Report for 2004DC59B: DC H2O: Whats On Tap?

There are no reported publications resulting from this project.

Report Follows

DC H_2O: What's on Tap?

Annual Progress Report for FY 2004

Prepared by:

Dr. Rovenia Brock-Riggins
4-H/Youth Development Specialist
Cooperative Extension Service
University of the District of Columbia

Aisha Tyehimba, Student Intern
Department of Education
University of the District of Columbia

Cheryl Hayes, Student Intern
Department of Education
University of the District of Columbia

Carland Minor-Bey, Student Intern
University of the District of Columbia

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DC H_2O: What's on Tap?

Introduction

Recent issues of lead and bacteria contamination in the District's drinking water have become a major concern of the residents and policy-makers. The Water and Sewer Authority, responsible for distributing treated water to DC residents has taken the brunt of the blame and has developed mechanisms to disseminate water quality information to its clients. The Geographic Information System (GIS) is one method of reporting the status of the city's water supply and the progress made by government entities responsible for the safety of said supply. However, the majority of DC residents is not familiar with this new technology and cannot interpret nor understand the results provided. This project will introduce the GIS technology as a water resources management tool to DC 4-H youth, ages 12 to 18. They will learn to collect water samples, input results into GIS using global positioning system (GPS) units, and interpret the data collected. The objective is to train future leaders in the field of water resources management.

Progress Towards Achieving Objectives

The UDC 4-H/Youth Development program has recently completed literature review for the **DC H_2O: WHAT'S ON TAP** project. As part of the project, an eight week curriculum (see appendix) was compiled to provide youth participants with an

interactive environmental service-learning experience. The curriculum is project based and is designed particularly to familiarize students with the functionalities of Global Positioning Systems and Geographic Information Systems. The Global Positioning System is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations. A Geographic Information System is a computer system capable of capturing, storing, analyzing, and displaying geographically referenced information; that is, data identified according to location. The designated curriculum also addresses the use and purpose of watersheds and the different means of measuring water quality. Project resources have secured a GPS unit and additional resources have already been allocated for GIS software.

Project leaders have initiated the first wave of the recruitment plan and will have the required number of participants selected prior to beginning the second phase of the project. The project will move into its next phase in July and continue through the month of August. Phase II will be incorporated as a part of the 4-H Youth Cyber Camp. And as such, will incorporate the technological aspects of the DC H_2O project into the curriculum of the technology based Cyber Camp activities.

Arrangements have been made with Environmental Systems Service, Ltd. to retrieve samples from the University of the District of Columbia as well as test and analyze said samples. Individual tests and the total testing costs have been prepared including the pick-up and transport of the test samples (see Appendix).

Appendix A. Curriculum

LESSON 1 GPS

GRADE LEVEL: 6-12

SUBJECT: GPS technology

DESCRIPTION: Research and explain the origins of GPS, the basics of how it works, its benefits, and apply its function to a real-life scenario

DURATION: 90 minutes

LEARNING OBJECTIVES: To understand the design, function and use of GPS technology

LEARNING ACTIVITIES:

1. Students will define GPS
2. Students will explain GPS's initial design (function)
3. Students will identify the location of the GPS master control station
4. Students will understand the basic concepts of how GPS works
5. Students will utilize technology for research purposes
6. Students will identify a current or future use of GPS as it relates to their life
7. Students will identify a current or future GPS device useful in solving a proposed problem
8. Students will write a narrative with a logical beginning, middle, and end
9. Students will identify some of the possible benefits of GPS

MATERIALS

- Computers with Internet access
- Printer (optional)
- Copy of the questions for each group (or a large classroom display)
- Enough scenarios copied, cut, and placed in a container for each student to have one. (There are only six scenarios in all. You will need to copy these or if you prefer you may write your own.)

PROCEDURE

45 minutes

Discussion: Since many students will have some knowledge of or experience with a GPS device, allow them to discuss and share what they know about this system. This should provide other students with a basic framework regarding GPS.

Describe GPS to students as a constellation of 24 radio-transmitting satellites operated by the department of Defense to determine the precise position of a radio receiver on the ground.

Divide students into groups according to the number of computers available.

