how they finally get across.

Activity: Part 2

Step 1. Tell students they are about to experience some of the challenges pioneers faced when they arrived at a river by participating in a water crossing contest! The goal of the contest if for small groups of students to plan, design and construct a means of carrying a load across a body of water. The competition should encourage a variety of interesting approaches.

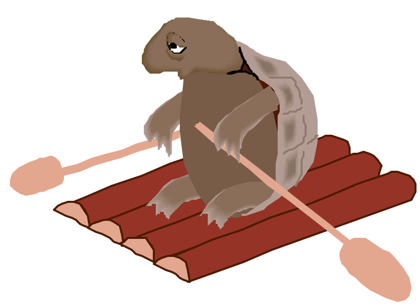
Step 2. Divide the class into small groups. Each group will build a water crossing conveyance from natural materials they gather in the outdoors. Since each group only gets one chance to succeed, encourage the group to discuss their ideas and options before beginning construction.

Step 3. Tell the students their load consists of a hardboiled egg (or tennis ball). Once each conveyance is complete, a hard boiled egg or tennis ball is placed on the conveyance and the whole thing floated on the water. It must support the load for two minutes without touching the sides or bottom of the container. It it does not capsize, fall apart or sink in two minutes, the group has succeeded in "crossing" the river.

Step 4. Have students vote on the most successful strategy and brainstorm improvements in raft designs for another contest. To make every group a winner, students may also vote on most aesthetic design, most innovative, best use of materials ,etc.

Extensions

1. Give students maps of the United States or Kentucky. Have them plan a pioneer trail across the country or the state that minimizes water obstacles. Compare historical trails and the modern highway system. Have students list differences and similarities.



Water Crossing, continued

Arrived at the Yellowstone with his company, Smith found it necessary, on account of the high water, to construct Bull-boats for the crossing. These are made by stitching together buffalo hides, stretching them over light frames, and paying the seams with elk tallow and ashes. In these light wherries, the goods and people were ferried over, while the horses and mules were crossed by swimming.

The mode usually adopted in crossing large rivers was to spread the lodges on the ground, throwing on them the light articles, saddles, etc. A rope was then run through the pin-holes around the edge of each, when it could be drawn up like a reticule. It was then filled with the heavier camp goods and, being tightly drawn up, formed a perfect ball. A rope being tied to it, it was launched on the water, the children of the camp on top and the women swimming after and clinging to it, while a man, who had the rope in his hand, swam ahead holding on the horse's mane. In this way, dancing like a cork on the waves, the lodge was piloted across; the passengers as well as freight consigned, undamaged, to the opposite shore. A large camp of three hundred men and one hundred women and children were frequently thus crossed in one hour's time.

Excerpt from Frances Fuller Victor's book, The River West

Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

Of Time and the River

Standards

Social Studies: SS-E-5.1.1, Students will understand that the accounts of historical events are influenced by the perceptions of people and passing of time.
Social Studies: SS-E-5.2.3, Students will understand that the way we live has changed over time for both Kentuckians and Americans because of changes in many areas (e.g., communication, innovations/inventions, homes, recreation, traditions, education).
The standard below is introduced in this activity
Social Studies: SS-E-5.1.2, Students will understand that history can be understood by using a variety of primary and secondary sources and tools (e.g., artifacts, diaries, time lines)

Activity Description

In this activity, students will read a diary account from a young river worker in 1806, then compare river travel today to river travel 200 years ago.

Materials

- Student copies of diary entries found at the end of this activity
- Internet access to locate modern navigational charts (optional) **http://www.lrd-wc.usace.army.mil/navcharts.html**
- Map of the United States that students can use to find the route John Stuart's flatboat took to get from Madison County to New Orleans
- Transparency of flatboat engraving at end of activity

Length of Lesson

Approximately 60 minutes

Essential Question

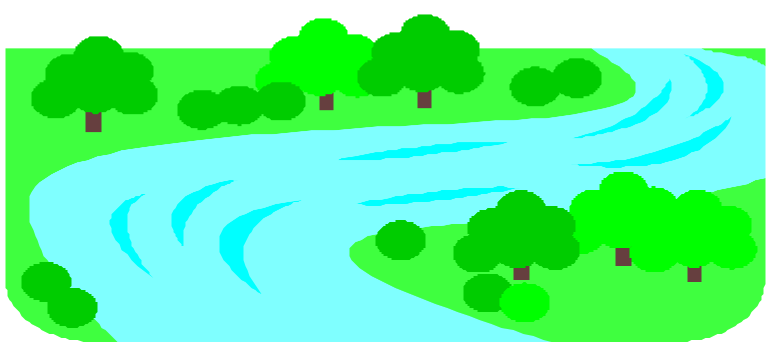
- How has our relationship with water changed over time?

Guiding Question

- How has Kentucky's water travel changed in the past 300 years?

Skills Used

Research	Read	Write	Communicate
Discuss	Visualize	Compare	Reflect



Time Travel Detectives, *continued*

Activity

Step 1: Copy John Stuart's diary for each student. Visit the web site, **http://www.lrd-wc.usace.army.mil/navcharts.html,** and copy navigational charts that can be used by river captains today.

Step 2: Explain to students that they will be reading some diary entries written by a young Kentuckian who was not much older than they are now when he traveled down the Kentucky, Ohio and Mississippi Rivers on a flatboat in 1806. Instruct students to pay particular attention to the problems encountered on the trip, and how long it took the flatboat to travel from Madison County, Kentucky to St. Louis, Missouri. Tell students that they will be comparing the trip described in John Stuart's diary to modern day river travel.

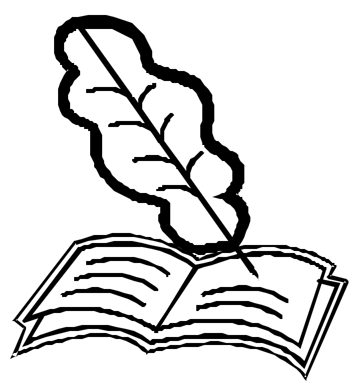
Step 3: Show students a transparency of the engraving of a flatboat traveling down the Ohio River. (Copy found at end of this activity.)

Step 4: Pass out copies of the diary, and instruct students to spend about 10 – 15 minutes reading over the selection silently (or orally, if preferred). Have them record any questions they have on questions strips.

Step 5: Once the diary entries have been completed, ask students to discuss, and completely answer the following questions within a small group:

- According to the diary entries, what were some of the major problems encountered by the flatboat John Stuart worked on in 1806? Were these problems human or nature related? Explain?
- Could the problems encountered during John Stuart's trip be cause for alarm today with river boat captains?
- What resources are available today for river boat captains to use that were not available 200 years ago?
- Students should list their own questions and water droplet facts.

Step 7: Give students maps of Kentucky with the river names on them. Read the diary entries out loud and have them follow John's progress along the rivers. Hold a class discussion about what students think it might have been like to be John during this time.



Extensions

1. **Invite a river boat captain, or a local boater, to talk to students about problems navigating boats up and down rivers. Ask speakers to also include the pleasures of boating.**
2. **Read *A River Runs Wild,* by Lynn Cherry. Develop a timeline of the events portrayed in the book. Discuss the implications of the actions of humans.**

Diary Entries from a Flatboat Worker in 1806

(To make money, frontier farmers could sell their produce in Kentucky or ship it to other cities. In February, 1806, young John Stuart got a job on a flatboat that was taking flour, tobacco, hemp, and whiskey to New Orleans. They started from Madison County on the Kentucky River, but did not get far because the river was too low. April showers finally made the river deeper and the journey began again. These entries from John Stuart's diary describe the trip up the Kentucky River and along the Ohio to the Mississippi.)

Wednesday, 16th (April). The rain I believe continued last night with but little intermission. I arose before daybreak and found the river had risen 10 feet. I had a good deal of difficulty to get our cable and stem fast for the water had risen considerably above them. By 10 o'clock it had risen 12 or 15 feet at which time we hove off. I shook hands with my acquaintances whose friendship had made me regret parting with them. I fired them a salute with my Pistol and we were soon out of sight. We were surrounded with drift wood, wild ducks, etc. We went rapidly — we compute our distance at nearly 40 miles. With much difficulty we landed about a mile below the Vineyard. The River still rises. Flying clouds and warm. I am now in a large Beech bottom which is all killed. This evening we saw 4 hogsheads of tobacco lodg'd on the River.

Thursday, 17th. Who that had been detained as I have been for 7 or 8 weeks by dry weather would have expected the contrary extreme to stop them; yet, this is literally the case. The river rose last night about 10 feet and has been rising rapidly ever since. It has now risen above 30. We judg'd it two high this morning to proceed. Accordingly, we are lying at a very good place about a mile below the Vineyard. Through the whole course of this day, large trees and timber of all kinds has been in a manner flying past; also, a cow, 3 or 4 canoes and this evening the wreck of a large new produce boat. We cannot tell who has lost her. This morning myself and one or two of our Boys went up to visit the Vineyards and to see the French there.

Friday, 18th. The river still continues to rise tho slowly this evening. We believe it has now risen above 50 feel perpendicularly. Vast quantities of driftwood has been passing us all day. I dropt our axe in cutting some bushes out of the way of the boat this morning into 15 or 20 feet of water. Went up to the Vineyard to borrow some tools to fix our boat; return'd them this evening and pass't some hours in conversing with an amiable Swiss girl. Weather clear and warm.

Saturday, 19th. This morning the River has ceased rising. I walk'd up to the Vineyard and spent some agreeable hours in the company of the amiable Maria Dunfore. Return'd in the evening to the Boat. The River has fallen today about 2 feet. We design to proceed down tomorrow morning. 4 flat boats and a keel has past us today.

Sunday, 20th. As in the rising of the River we had to keep watch, so last night on it fall we had to do likewise. The River fell about 4 feet last night & this morning early we put off; the river still high. We pass't the mouth of Hickman on our right and the mouth of Dick's River on our left. We pass't the 22 flat boats and 2 keels. We suppos'd we floated 45 or 50 miles and the sun was an hour and half high when we landed. We expect to reach Frankfort tomorrow. Berthond's Warehouse at shippingsport where G. Halley disposed of his Hemp to Berthond and Co. Flying clouds and windy. Lent G.H. 1/6.

Saturday, 26th. Went up to Louisville. Rec'd from G.H. 7/6. Bought a knife for 3/. Took a view of Louisville. A very handsome little Town. Two Gunboats building at the mouth of Beargrass creek which emptied in on the left side at the head of the Falls. Return'd and lay at the boat. Had company with us. Wind and clouds.

Sunday, 27th. High winds with rain last night. Went up through Louisville to the upper Landing and assisted T. Richardson to bring his House Boat over the Falls. Came very well without a Pilot. Windy weather. We bought some fine fish.

Monday, 28th. A number of boats have past the Falls. I repair'd our boat. Saw 6 boats put off together. Went on board the Western Traders, a handsome vessel lying at Anchor just below the Falls. She belongs to Berthond & Co. of 410 tons burthen. Some call her a ship, others only a square rigged brig. She is waiting for the River to rise to proceed down which must be 4 feet higher for her to go. It is now rising and has risen 2 or 3 feet since we have been here. Very windy weather. This evening I found a fresh Human jawbone on the beach.

Tuesday, 29th. About one o'clock P.M. we put off from the Falls, eight Flat Boats and a Keel in company. Left about 30 Boats at the Falls above and below. We lash't with the Ledgerwoods Keel and Mr. Joshua Baker's flat Boat. We proceeded on at the rate of between 3 and 4 miles an hour. An Island just below the Falls and 2 or 3 low rocky ones in it. This evening we divided into 4 watches of 3 hands, drew for precedence. I took the command of the first and sat until half an hour after 10 P.M.; about 9 we past the mouth of Salt River. Cool and windy. Banks of the river frequently low on each side. Growth Sugar tree Maple, Sycamore & Cottonwood; very good range here; about 70 miles below Louisville.

Wednesday, 30th. Had the 4th tour and just before daybreak 2 Indians came out to us. I bought a couple of fine Venison hams of them for 1/2 Gallon of whiskey. They could scarcely speak a word of English. Past the mouth of Blue River and an Island. This morning bought a catfish for 3 lbs. of tobacco weighing 40 or 45 lbs. Warm and pleasant; course of the River S.W.

Thursday, May 1st. We had a Thunder shower that brought us to for an hour or two. Past 2 or 3 Islands and the Yellow Banks about dark. Had the 3rd tour tonight. We think we float 80 miles in 24 hours. The Banks covered with cane. A number of wretched little huts scattered along on the river. Breckinridge & Ohio counties here, Henderson next & Livingston.

Friday, 2nd. We outfloat anything in company. Past a very Large Island this morning about 12 miles from the Red Banks. Past the Red Banks about 12. A small village there which is now in an improving state. Past the 2d Diamond Island about Dark—pretty large. I observed the marks of an hurricane on it. The right hand shoot the best, but our Boats took the left. 2d tour tonight. Mr. Ledgerwood parted with us about midnight and about 2 in the morning we past the mouth of the Wabash River an Island at its mouth. Flying clouds and pleasant weather.

Saturday, 3rd. Pass't the mouth of the Saline River about 10 this morning. The Banks covered with cane and cotton Wood. Past some very picturesque rocks today and this evening past the rock cave. Joshua Baker and self took our canoe and landed at it. We thought it worth looking at. An Island just above it—took the right hand shoot. Hurricane Island is said to be 6 miles below it. We made the left hand shoot with infinite difficulty and labour. We were to have only two watches tonight. I stood the 1st, but we landed about 12 or 1 at night on account of wind. Past an Island just before we landed. Flying clouds and warm.

Sunday, 4th. At daybreak, we putt off—several Boats that did not put to overtook us—15 boats in company. Past the mouth of Cumberland 12—an Island at its entrance—10 or 12 miles below past the Tennessee River—2 Islands at its mouth—8 or 10 miles below past Fort Massac just after dark. Flying clouds and very windy. Took the first watch, floated untill 11 and had to bring to on account of a Thunder cloud. Past 7 or 8 Islands today. Expect to reach the Mississippi tomorrow.

Monday, 5th. Put off about sunrise—several Boats past us while we lay to. Past Wilkersonville in the morning off which place 2 Cherokee Chiefs came on board us dresst in stile. A large Barge from St. Louis came up to us on their way t the mouth of Cumberland. They informed us that there was a likelihood of a Spanish & indian war; advised us to be on our guard. We Landed near night about half a mile about the mouth of Ohio. Mr. Joshua Baker and Foulger took our canoe and cross't the Mississippi and bought some sugar and salt. The Mississippi very low. Flying clouds and light breezes, but very hot.

Tuesday, 6th. Put off before light & row'd out into the Mississippi. Past 5 Islands—3 first on our left, 4th a very large one on right, 5th on left. Past a large Indian camp. Had to bring to at the Iron Banks for 2 hours on account of a storm. Landed in a bend with much difficulty and labour after dark. Cloudy, windy & a little rain. The river very low & falling—large sand bar.

Wednesday, 7th. Today we past Islands, 6 on right & 7—8 on left—had to bring to on account of wind about 12 where we staid till morning.

Thursday, 8th. Hung out an hook last night & this morning I caught a fine white cat fish about 30 lbs weight. Cloudy yesterday evening with a little rain & Thunder & last night we had a heavy fall of rain; expect the Mississippi will rise shortly. We put out this morning at the common time—5 Boats in Co.—2 Baker's, Spilman and Ramsay. An unlikely morning. Past New Madrid where J. Baker and self landed in a canoe and bought some necessaries—an handsome situation but said to be unhealthy. The wind continued to rise untill 2 P.M. when it blew an hurricane. Drove Ja. Baker, Spilman, & us on a Bar in the River. Ja. Baker and Famsay went farther down. We hung on the shoal about half an hour. The storm abated a little & We were off with the current—landed about half a mile below and found Ramsay's Boat sunk.

Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

Water Craft

Standards

Social Studies: SS-E-5.2.3, Students will understand that the way we live has changed over time for both Kentuckians and Americans because of changes in many areas (e.g., communication, innovations/inventions, homes, recreation, traditions, education).
Science : S-4-PS-3, Students will understand that the position and motion of an object can be described (e.g., measured, observed) by comparing it to another object or background.

The following standards are introduced.
Social Studies: SS-E-4.4.2, Students will understand that people adapt to or modify the environment (e.g., produce food, build shelter, make clothing) to meet their needs.
Social Studies: SS-E-4.4.3, Students will understand that the physical environment both promotes and limits human activities (e.g., mountains as barriers or as protection, rivers used as boundaries or transportation routes)

Activity Descrip-

In this activity, students will investigate different crafts used in early water transportation in Kentucky, then construct models of these vessels.

Materials

- E-mail access to contact Kentucky Historical Society **(http://www.kyhistory.org/Programs/Community_Services.htm)**
- Access to phone to contact local historical society.
- Encyclopedias
- Kentucky relief map without towns or roads, found at end of activity
- Pictures of early river vessels, found at end of activity
- Heavy aluminum foil, clay, toothpicks, craft sticks, etc., to use in construction of river vessels at school (optional)

Length of Lesson

Depends on how lesson is presented

Essential Question

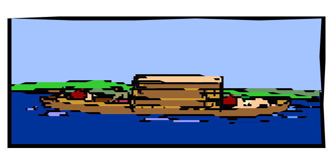
How has our relationship with water changed over time?

Guiding Questions

- How did pioneers travel long distances and/or move goods?
- What types of water transportation did early settlers use in Kentucky?

Skills Used

Research, Read, Write, Communicate, Discuss, Report, Construct, Analyze



Water Craft, *continued*

Activity (Thanks to the Portland Museum of Louisville for assistance with this activity)

Step 1: Prior to beginning this activity, make a transparency of the Kentucky map and the early river transportation pictures that are found at the end of this activity.

Step 2: Show students the map of Kentucky on an overhead projector. Ask students to imagine they are pioneers and think about how they would travel and move goods before there were roads. List ideas and questions.

Step 3: Explain that because of Kentucky's topography, there were many rivers, creeks and streams in Kentucky when the first settlers arrived. Ask students to think about the different types of water transportation people used to move themselves and their goods before there were roads and better forms of transportation (canoe, paddleboats, flatboats, river packet boats, keelboat, steamboats, etc.). Show pictures of some of these early forms of water transportation.

Step 4: Tell students that they will be researching and constructing different types of water vessels used in Kentucky over the past 300 years. Give students different ideas of resources they might use to find more information that may help them: the Kentucky History Museum, the Kentucky Heritage Council, the local historical society, the Portland Museum in Louisville, encyclopedias, etc. Explain that they will need to write a short report about the vessel they decide to build, as well as build a model of the river vessel.
NOTE: This lesson may go in two different directions at this point. The construction of the boats may be assigned as a homework project, or simple materials such as clay, craft sticks, glue, toothpicks, heavy aluminum foil, straws, tape, etc. may be made available for students to use in the classroom, and the boats may be completed at school.

Step 5: Give students time to complete their research and boat construction, then set a day for students to share the mode of water transportation they chose and report on it to the rest of the class.

Step 6: Use a water table or tub filled with water to test the completed crafts to see if they will float. Once this has been checked, create turbulence by stirring the water to check them further. Finally, add cargo (pennies, paper clips, etc.) to see if the boats will continue to float. If the boats sink, ask students to think about what design flaw caused the boat to sink, and how it might be improved.

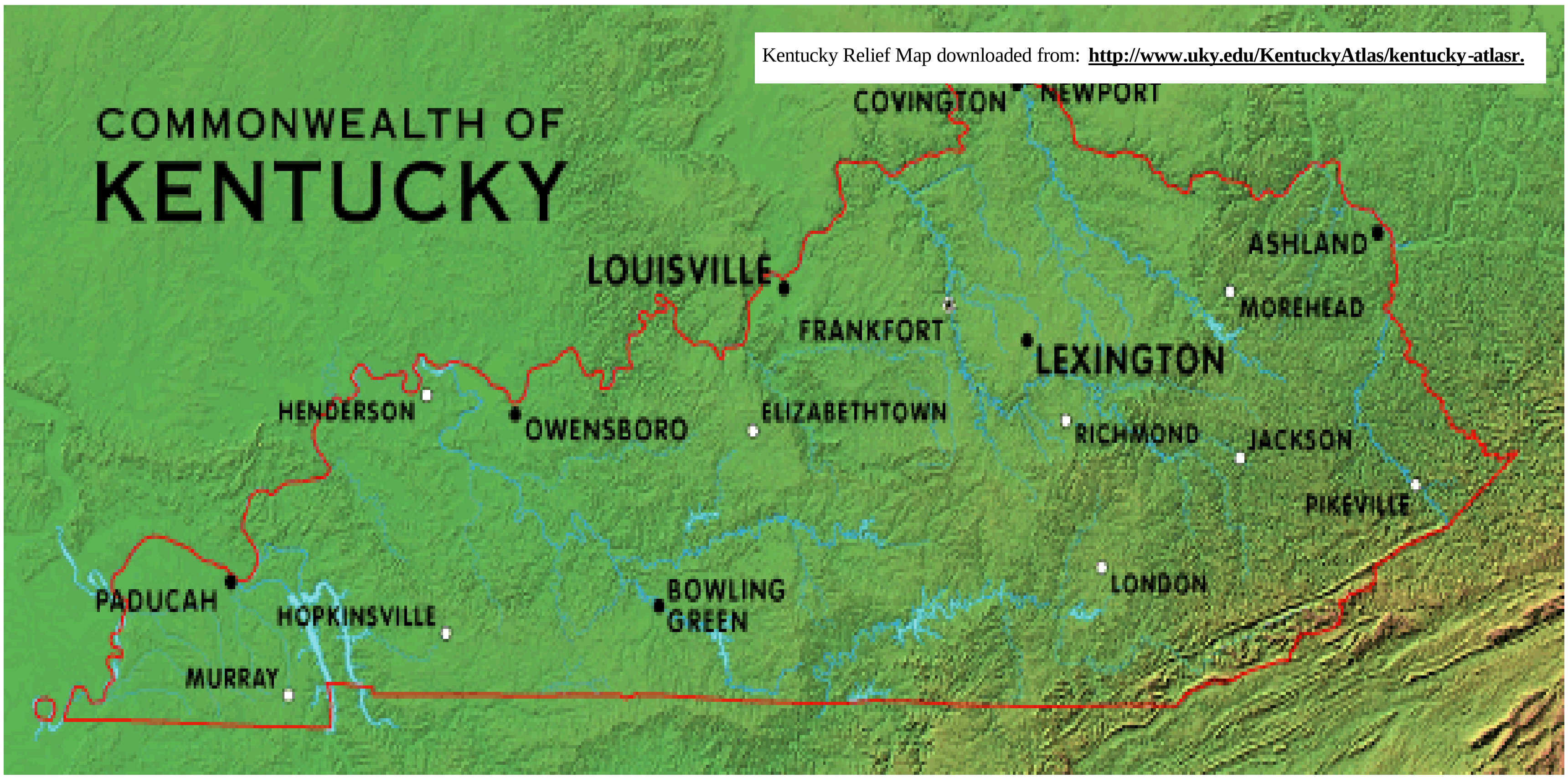
Step 7: Ask students to reflect on, and answer, this question: Why did people from different areas build different kinds of boats and why are handmade boats in less demand today than in the past?

NOTE: Extra activities are included at the end of this lesson to use with students, if desired. The pictures, short stories, and follow-up questions were supplied by The Portland Museum, in Louisville, Kentucky. (See **Extensions** for more information about the museum.)

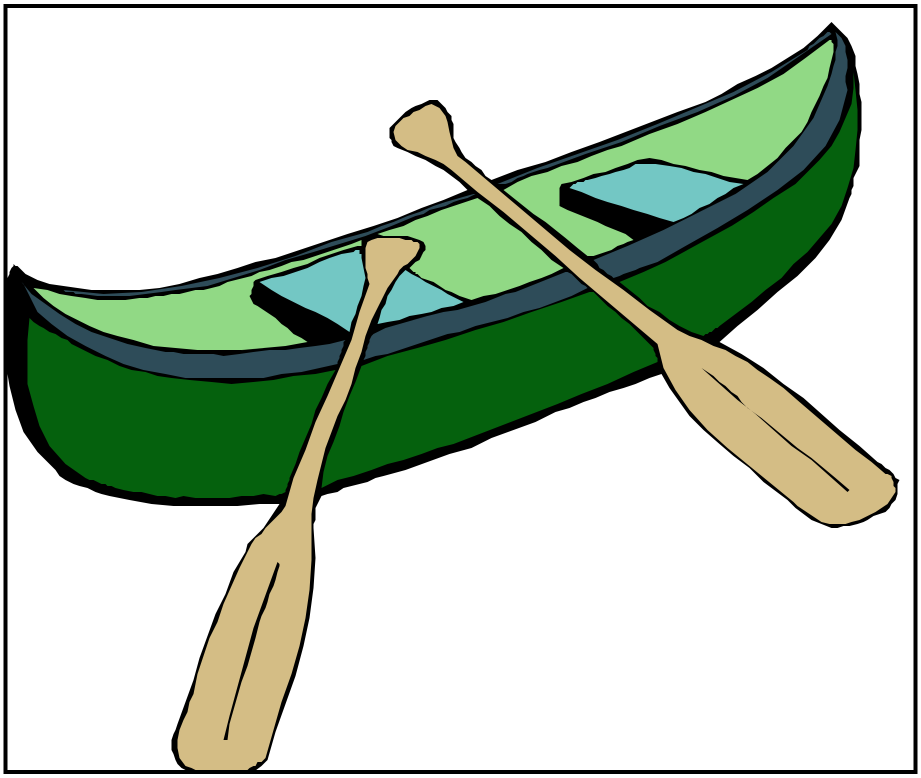
Extensions

1. **Contact or visit the Louisville Portland Museum at 2308 Portland Avenue, Louisville, KY 40212, TELEPHONE: 502/776-7678, to learn more about the history of the Ohio River development over the past 400 years.**
2. **Display river vessels, along with written reports, in a prominent area in the school, or at the local historical society.**
3. **Compare early river vessels with present day vessels. How are they similar? How have they changed?**
4. **Brainstorm river occupations, then research to see how accurate the guesses were. Invite local commercial fishermen, a boat captain or dock workers to come to class to talk about their jobs.**

Map of Kentucky Showing Major Rivers and Cities



Kentucky Relief Map downloaded from: **http://www.uky.edu/KentuckyAtlas/kentucky-atlasr.**



canoe

Canoe

aluminum	metal	river
canoe	paddles	tight
cover	pitch	water
easily	portage	wooden

A canoe is a long, narrow boat. Canoes are pushed through the water with paddles. Indians who lived near the Ohio River made canoes out of wood and bark. Sometimes they covered a wooden frame with skins. Sometimes they covered it with tree bark. Pitch was used to make the boat watertight. This type of canoe is light and fast. It can be easily carried across land to get from one river to another. This is called a portage. In this way, Indians and later trappers could travel great distances. Today, canoes are often made of light metal or plastic.

Questions:

1. What pushes a canoe through the water? ______________________________

2. Name two things you could use to make a canoe? ________________________

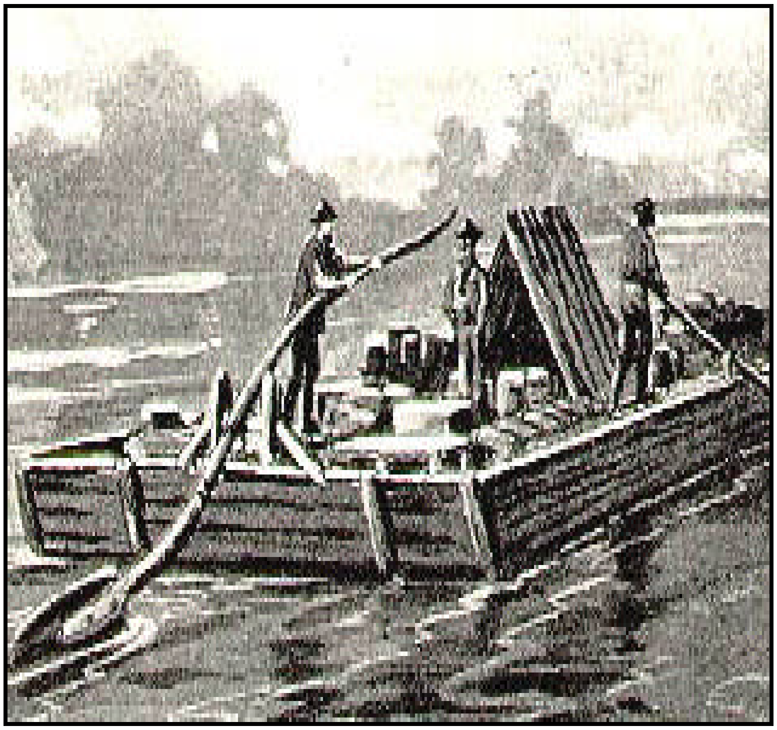
3. What is it called when you carry your canoe across land? ________________

Student Questions:

1. ____________________________________

2. ____________________________________

3. ____________________________________



Flatboat

How to make a flatboat

auger	flatboat	oakum
broad-horn	floating	oar
caulk	furniture	pioneer
chicken	house	steer

Pioneers came down the river to Kentucky in flatboats. A family could bring furniture, tools, chickens, pigs, and even a cow or horse on the boat. Some flatboats even had a cabin with a fireplace inside. At its arrival, the boat could be taken apart. The lumber could be used to build a house.

A flatboat, sometimes called a broad-horn, was a floating box. It was hard to steer with the long steering oars. And, the boat was too bulky to take back up river. That is why flatboats became known as one-way boats.

If your family wanted to move to Kentucky from Pennsylvania 175 years ago, here's how you would first build your boat.

Cut down a poplar tree that is a hundred feet to the first limb. Hand saw the tree into boards twenty feet long, two inches thick, and twelve inches wide.

Drive a spike into each board. Use your auger to bore a two-inch hole in each end. Put a wooden pin in each hole. The pins are hard to drive in the holes. When they get wet, they will swell. Nothing will be able to pull them out.

Be sure to caulk the bottom of the boat with oakum. Oakum is a natural fiber rope. Soak it in tar and stuff it in the cracks in the bottom. No water will leak into your flatboat now.

Questions:

1. Name the rope used to caulk flatboats. ____________________

2. What did some flatboats have in their cabins? ____________________

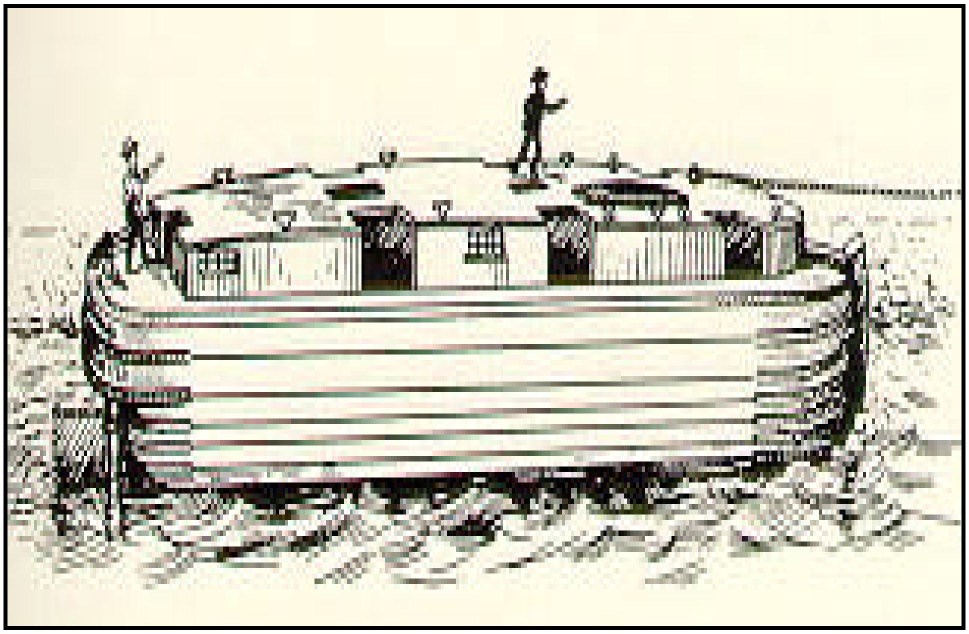
3. What is another name for flatboat? ____________________

Student Questions:

1. ____________________

2. ____________________

3. ____________________



KEELBOAT

The Keelboat

cordelle	keel	shoulder
downriver	keelboat	slender
engine	merchant	towpath
flatboat	pioneer	voyageur

Flatboats were good for pioneers coming downriver. As the country grew, more and more merchants wanted to ship goods on the river. A new type of boat was needed.

The keelboat was long and slender. It had no engine; sometimes boatmen used sails, sometimes oars, to move the keelboats up and down the river. Sometimes the workers pushed the boat, sometimes they pulled it.

When a clear towpath ran along the riverbank, keelboat workers used the cordelle – a rope nearly a thousand feet long and tied to a post in the middle of the boat. Workers, called voyageurs, pulled the boat along.

If there was no towpath, the voyageurs cut one. But, if the water was shallow, they had to use the poles. Eight voyageurs with eight poles lined up on each side of the boat. Then at the signal they all put their poles into the river bottom and pushed hard with their shoulders. As they pushed, they walked from the front of the boat to the back of the boat. In this way, they moved the boat forward. When the voyageurs pushed hard they looked as though they were crawling.

Pushing and pulling, walking and rowing, the voyageurs had a hard job getting their boats up the river. Imagine how amazed they might have been to see the first steamboat go chugging up the river.

Questions:

1. Name two ways to move a keelboat. ______________________________

2. What is another name for a keelboat worker? ______________________________

3. Did keelboats have engines? Yes ____ No ____.

Student Questions:

1. ____

2. ____

3. ____

Steamboat

Steamboat's a'coming

amaze	descend	journey
ascend	engine	navigation
compare	frightful	paddlewheel
current	harness	steam power

The first steamboat on the Ohio was named the New Orleans. Late at night, on October 28, 1811, she arrived in Louisville. Most people at the landing that night had never seen such a sight. The roaring and hissing of the steam engine was frightful.

Harnessing steam power for riverboats was an important step in river navigation. Fire and water create steam. The force of the steam drives paddle wheel and the wheel pushes the boat through the water. Steam power allowed large boats to go up the river easily.

The New Orleans waited in Louisville several months. While waiting, the captain amazed his Louisville friends by taking them up the river against the current. On December 15th there was enough water to pass over the falls. The long wait was over.

Four years later, another steamboat amazed people at the Falls. The Enterprise landed at Shippingport just twenty-five days after leaving New Orleans, Louisiana. A keelboat needed three or four months to ascend the river. The Enterprise was the first steamboat to make the long journey up the Mississippi and Ohio Rivers to the Falls.

Now boats could go both up and down the river highway. They could ascend and descend the river. Businesses and towns grew faster and faster. Steamboats grew bigger and more beautiful. A new age– the Golden Age of Steamboats– came to the Ohio River.

Questions:

1. How long did it take a keelboat to ascend the river? ____________________
2. What source of power allowed boats to go up river? ____________________
3. What was the New Orleans waiting for at the Falls? ____________________
4. Name the two amazing steamboats. ____________________

Student Questions:

1. ____
2. ____
3. ____

Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

The Ohio River Mussel Mystery

Standards

Social Studies: SS-E-5.2.3, Students will understand that the way we live has changed over time for both Kentuckians and Americans because of changes in many areas
Science: SC-E-3.3.3, Students will understand that all organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms; other changes are beneficial
The following standard is introduced in this activity.
Science SC-E-1.2.2, Students will understand that the position and motion of an object can be changed by pushing or pulling. The amount of change in the position or motion is related to the strength of the push or pull.

Activity Description

In this activity, students will learn about the importance of the mussel industry in Kentucky's history, as well as the invasion of the zebra mussel.

Materials

- Internet access (optional, but will speed up the research)
- Encyclopedias
- "Freshwater Mussels of the Ohio River" poster (may be obtained from KY Department of Fish & Wildlife , Phone: 502/564-448
E-mail: Wayne.Davis@mail.state.ky.us Cost: Free)

Length of Lesson

1 class period if poster is used

Vocabulary Words

Freshwater mussel—a type of bivalve shellfish (also referred to as clams, naiades, or unionids) that spend their entire adult life partially or wholly buried in mud, sand, or gravel, usually in rivers or streams.

Essential Question

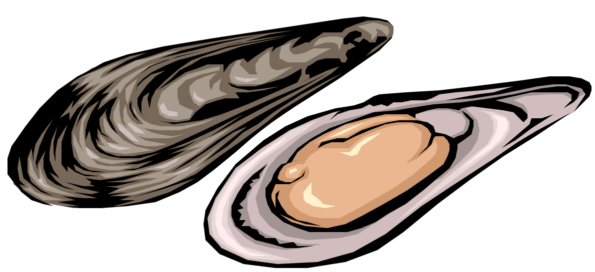
How has our relationship with water changed over time?

Guiding Questions

How have people used Kentucky's resources in the past?
How do organisms change Kentucky's environment?

Skills Used

Research	Read	Write	Communicate
Discuss	Report	Synthesize	Interview



The Ohio River Mussel Mystery, *continued*

Activity

Step 1: In preparation for this activity, contact the Kentucky Department of Fish and Wildlife Resources at 502 564-7109 to obtain a free copy of the "Freshwater Mussels of the Ohio River" poster to use as a research resource and teaching guide. Also, contact the Kentucky Folklife Program Administrator for the Kentucky Historical Society for more information on fishing for mussels (called Brailing), at 502-564-1792.

Step 2: Show students the poster, "Freshwater Mussels of the Ohio River" (or other resources showing pictures of mussels). Ask students if they have ever seen a live mussel.

Step 3: Explain to students that people in Kentucky have used mussels for thousands of years. Tell students that long ago Archaic Indians used freshwater mussels in Kentucky for food and ornaments. Mussels were also harvested, beginning in the 1890's, to make buttons, then in the 1950's to provide the shell implant to use for producing cultured pearls.

Step 4: Divide students into small groups of 3 or 4 and provide each group with Internet access. (Web sites containing background information about freshwater mussels can be found by accessing **www.google.com/** and typing in "freshwater mussels".) Give each group one of the following questions to answer. Students should list their own questions as well on question strips.

- What good are freshwater mussels?
- Do people eat freshwater mussels and what do freshwater mussels eat?
- Are freshwater mussels in trouble? Why?
- What can people do to help save freshwater mussels?
- What is a zebra mussel and how was it introduced into the Ohio River ecosystem?
- How is the zebra mussel affecting the freshwater mussel population in the Ohio River?

Step 5: Once the research has been completed and each group has answered the assigned question, bring the entire class back together to share their answers and any new questions or information.

Step 6: Take the gathered information and, as a class, design a PowerPoint presentation about freshwater mussels to share with a local river conservation group, at a parents' night or at a local community event. Ask each group of students to be responsible for designing at least one slide for the PowerPoint presentation that shares the information they had to research. Some students may be assigned the task of including slides showing a history of the freshwater mussel industry in Kentucky, also.

Step 7: Conclude this activity by reminding students that this is another example of how the activities of living things are all closely interconnected. Discuss extinction and endangered and threatened species.

Extensions

1. Locate on a map how the zebra mussels traveled from China, to the Great Lakes (where they were released from the ballast of cargo ships into the Great Lakes), then on to Kentucky.
2. Talk about competitions for niches in an ecosystem. What other animals have become extinct, or are on the endangered species list, because of the actions of other organisms in their ecosystems?
3. Look for "pearl" buttons or other items that are made from mussels.
4. Draw a poster of the food chain showing where freshwater mussels fit into the picture.

Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

The Mystery Surrounding Kentucky's Dams

Standards

Science: SC-E-3.3.3, Students will understand that all organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms; other changes are beneficial (e.g., dams build by beavers benefit some aquatic organisms but are detrimental to others).
Social Studies: SS-E-4.1.5, Students will understand that different factors in one location can have an impact on another location (e.g., natural disasters, damming a river).
Social Studies: SS-E-5.2.3, Students will understand that the way we live has changed over time for both Kentuckians and Americans because of changes in many areas (e.g., communication, innovations/inventions, homes, recreation, traditions, education).

