Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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The Journey of New Haven Water

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This curriculum unit is designed specifically for middle school New Haven students. Students will explore the journey of water through the hydrologic cycle to water treatment in New Haven. Clean water is something that is taken for granted in our society, yet for many in the world, clean water is a luxury. Very rarely does one contemplate the process that gets water to our homes clean and safe, however, this process is essential to our daily lifestyles. My goal in doing such a unit is to have urban New Haven students feel a connection to their environment. Often in an urban setting, the direct connection one would have with their environment is diminished compared to a student in a rural setting. I want my students to understand that an action that is made in Connecticut-their watershed- affects the water quality in New Haven, and that conversely an action made here, in New Haven, affects the quality of the water in lakes and reservoirs elsewhere. It is essential that students understand that actions have consequences. Often, New Haven students are exposed to Long Island Sound ecology and pollution, but rarely do they study fresh water ecology and pollution in the area.

My goal is to have my students ultimately be familiar with the water cycle, watershed, water treatment, water contaminates, and water pollution issues. I would like my students to understand that clean drinking water is something we all have to work to maintain not just something that comes out of your faucet. I plan to cover the above topics with four questions:

- Where does your water come from?

- What is in your water?

- Where does your water go?

- What can you do to protect your water?

These four questions will be specific to New Haven. Students will be assigned roles in which they will explore the above questions from their role perspective. Example: You are concerned about water quality for citizens in New Haven. You have recently read a report from the Environmental Protection Agency about industrial polluters in your neighborhood. You want to examine the impact of this pollution to your water supply. Your task is to become an expert in clean water legislation and research MTBE. Students would then work within their role to create a presentation answering the above four questions specific to New Haven. The second task for the groups will involve creating a “Plan of Action” to combat water pollution in New Haven. Students will

work in-groups, either their roles or jigsaw groups (individual role players meet with other role) to make a decision on what to do about the problem.

The school this unit will be taught in is an urban magnet school in New Haven, Connecticut. Average class size is 25 students. The demographic population of the New Haven public school is: Asian American- 1.24%, African American- 54.82%, Hispanic- 30.95%, Indian American: -0.05, White- 11.08%, Other: 1.86%. Students are comprised of both New Haven students and out of district students. Out of district students are from neighboring communities such as Derby, Hamden, East Haven, West Haven, and Orange. Classes are heterogeneous and students have varying abilities including learning disabilities. (1)

New Haven City Standards/Connecticut State Standards addressed are: *Performance Standard 1.1*- Students will acquire and practice the ability to do scientific inquiry. *Performance Standard 1.2*- Students will acquire and practice the ability to understand scientific inquiry. *Performance Standards 3.3*- Students will understand the fundamental connections between organisms and their environment. *Performance Standards 6.2*- Students will develop an understanding of the use of science and technology and its effect on the characteristics of changing populations, ecology, resources, and changes in the environment. *Performance Standard 6.3*- Student will identify fundamental connections between organisms and their environment. (2)

Where does your water come from?

Earth's water today is the same water that was on the Earth billions of years ago. Water cycles naturally through the environment from the ground to the atmosphere and is continually reused. The natural water cycle from the ground to the atmosphere is called the hydrological cycle. Water on the Earth's surface moves to the atmosphere through two paths; evaporation and transpiration. Water evaporates from bodies of water and land surfaces through heat energy and is transpired from living cells, such as plants. Water vapor enters the atmosphere and is circulated until is precipitated back to the Earth as rain or snow. Once water hits the surface of the Earth it will either run off into streams, lakes, or oceans or infiltrate the soil. Some infiltrated water becomes soil moisture that will be absorbed by plants or evaporated back into the environment. What water is not evaporated moves through the soil to become ground water at the water table. The water table volume varies in response to environmental conditions such as climate, annual precipitation, irrigation, and drainage into outlets such as springs. (3)