Assign each group one of the websites listed as general information sites. Discuss the task of the group. Note: More than one group may have the same site and not all sites have the information needed to answer all the questions. The class discussion at the end of the period will allow students to put all of the information together.

Researching GPS:

Using the site selected, your group's task is to answer as many of the questions as possible. Make sure each person in your group understands and can explain each of your group's answers.

What was the original purpose of GPS?

Where is the master control station located? What is its function?

How does GPS work? (Basics only)

Name three non-military uses of GPS today. Include any details you may find.

What is the fastest growing use of GPS? How will this benefit you?

Allow at least 10 to 15 minutes at the end of your class period for sharing and discussing answers. During this time, encourage each member of the group to share and each group to expand on other group's answers.

45 minutes

Student Application:

Review information from the day before. Allow students with new information to share.

Each student will draw one of six scenarios out of a bag. Emphasizing that their solution must utilize some type of GPS device (encourage creativity here), the assignment is to write a narrative using as many details as possible that must include:

A Beginning: How the day started.

A Middle: What happened?

An Ending: Conflict resolution

The identity of the GPS device (current or future) that help resolve the problem.

How the device functioned.

What may have happened without the device? (In the past)

Scenarios

1. While driving in an unfamiliar, deserted area, you notice that you are running out of gas…
2. You are on a skiing trip with a group of four friends, when a minor avalanche occurs. You only see one friend….
3. You are going to an out-of-state university to visit friends, when your car catches on fire. You are slightly injured and need immediate help but no one is in sight…
4. You are racing your boat across Lake Erie when your new $60 dollar hat suddenly flies off...
5. You stopped at a local convenience store for a snack. Just as you turn to leave, you see someone riding off on your new motorcycle…
6. You are on your first solo flight and a sudden fog rolls in…

When students have completed their stories, have them share with the class.

Discuss the current and future benefits of GPS as it relates to the students.

ASSESSMENT Observations of both individual and team participation in the research phase can form the basis for assessment. The information (quantity and quality) provided in their narratives can be assessed using your state's writing rubric or you and your students may generate your own.

LESSON 2 Mapping

GRADE LEVEL 6-12

SUBJECT Geography

DESCRIPTION Students will be introduced to maps and mapping terminology.

DURATION 2 hours

LEARNING OBJECTIVES Students will explore the meaning of longitude and latitude lines. Students will identify the parts of the map and how to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

MATERIALS

- computer with Internet access
- Handheld GPS devices
- colored pencils
- white construction paper
- ruler

PROCEDURE

1. Guide the students in a map making exercise where they depict the route they take from their home to the school. Make sure representation includes trees, buildings and any other descriptions of their environment.

2. Have students place all five parts of a map accurately on their map (title, grid squares, compass rose, scale and key). Students should compile an accurate and descriptive map title.

3. Instruct the students that grid squares are made up of imaginary lines on a map or a globe called longitude and latitude lines. Show the students the direction of each imaginary line then explain its significance in finding location. Go over warnings, hazards and proper use of GPS.

4. Students should plot a course from home to school using the GPS, then use latitude and longitude information to complete their map.

5. Explain to the students that the compass rose is the part of the map that indicates direction. Have students use the GPS to correct directional arrows on the map.

6. Instruct that a scale is a representation of distance on a map. Have students figure the distance using the GPS from home to school. By looking at different examples of maps have students decide which scale type to use.

7. Tell the students that the key is the part of the map that gives explanations for symbols on the maps. Have students place a key on their maps to explain map symbols

ASSESSMENT

The teacher will rate maps on a rubric 1-4, 1 being the highest rating. Students will engage in an open discussion about their experiences using the GPS.

EXTENSIONS

Have the students compare and contrast their maps with city and county maps of the same area.

Have students attach a 1-page narrative/descriptive story about their journey "From home to school".

LESSON 3 GIS/GPS Technology

GRADE LEVEL 6-12

SUBJECT Science/Technology

DESCRIPTION Familiarizes youth with the vocabulary associated with GPS/ GIS and water related concepts and allows students to exercise critical thinking skills and navigate the computer game GISquest.