Activity Description

This activity involves students conducting research to find out about the history of a nearby dam and how it changed life in the area.

Materials

- Internet access (optional, but will speed up the research)
- Encyclopedias and maps showing Kentucky 100 years ago and now
- Interview questions

Length of Lesson

Length of lesson depends upon how long it takes to complete research

Vocabulary Words

United States Army Corps of Engineers— military and civilian engineers, scientists and other specialists who work on engineering and environmental matters to meet the demands of changing times and requirements as a part of America's Army.
Tennessee Valley Authority (TVA)—began as a result of the TVA Act, in 1933, to monitor and protect natural resources in the Tennessee River Valley, by building dams for flood prevention and hydropower.
Lock—a part of a canal with gates at each end where boats are raised or lowered to different water levels.

Essential Question

- How has our relationship with water changed over time?

Guiding Questions

- How are the actions of humans within a watershed interrelated with other living things?

Skills Used

Research	Read	Write	Communicate
Discuss	Report	Synthesize	Interview

The Mystery Surrounding Kentucky's Dams, *continued*

Activity: Part 1

NOTE: There are some strong issues concerning the renovation or destruction of deteriorating dams in the state of Kentucky. This is not the focus of this activity. Caution should be used when allowing students access to the Internet to do research because several web sites do contain some controversial articles about dams that might worry students in the intermediate grades. This activity is centered around humans' influence on the environment and change over time.
.

Step 1: Ask students if they have ever seen a dam. Call on student volunteers (if there are any) to tell where the dam was that they saw and describe what it looked like for the rest of the class.

Step 2: Ask students to think about and discuss why they think dams have been built.

Step 3: Explain to students that Kentucky's topography has changed over the past century because of the construction of dams across the state. (As of April, 2002, according to the National Dam Safety Review Board State Evaluation Criteria reports, there were 943 dams in the state of Kentucky. Many of these dams are privately owned, but still must meet state regulations for safety.)

Step 4: Tell students that they will get to do more detective work during this activity. Explain that they will be choosing a dam in Kentucky about which they would like to learn more. (If you would prefer to have students research dams within the local watershed, that is fine.) Explain that it will be their job to find out the following things about the dam they choose to investigate:

- Why and when was the dam built?
- Were people moved to build it? Approximately how many?
- Were habitats lost and/or created by the dam?
- Students should also come up with their own questions.

Step 5: Arrange for students to visit the media center, or use classroom computers, to research dams in the state. Offer assistance, where needed, in finding a contact person, if answers are not found in other research tools.

Step 6: Have students share information with class after research has been completed.

NOTE: Information about the Army Corps of Engineer dams may be located at the following web site: **http://www.lrl.usace.army.mil/ld98/more.htm**. From this site, the Army Corps of Engineers District web sites in Louisville and Nashville can be viewed, and information about who to contact are available. By following the link to "Dam Safety", pictures of dams across the state may be viewed on the web site by clicking the dam on a map. There is a brief history and the name of a contact person on the web site.

Also, information about TVA dams may be accessed from the following web site: **http://www.tva.gov/sites/sites_ie.htm**

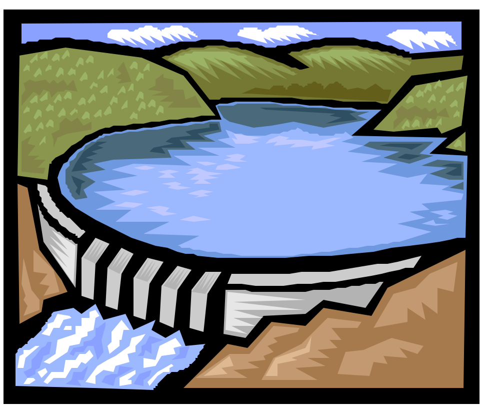
Step 7: If your school is close to one of the larger dams, you may wish to have students interview older residents who might be able to share some stories with the class about life in the area before and after the dam was built. Such a visit would make a wonderful social studies lesson about change over time and the results of human influence.

If there are privately owned dams in the area, you may wish to have some students contact and interview the property owner.

Extension

Investigate how the lock and dam system works and why this system is so important on some of Kentucky's rivers. Build models of a lock and dam system using the stream tables or watershed models created in earlier activities.

An 1895 map of Kentucky can be downloaded from **http://www.livgenmi.com/ky1895mp.htm**
For individual county maps, go to **http://www.livgenmi.com/1895ky**
Map may be enlarged, or a transparency made, for student viewing.



Extension

To investigate a dam during the building process, visit the following web site with students: http://www.nationalgeographic.com/geoguide/dams/index.html

Click on the "before" button to view the area before the dam is started. Then progress to the "during" button to see the water being piped into the reservoir area. Finally, click the "after" button to see the resulting reservoir. This site also presents advantages and disadvantages of damming rivers.

Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

Capturing a Moment in Time: A Culminating Activity

Standards

Social Studies: SS-E-5.1.2, Students will understand that history can be understood by using a variety of primary and secondary sources and tools (e. g., artifacts, diaries, time lines).

Writing: WR-E-1.4, Students will write an informative and persuasive piece for an authentic audience to accomplish realistic purposes.

Activity Description

Using photographs, interviews, surveys, stories, etc. collected throughout this unit of study about water, students will create a time capsule containing a biography of how water is used in their county to present to the local historical society, or school, to be kept safe for a specified number of years.

Materials

- Collections of stories, photographs, interviews, survey results, etc.
- Container to use for time capsule

Length of Lesson

Length will vary depending upon the amount of material that has been collected throughout this unit of study

Essential Question

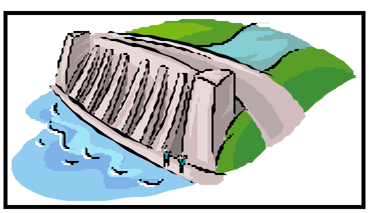
How has our relationship with water changed over time?

Guiding Questions

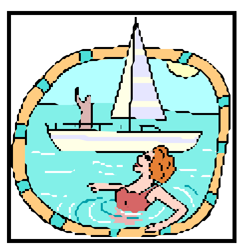
- How has water been used in my community?
- How can we preserve information for future generations to view?

Skills Used

Research	Read	Write	Communicate
Discuss	Synthesize	Organize	Create

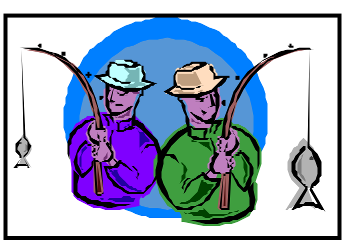


Dams/Hydroelectricity



Boating and Swimming

Fishing



Farming/Gardening

Capturing a Moment in Time, *continued*

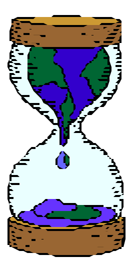
Activity

Step 1: As a culminating activity to the study of Kentucky's water, ask students to help sort interviews, stories, photographs, survey results, etc. that have been written and collected throughout the preceding activities.

Step 2: Tell students that they have investigated many different water topics and, hopefully, they have learned a lot about Kentucky's past and present dependency on water. Explain that they now have the opportunity to leave a legacy for future Kentuckians to view and study showing how water is currently being used in the local environment. Explain that they will prepare a time capsule to send to the local historical society, or place in a special area of school, to leave for students to open in 50 years.

Step 3: After examining all of the current information on local water usage that has been collected over the past weeks (using water droplets), ask students what other types of information they feel should be included, that may still need to be gathered. Make a list of suggestions, and narrow the list down. Assign different students the task of collecting the items suggested, if necessary.

Step 4: Once the photos, articles, brochures, etc. have been collected and organized, as a class peruse the material very closely. Explain to students that they must now narrow down the final items that will fit in the time capsule. (Show students the time capsule that will be used. Keep the time capsule small so students will have to be more selective when choosing the most important items to be placed in it.)



Step 5: Encourage students to offer suggestions and opinions about the most important artifacts that should be included in the time capsule through persuasive writings. Explain that each item suggested for inclusion in the time capsule should be defended with specific reasons why it would make an impact on future Kentuckians, and be of historical value.

NOTE: This writing activity would make a wonderful assessment, as it should show some higher level thought process as to what each student feels is a very important historical record of the way water is currently being used locally. (See Rubric.)

Step 6: Once the persuasive writings are completed, decide on a panel of impartial judges to make the final selections, based on the supportive arguments from the student writings.

Step 7: When the collection of artifacts to be placed in the time capsule have finally been selected, show them to the students, seal them in the time capsule, and deliver the time capsule to the place where it will rest until future Kentuckians decide to investigate the importance of water in their lives! Make a ceremony of this. Take digital photographs and have students mail them to the local media.

Step 8: Have students brainstorm a way to insure the time capsule is found and read by a class fifty years from now.

Extension

Assign students to write a news article for the local newspaper or television stations, telling about the class time capsule project.

	Assessment Rubric for “Capturing a Moment in Time”
Level Four	Student is able to describe at least four ways Kentuckians have used water in the past, how those particular uses of water have or have not changed, and how each use has affected the environment and the lives of the people living then and now.
Level 3	Student is able to describe at least three ways Kentuckians have used water in the past, how those particular uses of water have or have not changed and how at least one of those uses has affected the environment and the lives of people living then and now.
Level Two	Student is able to describe at least three ways Kentuckians have used water in the past and how at least one of those uses has affected the environment and the people who lived then.
Level One	Student is able to describe at least two ways Kentuckians have used water in the past.

Kentucky's Commonwealth of Water – Be a Water Historian
Intermediate

Investigating The History of Water Through Music

(An Enrichment Activity)

Standards

Arts and Humanities: AH-E-3.1.41, Students will create and perform using creative dramatics improvisation, mimicry, pantomime, role playing, and storytelling).
Social Studies: SS-E-2.1.1, Students will understand that language, music, art, dress, food, stories, and folk tales help define culture and may be shared among various groups.

Activity Description

After creating a timeline of historical events surrounding water in the local county and/or state, the music teacher will help students compile and perform a collection of songs and stories about the history of how water has been used (and abused).

Materials

- Collections of folk songs and other music about water
- Internet access for environmental history timeline

Length of Lesson

Length will vary according to how long it takes to prepare timeline and how long it takes to collect, learn and perform water songs.

Essential Question

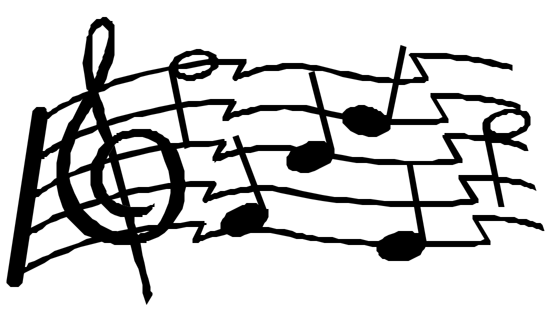
How has our relationship with water changed over time?

Guiding Questions

- What are some important water historical events in our area or state?
- Who can help us collect water songs?

Skills Used

Research	Read	Write	Communicate
Discuss	Sing	Perform	Create



Protecting Kentucky's Water – Be a Water Historian
Intermediate

Investigating the History of Water Through Music *continued*

Activity

Step 1: Before introducing this activity to students, talk to the music teacher, or a parent with a musical background, about working with students to collect songs about water — especially water in Kentucky.

Step 2: Explain to students that over the years, music has been used as a way to record people's feelings, thoughts, and historical events. Tell students that they will have the opportunity to help prepare, and perform, a collection of musical pieces about water, but that they must first develop a timeline showing historical water events that have happened locally, or at the state level.

Step 3: Decide as a class how far back in time you would like the students to research to come up with a history of water. Then, divide students up into small groups to research specific years for significant dates.

Step 4: To make the timeline research move more quickly, visit the following web site: **http://www.kyeqc.net/thirty/time/maintime.htm** and download information for students to refer to when creating their portion of the timeline.

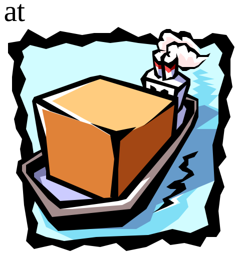
Step 5: Ask students to check with parents at home to see if they remember learning any songs when they were younger about water, or about historical events in Kentucky that were related to water. Instruct students to bring any ideas from parents to school with them.

Step 6: Work with students, a music teacher, or a parent volunteer, to search the Internet, musical tapes and CDs and music books looking for samples of songs that can be sequenced in such a way to tell a history of our relationship to water in Kentucky. For example, "There's a Hole in the Bucket, Dear Liza" can be used to show how people used to carry water. Or students can write songs to familiar musical tunes or to their own tunes. Also, begin working on short speaking parts for students to say that can be used to introduce each song during the performance.

Step 7: Once the songs have been collected, written, organized, and learned, schedule a performance date and time to share the musical with both the school and family communities, as you celebrate the history of water through music!

Water Songs

1. Cockles and Mussels
2. Crawdad
3. Hole in the Bucket
4. Down by the Old Mill Stream
5. Down by the Riverside
6. Have You Ever Gone A-Fishing
7. Michael Row the Boat Ashore
8. Row, Row, Row Your Boat
9. The Water is Wild
10. Shenandoah

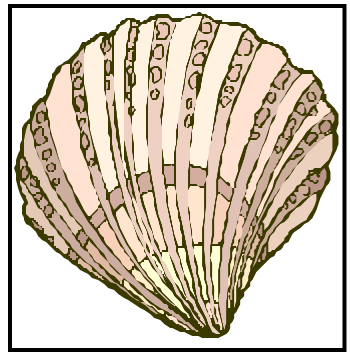


Assessment

We have been working on developing a timeline of the history of water in our area and trying to find music to help us tell that history in song.

Thinking about the different songs you have learned about water, which song do you think best describes a true historical event in our local history? Give examples.

Investigating the History of Water Through Music *continued*



Cockles and Mussels

In Dublin's fair city where girls are so pretty
I first set my eyes on sweet Molly Malone,
As she wheeled her wheelbarrow
Through streets broad and narrow

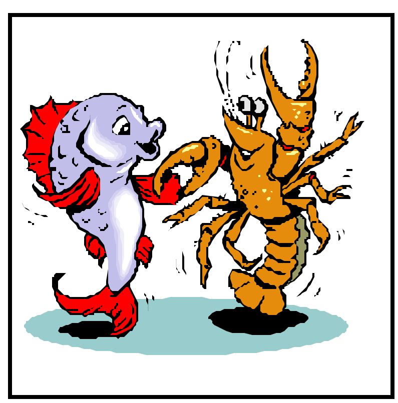
Refrain
Crying cockles and mussels
Alive, alive oh!
Alive, alive oh! Alive, alive oh!
Crying cockles and mussels
Alive, alive oh!

She was a fishmonger, but sure 'twas no wonder
For so were her father and mother before her,
And they each wheeled their barrow
Through streets broad and narrow

Refrain

She died of a fever, and no one could save her,
And that was the end of sweet Molly Malone,
Now her ghost wheels her barrow
Through streets broad and narrow

Refrain

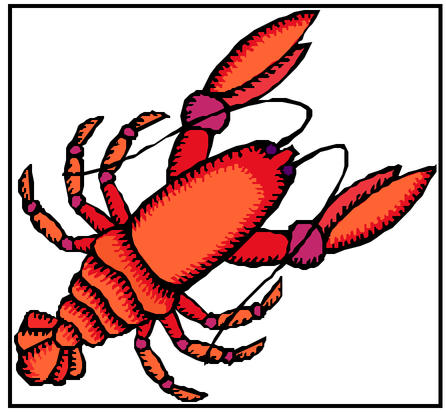


Crawdad
Chorus
You get a line and I'll get a pole, honey,
You get a line and I'll get a pole, honey
You get a line and I'll get a pole
And we'll all go down to the crawdad hole,
Honey, sugar - baby mine.

Get up old man, you slept too late, honey,
Get up old man, you slept too late, baby,
Last piece of crawdad's on your plate,
Honey, sugar– baby mine.

Protecting Kentucky's Water – Be a Water Historian
Intermediate

Investigating the History of Water Through Music *continued*

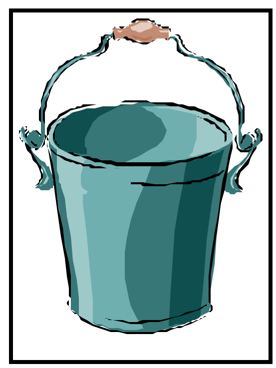


Get up old woman, you slept too late, honey,
Get up old woman, you slept too late, baby,
Crawdad man done past your gate,
Honey, sugar-baby mine.

Along come a man with a sack on his back, honey,
Along come a man with a sack on his back, baby,
Packin' all the crawdad he can pack,
Honey, sugar-baby mine.

What you gonna do when the lake goes dry, honey,
What you gonna do when the lake goes dry, baby,
Sit on the bank until I cry,
Honey, sugar-baby mine.

I heard the duck say to drake, honey,
I heard the duck say to the drake, baby,
There ain't no crawdads on this lake,
Honey, sugar-baby mine



Hole in the Bucket
(Sing in two parts if possible-Henry and Liza)

Henry: There's a hole in the bucket,
Dear Liza, dear Liza,
There's a hole in the bucket,
Dear Liza, a hole.

Liza: Then fix it, dear Henry,
dear Henry, dear Henry.
Then fix it, dear Henry,
dear Henry, fix it.

Henry: With what shall I fix it,
dear Liza, dear Liza,
With what shall I fix it,
dear Liza, with what?

Liza: With a straw, then, dear Henry,
dear Henry, dear Henry,
With a straw, then, dear Henry,
Dear Henry, a straw.

Henry: If the straw be too long,
dear Liza, dear Liza…
Liza: Then cut it, dear Henry
Henry: With what shall I cut it?
Liza: With a knife…
Henry: If the knife be too dull?
Liza: Whet the knife…
Henry: With what shall I whet it?
Liza: With a stone…
Henry: If the stone be too rough?
Liza: Then, smooth the stone…
Henry: With what shall I smooth it?
Liza: With water…
Henry: With what shall I fetch it?
Liza: In a bucket…
Henry: But, there's a hole in the bucket...

Investigating the History of Water Through Music *continued*

Down by the Old Mill Stream

Down by the old (not the new but the old) Mill Stream (not the river but the stream)
Where I first (not last but first) Met you (not me but you)
With your eyes (not your nose but your eyes) So blue (not green but blue)
Dressed in gingham (not in satin but gingham) Too (not one but two)
For it was then (not now but then) I knew (not old but new)
That you loved (not hated but loved) Me true (not false but true)
You were sixteen (not seventeen but sixteen) My village queen (not the king but the queen)
Down by the old (not the new but the old) mill stream (not the river but the stream)

Down by the Riverside

Gonna lay down my burden,
Down by the riverside,
Down by the riverside,
Down by the riverside,
Gonna lay down my burden,
Down by the riverside,
Down by the riverside.

Ain't gonna study war no more,
Ain't gonna study war no more,
I ain't gonna study war no more,
Ain't gonna more.

Gonna put on my long white robe…
Gonna lay down my sword and shield…
Gonna ride in the golden chariot…
Gonna try on my silver crown…
Gonna climb the road to Heaven…

I'll fight the wicked devil…
Gonna cross the river of Jordan…
Gonna read the Holy Bible...
Gonna meet my blessed Jesus...

Protecting Kentucky's Water – Be a Water Historian
Intermediate

Investigating the History of Water Through Music *continued*

<u>Have You Ever Gone A-Fishing</u>
(To the tune of Turkey in the Straw)

Have you ever gone a fishing (casting motions)
On a sunny, sunny day (make a circle with arms over heart)
With all the little fishies
Swimming in the bay? (swimming motions)
With their hands in their pockets, (hands in pockets)
And their pockets in their pants (hands on back pockets)
And all the little fishies
Do a hoochey-koochey dance! (dance like nobodies watching!)

(First two lines, wave arms above head and turn around; then gestures as above)
Tra-la-la-la, la-la-la-la-(2x)
With their hands in their pockets,
And their pockets in their pants,
And all the little fishies
Do a hoochey-koochey dance!

<u>Michael Row the Boat Ashore</u>
Michael, row the boat ashore, Alleluia
Michael, row the boat ashore, Alleluia
Sister, help to trim the sail
Sister, help to trim the sail
Brother, lend a helping hand
Brother, lend a helping hand
Jordan's river is deep and wide
Milk and honey on the other side

<u>Row, Row, Row Your Boat</u>
(Sing in rounds)

Row, row, row your boat
Gently down the stream
Merrily, merrily, merrily, merrily
Life is but a dream.

Investigating the History of Water Through Music *continued*

The Water is Wide

The water is wide; I can’t cross o’er,
And neither have I wings to fly.
Give me a boat that can carry two,
And both shall row, my love and I.

2.A ship there is, she sails the sea,
She’s loaded deep, as deep can be.
But not so deep as the love I’m in;
I know not how I sink or swim.

3.I leaned my back against an oak,
Knowing it was a trusty tree.
At first it bent, but never broke;
Thus did my love prove true to me.

4. O, love is handsome, love is fine,
Gay as a jewel when first it’s new;
And love grows old, and ever bold,
And shines as bright as morning dew.

SHENANDOAH

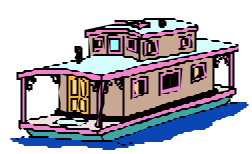
O Shenandoah ! I long to hear you,
Way-aye, you rolling river
Across that wide and rolling river.
Away, we’re bound away
‘cross the wide Missouri !

O Shenandoah, I love your daughter
Way-aye, you rolling river
I’ll take her ‘cross yon rolling water
Away, we’re bound away
‘cross the wide Missouri !

For seven years I courted Sally,
Way-aye, you rolling river
For seven more I longed to have her
Away, we’re bound away
‘cross the wide Missouri !

She said she would not be my lover
Way-aye, you rolling river
Because I was a tarry sailor
Away, we’re bound away
‘cross the wide Missouri !

At last there came a Yankee skipper
Way-aye, you rolling river
He winked his eye, and tipped his flipper
Away, we’re bound away
‘cross the wide Missouri !



Water Reading List for Intermediate Grades*

1. ***Bear Loves Water.*** (Preschool) By Ellen Weiss. Bear teaches readers about water in all its forms - puddles, bubbles, snowflakes and clouds.

2. ***Brother Eagle, Sister Sky: A Message from Chief Seattle.*** (4-8 years) Illustrated by Susan Jeffers. A story about Native American beliefs and how each generation deserves to breathe fresh air, drink pure water and to enjoy all the beauty that the earth offers.

3. ***Common Ground: The Water, Earth, and Air We Share.*** By Molly Garrett Bang. Explains how everyone in the world depends on each of us individually to protect resources and maintain respect for the environment.

4. ***The Drop in My Drink.*** (9-12 years) By Meredity Hooper and Chris Coady. Water takes on fascinating new significance as readers discover the amazing complexity of a substance we take for granted. Includes a detailed depiction of water cycles, amazing facts and important environmental information.

5. ***A Drop Of Water: A Book of Science and Wonder.*** By Walter Wick. Shows the different forms of water in amazingly detailed photographs; explains water's properties.

6. ***The Earth and I.*** (4-8 years) By Frank Asch. Explains the friendship between the earth and a young child and what each can do for the other.

7. ***Follow the Water from the Brook to the Ocean.*** By Arthur Dorrors. Explains how water flows from brooks, to streams, to rivers, over waterfalls, through canyons and dams to eventually reach the ocean.

8. ***The Four Elements: Water.*** (Preschool) By Carme Solé Vendrell and J.M. Parramón.Text and illustrations explain the properties of water and its uses. Includes a special section to help adults answer children's questions.

9. ***Gullywasher.*** (4-8 years) By Joyce Rossi. In English and Spanish. A grandfather tells tall tales of his life as a cowboy (vaquero) and of the harsh life in the desert, flash floods, and wildlife.

10. ***I Am Water*** (4-8 years) By Jean Marzollo. A first book about water in its different forms and uses.

11. ***Magic School Bus: At the Waterwork.s*** By Joanna Cole. Mrs. Frizzle, the science teacher, drives the magical school bus into a cloud where the children shrink to the size of water droplets and follow the course of the water through the city's waterworks system.

* Please note that not all books on this list are included in the PRIDE list approved for purchase. See http://www.kypride.org/ for that list.

12. ***Magic School Bus: Se Salpica Toda.*** (4-8 years) By Joanna Cole. In Spanish, experience the earth's water cycle first hand as Mrs. Frizzle's class rises into the air, forms a rain cloud, a drizzles down to earth just like rain.

13. ***Magic School Bus: Wet All Over.*** (4-8 years) By Joanna Cole. Experience the earth's water cycle first hand as Mrs. Frizzle's class rises into the air, forms a rain cloud, a drizzles down to earth just like rain.

14. ***One Small Square: Cactus Desert.*** (6-10 years) By Donald M. Silver. Teaches about all the plants and wildlife that exist in one small square of desert - an excellent introduction to ecosystems and biodiversity.

15. ***River Ran Wild: An Environmental History.*** By Lynne Cherry. A history of New Hampshire's Nashua River starting 7,000 years ago until its recent reclamation. This is a good explanation of what can happen over time to a body of water and its wildlife -- what people can do to the environment and what they can do for it.

16. ***Snail Girl Brings Water.*** (6-10 years) By Geri Reams. A retelling of a traditional Navaho creation myth which explains how water came to earth.

17. ***Splish, Splash, Splosh.*** (4-8 years) By Mick Manning and Brita Granström. Join the adventures of a young boy and his dog and ride the waves, float on rain-filled clouds, shoot down fast-flowing rivers, and splash through sewers until you get where all water ends…and begins.

18. ***This Place is Dry.*** By Vicki Cobb, Barbara Lavallee (Illustrator). Surveys the living conditions in Arizona's Sonoran Desert for the people and the unusual animals that live there. Also describes the engineering accomplishment of the Hoover Dam.

19. ***Water.*** By Frank Asch. Aimed at very young children, this book artfully describes water in it many forms, its uses, and its role in our lives.

20. ***Water (My First Nature Book).*** By Andrienne Soutter-Perrot, Etienne Delessert (Illustrator). Explains water in its different form and why every living thing needs water.

21. ***Water Science, Water Fun: Great Things to Do with H2O.*** (9-12 years) By Noel Fiarotta and Phyllis Fiarotta. Lessons and experiments teach about floating, refraction, leaching temperature gravity, buoyancy, flow and other water properties.

22. ***Water, Water Everywhere (Discovery Readers).*** By Melvin Berger, Gilda Berger, Bobbi Tull (Illustrator). A book about the water cycle, treatment, distribution, and wastewater treatment.

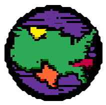
23. ***Where Do Puddles Go?*** (4-8 years) By Fay Robinson. An early book to explain water cycles and water in all its forms.

24. ***Where Does Water Come From?*** (6-10 years) By C. Vance Cast. Clever Clavin shows how much water there is on earth, how wells are dug to bring it out of the ground, and how water treatment plants work.

25. ***The Woman Who Outshone the Sun/La Mujer Que Brillaba Aún Más Que el Sol.*** By Alejandro Cruz Martinez, Fernando Olivera (Illustrator). A bilingual tale from ancient Mexico that tells of a beautiful woman who arrives in a mountain village and is driven out because she is different, taking the river with her.

Kentucky’s Wonderful
Commonwealth of Water

Middle School Unit
Be an Informed Water
Citizen



Kentucky's Wonderful Commonwealth of Water
Middle School

UNIT SUMMARY

This unit leads students through an exploration of why we have water problems, what those problems are and how they can be addressed. It culminates with an issue analysis activity in which students use research skills to investigate various sides of water issues they choose and then calls on student to design service-learning projects to address water issues in their communities.

In this unit, students will learn the following things

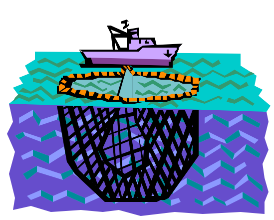
- ◊ There is only a limited amount of water on earth
- ◊ The hydrologic cycle
- ◊ How important water is to everyday life
- ◊ How much water we actually consume
- ◊ What a watershed is and how watersheds become polluted
- ◊ How to map their own watershed and "see" how water flows
- ◊ How point and nonpoint source pollution gets into our water
- ◊ How to think critically about water issues
- ◊ How to develop service projects to address water problems

Suggested Open Response Question – You are a member of the city council in your hometown. The council has just been told that a small stream that runs through the middle of town is severely contaminated with the bacteria found in human and animal waste. Describe how you will find the source of this contamination and give two strategies for how you would clean it up.

Portfolio suggestion: Have students choose a water issue of concern in your community. Ask them to write a persuasive paper on the issue, using the "Let's Analyze the Issues" sheet at the back of the unit as a guide for developing their paper.

Technology extensions

- ◊ Use Geographic Information Systems technology to investigate sources of drinking water and of waste water disposal in your community.
- ◊ Use a spreadsheet to record how much water each class member uses for one week (see activity "How valuable is Water?)



Kentucky's Commonwealth of Water—Be a Water Explorer
Middle School

Unit Essential Question: How can we learn to protect our water?

Standards

Science

Science SC-M-2.1.5, Students will understand that water, which covers the majority of the Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle. Water dissolves minerals and gases and may carry them to the oceans.
Scientific Inquiry, Students will use evidence (e.g., computer models), logic, and scientific knowledge to develop scientific explanations.

Social Studies

Social Studies SS-M-3.1.1, Students will understand that productive resources are limited and do not satisfy all the wants of individuals, societies, and governments (scarcity).
Social Studies SS-M-4.1.1, Students will understand that maps, globes, photographs, models, and satellite images are representations of Earth with different characteristics and uses.
Social Studies SS-M-4.2.1, Students will understand that places can be made distinctive by human activities that alter physical features.
Social Studies SS-M-4.4.4, Students will understand that individual perspectives impact the use of natural resources (e.g. watering lawns, planting gardens, recycling paper).
Social Studies SS-M-1.1.2, Students will understand that democratic governments function to preserve and protect the rights (e.g., voting), liberty, and property of their citizens by making, enacting, and enforcing appropriate rules and laws (e.g., constitutions, laws, statutes)

Math

Math MA-M-1.2.1, Students will compute (e.g., estimate, use pencil and paper, use calculator, round, use mental math) large and small quantities and check for reasonable and appropriate computational results.
Math MA-M-2.2.3, Students will develop and apply proportionality and relationships between scale models and actual figures.

Practical Living

Practical Living PL-M-3.1.5, Students will understand that environmental issues should be considered when making consumer decisions (e.g., recycling, reducing, reusing)

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 1	**"What's All the Fuss About? " —**Students will recognize that there is a lot of water in the world, but that only a very small percentage of it can be used for drinking water and other water supply needs. **Scientific Inquiry,** Students will use appropriate equipment, tools, techniques, technology, and mathematics in scientific investigations. **Standards:** Science: SC-M-2.1.5 **Essential Question**: How can we learn to protect our water? **Guiding Questions:** • Why isn't all fresh water usable? • Why do we need to take care of the surface water and ground water?
# 2	" **Water" You Supposed to Be?"—**Students will learn about the different parts of the hydrologic (water) cycle as they participate in a game of charades. **Standards:** Science: SC-M--2.1.5. **Introduced:** Arts and Humanities: AH-M-3.1.4 **Essential Question:** How can we learn to protect our water? **Guiding Questions:** • What are the parts of the hydrologic cycle and why is it important?
# 3	**"How Valuable is Water?"—**Students will work to budget the amount of water they use in order to save "Water dollars". They will also investigate why water is essential for day to day living and how water contributes to the standard of living in Kentucky. Finally, Students will create a game to teach others about water. **Standards:** Math: MA-M-1.2.1, Practical Living: PL-M-3.1.5 and Social Studies: SS-M-3.1.1 **Essential Question:** How can we learn to protect our water? **Guiding Questions:** • How do we use water on a daily basis? • Why is water essential for day to day living? • How does water contribute to the standard of living in Kentucky? • How can we conserve water?
#4	**"Just How Much Water Are We Talking About?"—**Students will calculate the value of one million gallons of water by comparing it to the volume of their classroom. They will also learn about water consumption in Kentucky and calculate the estimated cost of water. **Standards:** Math: MA-M-2.2.3 and Social Studies: SS-M-3.1.1 **Essential Question:** How can we learn to protect our water? **Guiding Question:** How much water do we use on a daily/yearly basis?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 5	**Race You to the Top of the Hill"—**Students will learn about reading and drawing topographic maps and watersheds by traveling outside their school and mapping their local micro-watershed. **Standards:** Math: MA-M-2.2.3 and Social Studies: SS-M-4.1.1 **Essential Question:** How can we learn to protect our water? **Guiding Questions:** • Why are topographic maps important? • What is a micro-watershed? • How can I find and draw my micro-watershed?
# 6	**" Follow the Flow"—**Students will use maps to identify their local watershed areas for 3 of Kentucky's major rivers. Students will also use mathematical skills to recreate a scale map of their watershed area. **Standards:** Social Studies: SS-M-4.1.1 **Essential Question:** How can we learn to protect our water? **Guiding Questions:** • Where is my watershed? • Why is it important to learn about watersheds?
#7	**Lets Make a Watershed Model"—**Students will create mini-watershed models that show examples of point and non-point pollution sources and natural filters in a community. Students will also identify the interrelationships between a community and its watershed. **Standards:** Science: SC-M-2.1.5 and Social Studies: SS-M-4.2.1 **Essential Question:** How can we learn to protect our water? **Guiding Questions:** • What are some of the causes of water pollution? • What natural and manmade filters help clean water?
#8	**"Whose Side Are You On?"—** Students will be introduced to the critical thinking process of " Issue Analysis" as they role play to answer the question, " Which group should be given custody of the last Truffula Tree seed?" **Standards:** Social Studies: SS-M-4.4.4 **Essential Question:** How can we learn to protect our water? **Guiding Question:** What is Issue Analysis and how can we use it to study current issues?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
#9	“**Curiosity Rules!”—** Students review all the questions that have been placed on the board during the unit and match to facts and concepts they have learned. An extension allows student to research questions that have not been answered during the unit. **Standards:** Science: S-8-SI-3**,** Students will use evidence (e.g., computer models), logic and scientific knowledge to develop scientific explanations. **Essential Question:** How can we learn to protect our water? **Guiding Question:** How can I continue to learn about water and how it affects me?
#10	“**Let’s Analyze the Issues!”—** Students will use steps involved in “Issue Analysis” to identify, research, write about, and present current water resource issues in Kentucky. **Standards:** Social Studies: SS-M-1.1.2, Social Studies: SS-M-4.4.4 and Writing-WR-M-1.4. **Essential Question:** How can we learn to protect our water? **Guiding Questions:** • What is a current water resource issue in our community or state? • How did the controversy begin? • Where is the controversy heading? • Who controls the resources that could resolve the issue? • What beliefs/values are at conflict with this issue? • What stand are you going to take on this issue? • Are you unable to support your stand with unbiased evidence?
#11	“**Now’s the Time to Act!”—** Students will work in small groups to design and implement a plan of action in their community to protect or conserve water. **Standards:** Social Studies: SS-M-1.1.2 **Essential Question:** How can we learn to protect our water? **Guiding Question:** What is a service learning project that is feasible for us to do, and will help make us more responsible water users?

Making The Unit More Inquiry-Based

Nearly all the activities in this unit are designed to help students ask questions and do some basic research on topics related to water quality in our state. However, a simple exercise woven throughout the unit can increase the numbers of questions asked by the students and make them your partners in finding answers to those questions. Here is how it works.

At the beginning of the unit, make (or have students make) about 100 wavy strips of colored paper long enough on which to write a question. (Strips should look like a stream or river) Also make (or have students make) about 100 drops of water on colored paper. These should be large enough on which to write an answer or fact. Also, designate a bulletin board or wall in the classroom as your “Water Discovery Area”. Place the paper in two boxes near the water discovery area. Label the two boxes, “question strips” and “answer drops”.

Encourage students to both ask questions in class and to write any questions they have on one of the question strips. They should then attach these to the water discovery area. Also tell students that each time they learn something new about water they are to write that new knowledge on an answer drop. (Students may need a little guidance at first.)

Throughout the unit pause occasionally to match question strips with answer drops. Explain to students that gaining knowledge is similar to the water cycle. It really never ends because each new question needs an answer and, very often, each new answer raises a new question. Also explain that, just as water changes forms, the answers to questions change as we gain new knowledge through science and inquiry.

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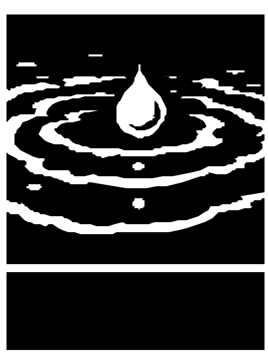

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Kentucky's Commonwealth of Water – Be an Informed Water Citizen
Middle School

What's All the Fuss About?

Adapted from *Water: The Resource That Gets Used and Used and Used for Everything* Poster; USGS, Reston, VA,

Standards

Scientific Inquiry, Students will use appropriate equipment, tools, techniques, technology, and mathematics in scientific investigations.
Science: SC-M-2.1.5, Students will understand that water, which covers the majority of the Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle. Water dissolves minerals and gases and may carry them to the oceans.

The following standard is introduced in this activity
Social Studies: SC-M-3.1.1, Students will understand the concept of scarcity (imbalance between unlimited wants and limited resources) as it applies to individuals, societies, and governments across geographic regions.

Activity Description

Students will recognize that there is a lot of water in the world, but that only a very small percentage of it can be used for drinking water and other water supply needs.

Materials

- Class set of activity sheets found at end of lesson/pencils

(One set of the remaining materials for each lab group)

- Four 1000 ml graduated cylinders
- One water dropper

Length of Lesson

60-90 minutes plus homework assignment

Vocabulary Words

Fresh water: inland water that has a low concentration of minerals, salts, and dissolved solids found as surface water or groundwater.
Surface water: precipitation that does not soak into the ground or return to the atmosphere by evaporation or transpiration. It is stored in streams, lakes, rivers, ponds, wetlands, oceans, and reservoirs.
Groundwater: water that infiltrates the earth and is stored in usable amounts in the soil and rock below the earth's surface; water within the zone of saturation.

Essential Question

How can we learn to protect our water?

Guiding Questions

- Why isn't all fresh water usable?
- Why do we need to take care of the surface water and ground water?

Skills Used

Compare	Analyze	Compute
Organize	Graph	Write
Reflect	Experiment	Teamwork

What's All the Fuss About?, *continued*

Activity

Step 1: Gather the materials needed to complete this activity prior to class time. Refer to **Teacher Fact Sheets** for background information about the amount of water on Earth.

Step 2: Introduce this water unit of study by telling students that they will be learning about Kentucky waterways, current water issues and things they can do to become responsible Kentucky water users. Encourage students to begin looking for newspaper and magazine articles related to this unit. Ask them to bring the articles to school as they find them, making sure they include the sources from which they obtained the articles, and the date of the publication. It might also be a good idea to begin collecting water pictures to use in later student publications. Make water droplet cutouts so students can record water facts as they learn them and question strips so they can keep track of what more they want to know as the unit progresses. Keep both droplets and question strips posted in the room for use throughout the unit.

Step 3: Explain that, in this first activity, each group of students will be conducting an activity to compare the total amount of estimated water found on Earth to the amount of fresh water that is usable. Then (in a follow-up activity) they will calculate how much usable water is available for each person on earth.

Step 4: Pass out lab equipment and the first activity sheet found at the end of this activity. Go over the sheet with students and offer explanations where needed. Define the terms fresh water, saltwater, ground water, and surface water.

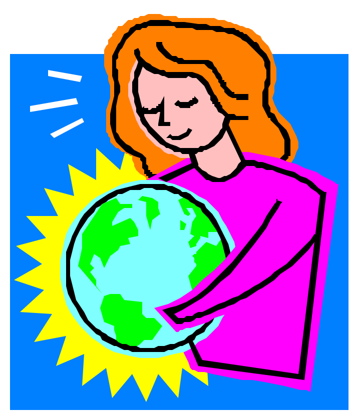
Step 5: Instruct students to begin the activity, following instructions on Activity Sheet 1.