The Regional Water Authority provides New Haven and its surrounding area's drinking water. The Regional Water Authority is a non-profit organization serving approximately 400,000 consumers in the New Haven area. Two boards govern the Regional Water Authority; the Representative Policy Board composed of community representatives, and an Authority that serves as the board of directors. The Regional Water Authority provides approximately 55 million gallons of water a day and during peak demand as much as 90 million gallons of water is delivered. Nine active reservoirs that can hold up to 19 billion gallons of water and five well fields provide the water for the Regional Water Authority. Water is distributed through a 1,600-mile long network of pipes, pumping stations, and storage tanks. Water to New Haven comes from Lake Gaillard located in North Branford. Reservoir water such as that from Lake Gaillard is filtered at Regional Water Authority plants and is disinfected with chlorine, phosphate, and fluoride. (4)

Water in reservoirs comes from precipitation and watershed/drainage basins. A watershed is the land over

which water drains over land or underground into a stream, river, lake, estuary, or ocean. Watersheds are defined by the geology of the highest elevation in the area. Size of watersheds varies from acres to millions of acres. Divisions of watersheds are based on where water runoff moves in opposite directions towards adjacent watersheds. In other words a highpoint or ridge where water moves down the highpoint in opposite directions. Water is vulnerable as it moves through the water system as water picks up contaminates as it moved through the watershed into a reservoir. (5) Farming, recreation, mining, construction, and forestry can affect the quality of water in your watershed. Many paved surfaces within a watershed cause storm water runoff, sedimentation, erosion, flooding, and bacterial contamination. Maintaining a healthy watershed is important because our watershed provides water for drinking, irrigation, recreation, and industry. (6) New Haven is in two major watershed areas, the Quinnipiac River watershed and the Long Island Sound watershed. The Quinnipiac watershed has 591,000 people and covers over 14 cities and towns. It supports native brook trout and many recreation areas. The Quinnipiac River drains into the third largest port in Connecticut and has one of the most productive seed oystering areas in the United States and its 834-acre tidal marsh is a wildlife refuge. (7) Long Island Sound is an estuary with two connections to the sea, the Race to the east and the East River to the west and has several freshwater rivers feeding into it as far away as Canada. Long Island Sound provides an important habitat for plant and animal life as well as providing $5.5 billion to the region from recreation and commercial boating, sport fishing, swimming, and sight seeing. Over eight million people live in the Long Island watershed and the increased development has presented many threats to the water quality in Long Island Sound. (8)

Once water is taken from the reservoir (in this case Lake Gaillard) water is sent to a treatment plant were undesirable odors and tastes are removed by aeration and filtration. When water is taken into a treatment plant dirt and other suspended particles are removed from the water. Clear water is then sent for disinfection, the Regional Water Authority adds chlorine to disinfect the water. Fluoride is added for dental health as well as phosphate to prevent corrosion of the pipes. Water then moves through filters made of layers of sand, gravel, and charcoal that help to remove small particles. Water is then piped to a household for consumption. (9/10)

What is in your water?

The history of drinking water treatment dates back to ancient times approximately 4000 BC. Ancient Greeks and Egyptians recommended cleaning water by filtering it through charcoal, exposing water to sunlight, boiling, and straining. Egyptians even used chemical alum in 1500 BC to cause particles to settle out of water. Many of the earliest water treatments were to improve the aesthetic value of water. The scientific explorations of the 1800’s left the understanding that disease could spread through water with the ‘germ theory’. In the late nineteenth and twentieth centuries concerns of water borne disease warranted concern for the public water supply. By the early 1900, many cities used slow sand filtration to reduce turbidity, which was discovered to harbor pathogens. In 1908, chlorine was used for the first time to disinfect water in the United States, which played the largest role in reducing disease. The United States government began federal regulation of drinking water in 1914 by setting standards for bacteriological levels. The standards applied to interstate carriers and only applied to contaminates that caused disease. The Public Heath Service revised and expanded those standards up to 1962. The revision of 1962 included 28 regulated substances and was the most comprehensive regulations until the Safe Drinking Water Act of 1974. In the late 1960’s chemicals

became a health concern as well and increased awareness of chemical contamination led to the passage of the Safe Drinking Water Act in 1974 with revisions in 1986 and 1996 and is administered by the Environmental Protection Agency. Today water treatment is mostly carried out with chlorination and filtration as well as advancements such as ultraviolet light, ozonation, and reverse osmosis. The significance of clean drinking water was recognized by the Centers for Disease Control and Prevention and the National Academy of Engineering as the most significant public health advancement of the 20th Century. (11)