DURATION 30-45 minutes

LEARNING OBJECTIVES

1. Recognize related terms and concepts
2. Use and understand terms

LEARNING ACTIVITIES Students will take a virtual tour of an area (wetland or desert) and use U.S. GPS and GIS technology.

MATERIALS

- Computer with Internet Access
- Windows requirements:
  - Netscape v.4.75+ or Microsoft Internet Explorer v..4+
- Macintosh requirements:
  - Netscape v.6.2
- RealPlayer (download link at www.gisquest.org)- Please note that once you select the link to RealPlayer download site 8 Basic (free version) download link on the left in the middle of the page

VOCABULARY

1. **GPS** - Global Positioning System
2. **GIS** - Geographical Information System
3. **ON STAR** - a company that uses GPS to locate your automobile.
4. **Portable (handheld) GPS** - GPS that you can carry in your hand.
5. **Animated Maps** - maps with a lot of pictures that are drawn.
6. **Bird's Eye View Maps** - maps shot from the air.
7. **Topographic Maps** - maps with land features.
8. **Historical Maps** - maps of a city from a long time ago.
9. **Virtual Reality** - 360 Degrees of a full circle also known as a Panorama.

PROCEDURE

Game Plating Options:

1. Individual play- requires one machine with Internet access.
2. Small group play (2-3 people)- can be accomplished with 2-3 people collectively providing input gathered around one computer with Internet access.
3. Larger group play (more than 3 people)- large-screen projection of computer screen with Internet access with one person entering the information from the groups collective input.

How the Game Works:

Participants are given clues to solve 3 simple GIS problems/quests (with one introductory problem). Participants will have to visit 4 GIS-powered Web sites to solve each quest.

Quests with corresponding Web sites;

1. **Introductory Quest**- http://www.lewisandclarkeducationcenter.com – The Lewis and Clark Web site will be used for trail investigation and exploration.
2. **FireQuest**- www.geomac.gov- The GeoMAC (Geospatial Multi-Agency Coordination Group) Web site will be used for wildland fire investigation and inspection.
3. **RoadQuest**- www.geographynetwork.com- Geographic data and solution sharing Web portal. This Web site will be used to solve a routing problem where you will route the presidential limousine from the White House to give a speech at the Washington Center Hospital.
4. **HazardQuest**- http://hud.esri.com/egis/ - HUD (Housing and Urban Development) Web site will be used to learn what environmental hazards lurk in a backyard similar to your own.

Participants can solve each quest using only the clues given (most difficult) or use the detailed set of instructions provided for participants to follow (medium difficulty) or participants may view a video that will walk them through each quest with detailed images (easiest). Once all the Quests have been solved, then the participant(s) will receive a GIS Quest game completion certificate to print out.

LESSON 4 **Wetlands**

GRADE LEVEL 6- 12

SUBJECT Science/Ecology

DESCRIPTION In school and at field-based sites, students investigate the characteristics and history of wetlands; the importance of wetlands to the establishment of cooperative living habitats; and the impact of wetlands upon man's lifestyles, available supplies of selective foods, and his built environments.

DURATION Five 50-75 minute sessions

LEARNING OBJECTIVES

1. Students will conduct research activities in the classroom and at selected field-based sites.
2. Students will interact with wetlands environments.
3. From community resource people, students will learn about the importance of wetlands to the total life space environment of the community/surrounding region.
4. Students will discuss and debate strategies to protect wetlands from man's intrusion and thus their eventual destruction.
5. Students will study the ecosystem of a selected wetlands site.

LEARNING ACTIVITIES As a result of conducting this research-oriented investigation, students will understand: the nature and characteristics of wetland environments, the effects of wetland environments upon the overall health of the total life space environment, types of wetlands flora and fauna, and the geographical location of wetlands in the local community/surrounding region.