Step 6: Once the measuring part of the activity has been completed, hold a class discussion to see what questions students have about the scarcity of water. Record any questions on question strips. Use water from the activity to water plants.

Step 7: Distribute the second activity sheet. Instruct students to work together to do the calculations and find the answers.

Step 8: Discuss answers on both sheets with students. Ask if the numbers surprised them and if they realized that such a small percentage of the water in the world is usable.

Step 9: Have students visit the website http://www.uswaternews.com/archives/. Have each group choose a story from the page and report the story and the issues surrounding it to the rest of the class. Discuss the articles and issues with students. Record any questions they have and any new facts they have learned.



What’s All the Fuss About?

Activity Sheet 1

Procedure

1. Fill container A with blue colored water to the 1,000 ml line. This represents the earth’s entire supply of water.

2. Pour 30 ml of the total water from container A into a second 1,000-ml graduated cylinder. The 30 ml of water in container B represents the earth’s total fresh water supply. The remaining 970 ml of water is salt water. Label container A “salt water” (You may actually put some salt in it to make the point.)

3. Of the world’s fresh water (in container B) approximately 80% is frozen in the polar icecaps or in glaciers. Pour this amount, which is 24 ml, into container C. Label container C “ice caps and glaciers.” Place it next to container A.

4. Of the world's fresh water that is NOT frozen in ice caps or glaciers (now represented in container B), approximately 99.5% is either too polluted or too far underground to be used. Using the water dropper, take one drop of the remaining water and put it into the final container labeled container D. (This drop represents all the water on earth that we can use to meet our human needs.) Label container B “polluted water and unreachable groundwater” and label container D “ usable water”.

After completing the activity, have a discussion about your findings and record any questions students may have. Put these on the question board along with new facts you have learned during this experiment. During the discussion, discuss the following questions as well. (Note: Students may need to do research to find the answers to these questions.)

1. Which of the fresh water graduated cylinders represents the most fresh water on Earth?

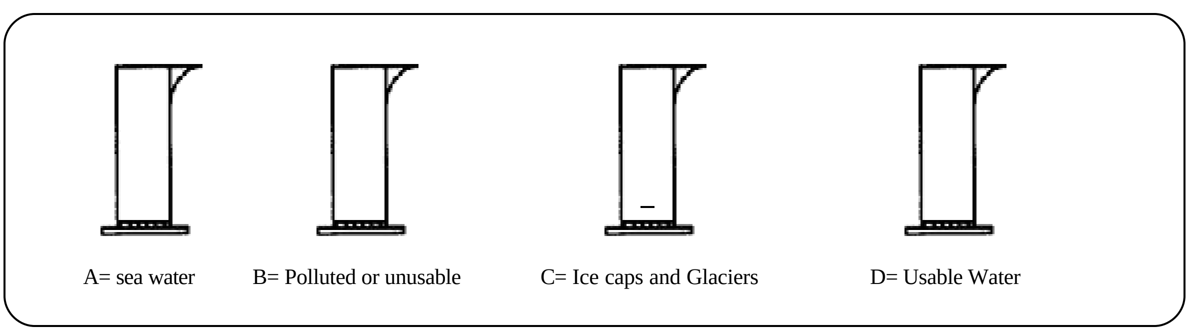
2. Is this a source of fresh water commonly used by humans for drinking, watering the lawn, etc.? Explain.

3. Approximately what percentage of Earth’s fresh water is ground water?

4. Where is most of Earth’s water found?

5. Can cities such as San Francisco, Miami, and New York City, which are near oceans, use the water from the oceans for households and industry? Explain.

6. Can the salts be removed from the water? Why do you think this isn’t commonly done?



What's All the Fuss About?

Activity Sheet 2

Water and population facts

Amount of water on earth	= 280 billion liters
Percentage of water on earth that is in the oceans	= 97%
Percentage of remaining fresh water that is frozen in the polar ice caps and glaciers	= 80%
Percentage of fresh water not in the icecaps or glaciers but still unavailable for human use	= 99.5%
Total number of people on earth as of 1/01/02	= 6,211,666,092

(Go to http://www.ibiblio.org.lunarbin/worldpop/ for the latest population figures.)

1. Using the chart above, divide the total amount of water on earth by the total population on earth. Remember, the total amount of water never goes up but population does. Record your answer. ____

2. Now, calculate the amount of water in the oceans and subtract that amount from the total amount of water on earth. This is the amount of fresh water on earth. Divide this amount by the total number of people on earth. This is how much fresh water there is for each person on earth. Record your answer. _______________________

3. Now, calculate how much of the fresh water on earth is tied up in the polar ice caps and glaciers and subtract that from the total amount of fresh water. Divide this amount by the total number of people on earth. This is how much fresh water, not tied up in polar ice caps, there is for each person on earth. Record your answer. ________

4. Finally, calculate out how much of the fresh water that is not tied up in the icecaps is too polluted or too difficult to reach. Subtract this from your last total and divide this by the number of people on earth. This should give you how much water is available for each person to use. Record your answer. ______________________________

5. Remember, the population keeps going up, but the amount of water does not. Write at the bottom of this sheet why you think it is, or is not, important for people to know this.

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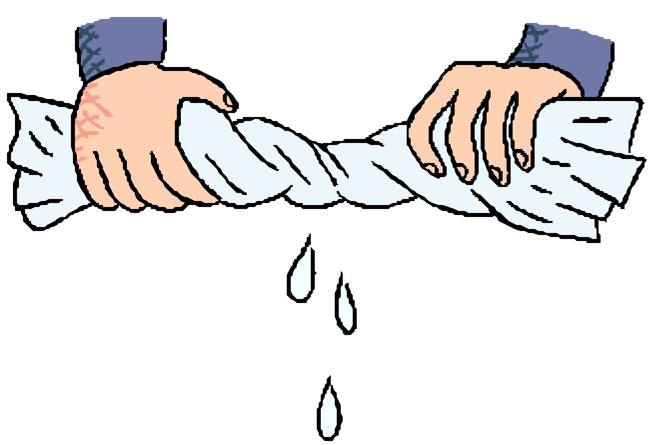
What's All the Fuss About?, *continued*

Extension

Have students look at the USGS map at http://water.usgs.gov/realtime.html (or do a internet search on U.S. water conditions.) This map shows available water for use. Ask students if they notice differences in the amount of water available for use in the eastern and western part of the country. Also have students look at the website http://www.uswaternews.com/archives/arcsupply/arcsupply.html which is a news source for water scarcity articles and issues. Have students or student groups report on issues that relate to water scarcity.
Have students role play the following scenario or create other role plays from articles they read on the water news website.

What if the severe drought conditions experienced in 2002 continue? Have students role play a debate between two western land owners. One who needs water for his cattle and the other who lives upstream and is using nearly all the available water to irrigate his crops.

Assessment: Ask students to write a portfolio piece which explains what they learned in this activity about water and population. Ask them to include how they think water scarcity may affect people now and in the future. Make sure they use examples, either from water news, or from their imaginations, of problems they think might be caused by water scarcity.



Kentucky's Commonwealth of Water – Be an Informed Water Citizen
Middle School

"Water" You Supposed to Be?

Adapted from "ACTING THE WATER CYCLE", P. 7, *Splashing in Kentucky!*, Kentucky Waterways Alliance, 1998

Standards

Science: SC-M-2.1.5, Students will understand that water, which covers the majority of the Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle. Water dissolves minerals and gases and may carry them to the oceans.
(The next standard is introduced in this activity)
Arts and Humanities: AH-M-3.1.4, Students will create characters using the elements of performance.

Activity Description

Students will learn about the different parts of the hydrologic (water) cycle as they participate in a game of charades.

Materials

Index cards containing each group's role in the hydrologic cycle along with definition. (See **Step 2**.)

Length of Lesson

60 – 90 minutes

Vocabulary Words

Atmosphere: The layer of gases surrounding Earth.
Condensation: process in which a gas (water vapor) changes into a liquid. A cloud is the visible collection of water vapor in Earth's atmosphere.
Evaporation: process in which the heat energy of the sun causes the water on the earth's surface to change into a vapor.
Ground water: water that infiltrates the earth and is stored in usable amounts in the soil and rock below the earth's surface; water within the zone of saturation.
Hydrologic cycle: continuous movement of water throughout Earth's atmosphere including evaporation, transpiration, condensation, precipitation, runoff, infiltration and accumulation.
Infiltration: the process by which water seeps into the ground.
Precipitation: any type of water falling from the atmosphere (rain, snow, hail, sleet).
Runoff: water (originating as precipitation) flowing across the earth's surface (rather than seeping into the ground) that eventually enters a body of water.
Surface water: precipitation that does not soak into the ground or return to the atmosphere by evaporation or transpiration. It is stored in streams, lakes, rivers, ponds, wetlands, oceans, and reservoirs.
Transpiration: the process by which water absorbed through plant roots evaporates from the leaves.

Essential Question

How can we learn to protect our water?

Guiding Question

What are the parts of the hydrologic cycle and why is it important?

Skills Used

Analyze	Apply	Communicate	Describe
Discuss	Identify	Listen	Observe
Role play	Visualize	Teamwork	Create

"Water" You Supposed to Be?, *continued*

Activity

Step 1: Remind students at the beginning of this lesson that they have probably learned about the hydrologic (water) cycle over and over again in previous years. Explain to students that they will be reviewing the different parts of the hydrologic cycle a little differently in this lesson — they will be playing charades, and acting out their assigned part of the cycle. Explain that, unlike charades, sound (not words) may be added to help classmates guess what they are. Divide the class into 10 groups and secretly give each group an index card that has the role the group will be playing in the hydrologic cycle, along with a definition. The roles are listed below: Cards may be made from the page following this one.

sun	**surface water**
atmosphere	**runoff**
evaporation	**condensation**
groundwater	**precipitation**
infiltration	**transpiration**

Step 2: Explain that each group of students will work as quietly as possible together to decide the best way to act out their role in the classroom improvisations. Give students approximately five minutes to get their acts ready. Answer any questions quietly within each group, so the different roles are secret until game time.

Step 3: Begin the activity. (**NOTE**: Teachers may decide to post a list of the terms, or a picture of the hydrologic cycle, in the classroom prior to the start of the game of charades. That should not take away from the focus of this lesson, which is to actively encourage students to internalize the different steps in the hydrologic cycle.)

Step 4: After all groups have performed, instruct the students to arrange their groups in a logical order, according to the hydrologic cycle, and follow a drop of water through the cycle as each group takes a turn acting out its action and sound.

Step 5: Conclude the activity by explaining that the homework, which is also the assessment, will be for students to individually create a product that shows the different parts of the water cycle to present to the class. Emphasize that accuracy and creativity are the main focus of this product, and that students may use any avenue they wish to show that they understand the hydrologic cycle. Products could include a poster, clay animation, mobiles, bulletin board, PowerPoint presentation, video, etc. Set a reasonable deadline for completed projects to be brought to school, and allow time in class to share and display the projects once they are completed.

Step 6: Grade the projects using the rubric found on the next page. **NOTE:** The rubric should be available for students to reference when preparing project and presentation.

Extensions

1. Use music, such as Vivaldi's *Four Seasons*, as background during the final class production.

2. Videotape the final class performance and/or the individual presentations to send to local elementary schools so teachers might use the material to introduce, or review the hydrologic cycle with their younger students.

3. Display projects in a prominent place in the school building, and/or post them on the school, or class, web site.

4. Do the activity "Imagine" on page 252 of Project WET.

Q&A - Remember to allow students an opportunity to write questions they have on the question board.

Cards to be used by groups in the hydrologic cycle charades game

Sun	Atmosphere
Evaporation	Transpiration
Surface Water	Runoff
Infiltration	Groundwater
Condensation	Precipitation

Hydrologic Cycle Presentation Rubric

Student Name ______________________________ **Date** ______________________________

Teacher Name ______________________________ **Class** ______________________________

CATEGORY AND SCORE	4	3	2	1
Accuracy of Retelling the Hydrologic Cycle Story	The storyteller includes all major points and several details of the hydrologic cycle. The concept is easy to understand and is logical. There are no loose ends.	The storyteller includes all major points and 1-2 details of the hydrologic cycle. The concept is easy to understand and is somewhat logical.	The storyteller includes all major points of the hydrologic cycle, but the concept was a little hard to understand.	The storyteller forgets major points of the hydrologic cycle and the concept of the water cycle was impossible to understand.
Knows the Story	The storyteller knows the story well and has obviously practiced telling the story several times. There is no need for notes and the speaker speaks with confidence.	The storyteller knows the story pretty well and has practiced telling the story once or twice. May need notes once or twice, but the speaker is relatively confident.	The storyteller knows some of the story but did not appear to have practiced. May need notes 3-4 times, and the speaker appears ill-at-ease.	The storyteller could not tell the story without using notes.
Connections/ Transitions	Connections between the components of the hydrologic cycle in the story are creative, clearly expressed and appropriate.	Connections between the components of the hydrologic cycle in the story are clearly expressed and appropriate.	Connections between the components of the hydrologic cycle are sometimes hard to figure out. More details or better transitions are needed.	The story seems very disconnected and it is very difficult to figure out the story.
Visual Setting	Lots of vivid, accurate, descriptive visual effects are used to show the audience when and where the hydrologic cycle takes place.	Some vivid, accurate, descriptive visual effects are used to show the audience when and where the hydrologic cycle takes place.	The audience can figure out when and where the hydrologic cycle takes place, but there is not much visual detail.	The audience has trouble telling when and where the hydrologic cycle takes place.
Acting/ Dialogue	The student uses consistent voices, facial expressions and movements to make the presentation more easily understood.	The student often uses voices, facial expressions and movements to make the presentation more easily understood.	The student tries to use voices, facial expressions and movements to make the presentation more easily understood.	The student tells the story but does not use voices, facial expressions or movement to make the storytelling more interesting or clear.

_____________**Total Score** **Comments:**

Kentucky's Wonderful Commonwealth of Water – Be an Informed Water Citizen

Middle School

How Valuable *Is* Water?

Water Dollar Activity Adapted from "The Value of Water", USGS Water Resource Education, Water Poster Series, 1993

Standards

Math: MA-M-1.2.1, Students will compute (e.g., estimate, use pencil and paper, use calculator, round, use mental math) large and small quantities and check for reasonable and appropriate computational results.
Practical Living: PL-M-3.1.5, Students will understand that environmental issues should be considered when making consumer decisions (e.g., recycling, reducing, reusing)
Social Studies: SS-M-3.1.1, Students will understand that productive resources are limited and do not satisfy all the wants of individuals, societies, and governments (scarcity).

Activity Description

Students will work to budget the amount of water they use in order to save "Water Dollars". They will also investigate why water is essential for day-to-day living and how water contributes to the standard of living in Kentucky. Finally, students will create a game to teach others about water.

Materials

- 5 pages of Water Dollars (located at end of activity) per student
- Class set of Table 1 (located at end of activity)
- Class set of Table 2 (located at end of activity)
- Variety of art materials to assist students in making a water game.

Length of Lesson

Approximately 3-5 days

Vocabulary Word

Conservation—the protection or wise use of natural resources that ensures their continuing availability to future generations.

Essential Question

How can we learn to protect out water?

Guiding Questions

- How do we use water on a daily basis?
- Why is water essential for day-to-day living?
- How does water contribute to the standard of living in Kentucky?
- How can we conserve water?

Skills Used

Analyze	Apply	Communicate	Calculate
Organize	Collect Data	Plan	Create

How Valuable *Is* Water?, *continued*

Activity

Step 1: Divide students into small groups, giving them instructions to list ways they, personally, use water. Give students about 5 minutes to complete this activity.

Step 2: Bring students back together and make a master list, either on an overhead projector, or directly on a computer, if classroom "presenter" is available to connect the computer to the classroom television. (Use the table setup at the bottom of this column.)

Step 3: Explain to students that, in an attempt to arrive at a rough estimate of how much water individuals use on a daily basis, they are going to be responsible for keeping a ledger showing how many times they use water for various activities during a 24 hour period.

Step 4: Give students a copy of the completed table, (or have students copy it onto a sheet of paper) and ask them to carry it with them for the next 24 hours and mark it each time they directly use water. Remind students to return completed tables to class the following day so the collected information can be used to continue the activity.

ACTIVITY	# of times
Brush teeth	
Take a shower	
Take a bath	
Shave	
Flush toilet	
Get a drink	
Wash hands	
Wash food	

Step 5: After preparing the table, ask students to think about, and discuss, how water is used across the state of Kentucky, not just for individual use, but in other ways. Separate the uses into two categories — instream use (recreation, transportation, plants, animals and hydroelectric power) and offstream use (homes, industry, . . .).

Step 6: Conclude this class session by encouraging students to think about their own county and the many ways water is used. Ask students to take a close look as they head home from school at all of the businesses, farms, homes, and recreational facilities (as well as plants and animals) that depend on water every day. REMIND STUDENTS TO RETURN HOMEWORK!

Day 2

Step 1: Before class time, make a class set of Table 1 and Table 2, and 5 sheets of Water Dollars for each student (all found after this activity). Ask students to use the information they collected on personal water usage over the 24 hour period to fill in Table 1. Explain that, using the conversion table at the top of the worksheet, they will convert the gallons to liters, then multiply to find the total amount of gallons and liters of water they used during the previous 24 hours. (**NOTE:** The correct answers are found on Table 2, but students do not need to see this sheet yet.)

Step 2: Once the conversion table has been completed, pass out, to each student, 5 sheets of the "Water Dollars" (found after Table 2) for students to cut apart.

How Valuable *Is* Water?, *continued*

Step 3: Explain that each student has the same amount of Water Dollars (370 Water Dollars each), and that they are going to have to pay for the amount of water they used during the last 24 hours. Explain that it costs one Water Dollar for every liter of water used and that they need to round up to the nearest liter when calculating the amount of money they owe for their use of water.

Step 4: Instruct students to return the spent Water Dollars to the teacher, or the appointed Water Dollar Banker (a student or parent volunteer). Students should discover that it does not take very long to use up all of their Water Dollars. If students run out of Water Dollars, ask for ideas on what they might have to do in real life to afford to pay for their water. Remind students that there are many choices that consumers must make, when they have a limited amount of money to spend for goods and services. Ask students to think about, and discuss, times when they were on a limited budget and could not buy things they really wanted and the compromises they had to make. Explain that as young adults, they have a responsibility to use water wisely, so the quality of life and the quantity of freshwater we enjoy today in Kentucky will be available for future generations.

Step 5: Explain to students that they will have a chance to learn to spend their Water Dollars more wisely in the next 24 hours by trying to conserve (or cut down) on the amount of water they are using to do everyday tasks. Pass out Table 2, which contains ways to conserve water. Explain that the students will once again keep track of the amount of water they use over the next 24 hours. This time, though, they have a chance to earn refunds, if they choose to conserve the amount of water they use. For example, when brushing teeth, if they conserve water by turning it off instead of allowing it to run as they brush, they will get a refund of 7 water dollars (8 liters – 1 liter = 7 liters of water saved). Encourage students to try to budget their Water Dollars so they have as much money as possible left over after paying for their water purchases in class the next day. (Incentives that are meaningful to students may be given to students who have the most money left by receiving water refunds in class on the following day.)

Step 6: Ask students to return all Water Dollars until the next day of class. Also, ask students to keep Table 1 in their class notebooks so they can compare their personal water consumption in class the next day.

Day 3

Step 1: Prior to class on the third day of this activity, sort the Water Dollars into groups of 370 Water Dollars for each student (10 tens, 10 twenties, 10 fives and 20 ones).

Step 2: When students arrive, as on Day 2, have them figure out how much money they have to spend for their water consumption. If they used water conservatively, though, they will receive their refunds. (Students or parent volunteers may be appointed as "Bankers" to distribute Water Dollar refunds to students who conserved their use of water.) Once refunds have been made, ask students to share with the entire class how much money they had left after budgeting the way they used water. Also, ask students to reflect on, and write about this experience in their class notebooks.

How Valuable *Is* Water?, *continued*

Optional Activity

Step 1: Once the Water Dollars have been put away for the day, remind students that in real life adults must purchase water from local water companies. Explain that the price of water differs from community to community, but that currently, the cost for residential customers in Kentucky is about $2.75 per 1,000 gallons of water up to 40,000 gallons. On top of this cost, homeowners must also pay a monthly service charge that is determined by the local water company. An average monthly service charge could run about $7.70 for a 5/8 inch residential connection line. Explain that water utility companies must bring in enough money to pay all of their expenses, plus have access to revenue in case equipment has to be repaired, new structures built, etc.

Step 2: Instruct students to use the information found on Table 2 to estimate the amount of water their ENTIRE FAMILY used (in gallons) over the past 24 hours. Instruct them to multiply that amount by 30 to determine an estimate of the amount of water used in one month. (Remind students to be sure to consider extra activities such as washing the car, watering the lawn, or filling the swimming pool.) Ask students to calculate their family's monthly water bill, based on a rate of $2.75 per 1,000 gallons of water, with a service charge of $7.70 added to the total bill.

Step 3: Instruct students to take their final calculation home and check it with a real water bill to see how accurate their estimate was on how much their parents must pay for the privilege to have water pumped into their home.

Step 4: Challenge students to think about what would happen to the cost of water, as well as the quality of water in Kentucky, if people pollute existing surface water, or do not conserve the amount of water they personally use.

Assessment

Step 1: Remind students that they have had an opportunity to play a game using the Water Dollars to learn about water conservation. Explain that they will be working in small groups to create a new game to teach people about conserving and protecting Kentucky's water. Tell students that the game can be designed to appeal to an older or younger audience. If desired, make Internet web sites available so students can do more research to come up with a variety of facts, or make copies of the Kentucky fact sheets found in the **Teacher Fact Sheets.**

Step 2: Share the grading rubric (found at the end of this activity) so students will understand how their games will be graded. Allow class time for students to work on games, and set a deadline for completion.

Step 3: If possible, team up with other classes within the school to field test the completed games. This would be a great way to spread the word about the importance of taking care of Kentucky's water!

Extensions

1. Invite a speaker from the local water company to talk to the class about their line of work, and how the local water system works to get water to consumers.
2. Assign students to investigate how much water is used on a monthly basis at school. What is the monthly cost of water at school? Is the school charged the same rate (price per gallon and service charge) as residential, or home, customers?
3. Challenge students to encourage family members to conserve water at home. After a few weeks, have students write about changes that have been made at home to cut down on water usage. Are families seeing a decrease in monthly water bills?

Estimated Daily Water Usage Table 1

Name_________________________ **Date**______________ **Class**_______

Directions: Over the next 24 hours complete this chart, based on water used during one typical day. Please return this completed chart to class tomorrow. Thank you!

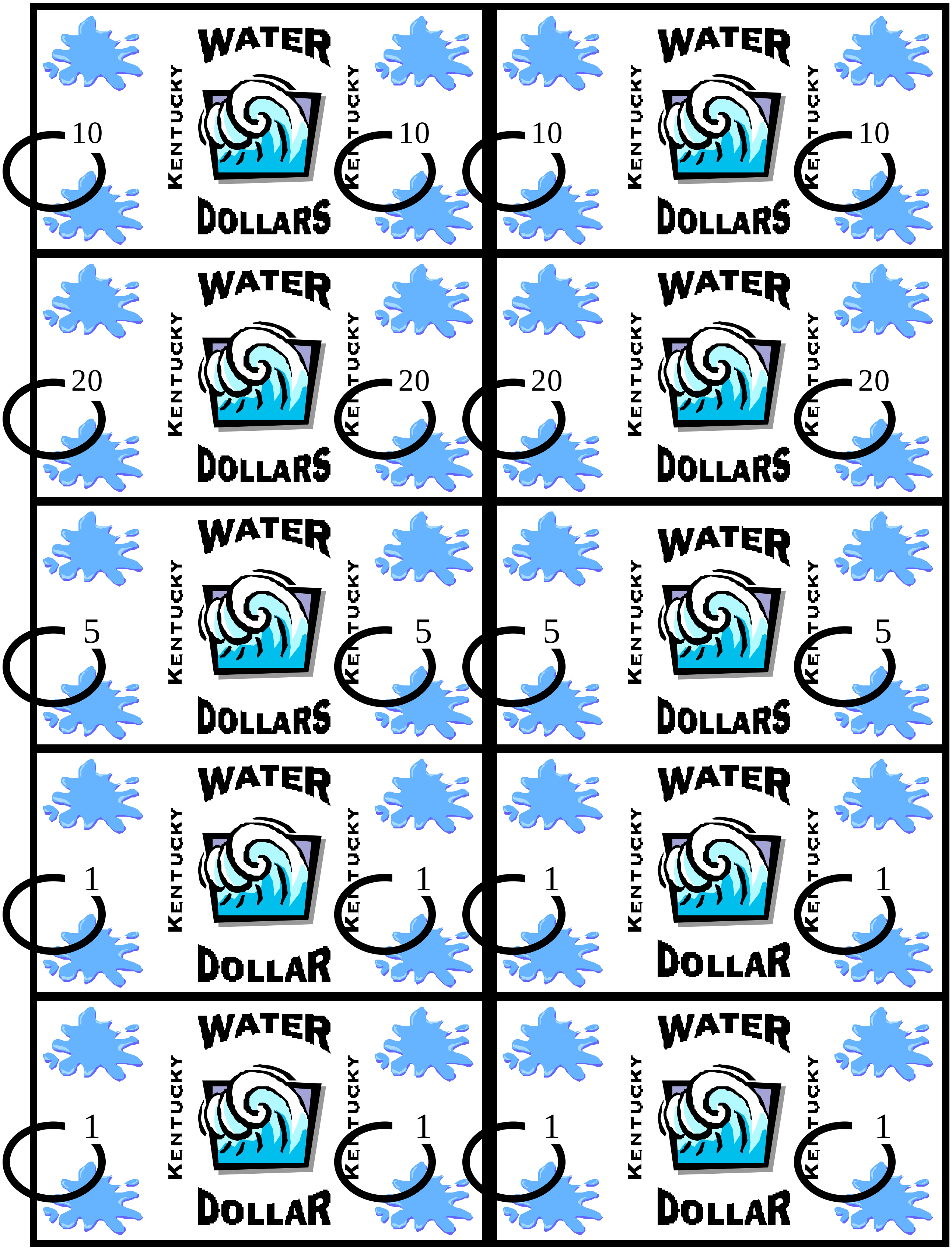
ACTIVITY	**Total Number of Times**	**Estimated Gallons of Water Used With Normal Usage**	**Convert to Liters (Multiply the # of gallons by 3.8)**	**Total Gallons / Liters of Water Used (Multiply # of times by gallons then liters)**
Example: Shave	2	15 gallons	15 x 3.8 = 57 liters	2 x 15 = 30 gallons 2 x 57 = 114 liters
Brush teeth		2 gallons		
Take a bath		40 gallons		
Take shower		50 gallons		
Shave		15 gallons		
Flush toilet		5 gallons		
Get a drink		1 gallon		
Wash hands or face		2 gallons		
Cook a meal		3 gallons		
Wash dishes by hand		30 gallons		
Run a dishwasher		16 gallons		
Do a load of laundry		60 gallons		
Watering lawn		300 gallons		
Washing car		50 gallons		
			Total Water Used	

Estimated Daily Water Usage Table 2

Name__________________________ **Date**______________ **Class**_______

Directions: Work at home, with family members to complete this chart, based on water used during one typical day. Please return this completed chart to school tomorrow. Thank you!

ACTIVITY	Total Number of Times	Estimated Gallons of Water Used With Normal Usage	Estimated Gallons of Water Used With Conservative Usage	Total Gallons of Water Used
Brush teeth		Water running 2 gallons / 7.6 liters	Water turned off .25 gallon / 0.95 liter	
Take a bath		Full tub 40 gallons / 152 liters	Low water 10 gallons / 38 liters	
Take shower		Standard shower head 50 gallons / 190 liters	Low flow shower head 25 gallons / 95 liters	
Shave		Water running 15 gallons / 57 liters	Plug & fill basin 1 gallon / 3.8 liters	
Flush toilet		Standard flow toilet 5 gallons / 19 liters	Low flow toilet 1.5 gallons / 5.7 liters	
Get a drink		Run water to cool 1 gallon / 3.8 liters	Keep water in fridge 0.062 gallon / .24 liter	
Wash hands or face		Water running 2 gallons / 7.6 liters	Plug and fill basin 1 gallon / 3.8 liters	
Cook a meal		Water running to wash vegetables: 3 gallons / 11.4 liters	Wash vegetables in bowl: 1 gallon / 3.8 liters	
Wash dishes by hand		Water running 30 gallons / 114 liters	Wash & rinse in sink: 5 gallons / 19 liters	
Run a dishwasher		Full cycle 16 gallons / 60.8 liters	Short cycle 7 gallons / 26.6 liters	
Do a load of laundry		full cycle / top water level 60 gallons / 228 liters	short cycle/ low water level 27 gallons / 102.6	
Watering lawn		300 gallons / 1140 li-ters	Early, shorter watering 150 gallons/570 liters	
Washing car		50 gallons / 190 liters	Rinse less often 25 gallons/95 liters	
			Total Water Used	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Water Game Rubric

Student Name ________________________ **Date** __________________________

Teacher Name ________________________ **Class** __________________________

CATEGORY AND SCORE	4	3	2	1
Knowledge Gained	All students in group could easily and correctly state several facts about the topic used for the game without looking at the game.	All students in group could easily and correctly state 1 – 2 facts about the topic used for the game without looking at the game.	Most students in group could easily and correctly state 1 – 2 facts about the topic used for the game without looking at the game.	Several students in the group could NOT correctly state facts about the topic used for the game without looking at the game.
Accuracy of Content	All information cards made for the game are correct.	All but one of the information cards made for the game are correct.	All but two of the information cards made for the game are correct.	Several information cards made for the game are not accurate.
Attractiveness	Contrasting colors and at least 3 original graphics were used to give the cards and gameboard visual appeal.	Contrasting colors and at least 1 original graphics were used to give the cards and gameboard visual appeal.	Contrasting colors and “borrowed” graphics were used to give the cards and gameboard visual appeal.	Little or no color or fewer than 3 graphics were included.
Rules	Rules were written clearly enough that all could easily participate.	Rules were written, but one part of the game needed slightly more explanation.	Rules were written, but people had some difficulty figuring out the game.	The rules were not written.
Cooperative Work	The group worked well together with all members contributing significant amounts of quality work.	The group generally worked well together with all members contributing some quality work.	The group worked fairly well together with all members contributing some work.	The group often did not work well together and the game appeared to be the work of only 1-2 students in the group.
Creativity	The group put a lot of thought into making the game interesting and fun to play as shown by creative questions, game pieces and/or game board.	The group put some thought into making the game interesting and fun to play by using textures, fancy writing, and/or interesting characters.	The group tried to make the game interesting and fun, but some of the things made it harder to understand and/or enjoy the game.	Little thought was put into making the game interesting or fun.

____________**Total Score** **Comments:**

Kentucky's Commonwealth of Water – Be an Informed Water Citizen
Middle School

Just How Much Water Are We Talking About?

Adapted from an activity in "Water Science for Schools, at http://ga.water.usgs.gov/edu/mgd.html

Standards

Math: MA-M-2.2.3, Students will develop and apply proportionality and relationships between scale models and actual figures.

The following standard is introduced in this lesson.

Social Studies: SS-M-3.1.1, Students will understand that productive resources are limited and do not satisfy all the wants of individuals, societies and governments.

Activity Description

Students will calculate the value of one million gallons of water by comparing it to the volume of their classroom. They will also learn about water consumption in Kentucky and calculate the estimated cost of water.

Materials

- Classroom dimensions (length, width, height) measured before class
- Transparency or diagram of Figure 1 and Figure 2 on board
- Student worksheet found at end of activity (optional)

Length of Lesson

60 – 90 minutes, plus math homework (optional)

Vocabulary Words

Consumed—that part of water that is evaporated, stored in food, drunk by people or animals, or somehow removed from the local environment.
Consumption—the amount of any product or resource (e.g., water) used in a given time by a given number of consumers.
Million gallons—the measurement used in the United States to report daily water consumption. Approximately 133,500 cubic feet of water.
Withdrawal—water removed from the ground or a surface water source for use.

Essential Question

How can we learn to protect our water?

Guiding Questions

How much water do we use on a daily and yearly basis?

Skills Used

Analyze	Calculate	Visualize	Estimate
Compare	Connect	Interpret	Investigate

Just How Much Water Are We Talking About?, *continued*

Activity

Step 1: Begin by having students estimate how much water they think their classroom would hold. Have each of them write their estimate down on a piece of paper. Then assign groups of students to measure the dimensions of the room (height, length, and width.) Write each group's measurements on the board and ask for a volunteer to average the measurements for each dimension. (The classroom measurements can be written in on question # 2 on worksheet, if it is being used.) Copy student activity sheets, if using them.

Step 2: Explain to students that in order to better understand how much water is consumed in Kentucky on a daily basis, people need to be able to visualize how much a million gallons of water is, since water consumption in the U.S. is generally measured in millions of gallons. Show students the diagram on the right, or pass out copies of the student activity sheet found on the next page. Explain that when we measure things they are approximations, or close estimates, of the actual amount, since measurement tools are not 100 % accurate.

Step 3: Draw the cube and pool in the next column on the board. Instruct students to calculate the volume of the cube and the pool by using the formula: Volume = length x width x height (The answer for the cube is 133,511 cubic feet and 133,500 cubic feet for the pool.)

Step 4: Write the dimensions of the classroom on the board. Ask students to calculate the volume of the classroom, using the same formula listed above.

Step 5: Next have students compare the size of the classroom with the size of one million gallons of water and calculate how many classrooms

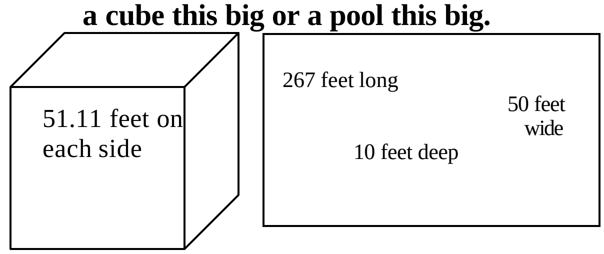
Step 5 (cont.)

it would take to hold one million gallons of water. (Divide 133,500 by the volume of the classroom to determine how many classrooms it would take.)

Step 6: Conclude this part of the lesson in measurement by asking students to think of buildings in their community they estimate would hold about 1 million gallons of water, and share the water fact on the bottom of the student worksheet.

Step 7: Finish this activity by passing out the second student activity sheet dealing with water use in the United States during 1995.

1 million gallons of water is equal to a cube this big or a pool this big.



Extensions / Variations

1. Visit the following web site to learn more about water consumption in the United States during 1995 by state:

http://ga.water.usgs.gov/edu/tables/dltotal.html

2. Make transparencies of the fact sheets found at the above web site and develop an entire math lesson based on comparing and ranking states according to water consumption.
3. Have students hypothesize, then investigate why the water consumption varies so drastically between states.
3. Contact the county water district to find out how much freshwater is withdrawn each day locally.

Just How Much Water Are We Talking About?

Student Activity Sheet 1

Name____________________ **Date_______________** **Class_______________**

In the United States, water consumption is expressed in millions of gallons of water used per day. 1 million gallons of water is equal to a cube this big or a pool this big.

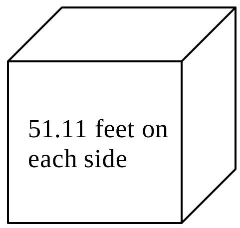


Figure 1

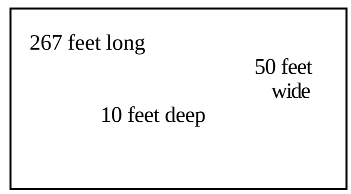


Figure 2

1. Find the volume (cubic feet of water that can be poured inside) of Figure 1 and Figure 2 by using the following formula:

   volume (cubic feet) = length x width x height *(l x w x h)*

2. Find the volume of your classroom by using the same formula.

3. How many classrooms would you need to hold 1 million gallons of water?

WATER TRIVIA

The U.S. Geological Survey, estimated that in 1995, Kentuckians used approximately 4,420 million gallons of water per day. How much would that be per year?

For extra credit, solve this problem. Using the figure above for how much water Kentuckians used in a day in 1995, figure out how much water was used per day by each Kentuckian. (hint: you will need to know the population of Kentucky in 1995.) Before water was piped into the house, it was usually the job of the children and young people to carry water from the well or spring. Assuming you had a two gallon bucket, how many trips per day would you need to make to carry water for one person?

Find out if per capita water consumption has gone up or down since 1995.

Just How Much Water Are We Talking About?

Student Activity Sheet 2

Name___________________________ **Date**_______________ **Class**________

Use the following information supplied by the United States Geological Survey (USGS) to calculate and compare domestic water consumption in the United States in 1995.

(Withdrawals are in million s of gallons per day. Figures are rounded.)

STATE	Population in thousands	Ground Water Use			Surface Water Use			TOTAL WATER USE		
		Fresh	Saline	Total	Fresh	Saline	Total	Fresh	Saline	Total
Kentucky	3,860	226	0	226	4,190	0	4,190	4,420	0	4,420
Indiana	5,800	709	0	709	8,430	0	8,430	9,140	0	9,140
Illinois	11,800	928	25	953	19,000	0	19,000	19,900	25	19,925
Ohio	11,200	905	0	905	9,620	0	9,620	10,500	0	10,500
Tennessee	5,260	435	0	435	9,640	0	9,460	10,100	0	10,100
Missouri	5,320	891	0	891	6,140	0	6,140	7.030	0	7,030
West Virginia	1,830	146	.5	146	4,470	0	4,470	4,620	.5	4,620
Florida	14,200	4,340	4.6	4,340	2,880	11,000	13,800	7,210	11,000	18,200
California	32,100	14,500	185	14,700	21,800	9,450	31,300	36,300	9,640	45,900
Texas	18,700	8,370	411	8,780	16,000	4,800	20,800	24,300	5,280	29,600
New York	18,100	1,010	1.5	1,010	9,270	6,500	15,800	10,300	6,500	16,800
Alaska	604	58	75	132	154	43	196	211	117	329
Hawaii	1,190	515	16	531	497	906	1,400	1,010	922	1,930
Maine	1,240	80	0	80	141	105	246	221	105	326

On another sheet of paper, answer these questions about all 14 states included in this table.

1. What would the estimated water usage be for one week? For one year?

2. Rank the states from least amount of water consumption to greatest amount.

3. If estimated water usage increases 2% each year, calculate the estimated total water usage for each state for the year 2000.

BONUS: Research and write a short paper describing why Hawaii's water consumption is higher than Maine's even though Hawaii has a very large amount of rainfall each year.

Just How Much Water Are We Talking About?

Answers for Student Activity Sheet 2

1. Estimated Water Usage Measured in Million Gallons (mg)

	One Week	One Year
Kentucky	**2940 mg/week**	**152,880 mg/year**
Indiana	**63,980 mg/week**	**3,326,960 mg/year**
Illinois	**139,475 mg/week**	**7,252,700 mg/year**
Ohio	**73,500 mg/week**	**3,822,000 mg/year**
Tennessee	**70,700 mg/week**	**3,676,400 mg/year**
Missouri	**49,210 mg/week**	**2,558,920 mg/year**
West Virginia	**32,340 mg/week**	**1,681,680 mg/year**
Florida	**127,400 mg/week**	**6,624,800 mg/year**
California	**321,300 mg/week**	**16,707,600 mg/year**
Texas	**207,200 mg/week**	**10,774,400 mg/year**
New York	**117,600 mg/week**	**6,115,200 mg/year**
Alaska	**2,303 mg/week**	**119,756 mg/year**
Hawaii	**13510 mg/week**	**702,520 mg/year**
Maine	**2,282 mg/week**	**118,664 mg/year**

2. Maine, Alaska, Hawaii, Kentucky, West Virginia, Missouri, Indiana, Tennessee, Ohio, New York, Florida, Illinois, Texas, California

3. Estimated Water Usage for the Year 2000 (adding on 20%)

Kentucky	**5304 mg/day**
Indiana	**10,968 mg/day**
Illinois	**23,910 mg/day**
Ohio	**12,600 mg/day**
Tennessee	**12,120 mg/day**
Missouri	**8,436 mg/day**
West Virginia	**5,544 mg/day**
Florida	**21,840 mg/day**
California	**55,080 mg/day**
Texas	**35,520 mg/day**
New York	**20,160 mg/day**
Alaska	**394.8 mg/day**
Hawaii	**2,316 mg/day**
Maine	**391.2 mg/day**

Kentucky's Commonwealth of Water – Be an Informed Water Citizen
Middle School

Race You to the Top of the Hill!