Federal legislation for water pollution and water quality has occurred relatively recently. The Federal Water Pollution Control Act was passed in 1972 and after further amendments, it became known as the Clean Water Act in 1977. The Clean Water Act established the foundations for regulating pollutants into the waters of the United States. The Clean Water Act has regulatory and non-regulatory tools to reduce pollutant discharge into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. The goal is to restore the nation's waters so that they can support wildlife and recreation in and on the water. Initially the Act focused on point source polluters such as municipal sewage facilities and industrial facilities. In the late 1980's efforts were made to deal with non-point source pollution such as runoff. The Clean Water Act now focuses on holistic watershed based strategies to reduce water pollution. (12)

Drinking water legislation was passed in 1974-The Safe Drinking Act. The goal was to ensure safe public drinking water supply. The law was amended in 1986 and again in 1996 and requires many actions to protect drinking water and its sources. The Safe Drinking Water Act (SDWA) covers individuals getting water from a system with at least 15 service connections or serve at least 25 people, but does not cover individuals getting their water from wells that serve less than 25 people. The SDWA authorizes the Environmental Protection Agency to set national health-based standards for drinking water to protect against water contaminants. The EPA sets standards through a three-step process: 1-The EPA identifies contaminants that may affect the public health adversely and occurs in drinking water as a threat to public health. 2-The EPA sets a maximum contaminant level (MCL) for the regulated contaminant. The MCL should be well below a level that causes harm. 3-The MCL is established for all facilities under the SDWA. Drinking water standards are legally enforceable and allow the EPA or governing body to take legal action for those in noncompliance. The SDWA also makes water providers provide a consumer confidence report on the quality of their water. (13)

A luxury of living in a technologically advanced society is that we take for granted much of the machinery that allows us to live healthy, happy lives. Having clean drinking water is one of those luxuries. Most Americans have no notion of the journey their water takes to get their faucet clean and drinkable. By the time water gets to our homes possible contaminants screened for have been eliminated or reduced to harmless levels, but not all. Though many harmful substances are eliminated from our water, some contaminants still persist, some even come from the purification process. Possible water contaminants are microbes, radionuclides, inorganic contaminants, synthetic organic contaminants including pesticides and herbicides, volatile organic contaminants, disinfectants, and disinfection byproducts. (14)

Microbes such as bacteria, viruses, and protozoa are common and are not generally harmful. Possible microbial contamination occurs through human and/or animal wastes through entering water supply. Common bacterial contaminants are Coliform bacteria, fecal coliform, E.coli, cryptosporidium, and Giardia lanblia. Coliform bacteria is a microbe that is usually harmless, but its presence in water is an indication that the water treatment process has failed and that other microbes that are harmful are present in the water supply. Fecal Coliform and E.coli are bacteria that contaminant the water supply through human and/or animal waste. A few symptoms of infection are nausea, cramps, diarrhea, and associated headaches. Cryptosporidium is a parasite that also enters the water supply through animal waste as well as sewage. Cryptosporidium causes

diarrhea, vomiting, and cramps that is mild in people with normal immune systems, but can be severe to fatal in those with compromised immune systems. Giardia lamblia is also a parasite that enters the water supply through sewage and animal waste. A symptom of infection is gastrointestinal distress. Turbid water, though the turbidity itself is not harmful, can lead to microbial contamination. Turbidity increases the risk of contamination because it can interfere with the decontamination process and provide microbes with a medium in which to live. (15)