MATERIALS

- magazines (eg: National Geographic , Political magazines)
- atlases, maps, and globes
- computer software (Photo Shop)
- Internet sites
- films, filmstrips, slide/tape presentations, videos, PowerPoint presentations
- overhead transparencies
- community resources (people, places, things, events, processes)
- construction paper, tape/glue, scissors, stapler, thumbtacks, crayons and color markers, paint, butcher paper
- transparency sheets -- to make overhead projector visuals
- 8mm/16mm motion picture cameras
- still photography cameras (35mm)
- video tape equipment

- water, dirt, sand, vegetation, and straw or hay
- a tabletop or piece of plywood

VOCABULARY

1. **Cooperative Living Habitat(s)** - Geographical locations within which Man and Nature coexist and mutually prosper from their associations.
2. **Interlocking Dependency** - The inextricable link that exists between Man and Nature on earth.
3. **Life space Environment** - The geographical/physical location in which an individual exists -- at any given moment in time. One's life space environment changes as he/she moves about from one geographical location to another.

PROCEDURE A biome is a major community (flora and fauna) located on a specific continental sub-division of the geosphere (solid portion of earth). Biomes are defined by combinations of physiognomy (vegetation structure) and environment. Students investigate wetlands in the classroom, in lab classes, and at field-based sites (whenever possible) -- bogs, marshes, swamps. Community resource guides introduce students to the characteristics of wetlands -- pointing out flora, fauna, the composition of the soil, etc. Data is collected using water sampling kits, graphic media devices (cameras), sketches and maps of the region, observations in logs, etc. Print/non-print materials and resources are used for data gathering purposes.

ASSESSMENT Students demonstrate acquired knowledge and research skills by conducting lab studies of water and soil samples from wetlands, creating audiovisual presentations about wetlands sites, writing reflective essays, constructing a tabletop diorama, writing poetry, composing songs, and writing term papers. Students also demonstrate knowledge through discussions concerning the importance of wetlands in the web of life and the impact of wetlands upon the quality of the total life space environment of the community/surrounding region.

LESSON 5 **Ecosystem**

GRADE LEVEL 6-12

SUBJECT Science/Ecology

DESCRIPTION Students will become familiar with the terms ecosystem, biotic, and abiotic. They will understand what an ecosystem is and the role of abiotic and biotic factors. Students will create an ecosystem using designated materials.

DURATION 1 hour

LEARNING OBJECTIVES

1. Students will be able to define the term ecosystem as a working unit made up of organisms interacting with each other and with nonliving factors. More specifically for this lesson, an ecosystem will be a 2-liter bottle filled with sand, gravel, an Elodea plant, water, fish, fish food, and sunlight.
2. Students will be able to discuss ecosystems in their surroundings.
3. Students will be able to create their own ecosystem, with given materials, in a bottle.

LEARNING ACTIVITIES Students will gain an understanding of what an ecosystem is and the role that humans play in ecosystems.

MATERIALS

- 2-liter bottle
- sand
- aquatic plants (Elodea)
- gravel
- scissors
- ruler
- water
- fish (1 small goldfish or guppy per student)
- fish food
- for the station activity: aquarium, plant with worm, bottle of nail polish, and a moldy sandwich

VOCABULARY

1. **Ecosystem** - an ecological community together with its environment, functioning as a unit.
2. **Biotic**- the living parts of an ecosystem.
3. **Abiotic**- the nonliving parts of an ecosystem.

PROCEDURE

Scientific Explanation:
What is an ecosystem? The biosphere is the part of the Earth that contains all the living things on the planet. Each ecosystem that we study is a part of the biosphere. A system is a group of things that interact with one another. The organisms that make up the living part of an ecosystem are called biotic factors. An organism depends on other biotic factors for food, shelter, protection, and reproduction. Nonliving things that we find in an ecosystem are called abiotic factors. Abiotic factors have an effect on the type and number of organisms living in an ecosystem. Some abiotic factors include soil, water, temperature, and sunlight.

Focus Phase:
Have students observe a working aquarium. Have students get into groups of two to think-pair-share about abiotic and biotic elements in the demonstrated ecosystem. Discuss the various elements that may be found in an ecosystem. Brainstorm elements and have students decide if the elements are abiotic or biotic.