Standards

Math: MA-M-2.2.3, Students will develop and apply proportionality and relationships between scale models and actual figures.
Social Studies: SS-M-4.1.1, Students will understand that maps, globes, photographs, models, and satellite images are representations of Earth with different characteristics and uses.

Activity Description

Students will learn about reading and drawing topographic maps and watersheds by traveling outside their school and mapping their local micro-watershed.

Materials

- Topographic maps of local community (1 for each group of 4 students)
- Clipboards, paper and pencils for each student
- Computer use for web site research on watersheds
- Enviroscape Groundwater Model (optional)

Length of Lesson

1 – 2 class periods

Vocabulary Words

Nonpoint source pollution: Pollution that cannot be traced to a single point (e.g. outlet or pipe) because it comes from many individual sources or a widespread area (typically urban, rural, and agricultural runoff).
Point Source Pollution: pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial, wastewater treatment plant, and certain storm water discharges).
Topographic map—a map that depicts an aerial view of land by using contour lines to show the elevation of land areas, or by using satellite photos and different colors to show the different elevations.
Watershed: an area of land that all drains to a single location
Micro-watershed: —the small, immediate area of water drainage

Essential Question

How can we learn to protect our water?

Guiding Questions

- Why are topographic maps important?
- What is a micro-watershed?
- How can I find and draw my micro-watershed?

Skills Used

Map	Apply	Describe	Explore	Create
Sketch	Identify	Observe	Visualize	Discuss

Race You to the Top of the Hill!, *continued*

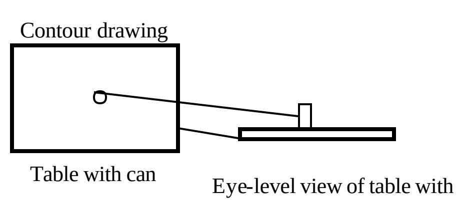
Activity

Step 1: Tell students that we want to show someone where rain goes when it falls on the school grounds. Tell them this person does not speak English so words cannot be used. Brainstorm how you could "show" this idea. Give students drawing materials and time to draw their own pictures and maps. As questions arise, record them on question strips.

Step 2: Explain to students that cartographers (map makers) have devised a way for "showing" where water flows. Students will be learning how to draw and read these "topographic" maps. This will help them better understand how water flows in their community.

Step 3: Distribute topographic maps of the local community to each small group. (Go to www.kygs.uky.edu to get topographic maps) Explain to students how a topographic map is read by referring to the map key. Work with the topographic maps for a few minutes until students appear to grasp the concept of "looking down from above" to visually understand the lay of the land. (Lay maps aside until later.)

Step 4: Tell students that they are going to draw their first topographic map — their table or desk. Remind students that they need to sketch their map to make it appear as if it is a "bird's eye view". (For students who are not strong visual learners, this task may be very difficult. It might even help to break it down into smaller steps and start by sketching just a contour map of a soft drink can sitting on a table, which would just have two different elevations.)



Step 5: After students complete the contour map of their table or desk, have them draw a map of the room, showing all of the furniture as if they can see it from the ceiling, looking down. Remind students that they need to scale all the objects down in size so they appear to be relatively the right size and distance from each other.

Step 6: Once students appear to be grasping the concept of making contour drawings, explain that they are going to be learning about watersheds, and by the end of this activity, working in groups, they will have produced a topographic map of a micro-watershed located on the school property. At this point, explain to students that a watershed is, generally speaking, a piece of land in which runoff drains toward a body of water. Watersheds come in different sizes, from a micro-watershed, which might be located in a front yard, to a large regional watershed, like the Mississippi River Basin.

Step 7: Demonstrate how water flows to lower ground levels and eventually into the closest waterways (or groundwater system) with an Enviroscape ground water model. These models are located across the state and can be borrowed free of charge. Check the teacher fact sheets for one near you. Explain to students that watershed boundaries are created depending on the flow of water from the crest, or highest area in a region. Topographic maps are important in water study because they show the highest and lowest points in a watershed.

If not using the Enviroscape model, ask students what they think happens to water when it precipitates in their area. (Students should understand that gravity forces water to flow downward to lower geographical points. Remind students of vocabulary covered in "Water You Supposed to Be?" lesson on the hydrologic cycle.)

Step 8: Tell students that they will be drawing a contour map of a micro-watershed on the school property so they can see how the water flows on school grounds. Prepare to go outside by gathering clipboards, paper, pencils and topographic maps.

Step 9: If some students are still having trouble understanding how to sketch contour maps, team them up with students who seem to have grasped the concept before journeying outside.

Step 10: Instruct students to locate some of the highest elevations on the school property that are easily accessible using the topographic map. Remind students that there are many micro-watersheds in any given area. Take students to the crest of a small hill, if one is available, and explain that when it rains, sleets, snows, or hails, the water eventually runs off down that small hill toward storm drains, or a body of water (anything from a puddle to a lake or river). Explain that the micro-watershed will fan out in all directions from the crest of the hill to the lowest point below.

Figure A

Figure B

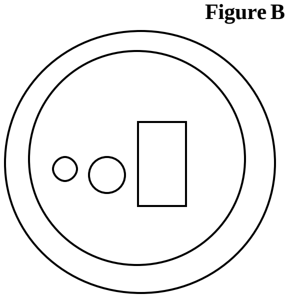
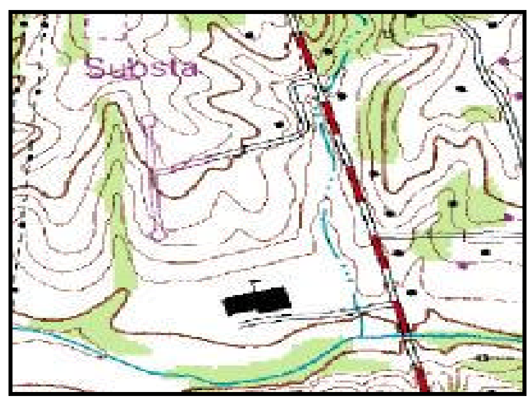


Figure C

Step 11: Once students have visually located a micro-watershed, have them sketch it from an eye-level view. Tell students to keep the sketch very simple. (See Figure A.) Then have them try to visualize the same area in a tall tree looking down on it. (See Figure B.) Finally, have students sketch the same area around the hill as if they are in the sky looking straight down on it. (See Figure C.)

> **<u>Technology Extension</u>: If you have access to a GPS unit, allow students to "exactly" locate the highest point in the watershed.**

Step 12: Students should study the lay of the land and try to show the slope of the hillside in their contour sketch of their small area, similar to those seen on the contour map shown below that was downloaded from:. **<u>http://terraserver.homeadvisor.msn.com/default.aspx.</u>**



Step 13: Applaud student attempts at drawing contour maps, since it is a whole new way at looking at the world. It will add new insight into learning about watersheds, though, once they work through this process. Display the completed maps.

> **The following web site may be useful for students who need more instruction on how to draw contour maps: <u>http://academic.brooklyn.cuny.edu/geology/leveson/core/linksa/elevation.html</u>**

Follow the Flow

Adapted from *Where is the Watershed*, **Enviroscape Activities,** Grades 6-8, pages 1-2

Standards

Social Studies: SS-M-4.1.1, Students will understand that maps, globes, photographs, models, and satellite images are representations of Earth with different characteristics and uses.
Social Studies: SS-M-4.2.1, Students will understand that places can be made distinctive by human activities that alter physical features.

Activity Description

Students will use maps to identify their local watershed areas and watershed areas for 3 of Kentucky's major rivers. Students will also use mathematical skills to recreate a scale map of their watershed area.

Materials

- Maps of Kentucky and community (1 for each group of 4 students)
- Maps of local watershed (can be downloaded from Internet)
- Poster board, markers, pencils, tape measures
- Computer use for web site research on watersheds
- Enviroscape Groundwater Model (optional)

Length of Lesson

2-3 class periods

Vocabulary Words

Nonpoint source pollution: pollution that cannot be traced to a single point (e.g. outlet or pipe) because it comes from many individual sources or a widespread area (typically urban, rural, and agricultural runoff).
Point Source Pollution: pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial, wastewater treatment plant, and certain storm water discharges).
Watershed: an area of land that all drains to a single location

Essential Question

How can we learn to protect our water?

Guiding Questions

- Where is my watershed located?
- Why is it important to learn about watersheds?

Skills Used

Analyze	Apply	Visualize	Map
Identify	Observe	Research	Organize

Follow the Flow, *continued*

Activity

Step 1: Obtain maps of your community and of Kentucky that show natural features in detail. Contact your local conservation district or the Kentucky Division of Water for assistance in locating such maps. Go to http://www.keec.ky.gov for contact information in your county.

Step 2: Ask students what they think happens to water when it precipitates in their area. Students should now understand that gravity forces water to flow downward to lower geographic points. Remind students of the vocabulary covered in the "Water You Supposed to Be?" lesson on the hydrologic cycle as well as the lesson on topographic maps.

Step 3: Divide the class into small groups and distribute the maps to each group. Discuss the map and the scale represented by the key with students. Have each group sketch a scaled drawing of Kentucky on poster board with pencils. Once the scaled map has been sketched, have them locate their community on the Kentucky map and mark it on their scaled drawing.

Step 4: Focusing back, once again, on their local community, Have students carefully study the Kentucky state map and look at the smaller waterways that are flowing into the larger river closest to their school. At this point, remind students what a watershed is. Watersheds come in different sizes, from a micro-watershed, which might be located in a front yard, to a large regional watershed such as the Mississippi river Basin. Explain to students that they will doing research to locate the boundaries of their local watershed.

Step 5: Have students go to the state watershed watch website (listed below) to help them define a watershed area and locate general information on Kentucky's waterways and 13 major watershed regions. There is also information at this site on how students can become involved in protecting their own watershed.

Http://water.nr.state.ky.us/watch

Follow the links to local watersheds for abundant information and detailed, colored maps. **(Samples of downloaded images and information on how to download images from the Internet are found at the end of this activity.)**

Step 6: After learning about Kentucky's 13 major watershed areas, instruct students to research their own watersheds by visiting the following website.

http:www.epa.gov/surf/locate/map2.cfm

Step 7: Once students have located their own watershed maps and printed them out, have them transfer that information to their group maps. Remind students that the watershed is the area around the river, not the river itself.

Follow the Flow, *continued*

Step 8: The scaled maps created by each group should show the state of Kentucky, the major river that is located in their watershed area, major towns, cities or marked developments that are within 50 miles of the river, and the shaded-in immediate watershed area. Remind students to keep their maps to scale and as accurate as possible. **Show students a copy of the rubric located on the last page of this activity so they will be aware of how this project will be graded.**

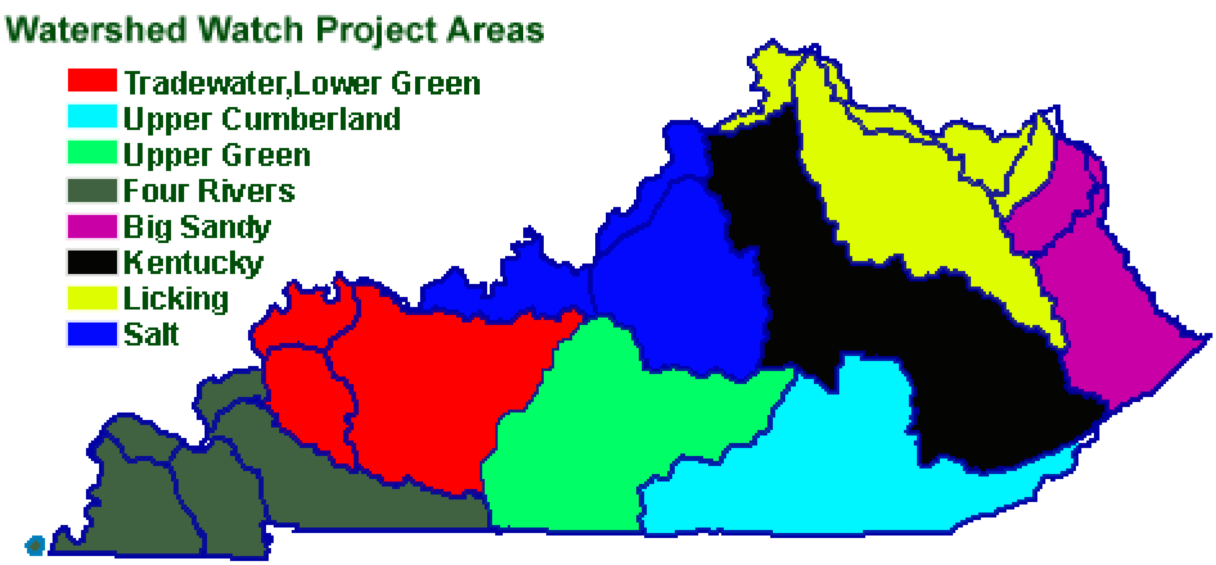
Step 9: Have students display digital images of completed maps on the class or school web site. They may also wish to take digital pictures of places in the watershed and display those as well. Maps and pictures may also be displayed in a prominent place at school, along with information learned about watersheds during this activity.

Portfolio Suggestion: Ask students to write a travel diary from the viewpoint of a drop of rain from the time it falls on the highest point in the school's watershed until it reaches the ocean.

Extensions / Variations

1. For more detailed watershed maps, have student groups identify the locations) where water comes from, where wastewater goes, whether surface runoff goes into storm drains, and where the drains empty. This information may be obtained from the local water utility, or researched by talking to people in the community.
2. Contact local elementary schools and make arrangements for students to visit intermediate classrooms to share their watershed maps and information with younger students.

Q&A: This activity connects students' local surroundings with what they have been learning. This should raise questions in their minds. Be sure and allow time for them to record both question strips and answer drops before moving to the next activity.



Map downloaded from **http://water.nr.state.ky.us/dow/dwover.htm**

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Middle

Follow the Flow, *continued*

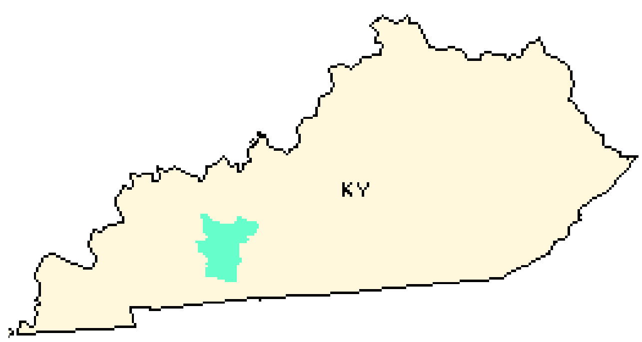
Samples of watershed maps downloaded from http://www.epa.gov/surf/locate/map2.cfm

Directions on how to download images:
1. Point mouse icon at the edge of image to download.
2. Right-click the image.
3. Highlight "save picture as" and the "save" box appears.
4. Give image a name and click "save".
5. The image will be saved in a "My Pictures" folder in C-drive.

Directions to import graphics into a Word document:
1. Click "Insert" on Tool Bar
2. Highlight "Picture" then "Clip Art"
3. Once clip art images appear, click "Import clips" and open the "My Pictures" folder in C-drive to locate the image.
4. Once the image is located, click onto it to highlight it, and click "Open" to place the image in clip art collection, then click "Insert".
5. Once image is inserted into Word document, the size of the image can be adjusted by clicking onto the image and dragging the corner of the image to the desired size.
5. Remember to credit the source from which the image was obtained.

Watersheds in Kentucky

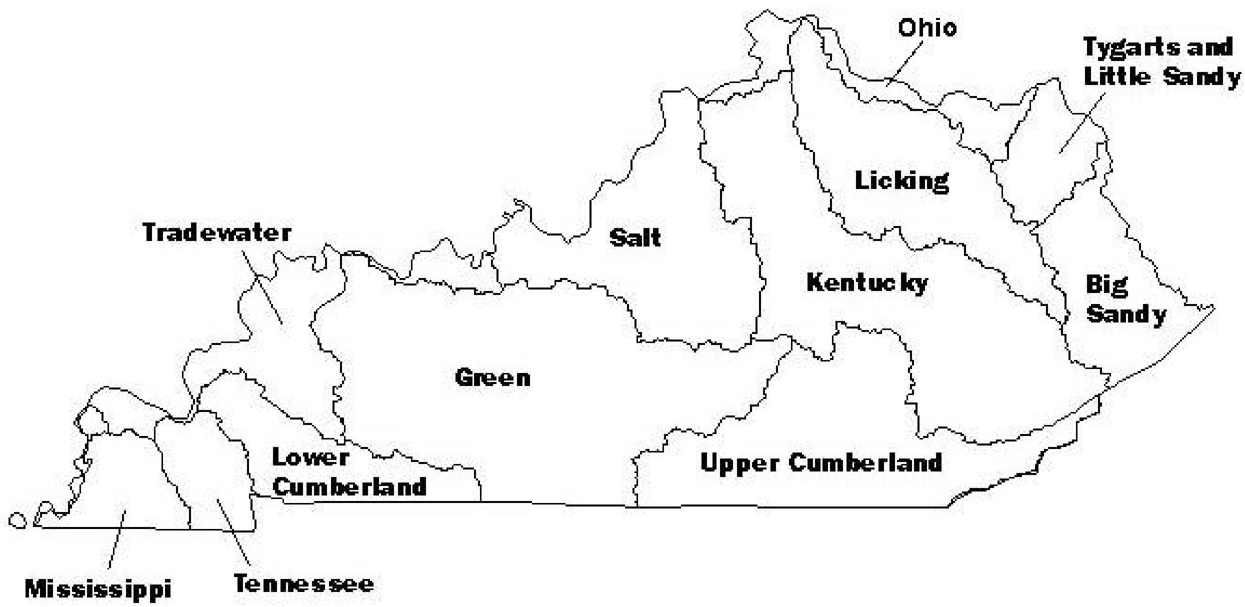
Middle Green Watershed



Close-up of Middle Green Watershed

Kentucky's 13 Major Watersheds

The Minor Ohio River Tributaries area follows the northern boarder of Kentucky, but is not shown on this map. The Tygart's and Little Sandy river basins are combined.



Map downloaded from **http://water.nr.state.ky.us/dow/dwover.htm**

Follow the Flow Map Making Rubric

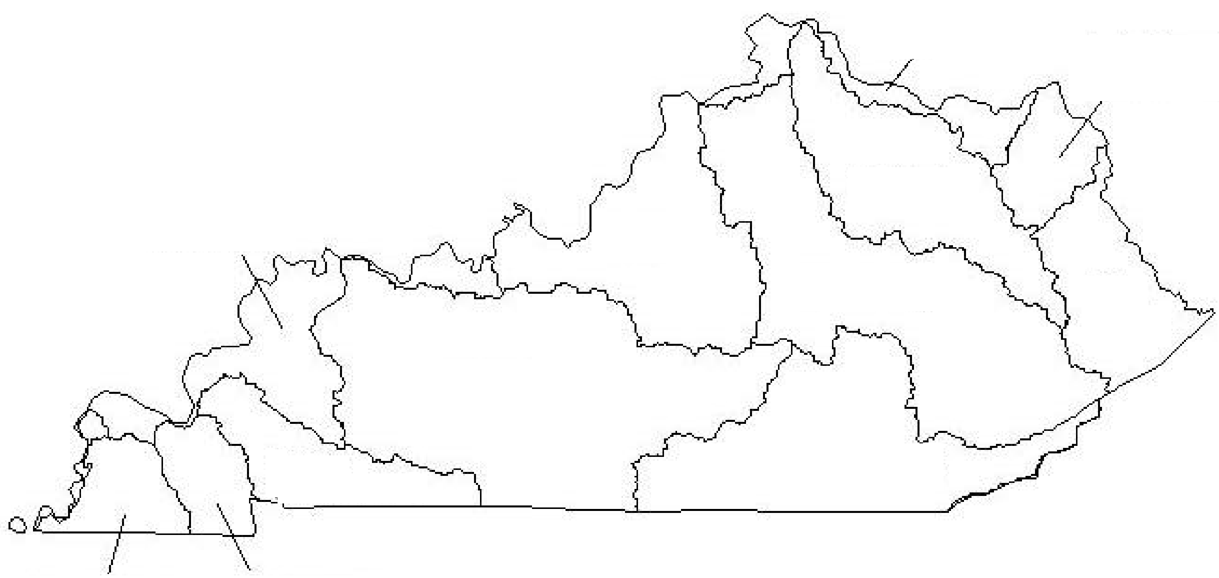
CATEGORY AND SCORE	4	3	2	1
Labels — Accuracy	At least 90% of the items are labeled and located correctly.	80 – 89% of the items are labeled and located correctly.	70 – 79% of the items are labeled and located correctly	Less than 70% of the items are labeled and located correctly.
Scale	All features on map are drawn to scale and the scale used is clearly indicated on the map.	Most features on map are drawn to scale and the scale used is clearly indicated on the map.	Many features on the map are NOT drawn to scale even though a scale is clearly indicated on the map.	Many features of the map are NOT drawn to scale AND/OR there is no scale marker on the map.
Knowledge Gained	When shown a blank base map, the student can rapidly and accurately label at least 90% of Kentucky's major watersheds.	When shown a blank base map, the student can rapidly and accurately label 80% of Kentucky's major watersheds.	When shown a blank base map, the student can rapidly and accurately label 70% of Kentucky's major watersheds.	When shown a blank base map, the student can label fewer than 70% of Kentucky's major watersheds accurately

Follow the Flow Activity Assessment

Name__________________ **Date**_____________ **Class**_____________

1. Reflecting on information learned from completing a scaled drawing of the local watershed, write at least five things you have learned about watersheds.

2. Label this blank watershed map of Kentucky by writing in the major river basins.



Adapted from a map downloaded from **http://water.nr.state.ky.us/dow/dwover.htm**

Kentucky’s Commonwealth of Water – Be an Informed Water Citizen
Middle School

Let’s Make a Watershed Model

Adapted from “Making a Watershed Model“, *Instructional Models For Use With Enviroscapes,* Grades 6-8, pages 1-2

Standards

Science: SC-M-2.1.5, Students will understand that water, which covers the majority of Earth’s surface, circulates through the crust, oceans, and atmosphere in what is known as the water cycle. Water dissolves minerals and gases and may carry them to the oceans.

(These two standards are introduced in this lesson.)
Math: MA-M-2.2.3, Students will develop and apply proportionality and relationships between scale models and actual figures.
Social Studies: SS-M-4.2.1, Students will understand that places can be made distinctive by human activities that alter physical features.

Activity Description

Students will create mini-watershed models that show examples of point and non-point water pollution sources and natural filters in a community. Students will also identify the interrelationships between a community and it’s watershed. **Note: You may use an Enviroscape watershed model in place of this activity. (See teacher fact sheets for where you can borrow one near you.)**

Materials

- An aluminum tray or cookie sheet
- Small plastic containers of various shapes and sizes.
- Modeling clay for creating contours on the model
- Materials to build and represent different natural and man-made areas in a community such as an industrial area, a residential area, a recreational area, agricultural areas, and a landfill. Materials could include: sponge bits, soil, pebbles, dried grasses, twigs, balloons (pond and landfill liners), toothpicks, plastic wrap, aluminum foil (pipes and drainage areas), household non-toxic materials such as powdered drink mixes, cocoa powder, pancake syrup, flour, sugar, etc.
- Water and spray bottle.

Length of Lesson

Allow one class period to build models and one period to demonstrate

Vocabulary Words

Nonpoint source pollution: pollution that cannot be traced to a single point (e.g. outlet or pipe) because it comes from many individual sources or a widespread area (typically urban, rural, and agricultural runoff).
Point Source Pollution: pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial, wastewater treatment plant, and certain storm water discharges).
Best Management Practices (BMPs): effective ways to prevent or stop pollution.

Essential Question

How can we learn to protect our water?

Guiding Questions

- What are some of the causes of water pollution?
- What natural and man made filters help clean water?

Skills Used

Analyze Hypothesize Describe Evaluate

Let's Make a Watershed Model, *continued*

Activity 1

Note: You may borrow and demonstrate an Enviroscape Model in place of this activity. See teacher fact sheets for one near you.

Q&A: Make sure students have access to question strips and answer drops. Check the question board to make sure students continue to post questions on the board.

Step 1: A few days before beginning this activity, explain to students that they are going to build models of their watershed. Let students know what types of materials are suggested for use when constructing the models. Ask students to look around at home for these materials, as well as other things they think might be useful when building the watershed models. (Check instruction sheet at the end of this activity for a detailed description of how to make and demonstrate a watershed. Share this with students.)

Step 2: Prior to beginning this activity, refer to **Teacher Fact Sheets** for detailed information on watersheds and a list of places that have Enviroscape models available to loan. If an Enviroscape model is available for class use, show students how the model looks, and demonstrate how it works. This should help students have a better understanding of what is expected of them as they build their watershed model. Gather materials needed to build the student watershed models.

Step 2: Remind students of the importance of the hydrologic cycle to life on earth. Explain that as water precipitates back to the earth's surface, any materials spilled or placed on the ground's surface will eventually become part of the surface water system through runoff, or ground water system, through infiltration. Explain that human activities such as landfill use, the use of chemicals in and around the home, industrial waste disposal, farming, etc. affect the quality of both the surface and ground water everywhere. Ask students if they can explain why this is so. (Remind students that water is known as the universal solvent, and mixes easily with other substances.)

Step 3: Explain to students that during this activity they will be working in small groups to build a model of their local watershed. Tell students that their community models will each need to include a water source (stream, pond, river, . . .) and at least 3 of the following areas: residential, industrial, recreational, agricultural, forests, transportation or landfills. **Also explain that each group of students should try to make the model as realistic as possible, since the models will be used to demonstrate point and nonpoint source pollution. (Explain these definitions, if the concepts have not yet been taught.)**

Step 4: Let students know what types of materials are available for them to use. Tell students that modeling clay needs to be used to build contours, terraces, rivers, or any downhill slope where water might be running on their models.

Step 5: Allow time in class for students to complete watershed models. Remind students that they can refer to their watershed maps while constructing the models (if the lesson " Follow the Flow" has been taught.)

Step 6: Explain to students that part of the assessment on this activity will include a demonstration of each watershed model. During the demonstration, explain that each group must be prepared to identify possible types of pollutants produced in each area on their model. For example: septic tank leakage; fertilizers, herbicides and pesticides from lawns , etc.; sediment from clear-cut areas and construction zones; oil and gas from parking areas or roadways. Ask students if they can explain what causes runoff water. What causes water to infiltrate, or soak into the ground? Show students different types of powders available for them to use on their models to show the pollutants.

Let's Make a Watershed Model, *contin-*

Day 2, Activity 1

Step 1: After the models have been completed, take 3 digital photos of each model; the first one before the demonstration begins, the second one after the pollutants have been sprinkled on the model, and the third one after the water has been sprayed on the model to simulate runoff. (This is optional, but it will be useful in Activity 2.)

Step 2: Gather students around one of the groups prepared to demonstrate how their model works. Encourage each group to be very dramatic and offer thorough explanations as to what is happening when they sprinkle the appropriate pollutants in each area of their watershed model (e.g., cocoa powder for sediment, pancake syrup for manure from farm animals, drink powder or tempura for pesticides, . . .).

Step 3: Once the pollutants have been sprinkled on the model, give the group a spray bottle filled with clean water to spray on the model until run-off occurs. Students in the group should identify the source of the pollution and explain whether it is point or nonpoint source pollution. Encourage students in each group to explain what is happening to the surrounding water sources as a result of the runoff water. Ask students if it they think it would be cheaper and easier to clean up the water after it is dirty, or keep it from getting dirty in the first place.

Step 4: As each group gets through demonstrating their watershed model, drain the dirty water off the model, squirt the model with clean water and dry it with paper towels. The models will be used in the following activity on pollution prevention. **(See Extension for ideas on what to do with dirty water.)**

Activity 2

Step 1: As a large group, brainstorm ways to prevent water pollution. As students come up with ideas, hand them something with which to build their **Best Management Practices** (BMPs or pollution control) such as a piece of clay, sponge, bean sprouts (for roots of trees and plants), etc. Allow time for students to build their BMPs onto the group model.

Step 2: If students have trouble coming up with suggestions for BMPs, offer some of the following ideas that might spur them to think in more divergent ways:

- Golf course – Use less fertilizer, plant a filter strip (sponge or porous shelf liner) at bottom of hill.
- Farm field – Build terraces of clay (parallel ridges) across the hill (not up and down).
- Cars and roads – Put sand or felt filter to catch oil.
- Bare spots on landscape – Cover with grass or trees (felt or sponges).
- Factory – Build a little dam of clay to hold the effluent (waste disposal), pretend to treat it.
- Farm animals – Build a lagoon (pond or pit) to put manure in.
- Anywhere – Pick up trash.
- Use sanitary landfills, that are lined to prevent seepage, instead of sink holes or illegal dumpsites.
- Lawns-use only as much fertilizer, etc. as absolutely needed.

Let's Make a Watershed Model, *contin-*

NOTE: If time is a factor at this point, teacher may decide to do this step in small groups at the same time, instead of having a large group of students observe as the small groups take turns assessing the value of their BMPs.

Step 3: After BMP's have been added to the models, reapply the pollution to each spot. Try to make sure the pollution is inside or up-slope of the BMP. For example, if terraces are built on the farm field, try to sprinkle cocoa on the flatter spots between the terrace ridges, not on the terrace ridges themselves. If a lagoon is built for the animal waste, put the waste within the lagoon walls.

Step 4: Once again, have a group member squirt the model until the runoff reaches the body of water. Some pollutants will probably get into the lake; hopefully, it will be less than the first time when there were no BMPs in place. Discuss how BMPs do not stop pollution completely, but they do lessen the amount of pollution.

Step 5: Conclude this activity by having students analyze the ways they think pollution may be getting into the water in the school's watershed. Have them create a Best Management Practice Plan for helping to prevent the pollution. Students can then present the plan to the School Council as a Power Point presentation and/or by demonstrating one of their watershed models.

Assessment for these activities may take the form of group cooperation during the different activities, the finished product (the watershed model), the presentations, the Best Management Practices that were applied to help control pollution, and the final journal reflection. A rubric to assess oral presentations has been included to help with the scoring of the group presentations.

Extension

1. Assign groups of students to design brochures that highlight one area of watershed/ groundwater protection for their community (proper oil disposal; solid waste disposal; homeowners' use of chemicals, pesticides, or fertilizers on lawns.) These brochures can be handed out to appropriate community leaders or community groups for distribution.

2. Collect the dirty water that was left over after each demonstration. Ask students for suggestions on what to do with the dirty water. (Refer to the activity in the primary water unit called "Filtering Away Pollutants" for a similar activity.)

Controlling & Preventing Pollution

There are 3 basic methods of pollution control or prevention.

1. Structural Controls – where you build something to prevent or treat pollution.

2. Vegetative Controls – where you plant something to treat pollution.

3. Management Controls – where you do something differently to prevent pollution.

When they are used to control nonpoint source pollution, these methods are called BEST MANAGEMENT PRACTICES OR BMPS.

How to Construct and Demonstrate a Watershed Model

Step One: Gather the materials you will be using to construct and demonstrate the model. These include the following.

An aluminum cookie sheet or other nonpermeable base for the watershed model.

Plastic, paper or Styrofoam containers — used as "bases" to add height to various areas of the watershed. For example, a butter container might be the base of a large hill, while one section of an egg carton might be a small hill.

Balloons or other small pieces of flexible rubber or plastic: Used as the "bed" of streams or ponds. These materials should actually be able to hold and/or channel water.

Clay, or other moldable material for covering the "bases" so that the model both looks realistic and will actually allow water to flow across it. (Note: Paper mache and salt and flour clay may work on these models if they are only to be used for demonstration once or twice. However, since both are water soluble, they will disintegrate easily.)

Materials to make features on the clay base of the watershed. Materials could include: sponge bits, soil, pebbles, dried grasses, twigs, balloons (pond and landfill liners), toothpicks, plastic wrap, aluminum foil (pipes and drainage areas), model houses, tractors, farm animals, cars, etc.

Materials to simulate substances that get into the water from throughout the watershed. These can include the following (and what they represent): powdered tempera paint or powdered drink mixes in the following colors, green (to simulate fertilizer), red (to simulate pesticides and herbicides), brown (to simulate sediment and mud), pancake syrup (to simulate sewer and manure sludge), cooking oil to simulate oil on roads and parking lots.

Materials to simulate BMP's (Best Management Practices): These can include small pieces of green felt, sponges, absorbent shelf paper, or even alfalfa/bean sprouts to simulate areas of plant cover. Clay to construct barriers, levees or holding areas.

Step Two: Constructing the Watershed Model

Plan: Decide as a group how your watershed will look (e.g. high points, low points, number, type and size of water features, etc.). Decide what features your watershed will have and where they will be (e.g. housing development, construction sites, roads, farms, etc) List these features on paper and draw (or map) them as well.

Build: Construct your watershed to match your plan. Use the clay or other modeling material to cover the base of the watershed model and connect all the areas together. When the clay has been molded to the model, it should look like a watershed would look if there were no trees, grasses, building, etc. Don't forget that the lowest point in your watershed should be a river, stream or other body of water.

How to Construct and Demonstrate a Watershed Model (cont.)

Step Three: Demonstrating Water Pollution on Your Model

Think: Decide as a group, what kinds of pollution might flow from the various features on your model (e.g. sediment from plowed fields and construction sites, fertilizers from lawns, oil from roads and parking lots) .

Pollute! Simulate pollution on your watershed model by putting the tempura paint, syrup, oil etc. on the appropriate features. Talk about the difference between point and nonpoint source pollution.

Precipitate: Using the water bottle, make it "rain" on your model. As the various kinds of pollution dissolve in water, watch where they go? What is happening to your watershed?!?

Remediate: Clean the model. Then, using sponges, felt, clay, etc. , create BMP's (Best Management Practices) to prevent the pollution from getting into your water. In the real world such features wood include grassy areas, trees, wetlands, terraces, holding ponds etc.

Pollute: Using the same amounts and patterns as before, place "pollutants" on your model again.

Precipitate: Using the water bottle, make it rain again in approximately the same places and amounts as before. Do your BMP's help prevent the pollution from getting into the water?

Discuss: Think about your school's watershed. Are there ways pollution might be getting into the water from your watershed?

Extension

Have students act out the play in the activity, "Who Dirties the Water?" from the High School Unit. This will help students see that water pollution is caused by all of us and it will take all of us to stop it!

Oral Presentation Rubric

Student Name ______________________ **Date** ________________________

Teacher Name ______________________ **Class** ________________________

CATEGORY AND SCORE	4	3	2	1
Preparedness	Student (group) is completely prepared and has obviously rehearsed.	Student (group) seems prepared, but might have needed a couple more rehearsals.	Student (group) is somewhat prepared, but it is clear that rehearsal was lacking.	Student (group) does not seem at all prepared to present.
Collaboration with Peers	Almost always listens to, shares with, and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with, and supports the efforts of others in the group. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others in the group, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others in the group. Often is not a good team member.
Comprehension	Student (group) is able to accurately address almost all questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.	Student (group) is able to accurately address most questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.	Student (group) is able to accurately address a few questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.	Student (group) is unable to accurately address questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.

__________**Total Score** **Comments:**

Kentucky's Commonwealth of Water – Be an Informed Water Citizen
Middle School

Whose Side Are You On?

Adapted from *Continuing Adventures of Truffula*, in Project Learning Tree, Secondary Guide, p. 165

Standards

Arts and Humanities: AH-M-3.1.45, Students will assume roles that communicate aspects of a character and contribute to the action based on experience, imagination, or characters in literature, history, or script.
Social Studies: SS-M-4.4.4, Students will understand that individual perspectives impact the use of natural resources (e.g. watering lawns, planting gardens, recycling paper).

Activity Description

Students will be introduced to the critical thinking process of "Issue Analysis" as they role play to answer the question, "Which group should be given custody of the last Truffula Tree seed?"

Materials

- Copies of the role cards found on page 190-191
- 3 copies of Issue Analysis Small Group Activity Sheets (included)
- "The Lorax", by Dr. Seuss, video or book

Length of Lesson

60 – 90 minutes to view video and prepare follow-up activity

Vocabulary Words

Issue Analysis—a critical thinking process of examining and evaluating alternative resolutions to perceived problems.
Current Issue—something that is viewed as a potential problem.
Values—principles, such as honesty and compassion, that are considered the basis of attitudes and behaviors.

Essential Question

How can we learn to protect our water?

Guiding Question

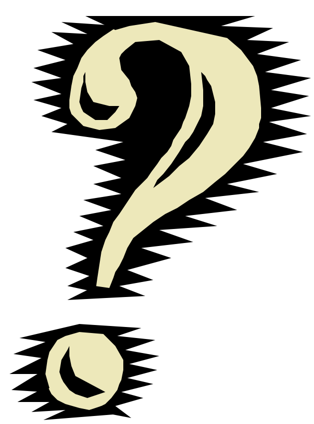
What is Issue Analysis and how can we use it to study current issues?

Skills Used

Analyze	Apply	Communicate	Describe
Discuss	Identify	Listen	Observe
Role play	Critique	Act	Interpret

To whom it may concern:
Re: The future of the Truffula seed

On the Street of the Lifted Lorax there arose a great need,
Just who could take care of the last Truffula seed?
The Once-ler had passed it, to a boy of just eight.
But, oh dear — oh my — he'll just have to wait!
You see it's quite simple as everyone knows,
Legal decisions must wait till he grows.
But you can help out — you're needed! Yes, you!!
Help him! Oh, help him decide what to do.
Sincerely,
The Lorax



Whose Side Are You On?, *continued*

Activity

Step 1: Prior to showing the video (or book, if the video is not available) explain to students that they will be working through a critical thinking activity known as "Issue Analysis". Explain that in an issue analysis activity, certain requirements must be met in order to better understand different sides of an existing problem. Encourage students to pay close attention to each character in the video, and try to look at what is happening from different points of view. Explain that students will be assigned to role play different positions at the end of the video. Show the video.

Step 2: As an entire class, discuss what the real issue is at the end of the video (Who should be given the final Truffula seed?)

Step 3: Either assign students to groups (Advisory Board, Neighbors, Animals, Employees) to role play the issue, or just make enough copies of the role cards (located at the end of this activity) that students will be able to draw a card that will let them know which group they will be assigned to role play.

Step 4: Before splitting into groups, read the following memo to students:

Dear Middle School Students,

The Once-ler has given the last Truffula Seed to a boy of just eight. He is too young to make a decision about what to do with the seed. I need your help to decide who should keep the last Truffula seed. It is not an easy decision but I know you can do it. Thank you for your help.

Sincerely,

The Lorax

Step 5: Give students approximately 10 – 15 minutes within their groups to fill out the Issue Analysis position paper that is found on the next page, select a spokesperson for their group, and prepare a 3 minute position statement. (The Advisory Board can spend this time reviewing all of the "facts" in the case, or walking quietly from group to group to see the process each group is using to prepare statements.)

Step 6: The Advisory Board will listen to each group testify for 3 minutes. (Appoint a timekeeper.) The board members have an opportunity to ask questions after each group presentation. After all three groups have spoken, allow time for the three opposing groups to ask each other questions, if desired. The Advisory Board then takes about a 5 minute recess to make a decision. They announce and thoroughly explain their decision to the rest of the group upon their return.

Assessment

Step 1: Assess each student group (animals, neighbors, employees) on the content and effectiveness of their presentation to the Advisory Board. Assess the Advisory Board members on the effectiveness of conducting the hearing and the explanation given for their decision.