Radionuclides can enter the water supply through natural occurrences or could be the result of oil and gas production and mining activities. Possible radionuclides that contaminate water are alpha emitters, beta/photon emitters, combined radium 226/228, and radon. People who drink radionuclides in excess of the Environmental Protection Agency's standards are at an increased risk of developing cancers. (16)

Many chemicals, both organic and inorganic, and synthetic and naturally occurring can contaminate water supplies. Inorganic contaminates can be naturally occurring or may be the result of urban storm water runoff, industrial or domestic wastewater discharge, oil and gas production, mining, or farming. Pesticides and herbicides enter the water supply through agriculture, urban storm water runoff, and residential uses. Organic chemical contaminants, both synthetic and volatile organic compounds, may enter the water supply through the by products of industrial processes and petroleum products, gas stations, urban storm water runoff, and septic systems. Common inorganic contaminants are arsenic, fluoride, and lead. Arsenic exposure in drinking water over many years can cause skin damage, circulatory system problems, and may have an increased risk of getting cancer. Many communities to promote dental health add fluoride. Drinking supplies that contain an excess of the EPA's standard of 4mg/L over several years could develop bone disease, including pain and tenderness of bones. Children should not drink water that contains more than 2mg/L to prevent dental fluorisis. Dental fluorosis only occurs in developing teeth below the gum and may result in staining or pitting of permanent teeth. Lead enters water supplies through the leaching of old plumbing. Pregnant women and children are at the most risk from lead poisoning. Lead plumbing has been banned since 1998. MTBE is a fuel additive that is used to reduce carbon monoxide and ozone levels in automotive emissions. Its high use in the United States has caused increased levels in the water supply. Studies are underway to examine the health impact of MTBE in the water supply. (17)

Many do not realize that the chemicals added to disinfect their water also contaminate their water. Chlorine is a common disinfectant as well as chloramine and chlorine dioxide. People drinking water with excess chlorine could experience effects to their eyes, nose, and stomach. Excess chloramine can cause irritation to the eyes and nose as well as stomach discomfort and anemia. Excess chlorine dioxide can cause nervous system effects in infants, young children, and unborn fetus. It may cause anemia in adults as well. Disinfectant byproducts, such as trihalomethanes, haloacetic acid, bromate, and chlorite are formed when disinfectants react with naturally occurring organic matter in water. Trihalomethane may cause an increases risk of cancer and disorders of the liver, kidneys, and the central nervous system. Haloacetic acid and bromate also increase the risk of cancer. Excess chlorite affects the nervous system of unborn fetuses, infants, and young children. It may also cause anemia in adults. (18)

Where does your water go?

Water waste disposal dates to ancient times. Sewers have been found in the ruins of Crete, Assyria, and storm drains built by ancient Romans are still in use today. Wastewater is carried by a pipe system from its source to the treatment facility. The type of pipe used depends on the type of waste moving through the system. A system that carries both domestic and storm water waste are a combined system and are typically used in older urban systems. Newer sewer systems have separated sewer systems, which is a more efficient system as it prevents combined sewer overflow. Combined sewer overflow is caused when a sewer is not big enough to handle storm water and domestic sewage. Overflow can contaminate drinking water supplies. Household sewer pipes are typically made of clay, cast-iron, or polyvinyl chloride and sewer mains are typically made of concrete, clay or asbestos cement. Waste water flow through to the treatment plant through gravity so the pipe must be sloped to permit the waste to move at a minimum velocity of 0.46 m/s. (19)

Wastewater originates from domestic sewage, industrial waste, groundwater (infiltration), and storm water sources. Domestic sewage results from day to day household activities like bathing, food preparation, recreation, and toilets. An average household has about 60 gallons of waste per person. Industrial wastewater varies from the type of industry, management, and treatment prior to sewage. Infiltration occurs when the sewage pipe is below the water table. Storm water waste depends on the amount of rainfall and its composition varies specific to the watershed. Storm sewers also collect water used for washing cars, watering lawns, and anything dumped into the sewers. Typical wastewater for an urban area is about 60- 80% of its daily water requirements. (20)