Challenge Phase:
Have four stations (aquarium, plant with worm, bottle of nail polish, moldy sandwich) set up for students to visit in small groups. As a group, students will decide whether or not each station is an ecosystem. Also have students determine what parts of the system are abiotic or biotic. Have students make predictions about whether or not the station fits the definition of an ecosystem. Have students make further predictions about what each station might need to fit the definition of an ecosystem. One person in the group will record the group's ideas and answers. This information will be shared with the class at a later time.

Concept Introduction:
As a class, share the results of the challenge phase. Which stations did students identify as ecosystems? Students should have determined that the aquarium and the plant with worm are ecosystems. The moldy sandwich is part of an ecosystem. The bottle of nail polish is not an ecosystem. Have students share their ideas about what needs to be added to make non-ecosystem stations an ecosystem. For the bottle of nail polish to become an ecosystem, it needs a source of energy, food, water, and a population of "animals" which could maintain life in extreme conditions. The sandwich is part of an ecosystem, but to be an ecosystem of its own, it would require another source of food that could maintain its growth. As a class, brainstorm factors necessary for an ecosystem and list them on the board.
Inform students that they are going to be creating an ecosystem in a 2-liter bottle. They will be given a 2-liter bottle, aquatic sand, gravel, an Elodea plant, water, and eventually,

one fish to add to their ecosystem. Students must first draw an ecosystem and have it approved before they can get their materials and begin construction.

Concept Application: After all students have had their plans approved, they may begin building their ecosystem. They will be given all the materials that they will need, except for the fish. Students will have some leniency in the construction of the ecosystem, but because they will be given a live fish to add to their ecosystem, the ecosystem must be safe for the fish. Once students have completed the construction of their ecosystem, students will explain how the fish will be able to survive in this ecosystem, and what they, as students, must provide to ensure the success of the ecosystem (i.e. food, sunlight, oxygen and clean water).

ASSESSMENT Students will be assessed on their ability to construct an ecosystem that is a safe and successful environment for a live fish. In their journals, students will be asked to describe the elements that make up their ecosystem. They should also explain the role that they will play in their ecosystem.

LESSON 6 WATER

GRADE LEVEL 6-12

SUBJECT Science/Aquatics

DESCRIPTION Every day, the average American uses about 50 gallons of water for drinking, bathing, cooking and maintenance. Most people, however, are unaware of the source of their water. In the United States, about 88 percent of the population is supplied by community water supply systems. The other 12 percent is supplied by non-community means, such as campgrounds, resorts, and private wells. Sixty-four percent of public water systems use surface water as their source, the other 36 percent use groundwater from wells. The aesthetic properties of drinking water from these public systems are often affected by the source of the water. Ground water often has a slightly metallic taste, and may contain high amounts of minerals. Surface water, on the other hand, usually has a musty taste and appears cloudy. Treatment techniques aim to produce water that is: safe for human consumption; appealing and good tasting to the consumer; and conforms to applicable State and Federal regulations at the lowest possible cost.

DURATION 1 hour

LEARNING OBJECTIVES This test should follow a class discussion on the possible sources of water for the community and strengthen student understanding.

LEARNING ACTIVITIES This taste test will illustrate the differences between groundwater and surface water, highlight some of the common contaminants in natural water, and encourage student thought on the sources of drinking water.

MATERIALS

- 1 gallon of distilled water
- 1 gallon of tap water (identify the source)
- 1 gallon of mineral water (or private well water, if available)
- 1 gallon of filtered tap water
- Cups for the class

PROCEDURE

1. Mark a set of 4 cups for each student. Label each cup 1 through 4 and fill them with the different types of water. Make sure that similarly labeled cups contain the same type of water.

2. Indicate on the board the different types of water present in the four cups. Have the students work together in groups to try to identify different tastes, smells, and appearances in the water. Have each group write down their observations on each water sample, and identify which cup has which type of water.

3. After everyone has completed their observations, have the students mark their guesses on the board.

Ask the students what types of impurities they would expect to find in the different types of water, and if their senses confirmed their intuitions. Record these observations on the board.

4. Reveal to the students which samples contained which type of water. Discuss with the students their observations and what other impurities might be found in these waters. Also discuss the source of water for the community. If anyone in the class lives in a location supplied by a private well, ask him/her to describe the water at their home, and how it compares to other water he/she drinks in the community.