Step 2: After the Advisory Board announces their decision, ask students to reflect, honestly, in their class notebook on the entire issue analysis process — the small group process, going before the Advisory Board, and if they felt the final decision was fair. This should give insight as to whether or not students are beginning to understand how to look at different sides of an issue.

Issue Analysis
Small Group Activity

Select a secretary for your group. Each player's name, position, beliefs and values should be recorded. Remember, there are no right and wrong answers. This is what you believe. However, you must support what you believe with facts.

MAIN ISSUE: **Which group should be given custody of the last Truffula Tree seed?**

Players/Positions	**The Beliefs**	**The Values**
What do you want?	What are the facts?	What is your point of view?

Advisory Board Member

It is your responsibility to listen to the evidence presented and, based on the strongest rationale, vote for the group that should have custody of the Truffula seed. While the other groups are developing their rationales, you may want to review the issue analysis worksheet to better understand the different viewpoints. Try to determine if the players positions, beliefs and values are consistent. Choose a chairperson to announce the results after the groups present their positions.

Employee Representative
Brother Once-ler

Based on the needs of the employees, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.

Advisory Board Member

It is your responsibility to listen to the evidence presented and, based on the strongest rationale, vote for the group that should have custody of the Truffula seed. While the other groups are developing their rationales, you may want to review the issue analysis worksheet to better understand the different viewpoints. Try to determine if the players positions, beliefs and values are consistent. Choose a chairperson to announce the results after the groups present their positions.

Employee Representative
Cousin Once-ler

Based on the needs of the employees, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.

Advisory Board Member

It is your responsibility to listen to the evidence presented and, based on the strongest rationale, vote for the group that should have custody of the Truffula seed. While the other groups are developing their rationales, you may want to review the issue analysis worksheet to better understand the different viewpoints. Try to determine if the players positions, beliefs and values are consistent. Choose a chairperson to announce the results after the groups present their positions.

Employee Representative
Auntie Once-ler

Based on the needs of the employees, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.

Neighbor Representative Based on the needs of the neighbors, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.	**Animal Representative** **Bar-ba-loot** ***You frisk around in your Bar-ba-loot suits, in the shade of the Truffula trees, eating Truffula fruits, your sole source of food.*** Based on the needs of the animals, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.
Neighbor Representative Based on the needs of the neighbors, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.	**Animal Representative** **Humming-Fish** ***You hum while you splash about in the clear, clean water under the reflection of the Truffula trees. You are very sensitive to water pollution.*** Based on the needs of the animals, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.
Neighbor Representative Based on the needs of the neighbors, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.	**Animal Representative** **Swomee-Swan** ***Your call is heard as you fly over the tufts of the Truffula trees. You are very sensitive to smog and lose your beautiful voice when you're around it.*** Based on the needs of the animals, what would be your position, beliefs and values? Develop a rationale for why your group would make the best guardian of the Truffula seed. Elect a fearless leader to present your case to the Advisory Board. The presentation should only last for 3 minutes.

Kentucky's Commonwealth of Water: Be an Informed Water Citizen
Middle School

Curiosity Rules!

Standards

S-8-SI-3: Students will use evidence (e.g., computer models), logic, and scientific knowledge to develop scientific explanations.

Activity Description

Students review all questions that have been placed on the board during the unit and match to facts and concepts they have learned. An extension allows students to research questions that have not been answered during the unit.

Materials

Question strips and answer drops used during the entire unit.

Length of Lesson

30-45 minutes over two class periods homework time in between.

Essential Question

How can we learn to protect our water?

Guiding Questions

How can I continue to learn about water and how it affects me?

Skills Used

Questioning   Research   Discussion   Analysis

Curiosity Rules! *Continued*

Step 1: This activity can only be done if, throughout the unit, you have been encouraging students to write any questions they have on "questions strips" and, as a class, you have been putting "answer drops" on the board with each new concept or water fact learned.

Step 2: Begin by reminding students once again that all questions are valid and no questions are silly or irrelevant if they have to do with the topic. Tell students it is important to get into the habit of asking questions both in class and in their minds since this is one of the first steps toward learning.

Step 3: Have students place all the questions strips on one side of the bulletin board—or you may write them on the chalkboard. As a class, put the questions into groups. For example, group all the questions about watersheds, all the questions about water quality and all the questions about water scarcity. Allow students to create the groupings.

Step 4: Do the same with the answer drops. These may or may not fall into the same groupings. Once this is complete, ask students to begin matching answer drops to questions strips. The goal, of course, is to find an answer for each question that has been asked. As this is being done, tell students how proud you are that they have learned so much about water!

Step 5: If students have been encouraged to ask questions and think critically throughout the unit, there will be some questions without answers. Here the activity can go in two directions. First, students can be allowed to conduct research on the unanswered questions and present that research to the class. Alternatively, students can be allowed to research their questions in the next activity, " **Let's Analyze the Issues**" .

Extension

Have each student write five questions for which they would like to have answers. Encourage them to ask "big" questions such as, " How many stars are there?" and "Why is there war?"

When students have completed their questions, tell them that nearly every question they could ask has been asked before and that all knowledge builds on knowledge that came before it.

Ask students to read some of their questions. Then ask how they might find the answers? Some students may need to become scientists themselves to find the answers!

Kentucky’s Commonwealth of Water – Be an Informed Water Citizen
Middle School

Let’s Analyze the Issues!

Standards

Social Studies: SS-M-1.1.2, Students will understand that democratic governments function to preserve and protect the rights (e.g., voting), liberty, and property of their citizens by making, enacting, and enforcing appropriate rules and laws (e.g., constitutions, laws, statutes)
Social Studies: SS-M-4.4.4, Students will understand that individual perspectives impact the use of natural resources (e.g. watering lawns, planting gardens, recycling paper).
Writing-WR-M-1.4, Students will use available and emerging technology to gather, organize, manipulate, and express ideas and information for a variety of authentic purposes.

Activity Description

Students will use steps involved in “Issue Analysis” to identify, research, write about, and present current water resource issues in Kentucky.

Materials

- Class set of Issue Analysis Worksheet and rubrics (included)
- Computers with Internet access for e-mail services, research and word processing program for note taking and final paper production
- Library research resources

Length of Lesson

3-4 class periods to introduce, work on and present research, with extra homework time needed

Vocabulary Words

<u>Issue Analysis</u>—a critical thinking process of examining and evaluating alternative resolutions to perceived problems.
<u>Current Issue</u>—something that is viewed as a potential problem.
<u>Values</u>—principles, such as honesty and compassion, that are considered the basis of attitudes and behaviors.

Essential Question

How can we learn to protect our water?

Guiding Questions

- What is a current water resource issue in our community or state?
- How did the controversy begin?
- Where is the controversy heading?
- Who controls the resources that could resolve the issue?
- What beliefs/values are at conflict with this issue?
- What stand are you going to take on the issue?
- Are you able to support your stand with unbiased evidence?

Skills Used

Analyze	Apply	Communicate	Describe
Discuss	Identify	Collaborate	Interpret
Research	Write	Present	Critique

Let's Analyze the Issues, *continued*

NOTE: This activity can be presented in different ways. It is left to the discretion of the teacher to decide which way will work best for the group of students participating in the activity.

Activity 1: Shorter, Teacher-Directed Method: Designed for students who need more direction, or if there is limited class time for this research project:

Step 1 – Before beginning this activity, collect newspaper and/or magazine articles that talk about water issues in the community or state. Most daily newspapers have online archives that are helpful in finding these articles. Go to www.kentuckyconnect.com to locate these archives.

Step 2: Tell students that this activity will involve them working within a small group to research a local or state water resource issue. Explain that they will be able to use the Internet, interview experts in the field, and use library resources for their research. Also, let students know that the project will involve a written paper, with 5 research sources cited, as well as an oral presentation. (Let students know how the sources are to be cited in their written paper.)

Step 3: Give each student a copy of the Issue Analysis worksheet, "Let's Analyze the Issues!", found at the end of this activity. Go over the nine steps each group will be expected to work through as they research the issue to arrive at a personal decision on whether to support or oppose the issue.

Step 4: Assign students to small working groups of 3 or 4 students and explain that each group will receive an article that talks about a real water resource issue. If there are enough articles, give groups 2 or 3 and let them choose the one they want to research. Explain that the group members will need to read the article, then talk about what they need to do in order to locate information to help them discover the facts about the issue, so they can analyze both sides fairly. Three good sources of online articles and information are www.water.nr.state.ky.us, www.epa.gov/water/ and www.eqc.nr.state.ky.us.

Step 6: Give students time to work through the Issue Analysis process. Provide computers for Internet research, library time for magazine, encyclopedia and newspaper research, and a list of local experts students can contact to help them answer any questions they may have. (Go to http://keec.ky.gov) to find natural resource expertise in, or near, your county.) Remind students to look for reliable sources to cite in their research paper. Set a deadline for the completion of this project. Also, give students a copy of the assessment rubric found at the end of this activity so they are aware of how this activity will be scored.

Step 8: Once student groups begin to finish their research and position papers, have them work on how they plan to present their findings and position to the rest of the class. Encourage students to be creative in their presentations, since this will keep their audience interested and give them a higher score on their presentation (if the attached scoring rubric is used.)

Step 9: Find ways for students to publish their findings from this activity, possibly at local conservation district meetings, state conferences, or through The Kentucky Technology Learning Network.

Let's Analyze the Issues, *continued*

Activity 2: Longer, Independent Research Method. Designed for students who are successful at working independently. This method will require more time for completion.

Step 1: Assign students to small working groups, and explain that they will develop a questionnaire to collect information about water resource issues in the state. Pass out copies of the Issue Analysis worksheet, "Let's Analyze the Issues!", found at the end of this activity, to give students a framework to use when preparing their questionnaire.

Step 2: Once each group has completed the first draft of their questionnaire, bring the class back together as a group to share the different questionnaires and decide on common questions from the different groups that should be included in the final draft.

Step 3: Once the class questionnaire has been revised and edited, supply students with a list of e-mail or postal addresses of experts at the local and state level who might be able to supply them with knowledgeable answers and information about water resource issues. Students may also be given a list of other contacts at schools in other parts of the state to e-mail the questionnaire to so information can be gathered from other communities. Three good sources for online information about issues are www.water.state.ky.us - www.eqc.nr.state.ky.us and www.epa.gov/water/

Step 4: While waiting for replies from the survey, instruct students to use library, media sources and Internet sources to identify and research water resource issues in Kentucky on their own. (If magazine and newspaper articles about water resource issues have been collected since the beginning of this unit, they should be beneficial as resources at this time.)

Step 5: Have students synthesize the information gathered from **Step 3** and **Step 4.** This step should start in small groups, as the material arrives or is collected, and organized according to topics, in folders or boxes.

Step 6: After students have developed a list of current water resource issues, give each small group an opportunity to select an issue to investigate further. Explain that this project will involve writing a research paper, as a group, with at least 5 research sources cited. Expla in that each group will also be responsible for giving an oral presentation before the rest of the class.

Step 7: Each group of students should work through the steps on the Issue Analysis form to arrive at a personal decision on whether to support or oppose the issue. Remind students that they will need to research the issue they select in order to have facts, rather than opinions, to study and help them formulate an educated conclusion. Give students in-class time to work on this process together. Set a deadline for completion of this project. Also, give students a copy of the assessment rubric found at the end of this activity so they are aware of how this activity will be scored.

Step 8: Once student groups begin to finish their research and position papers, have them work on how they plan to present their findings and position to the rest of the class. Encourage students to be creative in their presentations, since this will keep their audience interested and give them a higher score on their presentation (if the attached scoring rubric is used.)

Step 9: Find ways for students to publish their findings from this activity, possibly at local conservation district meetings, state conferences, or through The Kentucky Technology Learning Network.

Let's Analyze the Issues!

Name ____________________ **Date** ______________ **Class** _____________

1. **What is the main issue?**
   State the issue in the form of a question.

2. **Define any specific vocabulary needed to understand this issue.**

3. **Identify all possible positions on this issue. Which <u>two</u> are the key opposing sides?**
   Who is involved?
   Who is affected?
   Who might gain or lose?
   Who controls the resources that could resolve the issue?

4. **Find all of the <u>facts</u> that support one position by researching the issue.**
   What does this group want?
   What will they win or lose?

5. **Find all of the <u>facts</u> that support the opposite position by researching the issue.**
   What does this group want?
   What will they win or lose?

6. **What beliefs/values are in conflict in this issue?**
   What would happen in each instance if the group's idea was utilized?
   What would be the impact to others and the community, now and into the future?

7. **Take a position on the issue. Explain why you chose this position.**
   What is your opinion as to what should be done?
   How will individuals and groups get involved?

8. **How could you influence others to support your position?**
   Make an action plan.

9. **What steps did you use to analyze this issue?**

Information for this worksheet came from the following web sites: http://4h.unl.edu/citizenship/unicameral/issues.htm.
http://www.bcpl.net/~sullivan/modules/comadv/issanalysis.htm.
http://www.mdk12.org/practices/support_success/has/critical_thinking/issue_analysis.html

Issue Analysis Research Project Rubric: Paper

Group Members____

Teacher Name__________________ **Date**________ **Class**_____________

CATEGORY AND SCORE	4	3	2	1
Problem: Issue Statement	The paper states the issue as a question, doesn't suggest solutions or judgment, focuses on a single concept, change is possible.	The paper states the issue as a question, doesn't suggest a solution or judgment, focuses on single concept, change may not be possible.	The paper states the issue as a question, but issue has only some of the required qualities.	The issue is not stated as a question, but a topic. Has few of the required qualities.
Content: Theory and Research	The paper thoroughly explains both sides of the issue. Evidence of in-depth research is clear. There is no irrelevant information.	The paper provides sufficient explanation of the issue. Evidence of adequate research is clear. There is no irrelevant information.	The paper offers insufficient explanation of the problem. There is evidence that some research has be done. Paper contains some irrelevant information.	Content offered by the group in the paper does not explain the issue nor provide basis for analysis of it. Much irrelevant information is included.
Analysis	The paper identifies how each interested party is affected by issue & alternatives; whether & how it affects the community/ state & environment; there is analysis of own group process in doing project.	The paper identifies how each interested party is affected by the issue & alternatives, whether & how it affects the community/ state & environment, but omits their group analysis process.	The paper neglects to identify all those who are affected by the issue, but does include one or two of the other requirements.	This step was skipped or only one of the requirements has been met.
Quality and Number of References	The paper cites 5 or more reliable and varied references (not just Internet sites), properly using the style shown in class as acceptable for citing sources.	The paper cites 3-5 reliable and varied references (not just Internet sites), properly using the style shown in class as acceptable for citing sources.	The paper cites 3-5 reliable sources, but the sources are not varied. The sources may or may not be cited in an acceptable manner.	The paper has fewer than 3 references. Some are from questionable sources. They may or may not be cited in an acceptable manner.
Collaboration with Peers	The group worked well together with all members contributing significant amounts of quality work..	The group generally worked well together with all members contributing some quality work.	The group worked fairly well together with all members contributing some work.	The group often did not work well together and the final paper appeared to be the work of only 1-2 students in the group.

____________**Total Score** **Comments:**

Issue Analysis Research Project Rubric: Oral Presentation

Group Members ____

Teacher Name _________________ **Date** _____________ **Class** _______

CATEGORY AND SCORE	4	3	2	1
Preparedness	The group is completely prepared and has obviously rehearsed. The project is presented in an educational and creative manner.	The group seems fairly well prepared, but might have needed a couple more rehearsals. The presentation is somewhat creative.	The group is somewhat prepared, but it is clear that rehearsal was lacking. The presentation lacks creativity.	The group does not seem at all prepared to present.
Collaboration with Peers	Every group member has an important part in the group presentation. Cooperation and support are evident	Every group member has an important part in the group presentation. Cooperation and support are somewhat evident.	Every group member has a part in the group presentation, but it is monopolized by 1 or 2 group members. Cooperation and support are lacking.	Only 1 or 2 group members participate in the oral presentation. Other group members seem uninterested. Little evidence of group cooperation and support.
Comprehension	Student (group) is able to accurately address almost all questions relating to the issue the group researched.	Student (group) is able to accurately address most questions relating to the issue the group researched.	Student (group) is able to accurately address a few questions relating to the issue the group researched.	Student (group) is unable to accurately address questions relating to the issue chosen to research.
Content	Shows a full understanding of the topic and the steps involved in Issue Analysis.	Shows a good understanding of the topic and the steps involved in Issue Analysis.	Shows a good understanding of parts of the topic and some of the steps involved in Issue Analysis.	Does not seem to understand the topic or the steps involved in Issue Analysis very well.

__________ **Total Score** **Comments:**

Kentucky's Commonwealth of Water: Be an Informed Water Citizen
Middle School

Now's the Time to Act!

Adapted from "Give Water A Hand", University of Wisconsin Water Action Guide

Standards

Social Studies: SS-M-1.1.2, Students will understand that for the U.S. government to function as a democracy, citizens must assume responsibilities (e.g., performing community service, voting in elections) and duties (paying taxes, serving in the armed forces) for its functioning.

Activity Description

Students will work in small groups to design and implement a plan of action in their community to protect or conserve water.

Materials

- Issue Analysis research papers
- The book **<u>50 Simple Things Kids Can Do to Save the Earth</u>**, The Earthworks Group, 1990, pages 42-57
- Various supplies as needed, depending on the projects
- Copies of *Ranger Rick* and *Zillions* magazines from the library — most have at least one article per month on environmental responsibility for young adults.

Length of Lesson

1-2 class periods for the introductory activity in this unit, the rest will depend on the action plans selected by the students

Essential Question

How can we learn to protect our water?

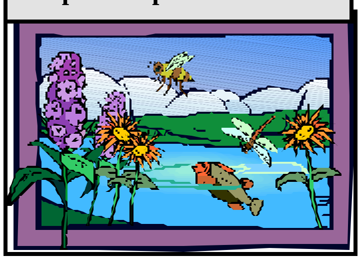
Guiding Questions

What is a service learning project that is feasible for us to do and will help make us more responsible water users?

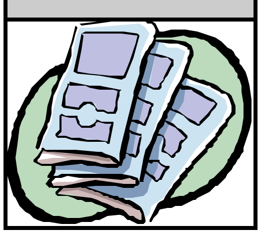
Skills Used

Analyze	Apply	Communicate	Describe
Discuss	Identify	Collaborate	Initiate
Research	Write	Present	Plan

Improve riparian habitat.



Develop educational brochures on local watersheds.



Stencil storm drains.

Educate community on using alternative cleaning products.

Now's the Time to Act!, *continued*

Activity

Note: This activity sequentially follows "Let's Analyze the Issues", since a lot of time will be spent researching current water resource issues during that activity. The research will lay the groundwork for students to decide on an issue they feel strongly about so they will be more enthusiastic about developing a plan of action.

Step 1: Review with students key points that have been covered during this water unit. Explain that this final activity will involve students deciding on something that can be done as a service project that will help protect or conserve water. Share the assessment rubric with students at the beginning of this activity so they will each understand that they are all expected to actively participate in this final unit project

Step 2: Explain to students that **service learning** combines meaningful school and community service with the learning that is taking place in the classroom. Using information learned from completing the research projects, ask students to brainstorm suggested ideas for service learning projects. Keep a master list of the ideas on the board, chart paper or overhead projector.

Step 3: Once several suggestions have been listed, explain that in order to decide on a service project that will be manageable, students should think about the cost (money as well as time commitment) of each project idea and the importance (as far as making a lasting change to water quality or conservation). Begin prioritizing the service project ideas.

Note: At this point, it is recommended that a qualified community expert be invited to come in and offer advice on the suggested projects. Check http://keec.ky.gov for natural resource experts in or near your county.

Step 4: Once the list of service learning projects has been prioritized, place students into working groups of 4-8 students, and pass out the "**Choosing a Service Learning Project**" sheet on the next page. Tell students to follow directions in filling out that sheet. That process should help each group pinpoint the service project they are qualified to initiate.

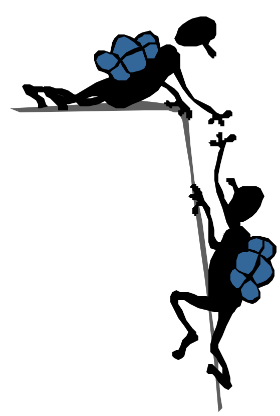
Step 5: After student groups have completed **Step 4,** ask a spokesperson from each group to report to the class on the service project their group has chosen to pursue.

Step 6: Next, pass out the **"Planning the Service Learning Project"** sheet for each group to work through together. Offer suggestions and support during this process, if needed. Call on each group to report when finished with this step.

Step 7: Finally, pass out the sheet, **"Outlining the Service Learning Project Plan"**, for each group to complete. After this step is completed, the service projects should be ready to initiate.

Step 8: Build in time for students to reflect (see reflection sheet prior to rubric), report on their projects to the class as well as to others, and to

CELEBRATE A JOB WELL-DONE!



Now's the Time to Act
Choosing a Service Learning Project

1 Fill out the "What We Know How To Do" column by listing things you are good at and/or enjoy doing. (Examples include art work, gardening, working on computer, talking to people, singing, ...)
2 Fill in the "Priority Water Needs" boxes at the top of the table. List top priority projects decided upon by the class.
3 Under the "Priority Water Needs" list, put an "X" in any line that matches up with something you can do that would be useful in working on that issue. (For example, if you wrote that you are good at art work and a priority need was to educate the community about conserving water, you could make posters.) Circle any "Needs" with lots of "X's" in their column. This means you have several helpers for that service project idea.
4 As a group, select the project that most interests you, then complete the bottom of this page.

What We Know How To Do	Priority Water Needs						

Our project idea is ____
Write in the water project you select from above.

By using these skills ____
List the sk ills your group will use to do this project.

____

We can ______________________________________ **to protect or improve water.**
Writ in the action plan you will do.

Now's the Time to Act
Planning the Service Learning Project

Group Members ____
Teacher___________________ **Date**________________ **Class**________________

As a group, complete the following survey about the service learning project you have chosen.

• Would the project meet a real need? How do you know? Has it been a topic in the newspaper?)____

• Are others working on the problem? Who are they? Can you join them?______________

• Are you excited about working on the project? If not, how could you make it exciting?

• What difference will this project make to you?______________________________

To your project site?______________________________

To the people, plants and animals in the watershed?______________________________

• What resources do you need to do the project? (Tools, information, skills, money, and, especially, time.)______________________________

Which resources do you have?______________________________

What resources do you still need?______________________________

Can you get the resources you still need? Where?______________________________

• What is your next step?______________________________

Now's the Time to Act
Outlining the Service Learning Project Plan

As a group, follow the directions as you outline your project plan at the bottom of this page.

1) Give your project a name. Make it one that people will remember. It could be simple like Butler County Middle School Stream Clean-Up or catchy like Mud Patrol: Erosion Prevention Program. Write in your group's name and project partners.

2) What is the most important task that needs to be completed first? Write it on your Project Plan under "#1 Project Task?" Write the next most important thing, and the next, until all the tasks are on the Plan.

3) Who will do each task? Write his or her name (or names) under "Who?" This person must make sure the job gets done. He or she can ask for help.

4) Brainstorm the resources (tools, information, people) you need to get each task done. Write them down. Could your partners or other experts or organizations help?

5) Get a calendar. Write today's date over "start" on the Time Line. When does the project have to be done? The end of the semester? A specific month? Write that date over "finish." How many months is it from start to finish? Using your Timeline, figure out when you need to complete each task. It often helps to start at the end date and work backwards. For example, if you are planning a Water Fair, think how much time before the Fair people need to know about it so they can plan to come. If they need to know two weeks ahead, then you must make all posters, radio ads, buttons, stickers, etc. and get them distributed by then.

6) Think of ways someone might get hurt on your project. What can you do to prevent it? What would you do if someone were hurt? Write your ideas in the "Safety Plan" box.

7) You are ready to go!

Outline of Service Learning Project Plan

Project Name____

Project Partners____

____

#1 Project Task____

Who?____

Resources Needed____

#2 Project Task____

Who?____

Resources Needed____

#3 Project Task____

Who?____

Resources Needed____

#4 Project Task____

Who?____

Resources Needed____

Service Learning Project Timeline

__________ __________ __________ __________ __________ __________

Starting Date Finish Date

Safety Plan

____

____

____

____

Now's the Time to Act
Reflecting on the Completed Service Learning Project

Student_________________________ **Project Title**___________________________
Teacher__________________ **Date**_______________ **Class**______________

Complete the following reflection about the service learning project you have completed.

* What has been the best part of this project? Why?__________________________________
* What has been the hardest part of this project? Why?________________________________
* What have you learned that you did not know at the beginning of this project?___________
* Do you feel your project benefited others? If yes, how?______________________________
* What data or information did you find useful?_____________________________________
* What have you learned from the people involved in this project?______________________
* What have they learned from you?____
* What have you learned about yourself and your community by doing this project?_________
* Are there ways that you could stay involved in this project in the future?_______________
* If you could change anything about this project, what would it be? Why?_______________
* How do you feel about service learning projects after having just completed this one?______

Now's the Time to Act
Service Learning Project Rubric

Group Members ____

Teacher Name ____________________ **Class** ___________

Project Title ____________________ **Project Completion Date** ____________

CATEGORY AND SCORE	4	3	2	1
Group Participation	All students in the group enthusiastically participated in the service learning project.	At least 3/4 of the students in the group actively participated in the service learning project	At least half of the students in the group actively participated in the service learning project.	Only 1 or 2 students in the group actively participated in the service learning project.
Shared Responsibility	Responsibility for the project was shared evenly.	Responsibility for the project was shared by most group members.	Responsibility for the project was shared by 1/2 of the group members.	There was evidence of exclusive reliance on one person to do the project.
Quality of Interaction	Excellent listening and leadership skills exhibited; students reflected awareness of others' views and opinions in their discussions and work.	Students showed adeptness in interacting; lively discussion centered on the timely completion of the task .	Some ability to interact; attentive listening and cooperation; some evidence of discussion or alternative solutions when problems arose.	Little interaction; very brief cooperation, students were disinterested or distracted from completing the service learning project.
Roles Within Group	Each student assigned a clearly defined role; group members performed roles effectively.	Each student assigned a clearly defined role, some group members did not consistently adhere to roles.	Students assigned roles but roles not clearly defined or consistently adhered to.	No effort made to assign roles to group members. There was a lot of confusion within the group.

__________ **Total Score** **Comments:**

Middle School Reading List*

Biodiversity. By Dorothy Hinshaw Patent. Stresses the importance of protecting the planet's rich gene pool for the survival of all species.

Clean Water. By Karen Barss. Discusses the problems of maintaining a clean water supply and relates this issue to such topics as pollution, depletion of resources, and other environmental concerns.

Deserts and Drylands. By Steve and Jane Parker. Explains why deserts have developed, where they are, and why overfarming has causes them to spread. Shows how plants and animals cope with extreme temperatures and lack of water.

A Drop Of Water: A Book of Science and Wonder. By Walter Wick. Shows the different forms of water in amazingly detailed photographs; explains water's properties.

Drought. By Christopher Lampton. Investigates the causes and disastrouns effects of drought, giving the history of some of the most severe droughts on record in the U.S. and elsewhere.

Every Drop Counts. By Jill C. Wheeler, Angela Kamstra (illustrator), and Kristi Schaeppi (illustrator). Full of ideas on how kids can stop water waste at home, outside, and in school. Also talks about water pollution.

Ground Water and Surface Water: A Single Resource. U.S. Geological Survey Circular 1139 Presents an overview of the interaction of ground water and surface water, in terms of both quantity and quality, as applied to a variety of terrains across the counry. Discusses the firm scientific foundation for policies governing the management and protection of aquifers and watersheds.

Our Endangered Planet: Rivers & Lakes. By Mary Hoff and Mary M. Rodgers. Explains the way rivers and lakes work together and how we have harmed them. It tells stories of success in reviving dying rivers and lakes and of failure to preserve our fresh water.

Protecting Our Rivers and Lakes. By Rosa Costa-Pau. Presents overviews of the problems facing the survival of rivers and lakes in light of the effects and solutions to pollution and the mismanagement of resources.

Rivers: Make It Work! By Andrew Haslam, Barbara Taylor. Explains where rivers come from, why people settle near them, and how rivers form valleys and underground caves. Discusses how rivers create energy and why it's important to control flooding.

Water : A Resource in Crisis. By Eileen Lucas. Discusses the quality and quantity of water on a global scale and includes discussions of resources, the ways we use water, pollution, making water safe, taking care of our water, and taking action.

* Please note that not all books on this list are included in the PRIDE list approved for purchase. See http://www.kypride.org/ for that list.

Water Conservation: Student Edition. By Leslie Crawford, Jeri Hayes (Editor), Cathy Anderson (Editor) Shows students different ways to analyze, consider options, and take action on issues such as sources of water pollution, community water supply, the school water system, reading a water bill, conservation technologies and practices, and assessing costs and benefits.

Water (Designs in Science): How Technology Mirrors Nature. By Sally Morgan and Adrian Morgan. Investigates the use of water from water for energy and transportation to water as a solvent. Other topics include filtration, desalination, recycling and conservation.

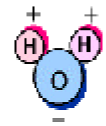
Water Squeeze. By Mary O'Neill. Discusses the importance of water in our lives and the dangers we create when we pollute the waters of the planet.

Kentucky's Wonderful Commonwealth of Water

High School Unit
Be a Water Scientist

Kentucky’s Wonderful Commonwealth of Water
High School

Unit Summary



This unit is research based and, though it touches on social studies and practical living, is more focused on science that previous units in this series. In this unit students learn the four different types of water pollution, where they originate and how they can be addressed. There is particular emphasis on water issues that affect Kentucky. In the culminating activity, students are given actual problems they must solve in order to protect valuable water supplies.

In this unit student will learn these things.

- What a watershed is and about watersheds in their own communities
- How people contribute to water pollution and how it can be prevented
- Where drinking water comes from and how it is (or is not) treated before reaching our homes.
- How to define overnutrification and how nutrients get into our water supply
- The standards for water pollution and how water pollution is measured
- How toxic chemicals get into our water and which chemicals are natural and which are manmade
- The role of water in transmitting disease
- The role of government and private citizens in protecting our water

Portfolio Suggestions: Using the research they do during the unit, have students write scientific papers describing their findings. Send these to local or state environmental officials.
Or
Write a persuasive paper describing why it is the responsibility of young people to convince their elders to protect water quality.

Suggested Open Response Question: You are a local fisherman. You have begun to notice large numbers of dead fish along the streams and rivers in your community. Describe two possible causes for these fish kills. Include both how the root causes might be addressed and who you would contact to get assistance to remediate the problems.

Technology Extensions

- Use GIS to study where streams and sewer lines exist in your community. Make maps of where you think water pollution problems may exist.
- Take samples of water and measure pH, water temperature, and dissolved oxygen in streams and creeks around your community. Use an excel spread sheet to create tables and graphs of your findings.
- Create a website and post your findings about water quality on the website. Use word-processing software to write a letter to the editor telling him or her about the website.
- Use desktop publishing to create a brochure that explains the different kinds of water pollution that exist in you community. Be sure and include names and phone numbers of places citizens can go for technical assistance to address these issues.

Kentucky's Commonwealth of Water— Be a Water Scientist
High School

Essential Question: How can I tell if my water is clean?

Standards

Science

SC-H-3.5.1, Students will understand that organisms both cooperate and compete in ecosystems. Often changes in one component of an ecosystem will have effects on the entire system that are difficult to predict. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years,

SC-H-2.2.1, Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different reservoirs. Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.

SC-H-3.5.5, Students will understand that human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected.

S-H-Applications and connections, Students will investigate how science can be used to solve environmental quality problems and use science to investigate natural and human-induced hazards.

S-H-Applications and Connections, Students will use science to investigate natural hazards and human-induced hazards.

S-H– Scientific Inquiry, Students will use evidence, logic, and scientific knowledge to develop and revise scientific explanations and models.

Social Studies

SS-H-3.1.1, Scarcity of resources necessitates choices at both personal and societal levels.

SS-H-1.3.3, In order for the U.S. government to function as a democracy and preserve individual rights, citizens must assume responsibilities and duties for its functioning.

SS-H-4.4.4, Group and individual perspectives impact the use of natural resources (e.g., mineral extraction, land reclamation)

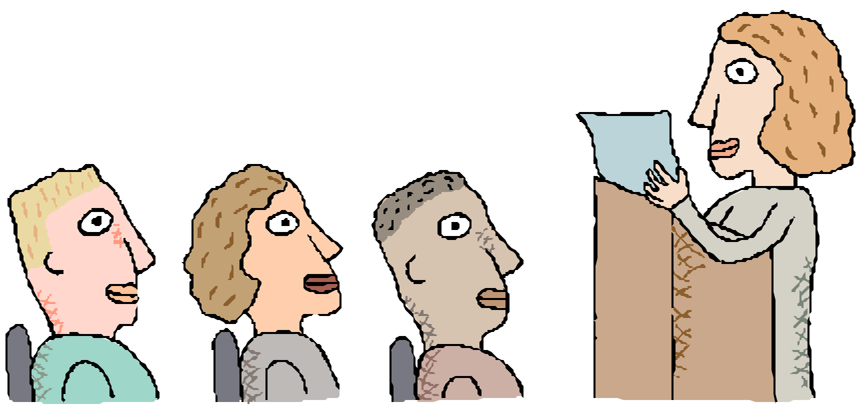
Practical Living

PL-H-3.3.2, Students will analyze community health standards and regulations

PL –H-3.3.3, Students will identify ways to protect the environment

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 1	**" Let's Make a Watershed Model "-** Students will create watershed models that show examples of point and non-point water pollution sources and natural filters in a community. Students will also identify the interrelationships between a community and it's watershed. **Standards:** Science: SC-H-2.2.1 and Practical Living, PL-H-3.3.3 and Social Studies, SS-H-4.4.4 **Essential Question:** How can I tell if my water is clean? **Guiding Questions:** • What are some of the causes of water pollution? • What natural and manmade filters help clean water?
# 2	**"Who Dirties the Water? Not Me, Dude."-** Students will listen to, and interact with, a prepared script depicting the "history" of water pollution as they gain an understanding that pollution can occur as a result of many interacting factors. In Part 2, students will try to simulate nature's water filtration system by devising a system to filter out both visible and invisible pollutants from water. **Standards: Scientific Inquiry,** Students will use evidence, logic, and scientific knowledge to develop and revise scientific explanations and models and Science SC-H-3.5.5 and Practical Living, PL-H-3.3.3 **Essential Question:** How can I tell if my water is clean? **Guiding Questions:** • What is the most effective way to clean dirty water? • How do we know when it is clean? • Who is responsible for polluting the water and for preventing pollution?
# 3	**"Tapping Into Our Local Water Supply"—** Students will investigate where local water originates and what happens to it before it arrives at their homes. **Standards:** Science Applications and Connections**:** Students will investigate how science can be used to solve environmental quality problems and use science to investigate natural and human-induced hazards. Practical Living: PL-H-3.3.2**,** **Essential Question:** How can I tell if my water is clean? **Guiding Questions:** • Where do we get our drinking water? • What happens to it before it arrives in our homes? • What is a watershed?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# **4**	**"Nitrates and Nutrients"—**students will collect water samples from different sites and test for nitrate levels. **Standards:** Science: SC-H-3.5.5 and Practical Living: PL-H-3.3.2 **Essential Question**: How can I tell if my water is clean? **Guiding Questions**: • Do the amounts of nitrate in natural bodies of water and drinking water vary? • What is "over nutrification?
#5	**"Searching for Nitrate Pollution Solutions"—**Students will collaborate in groups, without teacher direction, to carry out a complex project that examines a model of an environmental problem. **Standards:** SC-H-3.5.5 and Practical Living: PL-H-3.3.2 **Essential Question:** How can I tell if my water is clean? **Guiding Questions:** • What can affect nitrate levels in water? • What are the EPA and state standards for nitrate levels? • What can be done to keep nitrate concentration at safe levels in our drinking water?
#6	" **Can Being Clean Make You Sick?"—**Students will learn about toxins and how they enter the environment. They will also "survey" products used in their homes to see if they are potential pollutants. **Standards: Science, Applications and Connections:** Students will use science to investigate natural hazards and human-induced hazards. SC-H-3.5.1 and Social Studies: SS-H-4.4.4 and Practical Living, PL-H-3.3.3 **Essential Question:** How can I tell if my water is clean? **Guiding Questions:** • How do toxic substances get into the environment and into water sources? • Are there toxic substances in my home? • How can we prevent toxic substances from entering the environment?
# **7**	**"Scientific Sleuthing"—**In this activity, students will identify the role of water in transmitting diseases, compare symptoms of several waterborne diseases and analyze the characteristics of environments that promote transmission of these diseases around the world. **Standards:** SC-H-3.5.5 and Practical Living: PL-H-3.3.2 **Essential Question:** How can I tell if my water is clean? **Guiding Questions:** • What are the symptoms of different waterborne illnesses?

Unit Overview	
Lesson	**Title and Description of Activities, Essential and Guiding Questions and Standards**
# 8	**"Pollution Solution: A Culminating Activity"—**Students will work in groups and read scenarios that describe a variety of water pollution issues. They will then use knowledge gained in the unit, along with original research and problem solving, to come up with practical solutions and then present those to the class and defend their work. **Standards:** All standards from the unit plus Social Studies: SS-H-1.3.3 **Essential Question:** How can I tell if my water is clean? **Guiding Questions:** • All questions from the unit  

Kentucky's Commonwealth of Water – Be an Water Scientist
High School

Let's Make a Watershed Model

Adapted from "Making a Watershed Model", *Instructional Models For Use With Enviroscape*, Grades 6-8, pages 1-2

Standards

SC-H-2.2.1, Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different reservoirs. Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.
SS-H-4.4.4, Group and individual perspectives impact the use of natural resources (e.g., mineral extraction, land reclamation)
PL –H-3.3.3, Students will identify ways to protect the environment

Activity Description

Students will create watershed models that show examples of point and non-point water pollution sources and natural filters in a community. Students will also identify the interrelationships between a community and it's watershed. Or see teacher fact sheets for where to borrow an Enviroscape model. **Note: You may use an Enviroscape model in place of this activity. See the teacher fact sheets to borrow one near you.**

Materials

- An aluminum tray or cookie sheet
- Small plastic containers of various shapes and sizes.
- Modeling clay for creating contours on the model
- Materials to build and represent different natural and man-made areas in a community such as an industrial area, a residential area, a recreational area, agricultural areas, and a landfill. Materials could include: sponge bits, soil, pebbles, dried grasses, twigs, balloons (pond and landfill liners), toothpicks, plastic wrap, aluminum foil (pipes and drainage areas), household non-toxic materials such as powdered drink mixes, cocoa powder, pancake syrup, flour, sugar, etc.
- Water and spray bottle.

Length of Lesson

Allow two class periods to plan and build models and one period to demonstrate

Vocabulary

Nonpoint source pollution: pollution that cannot be traced to a single point (e.g. outlet or pipe) because it comes from many individual sources or a widespread area (typically urban, rural, and agricultural runoff).
Point source pollution: pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial, wastewater treatment plant, and certain storm water discharges).
Best Management Practice (BMP): effective ways to prevent or stop pollution.

Essential Question

How can I tell if my water is clean?

Guiding Questions

- What are some of the causes of water pollution?
- What natural and manmade filters help clean water?

Skills Used

Analyze	Hypothesize	Describe	Evaluate
Discuss	Identify	Observe	Design

Let's Make a Watershed Model, *continued*

Note: If you do not have time to build models, consider borrowing an Enviroscape (see teacher fact sheets) to teach students about nonpoint source pollution and watersheds . It is essential that students understand these concepts before proceeding with the unit.

Step 1: A few days before beginning this activity, explain to students that they are going to build models of their watershed. Let students know what types of materials are suggested for use when constructing the models. Ask students to look around at home for these materials, as well as other things they think might be useful when building the watershed models. (Check instruction sheet at the end of this activity for a detailed description of how to make and demonstrate a watershed. Share this with students.)