Primary wastewater treatment involves water passing through a screen to remove debris that is later burnt or buried. Screened water is then moved through a comminutor where leaves and other organic materials are ground to reduce its size for treatment. The next step is a grit chamber also known as settling chambers. Grit chambers are used to eliminate sand, silt, gravel, and cinders from the wastewater. Inorganic particles larger than 0.2 mm settle to the bottom of the chamber and are removed to sanitary landfills. Once the grit is removed, the water then moves to a sedimentation tank where organic materials settle out and are removed. 20-40% of microbes are removed and 40-60% of suspended solids are removed. To accelerate this process some plants induce chemical coagulation and flocculation. Aluminum sulfate, ferric chloride, or polyelectrolytes are added to the wastewater in coagulation. The chemicals cause a change in the surface of the water that makes the suspended particles attach to one another and precipitate. They then fall to the bottom of the tank. Flocculation is similar to coagulation in that it causes the particles to coalesce and fall to the bottom of the tank. Flotation is an alternative to sedimentation. Air is forced into the wastewater and then the water is discharged into an open tank. The rising air bubbles cause particles to rise to the surface where they are removed. Another alternative to sedimentation is digestion of suspended particles by microbes that convert the organic sludge to methane, carbon dioxide, and humus like material. The reaction occurs in an anaerobic digestor tank. Digested sludge is then placed on sand beds for air-drying. Dried sludge is often used as fertilizer because of its high nitrogen and phosphorus content. (21)

Secondary wastewater treatment involves biologically reducing the organic material that remains in the water. This treatment accelerated natures waste disposal with aerobic bacteria converting the organic material into carbon dioxide, water, nitrates, and phosphates. These by products must be removed before the water is returned to a receiving stream. Trickling filters are used in secondary treatment. The wastewater is distributed over a bed of porous medium where a film of microorganisms covers the water. Activated sludge is also a

treatment method used in secondary treatment. Activated sludge particles, known as floc, are millions of active bacteria that cover the water. Stabilization pools are used in treatment plants with available land and anaerobic and aerobic bacteria are utilized to reduce the organic particles in the water. (22)

Tertiary treatment, also known as advanced wastewater treatment is used to further purify wastewater for release into bodies of water or for reuse. Phosphorus is removed in this step. Refractory pollutants are also removed at this step by a variety of methods including reverse osmosis, electro dialysis, ammonia stripping, denitrification, and phosphate precipitation. If the water is to be reused then a disinfectant such as chlorine is used. (23)

Septic tanks are a common treatment process used for domestic waste. A septic tank is composed of a concrete, cinder block, or metal tank where solids settle and floatable materials rise. The liquid stream flows from an outlet that is submerged into a subsurface rock filled trench. Wastewater flows and percolates through the rock filled trench into the soil where it is oxidized aerobically. Solids and floating matter may remain in the septic tank for 6 months to years where it is decomposed by anaerobic bacteria. (24)

After wastewater has been treated it is disposed of into a receiving stream or lake. In areas of the United States that face water shortages, water is reused for both domestic and agricultural uses. Treated wastewater can be used for groundwater recharge, irrigation of nonedible crops, industrial processing, and recreational uses. (25)

What can you do to protect your water?

There are two types of water pollution: point source pollution and nonpoint source pollution. Point source pollution comes from a source that is easily identifiable such as a pipe, leaking tank, or an industrial site. Nonpoint source pollution is caused by runoff that contaminant ground water, lakes, and streams. Nonpoint source pollution originates from many sources such as farms, lawns, paved urban area, roadways, construction sites, landfills, home septic tanks, etc. These sources can contribute pesticides, fertilizers, metals, fecal matter, road salt, and other pollutants. (25) Nonpoint source pollution is responsible for 40% of the nation’s rivers, lakes, and estuaries are not clean enough to fish and swim in. Agriculture is the largest contributor to nonpoint source pollution. Urban runoff is responsible for poor water quality in estuaries. (26)

Tips to protect your water supply:

In your house

- Fix leaky faucets

- Turn the water off when you shave and brush your teeth

- Install low flow toilets, shower heads, and faucets

- Conserve!