FOLLOW-UP QUESTIONS

1. What are some possible sources of water in your community?

2. Which type of water tasted best? Why?

3. Which type of water would you consider safer to drink, groundwater from a spring, or surface water from a stream?

LESSON 7 WATER QUALITY

GRADE LEVEL 6-12

SUBJECT Science/ Aquatics

DESCRIPTION In an effort to develop a system to compare water quality in various parts of the country, over 100 water quality experts were called upon to create a standard Water Quality Index (WQI). The index is basically a mathematical means of calculating a single value from multiple test results. The index result represents the level of water quality in a given water basin, such as a lake, river, or stream.

The WQI, which was developed in the early 1970s, can be used to monitor water quality changes in a particular water supply over time, or can be used to compare the quality of a water supply with other water supplies in the region or from around the world. The results can also be used to determine the healthfulness of a particular stretch of water.

DURATION 4 hours

LEARNING OBJECTIVES To determine the WQI using the following nine water quality parameters.

The Water Quality Index uses a scale from 0 to 100 to rate the quality of the water, with 100 being the highest possible score. Once the overall WQI score is known, it can be compared against the following scale to determine how healthy the water is on a given day.

Table I - WQI Quality Scale	
91-100:	Excellent water quality
71-90:	Good water quality
51-70:	Medium or average water quality
26-50:	Fair water quality
0-25:	Poor water quality

Water supplies with ratings falling in the good or excellent range would able to support a high diversity of aquatic life. In addition, the water would also be suitable for all forms of

recreation, including those involving direct contact with the water. Water supplies achieving only an average rating generally have less diversity of aquatic organisms and frequently have increased algae growth.

Water supplies falling into the fair range are only able to support a low diversity of aquatic life and are probably experiencing problems with pollution. Water supplies that fall into the poor category may only be able to support a limited number of aquatic life forms, and it is expected that these waters have abundant quality problems. A water supply with a poor quality rating would not normally be considered acceptable for activities involving direct contact with the water, such as swimming.

LEARNING ACTIVITIES After the nine water quality tests are completed and the results recorded, you can calculate the Water Quality Index (WQI) for the section of the water supply you monitored.

To calculate the overall WQI, you must first compute what are known as Q-values for the results you obtained for each of the nine tests and record them on the WQI Worksheet. This section outlines the procedures for computing these values:

1. Locate the chart for the appropriate test parameter (see links below).
2. Locate and mark your test result on the bottom, or horizontal axis, of the chart.
3. Beginning at your mark, draw a vertical line up until it intersects the curve on the chart.
4. From the point where your line intersected with the curve, draw a horizontal line to the left until you reach the vertical axis of the chart.
5. Record the value where this horizontal line intersects the vertical axis of the chart on the form. This would be the Q-value for the test.
6. Repeat each of these steps to find the Q-value for each of the remaining tests results.

You can select each of the following test parameters to view (or print) a copy of the Q-value chart for that parameter.

- Biochemical Oxygen Demand (BOD)
- Dissolved Oxygen
- Fecal Coliform
- Nitrate
- pH
- Temperature Change
- Total Dissolved Solids
- Total Phosphate
- Turbidity

Make sure you record the correct Q-value in the appropriate column next to each test parameter on the WQI Worksheet before you proceed to the next step. After the nine water quality tests are completed and the results recorded, a "Q" value is calculated for each parameter, and the overall WQI for the sampling site is then calculated. It is important to monitor water quality over a period of time in order to detect changes in the water's ecosystem. The Water Quality Index can give an indication of the health of the watershed at various points and can be used to keep track of and analyze changes over time.

Completing the WQI Calculation

The Q-value for each test should then be multiplied by the weighting factor shown on the Worksheet for each test, and the answer should be recorded in the "Total" column. The weighting factor indicates the importance of each test to overall water quality. For example, the weighting factor for fecal coliform is 0.16, so it is considered more important in evaluating the overall water quality than nitrates, which only has a 0.10 weighting factor.

Finally, add the numbers shown in the Total column to determine the overall Water Quality Index (WQI) for the water source tested. Compare your Index result to the scale shown in Table I to determine the water quality rating for the water supply tested.