Step 2: Prior to beginning this activity, refer to **Teacher Fact Sheets** for detailed information on watersheds and a list of places that have Enviroscape models available to loan. If an Enviroscape model is available for class use, show students how the model looks, and demonstrate how it works. This should help students have a better understanding of what is expected of them as they build their watershed model. Gather materials needed to build the student watershed models.

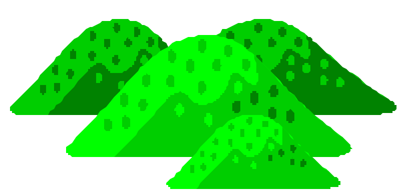
Step 2: Remind students of the importance of the hydrologic cycle to life on earth. Explain that as water precipitates back to the earth's surface, any materials spilled or placed on the ground's surface will eventually become part of the surface water system through runoff, or the ground water system, through infiltration. Explain that human activities such as landfill use, the use of chemicals in and around the home, improper industrial waste disposal, farming, etc. affect the quality of both the surface and ground water everywhere. Ask students if they can explain why this is so. (Remind students that water is known as the universal solvent, and mixes easily with other substances.)

Step 3: Explain to students that during this activity they will be working in small groups to build a model of their local watershed. Tell students that their community models will each need to include a water source (stream, pond, river, . . .) and at least 3 of the following areas: residential, industrial, recreational, agricultural, forests, transportation or landfills. **Also explain that each group of students should try to make the model as realistic as possible, since the models will be used to demonstrate point and nonpoint source pollution. (Explain these definitions, if the concepts have not yet been taught.)**

Step 4: Let students know what types of materials are available for them to use. Tell students that modeling clay needs to be used to build contours, terraces, rivers, or any downhill slope where water might be running on their models.

Step 5: Allow time in class for students to complete watershed models.

Step 6: Explain to students that part of the assessment on this activity will include a demonstration of each watershed model. During the demonstration, explain that each group must be prepared to identify possible types of pollutants produced in each area on their model. For example: septic tank leakage; fertilizers, herbicides and pesticides from lawns or golf courses, etc.; sediment from clear-cut areas and construction zones; oil and gas from parking areas or roadways. Ask students if they can explain what causes runoff water. What causes water to infiltrate, or soak into the ground? Show students different types of powders available for them to use on their models to show the pollutants.



Let's Make a Watershed Model, *contin-*

Day 2, Activity 1

Step 1: After the models have been completed, take 3 digital photos of each model; the first one before the demonstration begins, the second one after the pollutants have been sprinkled on the model, and the third one after the water has been sprayed on the model to simulate runoff. (This is optional, but it will be useful in Activity 2.)

Step 2: Gather students around one of the groups prepared to demonstrate how their model works. Encourage each group to be very dramatic and offer thorough explanations as to what is happening when they sprinkle the appropriate pollutants in each area of their watershed model (e.g., cocoa powder for sediment, pancake syrup for manure from farm animals, drink powder or tempura for pesticides, . . .).

Step 3: Once the pollutants have been sprinkled on the model, give the group a spray bottle filled with clean water to spray on the model until run-off occurs. Students in the group should identify the source of the pollution and explain whether it is point or nonpoint source pollution. Encourage students in each group to explain what is happening to the surrounding water sources as a result of the runoff water. Ask students if they think it would be cheaper and easier to clean up the water after it is dirty, or keep it from getting dirty in the first place.

Step 4: As each group gets through demonstrating their watershed model, drain the dirty water off the model, squirt the model with clean water and dry it with paper towels. The models will be used in the following activity on pollution prevention. **(See Extension for ideas on what to do with dirty water.)**

Activity 2

Step 1: As a large group, brainstorm ways to prevent water pollution. As students come up with ideas, hand them something with which to build their **Best Management Practices** (BMPs or pollution control) such as a piece of clay, sponge, bean sprouts (for roots of trees and plants), etc. Allow time for students to build their BMPs onto the group model.

Step 2: If students have trouble coming up with suggestions for BMPs, offer some of the following ideas that might spur them to think in more divergent ways:

- Golf course – Use less fertilizer, plant a filter strip (sponge or porous shelf liner) at bottom of hill.
- Farm field – Build terraces of clay (parallel ridges) across the hill (not up and down).
- Cars and roads – Put sand or felt filter alogn highways to catch oil.
- Bare spots on landscape – Cover with grass or trees (felt or sponges).
- Factory – Build a little dam of clay to hold the effluent (waste disposal), pretend to treat it.
- Farm animals – Build a lagoon (pond or pit) to put manure in.
- Anywhere – Pick up trash.
- Use sanitary landfills, that are lined to prevent seepage, instead of sink holes or illegal dump-sites.

Let's Make a Watershed Model, *contin-*

NOTE: If time is a factor at this point, teacher may decide to do this step in small groups at the same time, instead of having a large group of students observe as the small groups take turns assessing the value of their BMPs.

Step 3: After BMP's have been added to the models, reapply the pollution to each spot. Try to make sure the pollution is inside or up-slope of the BMP. For example, if terraces are built on the farm field, try to sprinkle cocoa on the flatter spots between the terrace ridges, not on the terrace ridges themselves. If a lagoon is built for the animal waste, put the waste within the lagoon walls.

Step 4: Once again, have a group member squirt the model until the runoff reaches the body of water. Some pollutants will probably get into the lake; hopefully, it will be less than the first time when there were no BMP's in place. Discuss how BMP's do not stop pollution completely, but they do lessen the amount of pollution that reaches the water.

Step 5: Conclude this activity by having students analyze the ways they think pollution may be getting into the water in the school's watershed. Have them create a Best Management Practice Plan for helping to prevent the pollution. Students can then present the plan to the School Council as a Power Point presentation and/or by demonstrating one of

Assessment for these activities may take the form of group cooperation during the different activities, the finished product (the watershed model), the presentations, the Best Management Practices that were applied to help control pollution, and the final journal reflection. A rubric to assess oral presentations has been included to help with the scoring of the group presentations.

Extension

1. Assign groups of students to design brochures that highlight one area of watershed/ groundwater protection for their community (proper oil disposal; solid waste disposal; homeowners' use of chemicals, pesticides, or fertilizers on lawns). These brochures can be handed out to appropriate community leaders or community groups.

2. Collect the dirty water that was left over after each demonstration. Ask students for suggestions on what to do with the dirty water. (Refer to the activity in the primary water unit called "Filtering Away Pollutants" for a similar activity.)

Controlling & Preventing Pollution

There are 3 basic methods of pollution control or prevention.

1. Structural Controls – where you build something to prevent or treat pollution.

2. Vegetative Controls – where you plant something to treat pollution.

3. Management Controls – where you do something differently to prevent pollution.

When they are used to control nonpoint source pollution, these methods are called BEST MANAGEMENT PRACTICES OR BMPS.

How to Construct and Demonstrate a Watershed Model

Step One: Gather the materials you will be using to construct and demonstrate the model. These include the following.

An aluminum cookie sheet or other nonpermeable base for the watershed model.

Plastic, paper or styrofoam containers — used as "bases" to add height to various areas of the watershed. For example, a butter container might be the base of a large hill, while one section of an egg carton might be a small hill.

Balloons or other small pieces of flexible rubber or plastic: Used as the "bed" of streams or ponds. These materials should actually be able to hold and/or channel water.

Clay, or other moldable material for covering the "bases" so that the model both looks realistic and will actually allow water to flow across it. (Note: Paper mache and salt and flour clay may work on these models if they are only to be used for demonstration once or twice. However, since both are water soluble, they will disintegrate easily.)

Materials to make features on the clay base of the watershed. Materials could include: sponge bits, soil, pebbles, dried grasses, twigs, balloons (pond and landfill liners), toothpicks, plastic wrap, aluminum foil (pipes and drainage areas), model houses, tractors, farm animals, cars, etc.

Materials to simulate substances that get into the water from throughout the watershed. These can include the following (and what they represent): powdered tempera paint or powdered drink mixes in the following colors, green (to simulate fertilizer), red (to simulate pesticides and herbicides), brown (to simulate sediment and mud), pancake syrup (to simulate sewer and manure sludge), cooking oil to simulate oil on roads and parking lots.

Materials to simulate BMP's (Best Management Practices): These can include small pieces of green felt, sponges, absorbent shelf paper, or even alfalfa/bean sprouts (to simulate areas of plant cover), clay to construct barriers, levees or holding areas.

Step Two: Constructing the Watershed Model

Plan: Decide as a group how your watershed will look (e.g. high points, low points, number, type and size of water features, etc.). Decide what features your watershed will have and where they will be (e.g. housing development, construction sites, roads, farms, etc) List these features on paper and draw (or map) them as well.

Build: Construct your watershed to match your plan. Use the clay or other modeling material to cover the base of the watershed model and connect all the areas together. When the clay has been molded to the model, it should look like a watershed would look if there were no trees, grasses, building, etc. Don't forget that the lowest point in your watershed should be a river, stream or other body of water.

How to Construct and Demonstrate a Watershed Model (cont.)

Step Three: Demonstrating Water Pollution on Your Model

Think: Decide as a group, what kinds of pollution might flow from the various features on your model (e.g. sediment from plowed fields and construction sites, fertilizers from lawns, oil from roads and parking lots) .

Pollute! Simulate pollution on your watershed model by putting the tempura paint, syrup, oil etc. on the appropriate features. Talk about the difference between point and nonpoint source pollution.

Precipitate: Using the water bottle, make it "rain" on your model. As the various kinds of pollution dissolve in water, watch where they go? What is happening to your watershed?!?

Remediate: Clean the model. Then using sponges, felt, clay, etc. create BMP's (Best Management Practices) to prevent the pollution from getting into your water. In the real world such features would include grassy areas, trees, wetlands, terraces, holding ponds etc.

Pollute: Using the same amounts and patterns as before, place "pollutants" on your model again.

Precipitate: Using the water bottle, make it rain again in approximately the same places and amounts as before. Do your BMP's help prevent the pollution from getting into the water?

Discuss: Think about your school's watershed. Are there ways pollution might be getting into the water from your watershed?

Extension

1. Have the students go to other classes or even other schools to demonstrate their watershed models.
2. Have students create a video of what happens in the school watershed when it is raining. Show this to other classes.

Oral Presentation Rubric

Student Name________________________ **Date**__________________________

Teacher Name________________________ **Class**__________________________

CATEGORY AND SCORE	4	3	2	1
Preparedness	Student (group) is completely prepared and has obviously rehearsed.	Student (group) seems prepared, but might have needed a couple more rehearsals.	Student (group) is somewhat prepared, but it is clear that rehearsal was lacking.	Student (group) does not seem at all prepared to present.
Collaboration with Peers	Almost always listens to, shares with, and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with, and supports the efforts of others in the group. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others in the group, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others in the group. Often is not a good team member.
Comprehension	Student (group) is able to accurately address almost all questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.	Student (group) is able to accurately address most questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.	Student (group) is able to accurately address a few questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.	Student (group) is unable to accurately address questions relating to the correlation between human activities and pollution of Kentucky's waterways, including how to prevent or reduce this pollution.
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.

____________**Total Score** **Comments:**

Who Dirties the Water? Not me, Dude.

Adapted from *Who Dirtied the Water?*, by Carmen Hood. Originally from the Science Education and Environmental Research (SEER) Water Project and Ginger Hawhee/Sandy McCreight (Omaha North High School, Omaha, Nebraska) whose original source was undocumented

Standards

Scientific Inquiry, Students will use evidence, logic, and scientific knowledge to develop and revise scientific explanations and models.
Science: SC-H-3.5.5, Students will understand that human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected.
PL –H-3.3.3, Students will identify ways to protect the environment

Activity Description

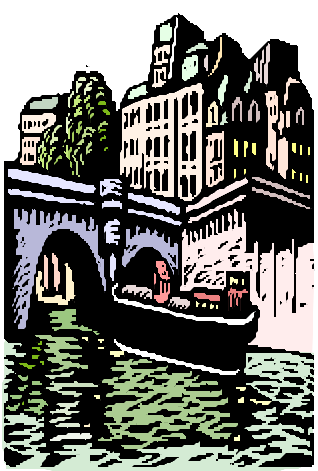
Students will listen to, and interact with, a prepared script depicting the "history" of water pollution as they gain an understanding that pollution can occur as a result of many interacting factors. In Part 2, students will try to simulate nature's water filtration system by devising a system to filter out both visible and invisible pollutants from water.

Materials

For Part 1

- Copy of script for teacher or assigned student to read
- Large jar or aquarium containing clean water
- Large spoon used to stir water
- Notebook and pencil for each student
- Film canisters labeled on the outside with the underlined word, and containing the substance listed on the right of the underlined word.

Beaver:	wood chips	**River:**	sand
Runoff:	charcoal	**Wetlands**:	dry grass
Shellfish:	crushed shell	**Aquarians:**	shells
Settlers:	organic garbage	**Carpenters:**	nails
Farmers:	potting soil	**Fisherman:**	nylon line
Straight Pipes:	toilet paper	**Boaters:**	Styrofoam
Sunbathers 1:	suntan lotion	**Homeowners:**	fertilizer
Sunbathers 2:	newspaper	**Factories:**	molasses
Sunbathers 3:	plastic pieces	**People:**	baking soda
Laundromats:	dish detergent		
Patients:	artificial sweetener tablets		



For Part 2

- Beakers — Rubber bands — Nylon mesh
- Sand — Charcoal — Cotton balls
- Water — Graduated cylinder — Test tubes
- Ring stand — Filter paper — Dirty water
- Class set of student task sheet found at the end of this activity

Who Dirties the Water?, *continued*

Length of Lesson

1 – 2 class periods

Vocabulary

<u>Filtration</u>—the process whereby a substance (e.g., water or air) is filtered, or cleaned.
<u>Pollutant</u>—a liquid, gas, dust, or solid material that causes contamination of air, water, earth and living organisms.

Essential Question

How can I tell if my water is clean?

Guiding Questions

- What is the most effective way to clean up dirty water?
- How do we know when it is clean?
- Who is responsible for polluting water and for preventing pollution?

Skills Used

Analyze	Write	Reflect	Experiment
Observe	Simulate	Organize	Compare
Investigate	Discuss	Hypothesize	Sketch

Class Preparation

Prior to class time, collect the materials needed to conduct these activities. Label the film canisters as indicated in the material list, and put listed materials inside canister. (Preparation time can be extensive, especially if setting up for more than one section of students, so seek help from student or parent volunteers.)

NOTE: A variation on the filtering segment of this activity may be done in order to set up a comparison study on the effectiveness of natural filters to man-made filters. If desired, have half the class use filtering materials that would be found in nature (pebbles, roots, grass clippings, sand) to try to filter pollutants from the water, while the other half of the class uses lab materials listed.

Who Dirties the Water?, *continued*

Part 1

Step 1: As students enter the room for class, hand them a film canister that contains materials that will be added to a clear container of water as the script is read.

Step 2: Once students are settled, explain that they will be listening to a story read by the teacher (or a designated student). Students with a canister will come forward as they hear the word on the outside of their canister read, tell the class who or what they represent, describe what they think is in the canister, and add it to the water. A group of three students reads the chorus in unison.

Step 3: On the board, write the following:

WHO DIRTIES THE WATER DATA TABLE

WHO IS ADDING	WHAT IS ADDED

Instruct students to copy this data table into their class notebooks and, as the script is read, record on their data table who or what is doing the adding and the actual substance that has been added to the container of water.

Step 4: Read the script. (Reader needs to use lots of expression and emphasize the capitalized words so students will be reminded to step forward with appropriate film canisters. Also, either the reader, or another designated student, should stir the murky substance and lift up the spoon from time to time so students can see how "gross" the water looks.)

Step 5: After the script has been completely read, give students an opportunity to reflect in their notebooks on the final two questions of the script:

1. Who dirtied the water?
2. Who is responsible for cleaning it?

Also, ask students to reflect on and discuss a third question:

3. Why do you think it is so important to keep our water supply free of pollutants?

It is important that students understand that, because of the small amount of usable water on Earth, clean water is not a limitless resource.

NOTE: Information about available water on Earth may be used at this time, if desired. See "What's all the Fuss About?" in the middle school unit.

Oceans	**97.2% of total water**
Ice caps/glaciers	**2.38%**
Ground water	**0.397%**
Surface water	**0.022%**
Atmosphere	**0.001%**

Add percentages to find available drinking water.

Ground water ____________
Surface water ____________
Total ____________

Step 6: If plans are to continue on into part 2 of this activity, pose the following question:

Now, how can we clean this dirty water?

Who Dirties the Water?, *continued*

Part 2

Step 1: Collect the materials needed to conduct this lab (See Part 2 of Materials Section.) and copy the student task sheet, (included) or make a transparency to show on the overhead projector.

Step 2: Assign students to lab groups and instruct students to devise a filtration system that they will use to clean a dirty water sample. (If Part 1 of "Who Dirties the Water?" is acted out prior to beginning this activity, the water left at the end of that story can be used in this lesson. The molasses used in this activity can cause the water to have a yellowish look, even after it has been filtered.)

Step 3: Explain that, using the lab materials present in class, each group will need to write out, in detailed step-by-step instructions, how to filter the water sample. Each group will also need to sketch the filtration system set-up and label the parts. Tell students to also make a list of any questions they have about this activity.

Step 4: Give each lab group a sample of dirty water with instructions to make the water sample as clean as possible. Give students time to make any adjustments to their models that they feel are necessary in order to better cleanse the water sample.

Evaluation

Step 5: Assign the work found on the student task sheet (located at the end of this activity) to be completed by each student, and turned in, by a specified date. Encourage students to use the Internet to find answers to some of the research questions as well as questions of their own. Tell them that finding the answers to questions of their own will improve their grade!

Extensions

1. **Using classroom test kits, test for pollutant levels in unfiltered water samples, then redo the tests using the filtered water and compare the results.**
2. **Research the local watershed to learn more about the flow of pollutants into the surface and groundwater in your area.**
3. **Visit a local body of water (preferably a small creek) to observe, first-hand, how nature works to clean the impurities from water.**
4. **Challenge students to research different water filters available for consumer use, or the home filtration system currently being used, to determine their effectiveness at removing pollutants from drinking water. Report findings to the class.**

Who Dirties the Water Script

The Story:
Once upon a time there was a beautiful piece of land. It was almost an island, since it was onnected to the mainland by a narrow land bridge, and surrounded on three sides by a lake. The lake was filled with clear water and was dotted with a few small green islands. (Point to the jar.) Fish and other aquatic life thrived in the water. The land was covered with trees and the land and the lake teemed with wildlife.

Chorus:
Would you want to swim in this lake"
Would you eat fish caught in this water?
Would you like to go boating in this lake?

Animal life flourished along a nearby river and the **BEAVER** were plentiful. A **RIVER** ran along one side of the land, carrying sediment with it as it flowed into the lake.

WETLANDS bordered the edges of the lake. Grasses from the wetlands sometimes washed into the lake and became food for the fish.

In the shallow water, clams and other **SHELLFISH** thrived.

A small group of people lived on this land, which they called Aquarian. The people were called the **AQUARIANS**. The Aquarians fished for food and shellfish in the lake. They dumped some of their garbage near the lake. We still find the piles of the shells they left.

Chorus:
Would you want to swim in this lake?
Would you eat fish caught in this water?
Would you like to go boating in this lake?

After many years **SETTLERS** from Europe came to live in the area. The settlers built a town much larger than the Aquarian villages. Some of the town's garbage was dumped into the lake. **CARPENTERS** built houses, farms, and stores that filled the Aquarian valley.

As the town grew, the settlers filled the wetlands to provide more land on which to build. **FARMERS** cut down trees to clear their fields. Without trees and wetlands to hold the soil, rain carried soil into the lake.

Chorus:
Would you want to swim in this lake?
Would you eat fish caught in this water?
Would you like to go boating in this lake?

More and more houses and shops were built, and the town of Aquarian grew into a city. Sewer pipes were constructed to remove the waste from houses and bathrooms. Some houses sent their sewage into the rivers and lake without going into the sewage system. These were called **STRAIGHT PIPES**.

Since the wetlands had been filled in, **RUNOFF** water washed pollution from the streets directly into the lake.

Who Dirties the Water?
Script (cont.)

FISHERMAN found that nets made of plastic were stronger than those made of rope. Sometimes these nets got lost in the water.

Fisherman and **BOATERS** sometimes threw their rubbish overboard.

Chorus:
Would you want to swim in this lake?
Would you eat fish caught in this water?
Would you like to go boating in this lake?

The city built **LAUNDROMATS** where people could wash their clothes. The detergents went down the pipes with the sewage into the lake.

People cleaned their houses. The **PEOPLE** used poisonous tile and drain cleaners, which flowed into the sewage system.

Even swimmers and **SUNBATHERS** going to enjoy the lake sometimes left garbage on its beaches.

As the city grew, **HOMEOWNERS** fertilized their lawns. The excess fertilizer poured into the lake.

Some of the **FACTORIES** built along the water's edge dumped their toxic wastes and chemicals into the water.

PATIENTS took medicines and tiny amounts of the medicines showed up in the water.

Chorus:
Would you want to swim in this lake?
Would you eat fish caught in this water?
Would you like to go boating in this lake?

Who dirties the water? WE ALL DO.
Who is responsible for cleaning it up? WE ALL ARE.

Who Dirties the Water Filtration Design
Task Sheet

Name______________________ Date________________ Class_______________

Directions for first day:

A. Using the available equipment, devise a filtration system that you will use to clean your dirty water sample.

1. Write out, in detailed step-by-step instructions, how you will use the lab materials to filter the water sample. (Each group should have one set of instructions.)

2. Sketch your filtration system set-up and label the parts. (Each group should have one sketch.)

Directions for second day:

B. Using your proposed filtration system, work with your group to make your water sample as clean as you can.

C. As a group, make any adjustments to your model that are necessary in order to cleanse your water sample.

D. Individually, on another sheet of paper, thoroughly answer the following questions. Complete and return this assignment by ______________________.

3. Was your original filtration system successful?

4. Describe any adjustments you made to your original model.

5. Were you able to remove all impurities?

6. What were some of the limitations of your system?

7. How could you tell if your water was purified? (HINT: What physical and/or chemical changes took place that would indicate that you accomplished your goal?)

8. What kinds of tests could you perform on your filtered water to prove that it had been cleansed?

Research Extension: You may use library or community resources to find the following information or to find answers to your own questions.

9. Describe a water purification system that could be used in a municipal area.

10. What is our city's / town's / county's main source of drinking water?

11. What "natural filters" are present in our local water supply?

12. What kinds of tests are done on our water supply to meet health and safety standards?

13. What agency sets the criteria for water safety standards?

Tapping Into Our Local Water Supply

Adapted from "How Water Is Cleaned", ", found in ***Always a River***, EPA, 1992, pages 193-197.

Standards

Science Applications and Connections: Students will investigate how science can be used to solve environmental quality problems and use science to investigate natural and human-induced hazards.
Practical Living: PL-H-3.3.2, Students will analyze community health standards and regulations (e.g., air/water quality, immunization, health and safety protection of citizens).

Activity Description

Students will investigate where local water originates and what happens to it before it arrives at their homes.

Materials

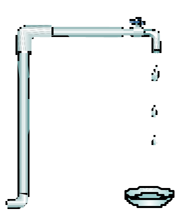
- Access to computers, telephone and library materials for research
- List of resource people to contact about local water
- Local watershed maps (at least 4 to be shared by groups of students)
- "How a Water Treatment System Works" handout, included
- Bucket containing 5 liters of "swamp water" (or add 2 1/2 cups of dirt or mud to 5 liters of water)
- One 2-liter plastic soda bottle with its cap
- Two 2-liter plastic soda bottles — one bottle with the top removed and one bottle with the bottom removed.
- One 1.5 liter (or larger) beaker or another soft drink bottle bottom
- 2 tablespoons alum (potassium aluminum sulfate), found at pharmacy
- Fine sand (about 800 milliliters in volume)
- Coarse sand (about 400 milliliters in volume)
- Small pebbles (about 400 milliliters in volume)
- Large beaker or jar (500 milliliters or larger)
- Small piece of flexible nylon screen (approximately 5 centimeters x 5 centimeters)
- A tablespoon, a rubber band and a stopwatch

Length of Lesson

1 class period

Vocabulary Words

Clean Water Act—the Federal Water Pollution Control Act of 1972, Public Law 92-500, is a law passed by the United States Congress, in 1972, that created guidelines for states to follow concerning water quality.
EPA standards—national standards for a variety of environmental programs that have been researched and set by the Environmental Protection Agency (EPA), which was established by the United States Congress in 1970, in an effort to control pollution of air, land and water.
Wastewater treatment plant—a large facility that treats wastewater from homes and industry to a point where it can be safely discharged into the environment.
Watershed—region draining into a river, river system, or body of water.
Water treatment plant—a facility that cleans and purifies water pumped from wells, rivers, and streams prior to distributing the water to customers.



Tapping Into Our Local Water Supply, *continued*

Essential Question: **How can I tell if my water is clean?**

Guiding Questions:

- Where do we get our drinking water?
- What happens to it before it arrives in our homes?
- What is a watershed?

Skills Used:

Observe	Research	Organize	Compare
Speculate	Investigate	Discuss	Communicate

****

Preparation

NOTE: Depending on the amount of time allotted to study this topic, this activity may be designed in different ways. The shortest way will be presented, but an extension is given that may be used to lengthen the activity and give students time to investigate their local watershed.

Step 1: Prior to beginning this activity, locate a Kentucky watershed map. A map may be obtained by contacting the local Conservation District or Soil Conservation Service office. A detailed watershed map may be obtained for about $6 from Kentucky Geological Survey, University of Kentucky, Lexington, 859-257-3896. Also, contact the local water company to find the names and numbers of people to contact in the community to learn more about local drinking water sources and quality.

Step 2: Refer to the materials section on the previous page for a list of supplies needed. Collect the equipment and materials before time for students to arrive. Copy the included handout: "How a Water Treatment System Works".

Activity

Step 1: Begin this activity by asking students where water originates. If, depending on student responses, you feel it is necessary, review the hydrologic cycle, and the amount of water found on Earth with students. Two activities from the middle school section of this publication address this topic thoroughly.

Step 2: Show students a Kentucky watershed map. Explain to students that watersheds are areas of land which drain into a stream, river, lake, or another body of water. Explain that within a single watershed, all of the precipitation drains to a given point in the same body of water, and that the elevation of the land determines the area of the watershed, with the highest ground forming the boundaries. Tell students that they are part of the largest watershed in the United States — the Mississippi River watershed — but that they are also located in much smaller watersheds that would include the closest ditch that water drains into after a large rain.

Tapping Into Our Local Water Supply, *continued*

Step 3: Pass out the watershed maps and have students move into smaller groups so they can locate their school on the map. Have students name the closest stream to their school. Next, ask students to follow the small stream to the next largest stream. Continue this until they arrive at a large lake, or the largest river on the watershed map.

Step 4: Explain to students that there are water quality guidelines that set the standards for local water companies to follow. Explain that these standards were developed by the Environmental Protection Agency and state agencies to keep our water safe for human consumption. (Refer to "Side Topics" for specific web sites that contain more information about water legislation.)

Step 5: Pour about 1.5 liters of "swamp water" into a 2-liter bottle. Have students describe the appearance and smell of the water. Tell students that, as a class, they will simulate what the local water companies must do to filter impurities out of the water and disinfect it so it is safe for us to drink when it reaches our homes.

Step 6: AERATION. Place the cap on the bottle of swamp water and shake the water vigorously for 30 seconds. Continue the aeration process by pouring the water into either one of the cutoff bottles, then pouring the water back and forth between the cutoff bottles 10 times. Ask students to describe any changes they observe. Pour the aerated water into a bottle with its top cut off. Explain that this process allows gases trapped in the water to escape and adds oxygen to the water.

Step 7: COAGULATION. Add approximately 2 tablespoons of alum crystals to the water. Slowly stir the mixture for 5 minutes. Explain that particles suspended in the water will clump together with the alum to produce floc.

Step 8: SEDIMENTATION. Allow the water to stand undisturbed in the bottle. Have students observe the water at 5-minute intervals for a total of 20 minutes and write their observation with respect to changes in the water's appearance. The floc should settle to the bottom.

NOTE: This would be a good time for students to begin locating information about the local drinking water supply. The local water company should have an Internet web site or a local telephone number so students might contact someone to find out where local water comes from, where it is stored, and where the local drinking water treatment and wastewater treatment plants can be found.

Side Topics for Student and Teacher Research

Visit the following web site to learn more about legislation that has affected Kentucky's drinking water quality by following links from the Environmental Timeline that was developed by the Kentucky Environmental Quality Commission: http://www.kyeqc.net/thirty/time/yeartime.html.

Also visit EPA's water web site (http://www.epa.gov/ebtpages/water.html) and follow links to research and learn more about drinking water standards, water pollutants, etc.

Visit the following web site for timely information about water quality issues in Kentucky: http://www.kyeqc.net/pubs/soke01/slide.html.

Tapping Into Our Local Water Supply, *continued*

Step 9: FILTRATION. While the floc is settling, construct a filter from the bottle with its bottom cut off:

- Attach the nylon screen to the outside neck of the bottle with a rubber band. Turn the bottle upside down and pour a layer of pebbles into the bottle — the screen will prevent the pebbles from falling out of the neck of the bottle.
- Pour the course sand on top of the pebbles.
- Pour the fine sand on top of the course sand.
- Clean the filter by slowly and carefully pouring through 5 liters (or more) of the clean tap water. Try not to disturb the top layer of sand as you pour the water.

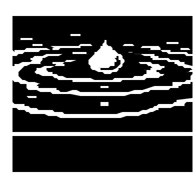
After a large amount of the floc has settled, carefully — and without disturbing the sediment — pour the top two-thirds of the swamp water through the filter. Collect the filtered water in the beaker. Pour the remaining (one-third bottle) of swamp water into the collection bucket. Compare the treated and untreated water. Ask students whether treatment has changed the appearance and smell of the water.

Step 10: DISINFECTION. Inform students that a water treatment plant would, as a final step, disinfect the water (e.g., would add a disinfectant such as chlorine) to kill any remaining disease-causing organisms prior to distributing the water to homes. Therefore, the demonstration water is not safe to drink.

Step 11: Ask students the following questions to trigger discussion of what they observed:

- What was the appearance of the original swamp water?
- Did the aeration process change the appearance or smell of the water? (If the original sample was smelly, the water should have less odor. Pouring the water back and forth allowed some of the foul-smelling gases to escape to the air of the room.)
- How did sedimentation change the water's appearance? Did the appearance of the water vary at each 5-minute interval? (The rate of sedimentation depends on the water being used and the size of alum crystals added. Large particles will settle almost as soon as stirring stops. Even if the water contains very fine clay particles, visible clumps of floc should form and begin to settle out by the end of the 20-minute observation period.)
- How does the treated water (following filtration) differ from the untreated swamp water? (The treated water should look much clearer and have very little odor.)

Step 12: After the experiment has been concluded, distribute copies of the "How a Water Treatment System Works" handout. Compare the steps you have just performed with those in a water treatment plant.



Extensions/Variations

A more complete study of the local watershed may be conducted, and a model of the local watershed built so on-site study can take place to determine how the water flows and possible causes of point and nonpoint source pollution in the area. Contact the local 4-H Agent to obtain a copy of the "Watershed Construction Manual", or visit the following web site: http://www.slo4h.org/!conman.html. For a general study of watersheds and point and nonpoint sources of pollution, an Enviroscape model may be borrowed from several locations listed in the Teacher Fact Sheets.

Kentucky's Commonwealth of Water – Be a Water Scientist
High School

Nitrates and Nutrients

Adapted from *Living in Water*, "What's in our water", Activity 18, National Aquarium in Baltimore, 1997

Standards

Science: SC-H-3.5.5, Students will understand that human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected.

Practical Living: PL-H-3.3.2, Students will analyze community health standards and regulations (e.g., air/water quality, immunization, health and safety protection of citizens).

Activity Description

Students will collect water samples from different sites and test for nitrate levels.

Materials

For each group:
- One or more water samples
- Nitrate test vials
- Tablets #1 and #2 from nitrate test kit

For class:
- 1-2 nitrate test kits
- Map of geographic area sampled
- Three colors of paper, cut into 1/2 inch by 2 inch strips, to be used to identify the level of nitrate concentration. (For example, green can represent 0-3 ppm nitrate, yellow for 4-7 ppm, and red for 10 ppm or more.)

For each student:
- Goggles
- Lab sheet (found at end of this activity) and pen or pencil

Length of Lesson

One class period

Vocabulary Words

Nitrate (NO_3)—an important plant nutrient and type of inorganic fertilizer (most highly oxidized phase in the nitrogen cycle). In water, the major sources of nitrates are septic tanks, straight pipes, feed lots and fertilizers, although some level of nitrates is normal due to decomposition of plants and animals, etc.

Water Pollution—the contamination of water by the discharge of harmful substances.

EPA standards—regulations set by the Environmental Protection Agency (EPA) limiting the nitrate levels in public drinking water supplies to 10 ppm (parts per million)

Nitrates and Nutrients, *continued*

Essential Question: **How can I tell if my water is clean?**

Guiding Question: Do the amounts of nitrate in natural bodies of water and drinking water vary?
What is "over nutrification?

Skills Used:

Observe	Measure	Organize	Compare
Speculate	Investigate	Discuss	Write

Activity

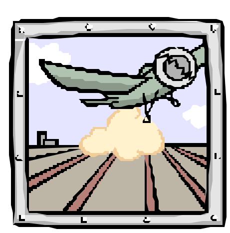
Step 1. (Preparation) Have students collect water samples from local sources (including drinking water). Make sure everyone uses the same collection techniques and, on a local map, locate where samples were gathered. Display map in the classroom.

Nitrate is stable in water samples stored out of the light where algae cannot grow. Collect water samples from streams, lakes and drinking water supplies. Colleagues or students can bring samples from home. (Just caution about storing the samples away from light sources.) It is especially interesting to compare rural well water from an agricultural area with city tap water.

If all the water you have access to comes from the same water source, you can buy bottled water samples from different geographic regions and compare them with your tap water. Many bottled waters are carbonated. If you cannot avoid them, open the bottles or cans several days ahead of time and let the gas out. Shaking helps. The water must be "flat".

Step 2: Assign students to lab groups. If students have not participated in a nitrate lab previously, take the time to explain how to conduct the test, and why testing for nitrate levels is important. Remind students to follow the instructions closely on the lab sheet.

Step 3: As the water samples are tested, instruct students to write the results on the lab paper and the board with the sample name and location, as well as whether it is drinking water or water from a natural habitat. At this time, students should also write the results on the colored paper, following the code explained in the materials section, and post it on the map in the classroom



Nitrates and Nutrients, *continued*

Activity

Step 4: Study the class results and look for any problems or patterns of pollution on the charts and on the map. Ask some of the following questions: Where might nitrate pollution come from? Is it point source or nonpoint source pollution? (Use Enviroscape models to show the difference. See the **Teacher Facts Sheets** for a place near you where you can borrow a model.) If any of the drinking water samples exceeded 10 ppm nitrate, why might this have happened? (EPA does not regulate private wells or bottled water.)

Step 5: If there appear to be no problems, then students may conclude that the area studied has good water quality with regard to nitrate levels. If there are problems, consider doing one of the extended lessons.

Evaluation

Step 6: At the completion of this lab, remind students that a written lab report will be due on a specified date.

NOTE: Extension activities may be assigned for extra credit.

Extensions

1. **Do research to learn more about drinking water quality standards, both state and federal. Discover why high nitrate levels in drinking water and in natural bodies of water are reasons for concern?**
2. **Did any of your samples test above 10 ppm nitrogen as nitrate? If so, have students make sure the proper authorities know. Look in your phone book under county or city government for the agency responsible for water quality, or try the Internet. Have students write letters reporting their findings and asking if there are programs in place to improve water quality.**
3. **Have students research the sources of nitrate in drinking water in your area by contacting local water suppliers, agricultural agents, environmental organizations, etc. Collect information and share with class. Have student groups write informational material specific to your area and distribute it to parents and others who can help reduce nitrate use.**
4. **Have students research to find out if there is a watershed protection program for your drinking water supply if it comes from surface water? Is there a groundwater protection program if it comes from wells? (Check on service learning hours for students who become involved in these projects.)**
5. **Correspond by email, letters or KTLN (The Kentucky TeleLinking Network) with other groups of students and compare test measurements.**
6. **Go to the Kentucky Geologic Survey Website to see results of well water testing across the state.**

Nitrates and Nutrients
Lab Sheet

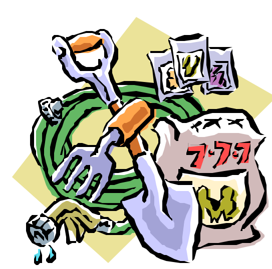
Name____________________________ **Date**________________ **Class**_________

Do the amounts of nitrate in natural bodies of water and drinking water vary?

1. Working together, your group should test the water samples you have for nitrogen as nitrate. Follow the instructions carefully. Be sure you keep the samples straight if you have more than one to test.
2. Describe how your group made sure the samples were not switched or confused with each other.
3. Write your results on the board to share with others in your class. Make a table of the class's results showing location, date of sample (if available), nitrate level and whether it was from drinking water or a natural body of water.
4. If 10 ppm is the most allowed in drinking water, did you identify any problems with water for humans? If so, where?
5. If anything over a trace (up to 1 ppm) may be a problem in natural bodies of water, have you identified any problems in natural habitats? If so, where?

Source and location	Date	Nitrate (ppm N as NO_3)	Drinking water or natural habitat

Note: 0-3 ppm nitrate indicates no human health concern
4-9 ppm nitrate indicates a reason to think about nitrate
10 ppm nitrate or more is over the drinking water standards set by the Environmental Protection Agency



Nitrates and Nutrients
Lab Sheet
(Sample Answers)

Name____________________________ Date________________ Class_________

Do the amounts of nitrate in natural bodies of water and drinking water vary?

1. Working together, your group should test the water samples you have for nitrogen as nitrate. Follow the instructions carefully. Be sure you keep the samples straight if you have more than one to test.
2. Describe how your group made sure the samples were not switched or confused with each other.
   We each labeled our jars and then we only worked with our own sample. We could not label the test tubes because you have to see through them.
3. Write your results on the board to share with others in your class. Make a table of the class's results showing location, date of sample (if available), nitrate level and whether it was from drinking water or a natural body of water.

Source and location	Date sample collected	Nitrate (ppm N as NO_3)	Drinking water or natural habitat
Tap Leitchfield	4/5/02	3 ppm	Drinking
Bear Creek	4/9/02	5 ppm	natural
Well Grayson Co.	4-6-02	15 ppm	drinking
Well Grayson Co.	4/3/02	4 ppm	Drinking
Rough River	4.9/02	trace	natural

4. If 10 ppm is the most allowed in drinking water, did you identify any problems with water for humans? If so, where?
   Yes, one person had a well that was over EPA limits. She thought since she lived in a nice area in the country she had good water. She was shocked.

5. If anything over a trace (up to 1 ppm) may be a problem in natural bodies of water, have you identified any problems in natural habitats? If so, where?
   Bear Creek had algae growing on the bottom, and it was too high.

Protecting Kentucky's Water – Be a Water Scientist
High School

Searching for Nitrate Pollution Solutions

Adapted from *Living in Water*, "Water pollution detectives", Activity 19, National Aquarium in Baltimore, 1997

Standard

Science-H-2.2-2.6, Students will investigate how science can be used to solve environmental quality problems (e.g., over consumption, food distribution).
PL-H-3.3.3, Students will identify ways to protect the environment.

Activity Description

Students will collaborate in groups, without teacher direction, to carry out a complex project that examines a model of an environmental problem.