Washing your car

- Use a bucket to wash the car instead of the hose to conserve water

- Use high pressure fittings to rinse your car quickly

- Use Eco-friendly soap

- Wash your car on gravel or on the lawn so that wastewater will not go into the drain

What you put down the drain

- Never put motor oil down the drain or down a storm drain

- Use Eco-friendly household chemicals

- Dispose of household chemicals properly

Lawn Care

- Conserve water when watering your lawn or garden

- Use native vegetation that does not need a lot of watering

- Test your soil to see exactly what your lawn needs

- More is not better

- Only apply fertilizer when it is necessary

- Do not leave fertilizer on sidewalks of driveways where it can leach into storm drains

- Be aware of the chemicals in pesticides and herbicides-Use them sparingly

(27)

Notes

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Lesson Plans

Objectives: The objective of the following activities is for students to understand the cycle of water in their community. Students will have roles within a group that ultimately produces a presentation of water in their community.

1- The hydrologic cycle and watersheds

-Lesson-Watershed Mapping

2-Water treatment and Drinking water legislation

-Lesson-Research of a pollutant and dilutions

3-Waste water treatment and sources of pollution

-Lesson-Filtration Activity and Pollution Detectives

4-Protection of the water supply-Community action

-Lesson-Create a “plan of action” to reduce pollution

Student Task: You are embarking on an in-depth investigation of water in your community! You, with help from your group members, are creating a water protection agency-New Haven Student’s Water Protection Agency. As a new civic group, you must gather all the information you can about water in New Haven. You need to have experts on the watershed of New Haven, experts in drinking water legislation, and experts in water treatment.

Challenge: You need to create a presentation answering four questions-where does your water come from, what is in your water, where does it go when you are done with it, and what you can do to protect your water.

Teacher Information: Create groups from 4-6 students and either have students choose their role within the group or choose for them. Each group needs to have “experts” in watershed science, water legislation, and water treatment. Each group is responsible for creating a presentation that answers the above four questions and a plan of action to reduce pollution in New Haven. Students will become experts in their role and teach this information to the other students in their group. Basic information packets should be given to the group for a planning session. At this point the students only have basic information and during this planning sessions the students should come up with questions or make a list of information they will need to become experts in their field. The students should then begin their research. Allow the students time to jigsaw and meet with other experts from different groups. While the students research their area of expertise there will be Discovery Activities that give the students hands on experience.

Student Roles:

Watershed Expert-This role will explore the watershed science, specifically the Quinnipiac River watershed. The expert in this field should understand how water moves through a watershed and be able to recommend a location for a landfill.

Legislation Expert-This role will examine the Safe Drinking Water Act and the Clean Water Act. This expert will explore a chemical that threatens our drinking water supply. Examples-atrazine, mercury, lead, MTBE, petroleum products, herbicides and pesticides, etc…

Water Treatment Expert- This expert should understand basic water treatment techniques. This expert will also investigate various disinfection techniques and recommend the technique they think is best.

Discovery Activities

Watershed Mapping

Materials:

Topographic map-Quinnipiac River Valley

Clear plastic the size of the map

Cardboard the size of the map

Dry Erase markers

Thumbtacks

Procedure

1. Place the clear plastic sheet over the topographic map and tack it on the cardboard with the thumbtacks.

2. Find your school on the map and mark it with the markers.

3. Find any body of water-stream, lake, marsh, rivers, and oceans closest to the school and mark them blue on the map.

4. Use the contour lines to find the highest and lowest points around your school. Mark the hilltops with X's.

5. Using the hilltops as reference points draw arrows on the map to show the flow of runoff away from your school.

6. Find the highest ground between two waterbodies. Draw a line along the highest points (the X's) around your watershed including it's bottom end or mouth. What is the water body that drains your watershed?