VOCABULARY

1. **Biochemical Oxygen Demand-** a measure of the amount of food for bacteria that is found in water. Bacteria utilize organic matter in their respiration and remove oxygen from the water. The BOD test provides a rough idea of how much biodegradable waste is present in the water. (Biodegradable waste is usually composed of organic wastes, including leaves, grass clippings, and manure).
2. **Dissolved Oxygen-** measures the amount of life-sustaining oxygen dissolved in the water. This is the oxygen that is available to fish, invertebrates, and all other animals living in the water. Most aquatic plants and animals need oxygen to survive; in fact, fish will drown in water when the dissolved oxygen levels get too low. Low levels of dissolved oxygen in water are a sign of possible pollution.
3. **Fecal Coliform-** a form of bacteria found in human and animal waste.
4. **Nitrates**- a measure of the oxidized form of nitrogen and are an essential macronutrient in aquatic environments. Nitrates can be harmful to humans, because our intestines can break nitrates down into nitrites, which affect the ability of red blood cells to carry oxygen. Nitrites can also cause serious illnesses in fish.
5. **pH-** a measure of the acid content of the water. Most forms of aquatic life tend to be very sensitive to pH. Water containing a great deal of organic pollution will normally tend to be somewhat acidic. Water with a pH of 7 is considered neutral. If the pH is below 7, it is classified as acidic, while water

with a pH greater than 7 is said to be alkaline. The pH of tap water in the U.S. is usually between 6.5 and 8.5.

6. **Temperature Change**- the water temperature of a river is very important, as many of the physical, biological, and chemical characteristics of a river are directly affected by temperature. Most waterborne animal and plant life survives within a certain range of water temperatures, and few of them can tolerate extreme changes in this parameter. Using the same thermometer, the water temperature should be checked at the test site and at a similar site one mile upstream. Care should be taken when taking the temperature upstream to ensure that the amount of sunlight and the depth of the river are similar to the original test site.
7. **Total Dissolved Solids**- a measure of the solid materials dissolved in the river water. This includes salts, some organic materials, and a wide range of other things from nutrients to toxic materials. A constant level of minerals in the water is necessary for aquatic life. Concentrations of total dissolved solids that are too high or too low may limit growth and lead to the death of many aquatic life forms.
8. **Total Phosphate**- chemical compounds made from the elements phosphorous and oxygen; they are necessary for plant and animal growth. Phosphates can be present in water in many forms, so total phosphate gives an estimate of the total amount of phosphate potentially available in a given water supply.
9. **Turbidity**- a measure of the dispersion of light in a column of water due to suspended matter. The higher the turbidity, the cloudier the water appears. If water becomes too turbid, it loses the ability to support a wide variety of plants and other aquatic organisms.

ASSESSMENT

National Water Monitoring Day

Many individuals and volunteer groups from around the country participate in National Water Monitoring Day, which was held last year on October 18, 2002. Participants are requested to sample local rivers and streams for a core set of water quality parameters, including Temperature, pH, Turbidity, Dissolved Oxygen. An inexpensive test kit is available for purchase at www.yearofcleanwater.org for those individuals who do not have access to testing facilities. Those monitoring organizations and government monitors who do have access to regular facilities may use their existing protocols, equipment, and monitoring methods and submit their test results online.

A second water quality monitoring project is coordinated each fall and spring by the Center for Improved Engineering and Science Education (CIESE) in New Jersey. To learn more about the monitoring program, you can visit their website at k12science.ati.stevens-tech.edu/curriculum/waterproj/index.shtml.

LESSON 8 Surface Water

GRADE LEVEL 6-12

SUBJECT Ecology, Physical Science, Social Studies, Economics, Government

DESCRIPTION Many towns and cities obtain their drinking water from a nearby river, lake or reservoir. The quality of this source water is influenced by the quality of streams flowing into it, the land uses and activities conducted near it, and any air deposition that might occur. Surface source water protection is a 3-step process involving: delineating areas contributing water to a surface water intake, identifying potential contaminant sources that may threaten the water supply, and protecting the supply using a combination of watershed management strategies for specific communities or watersheds. Watershed management strategies incorporate broad concepts such as land use control and/or management practices, and pollution prevention. Specific watershed management strategies may include the following: protection of inland wetlands that serve as filters for pollutants, appropriate forestry management practices, erosion controls, control of adjacent zoning and urbanization, creation of buffer zones along reservoir edges, reservoir access and activity control, and community education. Homeowners, businesses, farmers, and industries may also be encouraged to use pollution prevention and best management practices to prevent surface water contamination.