Materials

For each large group:
- Monroe River watershed map (found at end of activity description)
- 2-4 nitrate test kit vials
- 8 each of tablets #1 and #2 from nitrate test kit
- 4 labeled water samples (about 50 ml of each) in clean cups
- 4 clean plastic spoons
- 4 stick-on labels

For class:
- 2 nitrate test kits
- 4 Nutritabs
- 4 clean sample bottles: plastic milk jugs or soda bottles
- 4 stick-on labels
- 1 gallon distilled water from grocery store or tap water lower than 1 ppm nitrate

For each student:
- Goggles
- Nitrate pollution information sheet (found at end of this activity) and pen or pencil
- Worksheet (found at end of this activity)

Length of Lesson

2-3 class periods and homework

Essential Question

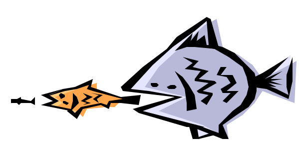
How can I tell if my water is clean?

Guiding Questions

- What can affect nitrate levels in water?
- What are the EPA and state standards for nitrate levels?
- What can be done to keep nitrate concentration at safe levels in our drinking water?

Skills Used

Observe	Measure	Organize	Graph
Infer	Communicate	Average	Investigate



Searching for Nitrate Pollution Solutions, *continued*

Preparation

Step 1: Prepare samples for class use in the following manner (1 quart should do 20 samples or more):

Clean and label bottles according to this recipe:

sample 1 – 1 liter or quart tap water (below 1 ppm) or distilled water

sample 2 – 1 liter or quart tap or distilled water with 1/2 Nutritab

sample 3 – 1 liter or quart tap or distilled water with 1 Nutritab

sample 4 – 1 liter or quart tap or distilled water with 2 Nutritabs

Prepare student samples by labeling four cups for each group with F, J or L and then one of the seasons. For example, one group gets F spring, F summer, F fall and F winter. Line the cups up to match the table below and put about 50 ml of the sample as indicated in this chart in each cup.

Group	**season written on sample cup**			
Letter on	spring	summer	fall	winter
F-Farmtown	Sample 4	Sample 3	Sample 2	Sample 2
J-Jacksonburg	Sample 2	Sample 2	Sample 1	Sample 1
L-Lincoln City	Sample 3	Sample 3	Sample 2	Sample 2

Step 2: Copy worksheets, maps, and reading sheets for each student. **Assign reading as homework prior to beginning this lab.**

Activity

Step 1: Challenge students to work as real environmental scientists do on a large scale problem. Assign a location to each group:

* Farmtown—the watershed is heavily fertilized corn fields; the corn is fed to cows, chickens and hogs which produce manure
* Jacksonburg—where the Jackson River enters the Monroe River; its watershed is heavily forested wilderness areas and a national park.
* Lincoln City—where millions of people use the Monroe River for drinking water from an upriver intake and do sewage disposal downriver.

Step 2: Explain to students that each group is located in a different county along a large river and works for its county government. All the cities are located on the Monroe River because they were founded before trains and roads when almost everything traveled by water, up and down the river. Each group is responsible for testing the river at their location (marked with an X on the map) for nitrate throughout the year. The samples have been stored, and each group will test a full year's samples at one time. In order to understand the river as a whole, the groups must work together even though they work for different county agencies. They should plan their work before beginning. The Monroe River map gives them details about their watershed and sampling location. Pass out the maps and data sheets, and let the learning begin!

Fast Facts

- **There are 89,431 miles of rivers and streams in Kentucky.**
- **In 1999, out of approximately 7,000 miles of monitored waterways, 34% were impaired by pollution.**
- **Groundwater pollution incidents have been reported in almost every county of the Commonwealth.**
- **61 species of freshwater fish are considered at risk due to pollution and ecosystem alterations.**
- **State, local and private sector efforts to restore water quality have been ongoing since the passage of the federal Clean Water Act in 1972.**

Background Information on Nitrate Pollution

Nitrate produced by humans

Humans have increased the amount of nitrogen in natural systems. Nitrogen enters in the form of ammonium, nitrate, or nitrogen oxide gas which forms acid rain as nitric acid. Naturally occurring bacteria convert all of these to nitrate. There are also bacteria that fix atmospheric nitrogen in a form available for plant use. These bacteria live in association with the roots of legume crops (alfalfa, beans, clover). They also add to the world's nitrate supply. Our current production of nitrate far exceeds the ability of the natural world to use it. Each year we add more.

Some nitrate sources are at specific sites which can be measured and regulated by laws. They come from a point source. Examples include nitrate in city sewage discharge, nitrous oxide gases from an electrical power station which burns fossil fuels, nitrous oxide from a large trash incinerator, nitrate in manure runoff from a major stockyard, or nitrate or ammonium leakage from a fertilizer plant. Nitrous oxide from cars can be regarded as point source, too.

Other nitrate sources are widespread over entire watersheds (nonpoint source) and are very hard to regulate by laws. These include nitrate and ammonium from inorganic fertilizer or animal manure spread over fields, lawns, gardens, golf courses and parks, from manure of domestic animals, including both farm animals and pets, and from human waste in septic systems or from sewer pipes that go straight into the streams. All these add nitrate to ground and surface water. In these instances, education, tax incentives and other programs may be the only solution.

Nitrate in natural ecosystems

Plants and algae need nitrate, but too much nitrate in aquatic habitats causes the too much algae growth. These algae cannot be eaten fast enough by grazers. The algae sink and die. Bacteria which breakdown the dead algae use oxygen. The bacteria use so much oxygen that the bottom water cannot support animals which need oxygen to live.

High nitrate also changes which kinds of algae grow in an aquatic environment. It may favor less nutritious or even toxic species. Places like farm ponds, animal watering troughs, and swimming pools can all produce these 'bad" kinds of algae if nitrate levels in them are too high.

Sometimes the algae is so dense that it blocks light from reaching plants rooted on the bottom, killing them by shading. Coral reefs become overgrown with algae in nutrient rich water. Corals have single-celled algae living inside the coral animal that need light. Corals die when their tiny helpers are shaded by seaweed growth.

Nitrate in drinking water

Drinking water with nitrate above certain levels is dangerous for both humans and animals. It causes a condition in which red blood cells of babies and baby animals are unable to carry oxygen. Nitrate is relatively non-toxic. However, it is changed by stomach bacteria to nitrite. In normal adults less than 5% of nitrate taken in becomes nitrite. Adults with low stomach acid and bacterial infections can change as much as 50% of nitrate to nitrite. Babies make more nitrite because their stomachs are low acid. Babies have special oxygen-carrying chemicals in their blood which combine permanently with nitrite, making them unable to carry oxygen. Babies drinking nitrate-contaminated milk (from their mother or formula) may die or suffer brain damage from low oxygen. No babies have died yet in the United States, but they have in Europe. Baby cows and sheep are even more likely to be hurt. They have died in some places in the United States due to nitrate water pollution.

Because of human risk, the U.S. Environmental Protection Agency (EPA) limits nitrate in public drinking water supplies in less than 10 milligrams per liter nitrogen as nitrate (10 ppm). No one regulates private wells even though they are at risk for this kind of pollution.

Nitrate itself does not cause cancer, but nitrite can combine with other chemicals to form probable human carcinogens. Farmers exposed to high nitrate in their well water are being studied to see if high drinking water levels of nitrate are linked to cancer.

No easy solutions

What can be done? The EPA regulates point sources, but education and individual action are necessary to reduce many of the nonpoint sources. Here are some problems and approaches.

Farm nutrient management programs

Some farmers may spread commercial fertilizer, manure or both without measuring soil nitrate or timing the fertilizer application to coincide with maximum crop growth. This leads to groundwater contamination and surface runoff. Nutrient management programs help farmers plan their fertilizer and manure use. These also save farmers money. Some areas have so much livestock, they lack enough land to dispose of the manure. Composting manure for home or garden use may help.

Urban sewage systems

These systems discharge large amounts of dilute nitrate into surface waters. They are regulated and have to meet standards. New treatment methods reduce nitrate discharge. Some small communities use wetlands they have created for sewage treatment. Bacteria in wetlands are capable of returning nitrogen to the atmosphere as a gas.

Land application of sewage sludge

Sewage treatment removes some nitrate in the solids collected as sludge. This creates a sludge disposal problem. It may be used as fertilizer on farms in place of chemical fertilizer. If it is spread too thickly, sludge nitrate may enter surface waters or contaminate ground water.

Homeowners, parks, sod farms and golf courses

Lawn fertilizer is very high in nitrate. Home owners often use too much. This problem is greatest in the northeastern U.S. where 34% of the total fertilizer use is non-farm use. Lawn products also mix pesticides, herbicides and fungicides with fertilizer, resulting in a chemical cocktail. Soil testing and restriction of use to periods of active plant growth help. The best solution is to change the way we manage our yards, school grounds and parks, reducing grass in favor of trees and shrubs. What grass we have should be cut taller to reduce runoff.

Septic systems

Building houses on rural land around cities causes the construction of many septic systems. These leach nitrate to groundwater, often the same water that the new homes use for drinking water. Nitrate is not filtered out by the soil. A family of four contributes about 73 pounds of nitrate per year to the groundwater. Septic system owners need education about their use and problems. Where septic systems are crowded along shorelines, the water itself becomes overloaded with nutrients leaching directly into it. Changing land use practices and constructing sewage treatment systems are two potential solutions to this problem. The first is very difficult due to opposition from developers, and the second is very expensive.

Searching for Nitrate Pollution Solutions

Name____________________ **Date_______________** **Class_______________**

A. Working in your group

1. Circle the location of your group: Farmtown Jacksonburg Lincoln City

2. What is the major river or stream in your watershed called?

3. Review the nitrate pollution information sheet as a group.

4. Using the Monroe River map of your area, the description of your watershed, and the nitrate pollution sheet, along with your knowledge of watersheds and water pollution, list the sources of nitrate water pollution you predict your watershed contributes to your sampling location.

   a. Point source

   b. nonpoint source

5. Test each seasonal water sample twice for nitrate. Design and make a table showing all of your data. Also, show the averages for each season.

6. Explain why each test was done twice.

7. Can you account for the nitrate levels you measured by looking only at your own small watershed? Explain your answer.

B. Working with all three groups together

1. Each environmental group sends one person with its data to an annual meeting. Elect your representative and send her/him to the front of the room. The representatives must decide on a table to display all the group information for the whole year in a logical fashion. While they are meeting, your group can clean up. The representatives must present their table to the class. It must be explained and may be modified, based on comments from the class.

2. Draw the final data chart here:

3. Can you now explain the nitrate levels measured in your part of the river better, including why there was seasonal variation? What have you learned by sharing data?

4. Applying information from the nitrate pollution information sheet, predict two problems that might occur along the Monroe River below Lincoln City that could be caused by nitrate pollution in the river. They may be problems for things living in the river or for humans.

5. If your group was in charge of the entire Monroe River watershed, list three things that you would do to reduce the level of nitrate in the river below Lincoln City. Explain how each would help improve the water quality of the river.

6. Explain why the rainfall graph was important for understanding the nitrate measurements you got.

Searching for Nitrate Pollution Solutions

(sample answers)

Name____________________ **Date**_______________ **Class**______________

A. Working in your group

1. Circle the location of your group: Farmtown Jacksonburg Lincoln City

2. What is the major river or stream in your watershed called?

   Jackson River

3. Review the Nitrate Pollution information sheet as a group.

4. Using the Monroe River map of your area, the description of your watershed, and the Nitrate Pollution sheet, along with your knowledge of watersheds and water pollution, list the sources of nitrate water pollution you predict your watershed contributes to your sampling location.

   a. Point source

      There might be a sewage treatment plant for Jacksonburg.

   b. nonpoint source

      There is almost none except for things like fertilizer in town or nitrogen from air pollution.

5. Test each seasonal water sample twice for nitrate. Design and make a table showing all of your data. Also, show the averages for each season.

season	Test 1	Test 2
spring	4 ppm	3 ppm
summer	3 ppm	3 ppm
fall	1 ppm	0.5 ppm
winter	1 ppm	1 ppm

6. Explain why each test was done twice.

   We did two tests to check our work and make sure we didn't make an error.

7. Can you account for the nitrate levels you measured by looking only at your own small watershed? Explain your answer.

   No, since it does not make any sense that we have so much since we really don't have that many sources of pollution.

B. Working with all three groups together

1. Each environmental group sends one person with its data to an annual meeting. Elect your representative and send her/him to the front of the room. The representatives must decide on a table to display all the group information for the whole year in a logical fashion. While they are meeting, your group can clean up. The representatives must present their table to the class. It must be explained and may be modified, based on comments from the class.

2. Draw the final data chart here:

	spring	summer	fall	winter
Farmtown	18 ppm	9 ppm	4 ppm	4 ppm
Jacksonburg	4 ppm	4 ppm	1 ppm	1 ppm
Lincoln City	8 ppm	9 ppm	5 ppm	5 ppm

3 .

Can you now explain the nitrate levels measured in your part of the river better, including why there was seasonal variation? What have you learned by sharing data that helped?

Our watershed added clean water to a polluted river and diluted the pollution. Then the city down river added more nitrate. The big spring rain and fertilizing the fields made a big difference in our results. By putting data together we were able to account for high and low levels and for seasonal changes.

4. By using information from the Nitrate Pollution Information Sheet, predict two problems that might occur along the Monroe River below Lincoln City that could be caused by nitrate pollution in the river. They may be problems for things living in the river or for humans.

1. If we don’t reduce the levels, the water might one day exceed EPA regulation levels.

2. We could have very large algae blooms and fish could die.

5. If your group was in charge of the entire Monroe River watershed, list three things that you would do to reduce the level of nitrate in the river below Lincoln City. Explain how each would help improve the water quality of the river.

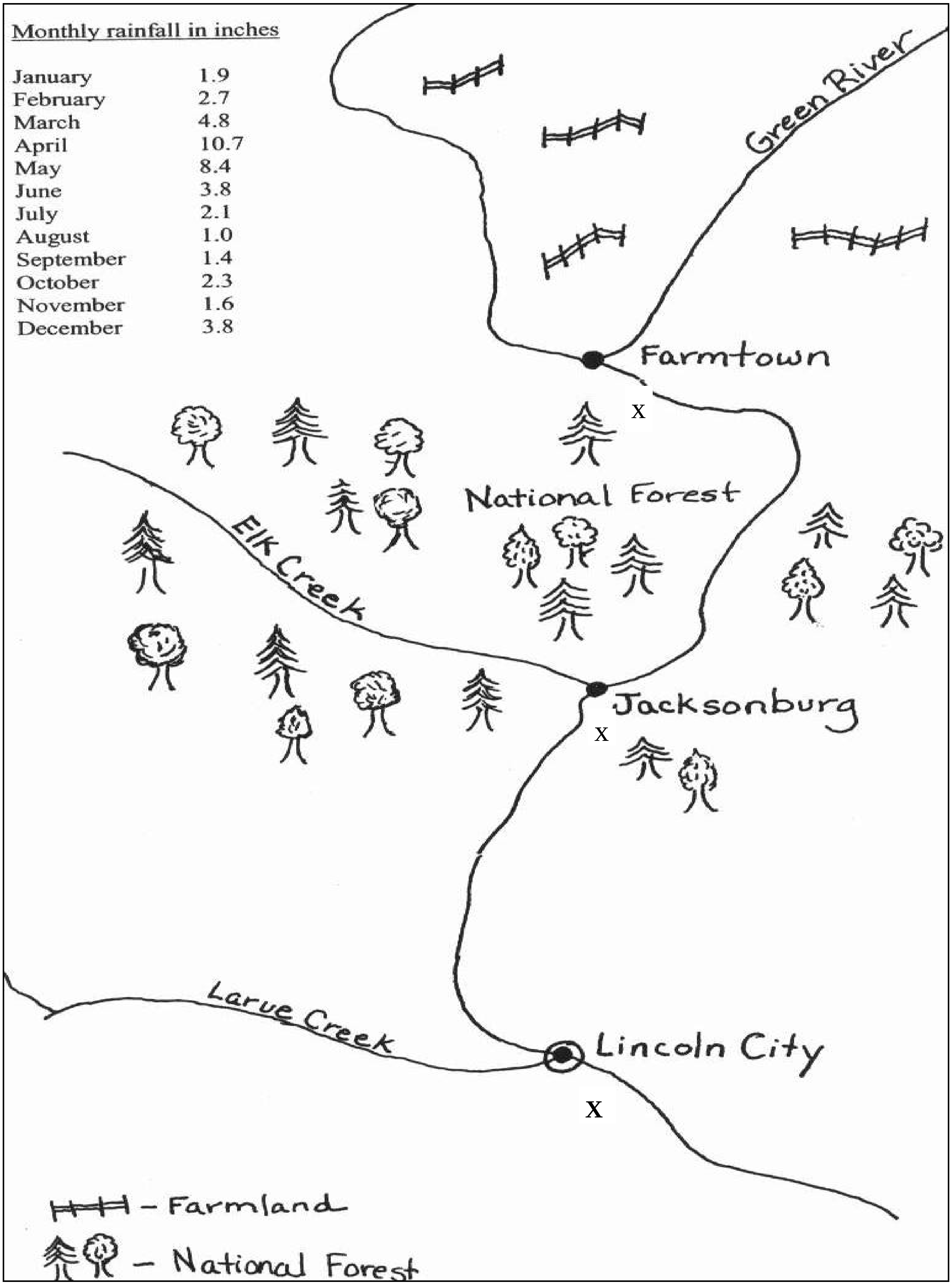
1. I would help the farmers reduce the loss of manure and fertilizer so they could keep it where they need it — on the fields.

2. I would make the Lincoln City sewage treatment plant work really well.

3. I would have programs to teach people how to reduce nitrate pollution in their yards.

6. Explain why the rainfall graph was important for understanding the nitrate measurements you got.

The big spring rain carried soil, manure and fertilizer into the river.


Monthly rainfall in inches
January 1.9
February 2.7
March 4.8
April 10.7
May 8.4
June 3.8
July 2.1
August 1.0
September 1.4
October 2.3
November 1.6
December 3.8
Green River
Farmtown
X
National Forest
Elk Creek
Jacksonburg
X
Larue Creek
Lincoln City
X
- Farmland
- National Forest

Kentucky's Commonwealth of Water – Be a Water Scientist
High School

Can Being Clean Make You Sick?

Adapted from EPA Water Sourcebook activity "Contaminant Scavenger Hunt"

Standards

Science, Applications and Connections: Students will use science to investigate natural hazards and human-induced hazards.
SC-H-3.5.1, Students will understand that organisms both cooperate and compete in ecosystems. Often changes in one component of an ecosystem will have effects on the entire system that are difficult to predict. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years,
Social Studies: SS-H-4.4.4: Group and individual perspectives impact the use of natural resources

Activity Description

Students will learn about toxins and how they enter the environment. They will also "survey" products used in their homes to see if they are potential pollutants.

Materials

Two copies of the "Contaminant Survey" and one copy of the "Alternative Cleaning Products" Sheet for each student. An overhead of the "House Cutaway Sheet. Household products (or labels) brought from home.

Length of Lesson

2 class periods

Vocabulary

Toxic Substance: A chemical or chemical mixture that may present an unreasonable risk of injury to health or the environment

Pollution: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems..

Essential Ques-

How can I tell if my water is clean?

Guiding Ques-

How do toxic substances get into the environment and into water sources?
Are there toxic substances in my home?
How can we prevent toxic substances from entering the environment?

Can Being Clean Make You Sick? *continued*

Step 1: Read the following excerpt from <u>Silent Spring,</u> by Rachel Carson.

"The most alarming of all man's assaults upon the environment is the contamination of air, earth, rivers, and sea with dangerous and even lethal materials...The poisons circulate mysteriously by underground streams until they emerge and, through the alchemy of air and sunlight, combine into new forms that kill vegetation, sicken cattle, and work unknown harm on those who drink from once pure wells...They travel from link to link of the food chain."

Step 2: Assign students to read and research <u>Silent Spring</u>, including reading about those who opposed its findings. Hold a debate, with one group of students taking Ms. Carson's side and another the side of the chemical industry officials who opposed her findings.

Note: As a shorter alternative, you may wish to do your own research on the topic and merely present it to students. Here is a brief overview.

Rachel Carson was a biologist who worked for the National Fish and Wildlife Agency in the 1960's. She wrote several books about the environment but her last book, <u>Silent Spring,</u> was a best seller that caused a revolution in the way people thought about science and the environment.

<u>Silent Spring</u> outlined, with scientific precision and in very readable prose, how chemicals of various kinds and amounts from numerous industrial, agricultural and household sources were getting into our ecosystems and often into our bodies. It has been cited as one of the most influential books of the 20th century and is credited by many as being the catalyst that created the environmental movement and made Americans begin to see science in a different light.

The book was very controversial and it had many opponents, especially in the chemical industry, who believed Ms. Carson's findings were biased and incorrect.

Step 2: Tell students that many of the substances we use to make our lives easier and more comfortable are made of chemicals that, in certain circumstances, can be potentially harmful. Some examples include pesticides, herbicides, carbon monoxide from cars, drain cleaners, oven cleaners, laundry detergents, floor or furniture polish, paints, and chemicals used in manufacturing processes.

Step 3: Tell students that, while there are many kinds of chemicals in the environment, they will be studying those found in our homes and looking at less toxic alternatives.

Step 4: Assign students to study the website http://www.epa.gov/kidshometour/ then discuss the site as a class. (The site examines toxic substances, answers students questions, and looks at potentially dangerous chemicals in household products.)

Can Being Clean Make You Sick? *Continued.*

Step 5: Tell students that, in this activity, they will be examining possible toxic substances in household products (For a list of possibly harmful substances go to the EPA's http://www.epa.gov/reg5rcra/wptdiv/p2pages/hhw.pdf to see potentially harmful chemicals and how they can be avoided.)

Step 6: Put the overhead of the house drawing (found at the end of this activity) up so all students can see it. Have students name various products that might be used in each room. Don't forget products in the garage; lawn and garden products; and medications. Discuss whether each product might end up as a water pollutant.

Step 7: Once you have a class list, divide the class into small groups and give each group a portion of the list. Have them either bring the actual products, or the information listed on the labels of the products, to class. (Note: for very toxic substances such as rat poison or pesticides, have students get help from adults to identify and get information from the product label.)

Step 8: Once students have assembled information about their products, have each group fill out the contaminant survey sheets for their products. This will require some research on their part. They can do this research on the Internet, contact the Kentucky Natural Resources Environmental Protection Cabinet or their local cooperative extension office for assistance.

Step 9: Once students have completed their contaminant survey forms, have them begin looking for less toxic alternatives to these products. (A sample list is at the end of this activity.)

Step 10: (Assessment) Have each group do a PowerPoint report on the products they researched and on some of the less toxic alternatives they discovered as well.

Extensions

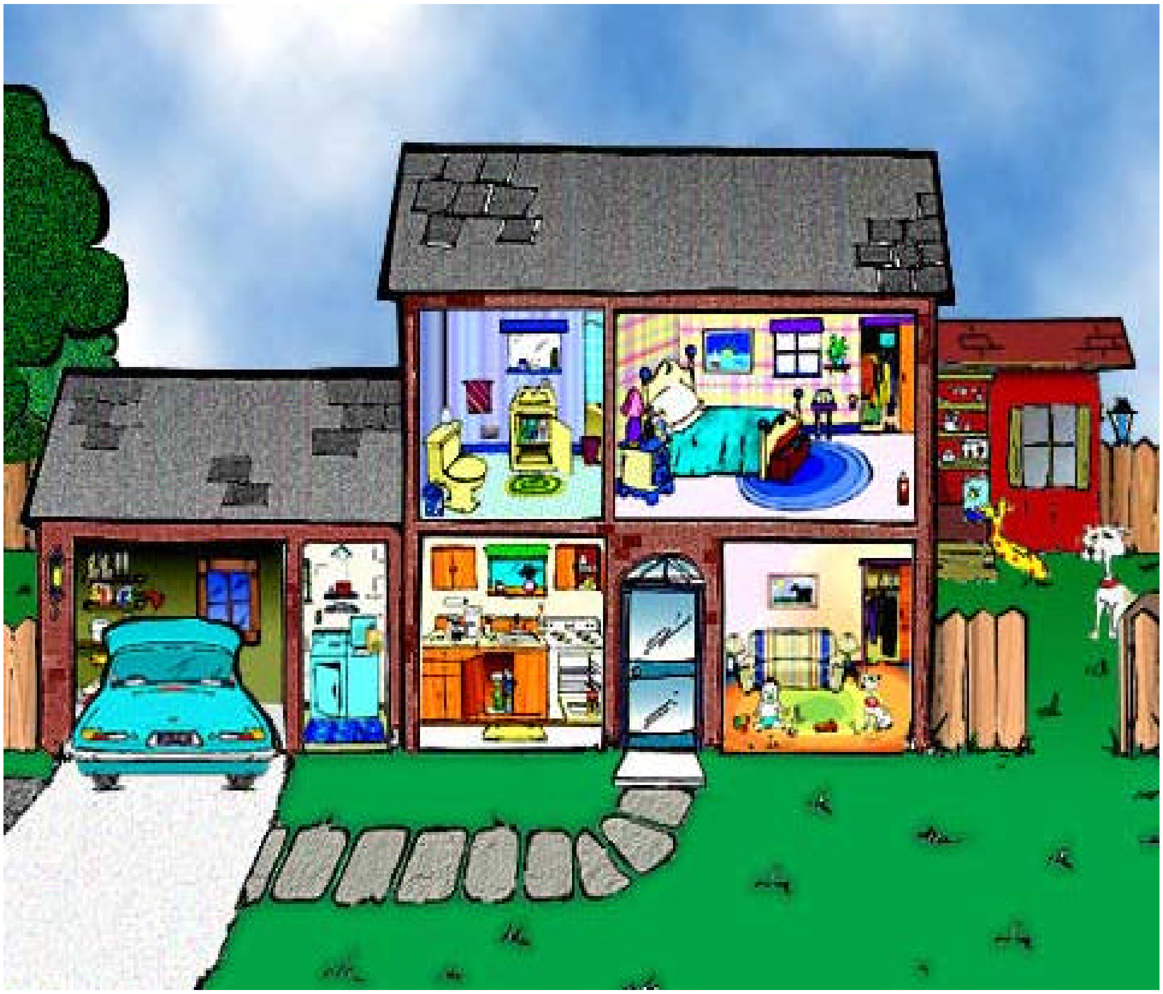
1. As a culminating activity, have students compile their research on alternative products and create a brochure that can be given to parents and other interested citizens.
2. Have students go to the website <http://kyeqc.net > This is the website for Kentucky's Environmental Quality Commission. The EQC monitors the state of Kentucky's environment and publishes its findings in an online report. Have students review the section on toxics.
3. As a portfolio piece, have students write a review of <u>Silent Spring</u>, by Rachel Carson.

Student Sheet **Alternative Cleaning Products**

Product	Safe Alternative Ingredients

Student Sheet — Contaminant Survey

Product Name	Four Main Ingredients	Container (plastic, glass, metal)	Caution Statement	First Aid	Disposal Procedure



List products in each room (or area) that might contain toxic substances .

A Few Alternatives to Common Household Products

ammonia-based cleaners	baking soda & water
abrasive cleaners	half a lemon in borax
floor/furniture polish	1 part lemon to 2 parts olive oil
silver cleaner	boiling water, baking soda, salt, and a piece of aluminum
toilet cleaner	baking soda and a toilet brush
disinfectants	1/2 cup borax in 1 gallon of water
drain cleaners	1/2 c. baking soda and 1/4 cup of vinegar in boiling water
rug/upholstery cleaner	dry cornstarch
mothballs	cedar chips, lavender flowers
oil-based paints	latex or water-based paints
furniture stripper	sandpaper
house plant insecticide	dishwater or bar soap & water
garden insecticide	cooking oil mixed with garlic and hot pepper
ant and roach killer	borax or boric acid

Kentucky's Commonwealth of Water – Be a Water Scientist
High School

Scientific Sleuthing

Adapted from *Project WET Curriculum and Activity Guide,* "Super Sleuths", Pages 107 – 115.

Standards

Science: SC-H-3.5.5, Students will understand that human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected.
Practical Living: PL-H-3.3.2, Students will analyze community health standards and regulations (e.g., air/water quality, immunization, health and safety protection of citizens).

Activity Description

In this activity, students will identify the role of water in transmitting diseases, compare symptoms of several waterborne diseases and analyze the characteristics of environments that promote the transmission of these diseases around the world.

Materials

For class:

- Symptom Card, included (3 copies, cut apart), numbered envelopes
- Class set of "Clue Sheet", included
- Copies of Scenarios, included, one Scenario per group of 6-7 students
- World map, newspapers and magazines (optional)

Length of Lesson

1 to 2 class periods

Vocabulary

<u>Waterborne disease</u>—disease acquired by ingesting contaminated water.
<u>Epidemiologist</u>—a scientist who studies the incidence, transmission, distribution and control of disease.
<u>Pathogen</u>—any disease-producing bacterium or microorganism.
<u>Bacterium</u>—any widely distributed unicellular microorganisms exhibiting both plant and animal characteristics and ranging from the harmless and beneficial to those that cause disease.
<u>Protozoan</u>—microscopic, single-celled organisms, largely aquatic and including many parasites.
<u>Virus</u>—any of a class of filterable submicroscopic pathogenic agents, chiefly protein in composition, and typically inert except when in contact with certain living cells.

Essential Question

How can I tell if my water is clean?

Guiding Questions

- What are the symptoms of different waterborne illnesses?
- How are pathogens introduced into my local aquatic systems?

Skills Used

Analyze Interpret Communicate Research

Scientific Sleuthing, *continued*

Preparation

Step 1: For the first activity in this lesson, copy a class set of the "Clue Sheet" found at the end of this activity. Make 3 copies of the Symptom Cards (depending on number of students in class, since each student needs a symptom envelope, and at least one other student needs to have the same disease) and cut the symptoms apart. Put them into separate, numbered envelopes, one disease per envelope. DO NOT put the identity of the disease in the envelope. Mix up the order of the envelopes containing the symptoms by randomly numbering them. REMEMBER to make yourself a "cheat sheet" so that you can easily determine which "disease" a pair of students have. To do this, label the envelopes with a unique number (1 — # of students in class). On a separate sheet of paper, list each disease and the corresponding numbers of the envelopes which contain the symptoms for that disease. For instance, if the envelopes numbered 4 and 17 contain symptoms of Giardiasis, write down Giardiasis — #4 and #17 on your sheet. Then when students ask questions about whether they have identified the correct disease, you will know at a glance.

Step 2: Have computers and other research tools available for student use, if plans are to extend this activity to include the Scenarios found at the end of the first activity. If Scenarios are going to be used, copy and cut apart the four scenarios found on the next two pages.

Visit the following web sites and decide how much help you want to give to your students during the research phase of this activity. If computers or other sources for research are not available, information may be printed from the following web sites so students have access to research materials that will help them find the answers to the questions following each Scenario.

Information on waterborne illnesses:
- **http://www.cdc.gov/ncidod/dpd/parasites/waterborne/default.htm**
- **http:www.pasteur-lille.fr/english/health/vaccine/gpwat.htm**

Information on emergency disinfection of drinking water
- **http://www.epa.gov/safewater/faq.emerg.html**
- **http://www.epa.gov/safewater/faq/faq.html**

Information on recreational water quality:
- **http://www.cdc.gov/healthyswimming/**
- **http://water.nr.state.ky.us/dow/dwswim.htm**

Information on fish consumption advisories:
- **http://www.scdhec.net/eqc/admin/html/fishadv.html**

Activity

Step 1: Ask students if they can identify the world's number one killer. Explain that thousands of children die each year from diarrhea, and that diarrhea is caused by microorganisms such as bacteria, viruses and protozoa. Define these terms, if needed. Ask students if they can identify the source of these organisms.

Step 2: Show students two glasses of water — one murky due to sediment, the other clear. Pretend to sneeze on the clear glass. Ask students which glass of water they would prefer to drink. Make the point that disease-causing organisms can be found in clear, clean-looking water.

Step 3: Tell students that like epidemiologists, they are going to compare symptoms and mode of transmission of diseases that they and others in the class have "acquired".

Scientific Sleuthing, *continued*

Step 4: Hand out the symptom envelopes and "Clue Sheets", one to each student. Instruct students to pull out only one symptom card at a time from their envelope. **(**Many students in class will have similar symptoms, but only a few will have the same disease.)

Step 5: Direct students to circulate around the classroom, asking other students about their symptoms. The goal of each student is to locate other students who have symptoms similar to their own. (Give students a choice as to whether they want to take notes, or just try to remember who has which symptom.)

Step 6: After one or two minutes of "sleuthing", instruct students to remove a second symptom card from their envelopes. They should continue to search for other students in the room with the same illness. Continue removing a new clue every one to two minutes until all clues have been removed from the envelopes and everyone has found at least one other person sharing the same waterborne disease.

Wrap Up

Step 1: Call on students to read their list of symptoms to the class, review the disease descriptions from the Clue Sheet, and identify their disease. Ask students to infer how they contracted the disease, how the disease was transmitted, and how it can be prevented.

Step 2: Discuss the control cards. Explain to students that these cards describe conditions that are not related to waterborne diseases. (For example, the person was tired in the late afternoon because he or she worked long days, and the pain and rattling in the chest were likely caused by smoking.)

Step 3: Direct students toward available research tools so they may conduct research to confirm their answers and to investigate where these diseases occur throughout the United States and the rest of the world. Have a world map available so students can plot their diseases and discuss conditions that might allow for the spread of these diseases (e.g., inadequate water treatment systems, concentrated population, political upheaval that forces large migrations of people suffering from lack of food and water, the presence of disease spreading organisms such as beavers or snails).

Step 4: Discuss the role of water in the transmission of disease. Emphasize that most waterborne diseases result from inadequate water treatment and poor sanitation practices. However, contamination occasionally occurs despite sound water treatment practices.

Step 5: Discuss how the cause and transmission of disease are studied by epidemiologists. The website http://www.ph.ucla.edu/epi/snow/uabsnow.htm tells the story of John Snow, a pioneering epidemiologist who stopped an 1854 cholera epidemic in London by locating cholera cases on the map of a London neighborhood and then deducing that the source of the disease was a water pump used by many residents. When the handle of the pump was removed, the epidemic stopped.

Activity 2

Step 1: Explain to students that people are faced with water issues every day, and that they are going to be given the opportunity to work through some common problems with a small group of classmates. Assign students to small groups, and pass out the Scenarios found at the end of this activity, one Scenario to each group of students.

Step 2: Give students time to read their group scenario, then discuss different ways students may go about trying to find the answers to the questions.

Scientific Sleuthing, *continued*

Step 3: Allow time for research, then, as a group, take turns reading the Scenarios and discuss the answers to the questions. Conclude this activity with the following assessment suggestions.

Resources

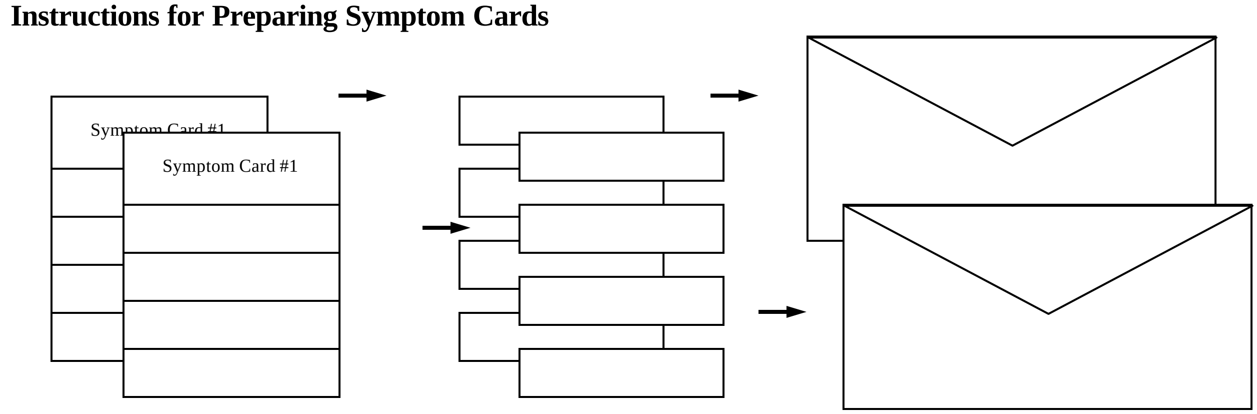
- **For information about occurrences of specific diseases within the United States and around the world, as well as information about specific diseases, students can contact the Center for Disease Control, 1600 Clifton Road NE, Atlanta, GA 30333. (404) 639-3311, www.cdc.gov/ . Follow the link "Health Topics A-Z".**
- **Contact a local health department official to talk to students about local water related illnesses and/or health careers.**

Assessment

Have students:

- **Describe the symptoms of several waterborne diseases.**
- **Relate how some waterborne diseases are transmitted.**
- **Analyze conditions that promote the spread of waterborne diseases.**
- **Research and identify career opportunities available in the health industry that deal specifically with waterborne illnesses and prevention.**

Instructions for Preparing Symptom Cards



Make 3 copies of each symptom card. This will be enough for 24 students.

Cut along dotted line to cut each card apart, then cut into strips along the thin solid lines.

Put each set of symptoms in separate numbered envelopes. **Do not include illness identity.**

Background Information for "Scientific Sleuthing"

Waterborne diseases are those acquired through the ingestion of contaminated water. About 80 percent of all diseases are water-related. In many of these illnesses, water infiltrated with sewage spreads the disease. An infected person or animal may pass pathogenic bacteria, viruses, or protozoa through waste into the water supply.

The microorganisms that cause illness cannot be seen, smelled, or tasted; contaminated water often appears fresh and clear. This causes particular concern with municipal water supplies. Contamination may not be detected until a noticeable number of people have become ill.

Most ailments caused by ingestion of water infiltrated with sewage are intestinal, causing gas, cramping, and diarrhea. Some pathogens (harmful microorganisms) attach to intestinal linings and produce toxic materials which the body then tries to purge. Others invade intestinal epithelial cells and cause inflammation but do not produce toxins. Fluids containing disease-fighting white blood cells are secreted into the intestine to aid in attacking or flushing the harmful organisms from the body. Unfortunately, this loss of fluids also causes dehydration, the major concern in patients with these types of diseases.

If the patient is very young, elderly, or malnourished, dehydration can be life-threatening. Children with diarrhea must be closely monitored. They have not developed the immunities of adults, and their systems can be quickly overwhelmed by the sheer number of pathogens. As many as one-third of pediatric deaths in developing countries are attributed to diarrhea and the resulting dehydration. Africa, Asia, and Latin America experience an estimated 3-5 billion cases of diarrhea, with 5-10 million deaths, each year. *Vibria cholerae, Salmonella sp., and Shigella* species of bacteria are among the leading causes of bacterial diarrhea.

Bacteria are everywhere, including in our water. However, municipal water supplies are monitored to prevent contamination by fecal pathogens in concentrations that will produce infections in humans. Water treatment facilities routinely test for these pathogens by checking levels of indicator bacteria, such as *Escherichia coli* (a common organism in our intestines). If these organisms rise above a set level, fecal contamination has occurred and more intensive water testing should begin. This does not mean other pathogens are present, but serves as an "indicator" that they may be. It may be necessary to accelerate water treatment procedures. Also, the source of contamination must be located and protective measures taken to avoid further contamination.

Until recently, Americans have regularly suffered through epidemics of waterborne illness such as cholera and typhoid fever. Improvements in wastewater disposal practices and the development, protection, and treatment of water supplies have significantly reduced the incidence of these diseases. The treatment and chlorinating of municipal water have made infection by microorganisms rare in developed countries; however, in many developing countries treatment of wastewater is minimal or nonexistent. In some cases, sewage and other wastes are dumped directly into rivers that are used by people downstream for drinking and washing.

Epidemiologists study the incidence, transmission, distribution, and control of disease. When outbreaks of a particular disease occur, epidemiologists research symptoms, incidence and distribution of the cases; they try to determine the cause of the disease, its means of spreading, and possible methods for controlling or preventing the illness. With waterborne diseases, determining how the water supply was contaminated is critical to solving the problem. The case histories of affected patients and any associations among patients help epidemiologists solve the mysteries of disease. (Reprinted from with permission, from "Super Sleuths", Project WET Curriculum and Activity Guide, The Watercourse and Council for Environmental Education, pages 107 – 108.)