Discussion

1. How big is your watershed?

2. What surfaces does runoff in your watershed go over?

3. What substances would runoff pick up in your watershed?

- The watershed expert will use this as a resource to make choices about land use in the watershed. The expert will also think of ways that your community might affect water quality in your watershed.

- Also provide your watershed experts with the materials to create a model watershed to experiment how water moves through a watershed.

Adapted from Consider the Source produced by the Connecticut Water Works Association

Dilution Lab

Materials

Four clear plastic cups

Red food coloring

Water

Pitcher

Measuring cup

Procedure:

1. Pour one cup of water into one of the glasses. Add 3 drops of food coloring. This water is now polluted by chemicals that have moved into the water. Label this glass #1. Record your observations.

2. Pour ½ cup of polluted water from glass #1 into a cup labeled #2. Add ½ cup of fresh water to cup #2. Stir to mix the waters. Record your observations.

3. Pour ½ cup of water from #2 into cup #3. Add ½ cup of fresh water into #3. Stir to mix the waters. Record your observations. What is happening to the chemicals?

4. Pour ½ cup of water from #3 into cup #4. Add ½ cup of fresh water to cup #4. Stir to mix the waters. Record your observations.

Discussion

1. Look at your observations what has happened from cup to cup?

2. What has happened to the chemicals?

3. Do you think dilution is a good way to deal with chemicals that get into our water supply?

- The legislation expert can use this as an example of dilution and compare it to the amounts of chemicals allowable by law.

Adapted from Hazardous Household Waste produced by the Regional Water Authority, New Haven, CT

Filtration Lab

Materials:

Water

Safety goggles

A gallon sized container

100ml beakers (or plastic cups)

Wastewater materials-

Coffee grounds

Salt

Vegetable oil

Soil

Yeast

Soap

Food scraps

Vinegar

Possible water cleaning materials-

Screens used as filters

Coffee filters

Baking soda

Bleach

Alum (available at grocery stores in the baking section)

Bowls or cups

Straws

Pipettes

Spoons

Charcoal

Talc

Sand

Testing materials-

pH paper

Brown paper bag

Wax paper

Procedure:

1. Have students make wastewater from the materials available. Add soil, coffee, oil, etc to a gallon jug of water.

2. Shake the mixture well and distribute the wastewater into cups or beakers for the student groups. Students should record their observations.

3. The students' mission is to try to clean the wastewater using the materials given. Students should wear goggles at all times. Limit the amount of bleach, alum and baking soda to about 1/2 a teaspoon.

4. Students will write a procedure they plan to use and record it in the data table.

5. After the students have written a procedure they will record their observations in the data table. Have students evaluate their results about the effectiveness of the method.

Observation of Initial Wastewater

Cleaning Strategy Used	Observation of Water	Effectiveness of Method

Discussion Questions:

1. Was your cleaning method similar to those used by wastewater treatment plants?

2. Did you find that any of the material remained after you cleaned the water?

3. Would you recommend that treatment plants remove these materials? Do they? Why or why not?

- The watershed expert should be able to take this further and evaluate disinfection techniques.

Adapted from Project WET curriculum

Pollution Detectives

Materials:

Aluminum baking pans

Unsweetened lemonade-flavored powdered drink mix

Books to raise the end of the pan

Sand-Enough to fill baking pan

Straws

13 pH papers

Misting bottle

Beaker of water

Procedure:

1. After students have been divided into small groups inform them that they are a well drilling company that tests quality of ground water.