> Note: More than 36,000 "straight pipes" have been found in Eastern Kentucky alone. Approximately 25% of all Kentuckians get their water from wells. (Source, Ky Division of Water)

Clue Cards for Scientific Sleuthing Activity

Cholera, caused by *Vibrio cholerae* bacteria

This disease is extremely contagious; if untreated, dehydration can lead to death. Cholera originated in Europe and was spread to the United States by transatlantic liners through New Orleans. Outbreaks have been linked to eating food that has contacted contaminated water.

Giardiasis, caused by the *Giardia lamblia* protozoan

Sickness results with only a low dose of the protozoan; it is the most commonly reported causative pathogen of waterborne outbreaks. The giardia protozoan is killed by boiling water for at least five minutes or is removed by passing water through a filter whose pore size is at least 0.2 microns. Found in fresh water.

Arsenic

Arsenic can enter water from natural sources, such as bedrock or from arsenics in pesticide runoff. Can cause anemia with paleness, weakness, and breathlessness. Affects the skin, causing thick patches on hands and feet.

Lead

Lead can get into water from pipes or solder in the home plumbing system. Homes built up to the early 1900's often used lead for interior plumbing. Can cause serious nerve, brain, and kidney damage, especially in young children.

Cryptosporidiosis, caused by *Cryptosporidium*

This was first identified as a cause of diarrhea in people in 1976. It can be transmitted through contact with animals, particularly cattle and sheep, other humans (especially daycare centers) and contaminated water supplies.

Hepatitis A., caused by *Hepatitis A* virus

This is the third most common cause of waterborne disease in the United States. The term hepatitis relates to inflammation of the liver. Symptoms include jaundice.

Control Card

You probably don't have a waterborne disease. Many of the symptoms are confusing and must be diagnosed by a competent health care professional. Many things in our environment and our lifestyles affect our health.

Legionnaire's disease, caused by *Legionella pneumophilia* bacteria

Found naturally in water environments; bacteria often colonize artificial water systems such as air conditioners and hot water heaters, and can be inhaled with aerosols produced by such systems. Smoking and lung disease increase susceptibility to disease.

Salmonellosis, caused by species of *Salmonella* bacteria

This is carried by humans and many animals; wastes from both can transmit the organism to water or food. The largest waterborne salmonella outbreak reported in the United States was in Riverside, California, in 1965 and affected over 16,000 people.

Shigella, caused by species of *Shigella* bacteria

Most infection is seen in children 1 – 10 years old; a very low dose can cause illness. Waterborne transmission is responsible for a majority of the outbreaks.

Symptom Cards for Scientific Sleuthing Activity

Cut symptoms apart and place in envelope, without identity.

Symptoms #1 — Cryptosporidiosis	**Symptoms #2 — Hepatitis A.**
Four years old	Visited favorite beach and swam with friends
Attends a daycare center five days a week	Malaise – general weakness and discomfort
Diarrhea	Anorexia – loss of appetite
Nausea and vomiting	Fever
Fever	Nausea, mild diarrhea
Sucks thumb	Jaundice – yellowing of skin and whites of eyes
Recently swam in a local pond	Sick for a week

Symptoms #3 — Control Card	**Symptoms #4 — Giardiasis**
Lives on a ranch that raises cattle and chickens	Symptoms occurred two weeks after backpacking trip
Just returned from visiting friends in Mexico	Filled water bottle with clear, fresh-tasting water from a stream below a beaver dam
Lives in a home that is constantly air conditioned during the summer months	Abdominal cramps
Is tired in the late afternoon	Intermittent dysentery (which is greasy and odorous)
Often conducts pack trips in the mountains	Excessive intestinal gas
Works 14 hours a day, usually seven days a week	Malaise – general weakness and discomfort
Drinks eight glasses of water per day	Weight loss

Cut symptoms apart and place in envelope, without identity.

Symptoms #5 — Legionaire's disease
Chain smoker living in warm climate
Lives in a home that is constantly air conditioned during summer months
Sudden onset of fever that progressed to a high fever with shaking chills
Developed a cough and excessively rapid breathing
Pain in chest; lungs have rattling sound when breathing
General, diffuse muscular pain and tenderness
Intense headache and mental confusion

Symptoms #6 — Lead Poisoning
Attends a daycare center five days a week
Sucks thumb
Recently swam in a local pond
You are two years old
You live in a home built in 1889 in a big city
The doctor has found you have some damage to your nervous system

Symptoms #7 — Cholera
Recently returned from Bangladesh
Symptoms occurred two days after eating fruit thoroughly washed at outdoor pump
Family members have begun coming down with the same symptoms
Severe dehydration
Painless diarrhea, vomiting
Severe muscular cramps in arms, legs, hands and feet
Eyes and cheeks appear sunken; hands have dishwashing appearance

Symptoms #8 — Arsenic poisoning
About four months ago, had fever, cough, diarrhea, and muscular pain
Numbness and tingling in toes and fingertips
Weakness in hands and thickened patches of skin on hands and feet
Does not smoke
Has lived on his farm for 10 years and drinks well water
Other family members are not ill

Scientific Sleuthing
Student Scenario Extension Sheet #1

Directions: Read the following scenario then, in your group, research and answer the accompanying questions.

SCENARIO ONE:
Nicole is 16 today and a pool party is planned. It has been raining for two days straight after a long dry spell, but today the sun is shining. She has prepared everything needed including making ice, pitchers of lemonade, filling the pool and preparing the balloons for the water balloon toss game. Her mother phoned and said that she was late for work due to a water main break and will be home late. All seems fine and then Nicole hears on the radio that there has been a "boil water advisory" for her county. Does Nicole have to cancel the birthday party?

- **Describe boil water advisories?**
- **Who is responsible for issuing boil water advisories?**
- **List two reasons in this scenario that could have caused the advisory?**
- **Determine possible pathogens for the illness in this advisory?**
- **What professionals would you call for complete information on the advisory?**
- **Compile a list of boil water advisories for your area of Kentucky with causes.**

Directions: Read the following scenario then, in your group, research and answer the accompanying questions.

SCENARIO TWO:

You and some friends have just returned from an afternoon of fishing at a local river. The fish were biting, and you have a small cooler full of fish that are going to make a delectable feast for dinner. You have already invited your friends to stay for dinner.

Upon arriving back at the house, you prepare to clean the fish as your dad walks out and asks where the mess of fine looking fish were caught. Everybody talks at once, relating the great story of the exciting fish catch over on the banks of the local river.

As he listens to the story, you notice your dad is not as excited as you and your friends are about the big catch. When asked what is wrong, your dad announces that a "fish consumption alert" for the river where these fish have been caught has been announced on the television and radio for the past two days. What are the implications for the planned fish fry?

- **Why are fish consumption advisories issued?**
- **Who is responsible for issuing fish consumption advisories?**
- **What possible contaminants may be present in the fish?**
- **What is currently known about the dangers to humans of contaminants found in some fish?**
- **Are some members of the general population at a greater risk than others? Explain.**
- **What can be done to reduce the health risks from eating fish?**

Scientific Sleuthing
Student Scenario Extension Sheet #2

Directions: Read the following scenario then, in your group, research and answer the accompanying questions.

SCENARIO THREE:

Trish is an experienced hiker and has traveled to Red River Gorge for the week before school. Trish is an instructor at the high school and is enjoying her last week of summer vacation. On her 12 mile hike, she comes across inexperienced campers who have run out of drinking water. She gladly shares hers knowing that her campsite has a nice spring from which she can get water. A week after school starts, she begins to feel ill. What could be wrong?

- **Why did Trish get sick?**
- **Compile a list of possible pathogens that could have caused this sickness?**
- **What are the exact symptoms for the infection of the pathogens you described above?**
- **What could have prevented the illness for Trish?**
- **What could have prevented the illness for the environment?**

Directions: Read the following scenario then, in your group, research and answer the accompanying questions.

SCENARIO FOUR:

Greg and several of his friends are on a three day canoe trip on the Licking River. Spotting a sandy beach and a rope swing, they feel the perfect place for camp has been found. As they approach the shore, they observe a pipe coming straight out of the hillside and detect a yucky odor. When Greg beaches his canoe, he cuts his foot on a broken bottle. The camp sight has lost its intrigue.

- **List five questions you think Greg and his friends are forming and debating.**
- **Describe the pathway of infection from the possible pathogens for Greg and his friends.**
- **Compile a list of professionals and their organizations that should be alerted to the straight pipe and odor.**
- **What are the legal regulations that have been violated?**
- **Determine what Greg and his friends should do so this area of the river can be safe for others.**

Pollution Solution: A Culminating Activity

Standards

All standards from the unit plus

SS-H-G0-GC-3: students will analyze the importance of rights and responsibilities of citizens in a democratic society.

Activity Descrip-

Students will work in groups and read scenarios that describe a variety of water pollution issues. They will then use knowledge gained in the unit, along with original research and problem solving, to come up with practical solutions and then present those to the class and defend their work.

Materials

Scenarios (on page three of this activity); research sources such as the library, the Internet and local and state experts who can provide information; power point or other software and/or materials that can be used to make a class presentation.

Length of Lesson

One half hour to explain the project, form groups and hand out scenarios. One hour for groups to take inventory of what they know and hand out assignments for gathering more data and information. Several hours for groups to analyze the information, come up with a solution and put together a presentation (or this can be done as a homework assignment), at least one hour for groups to present and answer questions.

Essential Question

How can I tell if my water is clean?

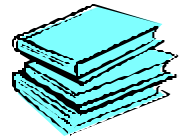
Guiding Questions

All questions from the unit

Skills Used

Research	Communicate	Present	Defend
Speculate	Organize	Discuss	

Pollution Solutions, *continued*



Activity

Step 1: Read the pollution solution scenarios on the next pages to make sure you understand them thoroughly. You will need to serve as a facilitator for students as they go through the process of coming up with solutions to the problems.

Step 2: Tell the librarian that your students will be doing independent research on water issues over the next few weeks. Ask if she can be ready to assist them.

Step 3: Tell students you are going to put them into groups to solve four water pollution problems. You may form four or eight groups depending on the size of the class. If you form eight groups, two groups will come up with solutions to one problem. In that case, they should do so independently to see if they create the same or different solutions.

Step 4: Tell students that each group will be responsible for doing research on their problem and using that research and their own knowledge to create a possible solution to the problem. Tell them solutions must be practical. Also tell them they will responsible for making a presentation to the entire class on how they would solve the problem and why they chose that solution. The class can then question them about their solution and even challenge them on it. Therefore they need to be ready to defend their idea and back it up with solid information.

Step 5: Give each group the first part of a scenario. Save the second part (the solution, which is in italics) until after the presentations are complete. Also give each student the "Pollution Solution Process" sheet to help them think through how to create a solution. **Have students create their own assessment rubric using the Pollution Solution Process as a guide.**

Extension

1. **Have students write their own scenarios of water pollution problems as portfolios pieces.**
2. **Have students use the information they have gathered and learned on the different kinds of water pollution to write an educational article for the local paper.**
3. **If they have not already done so in their unit, have students test local streams for different kinds of pollution identified in this unit.**
4. **Have students make a presentation to the local city council or fiscal court about what they have learned, especially as it relates to their community.**
5. **Have students research different careers in which people help monitor and protect water.**

Pollution Solutions (cont.)

Scenario One—Siltation

A large new shopping mall is being built in Mountainville, Kentucky. The builders say it will bring business to the community and make it easier for local residents to buy goods and services at competitive prices. The mall will include a new movie theater. Local teenagers look forward to this. However, there is a problem. There has been a great deal of rain this year and dirt from the building site has been running off into the Boone River, which runs through Mountainville. Dead fish have been found along the river banks and a bad odor is pervading the town.

Find out why the fish are dying and what is causing the odor. Find a solution to the problem that includes both the completion of the new mall and the restoration of the river.

<u>*Possible Solution*</u>

A large amount of dirt has been washed into the river filling it up with silt and mud. This means that the river is so shallow in some places that very little water is flowing at all. When a river or stream becomes much more shallow than before, several changes occur. First, the water becomes warmer because sunlight reaches to the bottom. Also because sunlight reaches the bottom, many more plants grow in the river, thus using up much of the oxygen. These changes will cause some fish to go elsewhere where the ecosystem is more to their liking. The fact that the plants are using up the oxygen is killing some fish.

The smell may have several sources. The dead fish smell bad of course, and other organisms are dying as well because of the changes in their ecosystem. In addition, since a more shallow stream flows more slowly, pollutants such as fecal matter from straight pipes, that are usually washed away by the stream, now pile up and begin to smell. These pollutants can even cause health problems.

A number of things can be done to prevent the siltation of the river. The first is for the builders of the mall to have the dirt carried off to a more suitable site. The second is to plant filters such as trees and shrubs along the river near the building site to "capture" some of the silt that is now being washed into the river. Finally, straight pipes can be eliminated along the stream.

Scenario Two—Nutrients

Due to a fire, a large whiskey distillery has accidentally spilled thousands of gallons of whiskey into the Kentucky River. Fish in the area of the spill are beginning to die in large numbers. Find out why the fish are dying and what can be done to help save the rest of the fish.

<u>*Possible Solution*</u>

Whiskey contains alcohol which is a type of sugar. The sugar that is released into the stream in the form of alcohol causes an algae "bloom". This simply means that millions of new algae grow in a very short time. As the large number of new algae die, the decaying process uses up large amounts of oxygen. This means there is little left in the river for fish and the fish literally suffocate. It is this "imbalance" in the ecosystem that causes the many problems that result from having too many nutrients in the water.

The solution to the whiskey spill and to other "overnutrification" problems such as manure from feedlots and fertilizers from lawn runoff, is two-fold. First, efforts should be made to reduce the amount of nutrients being put into the ecosystem. The second is to build buffer areas and vegetation between the source of the nutrients and bodies of water.

Pollution Solutions (cont.)

Scenario Three - Pathogens : In August, the Smalltown Baptist Church held a Saturday morning revival. The young preacher gave several very moving sermons, the choir sang rousing versions of old hymns and the congregation turned out a wonderful picnic dinner. By the afternoon, many new folks had come forward to be baptized and over twenty people were baptized in the pool at the mouth of Coldwater Creek, which runs by the church.

However, the next morning only a few of these new converts appeared at church. When the young preacher began to investigate why, he found that nearly all had succumbed to stomach ailments, including, nausea, diarrhea and stomach cramps. He is puzzled because a similar event, including a baptism, was held in early May with no problems.

Come up with at least two scenarios for what might have happened to the folks of Smalltown Baptist Church and how it could have been avoided.

<u>*Possible Solution*</u>

There are two possible explanations for the parishioners' distress. The first it food poisoning. Since there was a picnic and the day was warm, (it was August) the food that was brought, even if it was prepared with the greatest care to cleanliness, might have set out too long, allowing bacteria to grow. Bacteria that often grow when such foods as potato salad and fried chicken are allowed to set at warm temperatures can easily cause the distress experienced by these folks. However, in this case, only those who were baptized became ill. Therefore, there is another and more likely explanation.

Coldwater Creek is at the mouth of Coldwater Hollow. About twenty families live in the hollow and nearly all of them have straight pipe sewer systems. In other words, human waste goes directly from the toilet to the creek without being treated in any way. Many such systems exist across the state. On a hot August day when there has been little rain for the past few weeks, bacteria from these straight pipe sewer systems are at very high levels in the water of the creek. People who were baptized in the Creek were immersed in the water and came up with water—and bacteria— in their noses and mouths. The bacteria quickly made its way from their mouths to their guts . In contrast, though the same bacteria exist in the stream in May, the spring rains insure that they are much more dilute since water levels are higher and the stream is moving at a much faster rate.

There are two possible solutions to this problem. The first is simply to stay completely out of the streams. That means no swimming , no boating, no fishing and no baptisms. It also means no tourism dollars that might result from using Kentucky's beautiful streams for recreation.

A second solution is to eliminate straight pipe sewer systems. If you did not do so in your presentation, explore the extent of this problem in your community (if it exists) and possible solutions. Present these findings to your local fiscal court or city council. Remember, bacteria can also get into streams when wastewater treatment facilities become overloaded. This is a more and more common occurrence in the Commonwealth.

Scenario Four: Toxins

Bill has been fishing with his grandfather in the Boone River since he was four. About twice a month (in good weather) they catch crappie and small mouth bass and bring them home for Bill's grandmother to cook. Bill is now in high school and his chemistry class is studying chemicals that exist naturally in some streams and about those that are introduced by human activity. Bill has learned that some chemicals that get into the water make their way up the food chain and get into fish. These fish can be unhealthy to eat. The Kentucky Division of Water even issues "Fish Consumption Advisories" to warn people of the dangers of eating fish from certain streams.

Bill becomes concerned about eating fish from the river, especially since his grandmother has recently been treated for cancer. However, when he tells his grandparents of his concerns, they are upset. They say they have been eating fish from the river for 60 years and fresh fish, fried in Grandma's special batter, is one of their favorites.

Scenario Four—Toxins (cont.)

Your task is to find a way that Bill can help himself and his grandparents understand and deal with this problem?

Possible Solution

Fish consumptions advisories have been issued across the United States for more that thirty years. Numerous human activities—and some natural ones - can cause toxic build ups in fish that humans consume. Some come from particular sources such as runoff from pesticides and factories, others come from the deposition of chemicals that have been released into the atmosphere. Bill can do several things.

- *First he can determine whether there is a Kentucky Division of Water fish consumption advisory for the river where he and his grandfather fish. If there is not, he can be extra cautious by asking the local county health department to test the water and fish where he and his grandfather like to fish.*
- *If there is a fish consumption advisory for the river, or if health department testing finds problems, Bill and his grandfather have two choices. They can begin searching for the source of the chemicals that are getting into the fish and, if they can find the source, try and have it removed.*
- *If they are unable to find or remove the source, they can follow the guidelines that the Kentucky Division of Water issues for how often fish from the river can be eaten and the best way to prepare the fish to minimize the danger. Since many fish consumption advisories are for pregnant and nursing women and small children, Bill and his grandparents may be at less risk than others.*

If you have not done so already, search the Division of Water Website for fish consumptions advisories. Do any occur near your community? If so, do you know the cause?

The Following websites may be especially helpful. Student should search for other websites as well. Www.state http://water.nr.state.ky.us/dow/regs.htm and http://www.epa.gov/ebtpages/water.html

The Pollution Solution Process

1. **<u>Summarize what you know</u>: Have your group read and summarize what you know about the scenario. It may be helpful to write down all the important pieces of information you already have. It is just as important to write down the information that you don't have but think you will need in order to come up with a realistic solution.**

2. **<u>Brainstorm</u>: As a group, brainstorm possible causes of the problem and possible solutions. It is important at this stage not to get into long discussions but rather to just think of as many ideas as possible, as quickly as possible. Respect all ideas - no matter how improbable they may seem at the time—and write them all down. Once again list information you may need.**

3. **<u>Research</u>: Look at the information you have and the information you think you will need. Assign group members to do research and gather information that the entire group thinks is needed to solve the problem. Do this in a least two stages. After initial information is gathered, reconvene the group to share that information and to see what other facts and concepts are needed and if any new information suggests the need for other areas of re search. Repeat this until the group feels comfortable that it has enough information to create a solution.**

4. **<u>Summarize the Research</u>. Make a list of facts and ideas you have discovered. Discuss how each affects the problem.**

5. **<u>List solutions</u>: Based on your own ideas and the information you have gathered, create a solution to the problem. Remember, the solution should be one that you think could be accomplished in your own community.**

6. **<u>Prepare to defend</u>: Once you have come up with a solution, think how others may view it. Is it practical? Is it a solution with which most people would agree. Make a list of possible criticisms of your solutions and how you would counter those criticisms.**

7. **<u>Create your presentation</u>: Using the talents and skills of your group members to organize, draw, compute, speak, etc., create an presentation that will both explain your solution to the problem given in the scenario and share with your classmates the knowledge you gained while researching possible solutions.**

High School Reading List*

Cadillac Desert: The American West and Its Disappearing Water. By Marc Reisner. This is a history of the American West's water and its great water projects that transplanted water to allow the phenomenal growth of California and the Southwest. The book's perspective of water rights, and ecologic and economic consequences of such actions focuses on government and business tactics.

Food and Water: Threats, Shortages and Solutions. By Bernard S. Cayne (Editor), Jenny E. Tesar. Discusses the vital importance of having an adequate supply of food and water and the effects of pursuing this need though various forms of storage and farming methods.

From Reclamation to Sustainability: Water, Agriculture and the Environment in the American West. By Lawrence J. MacDonnell. Tells the stories of four places in the West where development and use of water, primarily for irrigated agriculture, have been central to economic and social development.

Gila: The Life and Death of an American River. By Gregory McNamee. Follows the ecologic history of the Gila River from its source in New Mexico, through its confluence with the Colorado River and into Arizona. Today, half of the Gila is dead, due to overgrazing, damming, and other practices.

Ground Water and Surface Water: A Single Resource. U.S. Geological Survey Circular 1139. Presents an overview of the interaction of ground water and surface water, in terms of both quantity and quality, as applied to a variety of terrains across the country. Discusses the firm scientific foundation for policies governing the management and protection of aquifers and watersheds.

Last Oasis: Facing Water Scarcity. By Sandra Postel, Linda Starke (Editor). The worldwide water crisis, according to this book, is due to its ready availability, low cost, people's overuse, and lack of respect for this life-sustaining resource. Solutions are giving for restoring and sustaining this essential lifeline.

A River No More. By Philip L. Fradkin. This is a definitive history of the development of the Colorado River and the claims made upon it from its source in the Wyoming Rockies to the Gulf of California, where it evaporation in the sand.

* Please note that not all books on this list are included in the PRIDE list approved for purchase. See http://www.kypride.org/ for that list.

The High School Reading List about Water, cont.

Silent Spring. *By Rachel Carson. Considered a classic, this book describes the dangers of manmade chemicals to the environment and to human health. Often credited with being one of the books that led to the environmental movement of the 1970's.*

A Story That Stands Like a Dam: Glen Canyon and the Struggle for the Soul of the West. By Russell Martin. A narrative history of hydroelectric dams and their impact on ecological processes downstream and its drownings of natural landscapes behind their headwalls.

Tapped Out: The Coming World Crisis in Water and What We Can Do About It. By Paul Simon. Discusses increasing global population and a water supply that cannot increase; faced with this crisis, what can the average citizen do?

Vision in the Desert: Carl Hayden and Hydropolitics in the American Southwest. By Jack L. August. Focuses on longtime Arizona senator, Carl Hayden, whose career was centered on water and its distribution, inseparable from the history of the West and development of arid lands.

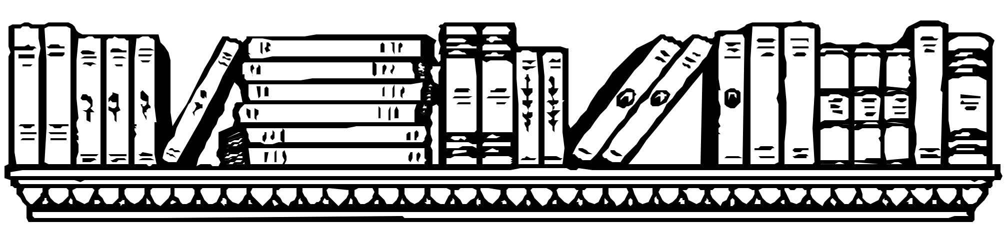
Water: A Natural History. By Alice Outwater. Takes us on a journey 500 years past to present to recover a lost knowledge - how the land cleans its own water, how natural ecologically interacting systems can create healthy waterways.

Water : A Resource in Crisis. By Eileen Lucas. Discusses the quality and quantity of water on a global scale and includes discussions of resources, the ways we use water, pollution, making water safe, taking care of our water, and taking action.

Water: Almost Enough for Everyone. By Stephanie Ocko. Through case studies, anecdotes, facts, and theoretical explanations, this book provides a look at the social and environmental implications of severe droughts, their causes, and some possible solutions.

Water Conservation: Student Edition. By Leslie Crawford, Jeri Hayes (Editor), Cathy Anderson (Editor). Shows students different ways to analyze, consider options, and take action on issues such as sources of water pollution, community water supply, the school water system, reading a water bill, conservation technologies and practices, and assessing costs and benefits.

Water Wars: The Fight to Control and Conserve Nature's Most Precious Resource. By Olga Cossi. Discusses how we have to change our habits and our ways of thinking in order to preserve the earth's water resources - the crucial role water plays in nature and how dwindling supplies are affecting the various ecosystems of the world.



Glossary of Terms

Absorb— movement of water into another material.

Acid rain— precipitation that contains a high concentration of acidity from the reaction of air pollution, primarily sulfur and nitrogen oxides, with sunlight and water vapor in the earth's upper atmosphere.

Aeration— the mixing or agitation of waste water, allowing for the mixture of oxygen or air with the microbial solids and waste water.

Alkalinity— the total measurable bases (OH, HCO_3, CO_3) in a volume of water; a measure of a material's capacity to neutralize acids; pH > 7.

Alluvium— a general term for clay, silt, sand, gravel or similar unconsolidated material deposited by a stream or other body of running water.

Aquifer— a water-bearing layer of rock or sediment capable of yielding supplies of water; typically is porous deposits of sandstone, limestone or granite. Can be classified as confined or unconfined.

Best Management Practices (BMPs)— structural, nonstructural (vegetative), and managerial techniques recognized to be the most effective and practical means to reduce surface water and ground water contamination while still allowing the productive use of resources.

Black water— water containing liquid and solid human body waste generated through toilet use.

Blue baby syndrome— blood related condition found in babies due to nitrate poisoning (poisoning limits blood's ability to carry oxygen thereby causing baby to look blue hued); known as methelmoglobanemia.

Carbon (C)— a nonmetallic element found in all organic substances and in some inorganic substances, like diamonds, graphite, coal, charcoal, etc.

Carbon Cycle— the movement of carbon among living and nonliving matter throughout the earth's system.

Carbon Dioxide (CO_2)— a heavy, odorless, incombustible gas taken from the atmosphere in the photosynthesis of plants and returned to it by the respiration of both plants and animals.

Cave— an underground geological feature that is formed when water percolating through acidic soils dissolves the limestone along rock fractures and between rock layers, creating underground channels that may carry groundwater through them.

Chlorination— the application of chlorine to water, sewage, or industrial wastes, generally to disinfect, to oxidize, or to improve settling.

Cistern— an artificial reservoir, like a tank, used for holding water or other liquids.

Clean Water Act— the Federal Water Pollution Control Act of 1972, Public Law 92-500, is a law passed by the United States Congress, in 1972, that created guidelines for states to follow concerning water quality. A summary of the law may be accessed at: **http://www.epa.gov/region5/defs/html/cwa.htm**

Combined sewer— a sewer system that carries both sewage and storm water runoff. Normally, its entire flow goes to a waste treatment plant, but during a heavy storm, the volume of water may be so great as to cause overflows of untreated mixtures of storm water and sewage into receiving waters (combined sewer overflows). Storm water runoff may also carry toxic chemicals from industrial areas or streets into the sewer system.

Condensation— the process of changing a gas or vapor to a liquid, as in the formation of water droplets when steam cools.

Conservation—the protection or wise use of natural resources that ensures their continuing availability to future generations; the intelligent use of natural resources, such as water, for long-term benefits.

Consumption—the amount of any product or resource (e.g., water) used in a given time by a given number of consumers.

Contamination—made impure or unsafe by contact with potentially harmful substances.

Cycle— a sequence of events or processes that happens over and over again.

Density— a measure of the compactness of matter and is defined as the amount of matter per unit of volume. The formula for density is “Density = Mass divided by Volume“. Density is sometimes thought of as the “lightness” or “heaviness” of a substance.

Discharge—the flow of surface water in a stream or canal or the outflow of ground water from a well, ditch, or spring.

Dissolve—the apparent disappearance of one material in another when they are mixed.

Distillation—the purification of a substance by heating and removing the more volatile parts of the substance through evaporation.

Drilled well—a well usually 10 inches or less in diameter, drilled with a drilling rig and cased with steel or plastic pipe. Drilled wells can be of varying depth.

Dug well—a large diameter well dug by hand, usually old and often cased by concrete or hand-laid bricks. Such wells typically reach less than 50 feet in depth and are easily and frequently contaminated.

Earth material—a substance that makes up or comes from the earth.

Ecosystem—community of plants and animals that interact with one another and with the surrounding nonliving environment. Examples of ecosystems include ponds, forests and beaches.

Effluent—the discharge of a pollutant in a liquid form, often from a pipe into a stream or river.

Environment—the external conditions that influence the development and survival of an organism or population; usually refers to air, water, land, plants and animals.

Environmental impact—the effect of an activity or substance on the environment.

EPA Standards—EPA (Environmental Protection Agency) is responsible for researching and setting national standards for a variety of environmental programs and delegates to states and tribes responsibility for issuing permits, and monitoring and enforcing compliance. Where national standards are not met, EPA can issue sanctions and take other steps to assist the states and tribes in reaching the desired levels of environmental quality. The Agency also works with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts.

Erosion—the process of the wearing away of land surface by the action of wind, water or ice.

Eutrophication—process whereby nutrients in water increase so that plant growth increases dramatically. These plants die and as they decompose they use up the oxygen in the water, making conditions unfavorable for fish and animals. Over a long period of time, the body of water fills in or up, and becomes land. This is a natural process that is often accelerated by human activities that allow excess nutrients into the water.

Evaporation—the process by which liquid water is heated to the point it changes into water vapor, a gas, and rises into the atmosphere.

Evapotranspiration—the combined loss of water to the atmosphere from land and water surfaces by evaporation and from plants by transpiration.

Fertilizer—a nutrient-rich substance used to promote plant growth.

Filter—a material with tiny holes, or pores, through which a liquid or gas is passed to remove impurities or potentially polluting substances.

Flow—movement of water over another material.

Fresh water—inland water that has a low concentration of minerals, salts, and dissolved solids found as surface water or groundwater.

Gray water—domestic wastewater other than that containing human excrete such as sink drainage, washing machine discharge, or bath water.

Greenhouse effect—the excessive trapping of heat in the earth's atmosphere by a blanket of gases. Gases such as water vapor, methane, and carbon dioxide exist naturally and help retain the earth's normal surface temperature. Changes in the normal volume of gases in the atmosphere, due to human-induced activities, are believed to contribute to **global warming.**

Groundwater—water that infiltrates the earth and is stored in porous spaces of soil and rock below the earth's surface; water within the zone of saturation. Many people depend on groundwater for their consumption.

Habitat—an area where a living organism is typically located that provides adequate food, water, shelter, and living space for survival.

Hardness—a characteristic of water caused by various salts, calcium, magnesium and iron (e.g. bicarbonates, sulfates, chlorides and nitrates) hazardous waste which because of it quantity, concentration, or physical, chemical, or infectious characteristics, may cause mortality (death), injury, or serious illness.

Herbicide—chemicals used to kill undesirable vegetation.

Household hazardous wastes—products used in the home that contain substances that are listed as or that exhibit the characteristics of hazardous wastes as defined by the Resources Conservation and Recovery Act (RCRA): ignitability, corrosivity, reactivity, and toxicity. RCRA does not require that household hazardous wastes be disposed of as hazardous wastes, but caution should be taken to dispose of them so as to minimize the impact to human health and the environment.

Hydrologic cycle—the circulation of water in and on the earth and through earth's atmosphere through evaporation, condensation, precipitation, runoff, ground water storage and seepage, and re-evaporation into the atmosphere.

Hydrologist—a scientist who applies scientific knowledge and mathematical principles to solve water-related problems in society such as problems of quantity, quality, and availability.

Hydrology—the science, or study of how water flows across the land.

Hydrosphere—water held in oceans, rivers, lakes, glaciers, ground water, plants, animals, soil, and air.

Infiltration—the process in which moisture soaks into the ground, where it is either taken up by plants or sinks below plant roots into the groundwater.

Insecticide—chemicals used to control undesirable insects.

Irrigation—process by which water is rerouted to land by way of ditches or a watering system.

Karst—a landform that occurs when carbonate rocks, such as limestone, are present at the earth's surface. It is characterized by features such as caves and sinkholes.

Lagoon—water impoundment in which organic wastes are stored or stabilized or both.

Lake—a standing body of water surrounded by land which undergoes thermal stratification and turnover by mixing.

Latitude—angular distance on the earth's surface northward or southward of the equator, measured in degrees along a meridian.

Leachate—liquid that has percolated through solid waste and/or has been generated by solid waste decomposition, and that has dissolved or suspended materials in it. The liquid may contaminate ground or surface water.

Limestone—a sedimentary rock composed wholly, or in part, of calcium carbonate.

Liquid—a free flowing substance that borrows the shape of its container.

Longitude—distance east or west on the earth's surface, usually measured by the angle that the meridian through a particular place makes with the prime meridian that runs through Greenwich, England. Longitude may be expressed either in hours (longitude in time) and minutes or degrees (longitude in arc).

Manure—the fecal and urinary defecation of livestock and poultry.

MCL—maximum contaminant level, the maximum concentration of specific contaminants that is allowed under the Federal Safe Drinking Water Act.

Minerals—a naturally occurring inorganic substance having a characteristic set of physical properties.

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

Natural resources—raw materials or energy supplied by nature and its processes (e.g., water, minerals, plants).

Nitrate (NO_3)—an important plant nutrient and type of inorganic fertilizer (most highly oxidized phase in the nitrogen cycle). In water, the major sources of nitrates are septic tanks, feed lots and fertilizers.

Nitrite (NO_2)—product in the first step of the two-step process of conversion of ammonium (NH_4) to nitrate (NO_3).

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

Nutrient pollution—a nourishing contamination that causes unwanted plant growth (e.g. fertilizer runoff).

Nutrients—food for living organisms. If more nutrients are applied to the land than the plants growing there can use, the excess can pollute water.

Organic compounds—natural or synthetic substances based on carbon.

Organism—a living body made up of cells and tissue; examples include trees, animals, and bacteria

Overwithdrawl—withdrawal of ground water over a period of time that exceeds the recharge rate of the supply aquifer.

Pathogens—(generally) microscopic organisms that cause disease, such as ecoli or salmonella typhi bacteria.

Percolation—water that moves through the soil at a depth below the root zone.

Permeability—the ability of a porous substance (rock, soil, etc.) to allow water to flow through it freely due to the connected pore spaces.

Pesticides—a chemical substance used to kill or control pests such as weeds, insects, fungus, mites, algae, rodents, and other undesirable agents.

pH number—a measure of acidity or alkalinity. The pH scale ranges from 0 to 14. A substance with a value less than 7 is acidic, 7 is neutral, and above 7 is alkaline. Water, in its pure form, is neutral.

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

Pollutant—a liquid, gas, dust, or solid material that causes contamination of air, water, earth and living organisms.

Pollution control technologies—equipment designed to reduce pollution and the resulting adverse environmental and health effects from waste combustion or disposal, or private or industrial emissions. Filters are often used to control emissions of particles, and scrubbers can control emissions of acidic gases such as sulfur dioxide and hydrogen chloride.

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

Porosity—the degree to which the total volume of soil, gravel, sediment or rock is permeated with pores or cavities through which fluids (including air) can move.

ppm—parts-per-million; a common basis for reporting water analysis. One ppm equals one unit of measurement per million units of the same measurement.

Precipitation—moisture that falls to Earth as rain, sleet, snow or hail.

primary wastewater treatment--the first stage of the wastewater-treatment process where mechanical methods, such as filters and scrapers, are used to remove pollutants. Solid material in sewage also settles out in this process.

Property—a characteristic of a material or object: something that you can observe such as color, smell, or taste.

Purify—to clean.

Renewable resource—a naturally occurring raw material or form of energy derived from an endless or cyclical source such as the sun, wind, falling water (hydroelectric), biofuels, and trees. With proper management and wise use, the consumption of these resources can be approximately equal to replacement by natural or human-assisted systems.

Reservoir—a lake, either natural or man-made, for collecting a supply of surface water to be used as a source for drinking water or to create hydro-electric energy.

Reverse osmosis—treatment that uses a very fine molecular sieve that permits water to pass through but not contaminants. Useful for nitrate removal.

Riparian area—an area close to water.

Runoff—water, usually from precipitation (rain), that flows across the ground—rather than soaking into it—and eventually flows to oceans or interior basins. Runoff sometimes carries substances, such as soil or contaminants, into a water body.

Salinity—the concentration of dissolved salts in water

Salt water—water that has a high level of dissolved salts (oceans, seas)

Sanitary sewer—a sewer that transports only waste waters (from domestic residences and/or industries) to a waste water treatment plant.

Scum—a solution composed of grease and oil which has settled on top of the water. Scum is removed from the top of the water by a skimming system before advanced treatment begins. Once skimmed off of the water the scum is incinerated or sent to a digester to be treated.

Secondary wastewater treatment—treatment (following primary wastewater treatment) involving the biological process of reducing suspended, colloidal, and dissolved organic matter in effluent from primary treatment systems and which generally removes 80 to 95 percent of the Biochemical Oxygen Demand (BOD) and suspended matter. Secondary wastewater treatment may be accomplished by biological or chemical-physical methods. Activated sludge and trickling filters are two of the most common means of secondary treatment. It is accomplished by bringing together waste, bacteria, and oxygen in trickling filters or in the activated sludge process. This treatment removes floating and settling solids and about 90 percent of the oxygen-demanding substances and suspended solids. Disinfection is the final stage of secondary treatment.

Sedimentation—eroded soil material (often suspended in water) that consists mainly of particles from rocks, soil, and inorganic materials.

Septic tank—an on-site wastewater treatment system, generally for single families, not connected to the wastewater treatment plant.

Sewage—waste and wastewater from people and animals.

Sinkhole—a depression in the Earth's surface caused by dissolving of underlying limestone, salt, or gypsum. Drainage is provided through underground channels that may be enlarged by the collapse of a cavern roof.

Slope—a slanted surface

Sludge—solid matter that settles to the bottom, floats, or becomes suspended in sedimentation tanks. It must be disposed of by filtration and incineration or by transporting to appropriate disposal sites.

Solubility—capability of being dissolved.

Spring—a place where ground water naturally comes to the surface resulting from the water table meeting the land surface.

Statistic—a piece of numerical information that shows the measure of a sample.

Storm sewer—a sewer that carries only surface runoff, street wash, and snow melt from the land. In a separate sewer system, storm sewers are completely separate from those that carry domestic and commercial wastewater (sanitary sewers).

Straight pipe—an illegal process of depositing raw sewage directly into a water way or sinkhole.

Surface area—the area of a liquid exposed to or touching air.

Surface tension—the skin-like surface on water (and other liquids) that pulls it together into the smallest possible area (sphere).

Surface water—water that is stored in water sources on Earth's surface.

Terrarium—a closed container in which small plants and sometimes small animals, such as toads and lizards, are maintained in a controlled environment.

Topography—the art of representing on a map the physical features of a place.

Toxins—compounds that pose a substantial threat to human health and/or the environment.

Transpiration—the process in which plants give off moisture (water vapor) as a by-product of photosynthesis.

Volatile organic compound—a carbon based substance which wastes away on exposure to the atmosphere.

Volatization—loss of a substance through evaporation or sublimation. When manure is spread on a field, ammonia-nitrogen in the manure may volatize quickly and be lost as fertilizer unless it is incorporated into the soil.

Waste water treatment plant—a large facility (group of process) that treat wastewater from homes and industry to a point that it can be safely discharged into the environment.

Water—a colorless, odorless, tasteless liquid that is essential to plant and animal life. In the form of oceans, water covers approximately 70 percent of the earth's surface.

Water budget—the depth of annual precipitation to cover an area. In the U.S. it is 30 inches.

Water cycle—see hydrologic cycle

Water quality—the properties of water that determine how it is used.

Watershed—a piece of land in which runoff drains to a body of water. Watersheds can be big or little, depending on the size of the body of water to which they drain.

Water table—the water level of an unconfined aquifer, below which the pore spaces are generally saturated.

Water vapor— the gaseous state of water.

Withdrawal—water withdrawal from the surface and ground water sources for various human uses.

Xeriscaping—a method of landscaping that uses plants that are well adapted to the local area and are drought-resistant. Xeriscaping is becoming more popular as a way of saving water at home.