2. Each group should have an aluminum pan filled with about 2 ½ inches of sand.

3. Mark one end of the pan with an X.

4. Have the students hide the contaminant-the lemonade flavored mix somewhere in the sand.

5. Draw a map and mark where the powder is located and then switch their pan with another group.

6. The task is to now find the site of contamination using only the pH testing strips you have been given.

7. Raise the end of the pan that is marked with an X and sketch the pan for your data sheet.

8. Fill a misting bottle with water. Test the water's pH and record the pH on the data sheet.

9. Create a gentle rain by misting the pan with water for about 5-10 minutes. No surface run-off should occur.

10. Fill a beaker with water and rinse the straw with water.

11. Begin testing the area for contamination by placing the straw over the suspected source of contamination. Remember to record your drilling site on your map.

12. Press the straw into the sand while plugging the top of the straw.

13. Carefully life the straw from the sand and place a small amount of the sample on the pH paper.

14. Observe and record the results.

15. Rinse the straw and repeat 11-14 until the contamination site has been found. Mark the contamination site with an X.

16. Compare your result with the group you switched trays with to see if you did find the contamination site.

Map of hidden contaminant tray Map of unknown contaminant trayU

*Remember the raised end of the tray is marked with an X

Clean Water Sample	pH		
Possible Contamination Site	pH	Contamination Site?	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Discussion Questions

1. How did you determine the site of contamination?

2. How does this activity help you understand how materials move through watersheds?

3. How does this apply to the real world-what challenges would you face in trying to locate the source of contamination?

4. What difficulties would you face in trying to clean the contamination?

- This activity will help all of the experts delve further into their topic. The watershed expert can think about how materials move in watershed. The legislation expert could think about what materials leach into the ground water and what legal action is taken in such cases. The water treatment expert could think about how

to clean the area and how to purify the water.

Adapted from Project WET curriculum

Resources for Teachers

The United States Environmental Protection Agency

www.epa.gov

www.epa.gov/teachers/

www.epa.gov/teachers/curriculumwater.html

http://www.epa.gov/OW/index.html

The EPA's web site is a wealth of information for teaching a water unit. You can get fact sheets with simplified information to very technical information. Follow the Water link to a variety of water topics. Follow the link Educational Resources to find helpful lesson plans with water lesson plans that would supplement any water unit. Go to the Office of Water link to find a ton of information on water, you can research specific watershed and even get a listing of companies that have been given citations for pollution in your region.

United States Geological Survey (USGS)

www.usgs.gov

http://www.usgs.gov/education/

http://ga.water.usgs.gov/edu/

This web site also has tons of information for teachers ranging from very broad topics to very specific. Follow the Water link and you can find specific watersheds and their make-up. You can also get information on water management. There is a page containing 'The Learning Web' that contains information for students, teachers, and parents. This site has good lesson plans and classroom activities.

The State of Connecticut

www.ct.gov

www.dep.state.ct.us

Search these web sites to get local information on water issues. The DEP site has a history of water legislation in Connecticut.

The Regional Water Authority

Consider the Source-A Connecticut waterworks Association Curriculum

Hazardous Household Waste-Regional Water Authority Curriculum

The Authority will give teachers a wealth of information.

Project WET Curriculum

A fantastic water curriculum resource.

Resources for Students

Environmental Protection Agency

http://www.epa.gov/kids/

This website opens with the Explorers Club-a very kid friendly page that opens into links. The website provides information for students to become active in their community. This site provides a lot of information on many environmental topics and plenty of link. This site may overwhelm younger students with too much information.

EcoKids!

http://www.ecokidsonline.com/pub/splash.cfm

This is a very colorful and kid friendly site with animation and sound. There are eco games for the kids to play, eco stories, and an eco notebook. Students will have a lot of fun exploring this site while learning a lot of information. This would be a great site to start an ecology unit.

Microsoft Encarta

The Encarta CD-Rom is a great place for students to get information. Encarta is an easy program to navigate and students will be able to find the information they are looking for without too much trouble. The information is straightforward and easy to read for older students. Topics have great picture and animations. Most topics also have a resource section. Encarta would be very helpful for students to start their research.

Brain Pop

This website has science movies that students can watch on the computer. There are good movies on water and the water cycle. Each movie is followed up by a quiz and some even have experiments. Students love the animation on the website.

www.brainpop.com