DURATION 4 hours

MATERIALS

- student sheets
- bus for field trip

VOCABULARY

1. **Best Management Practices (BMPs)-** techniques that are determined to be currently effective, practical means of preventing or reducing pollutants from point or nonpoint sources, in order to protect water quality. BMPs include, but are not limited to structural and nonstructural controls, operation and maintenance procedures, and other practices. Usually, BMPs are applied as a system of practices rather than as a single practice.
2. **Buffer Zone -** an area between the water supply source and the possible contamination sources where no contamination activities are likely to occur.

3. **Pollution Prevention** - preventing the creation of pollutants or reducing the amount created at the source of generation, as well as protecting natural resources through conservation or increased efficiency in the use of energy, water, or other materials.
4. **Source Water Protection** - process that involves delineating areas contributing water to a well or surface water intake; identifying potential contaminant sources that threaten the water supply; and using management strategies to protect the source water from contamination. Source water protection is applied to both surface water and groundwater supply sources.
5. **Watershed** - land area from which water drains to a particular surface water body.
6. **Zonings** - to divide into areas determined by specific restrictions; any section or district in a city restricted by law for a particular use.

PROCEDURE

1. Discuss Background Information with students.
2. Contact the local drinking water treatment plant and find out the water source in the community.

LEARNING ACTIVITIES

1. Schedule a visit to the water supply reservoir with a water system representative and ask about source water protection methods that are used, including upstream management methods in the watershed. If a field trip is not possible, have a water system representative visit the class.
2. From local, state, or other sources, define the water supply watershed on a topographic or other map and locate potential pollutant sources. (Use Student Sheet to determine potential pollution problems.)
3. Visit each pollutant source, or location downstream of each one, to determine the type and extent of pollutants to the reservoir. (Students could be assigned this as an out-of-class assignment and report to the class.)
4. Note any pollution prevention or best management practices in place or, where none exist, make notes of recommendations (not just what is needed but how to do what is needed).
5. Make a compilation of all notes from the class into a report on protection of the water supply watershed. Include recommendations as to the location and type of pollution prevention or best management practices used or needed, and other water quality management steps which should be taken.

EXTENSION

Have students construct a solar evaporator using the materials you have provided or some they may want to bring. They can follow the directions on the Student Sheet or try their own design. Students should wash hands and dip finger in salt solution and taste. Place solar evaporators in a warm, sunny place for 24 hours. Taste water in beaker (glass) using finger method after washing, and answer questions on Activity Student Sheet. Finally, discuss the findings.

ASSESSMENT

Share compiled information or reports with local watershed managers and ask them to comment on the class ideas.

LESSON 9 Watershed

GRADE LEVEL 6-12

SUBJECT Ecology

DESCRIPTION The land we live on is divided into watersheds. A watershed is a land area whose runoff drains into any river, stream, lake, or ocean. The runoff from small watersheds joins together, and their combined areas become a new, larger watershed. Large watersheds, such as the Anacostia watershed and the Chesapeake Bay watershed, drain into large bodies of water, and cover immense land areas. Despite their differences in size all watersheds share common properties. They all perform the same function of transporting water over the Earth's surface. The watersheds encompass suburban lawns, parking lots and city streets. Water seeps down through the soil to aquifers, which are underground rivers that slowly move water below watersheds to outlet points at springs, rivers, lakes, and oceans.

Many human activities have an effect on watersheds. Construction projects like dams can limit the flow of water; construction of roads and buildings can divert and even increase the flow of water. Agricultural fertilizers can run off of crop fields and inadvertently fertilize harmful microorganisms in rivers and lakes, having an adverse effect on water quality and marine life. The irresponsible disposal of household and industrial chemicals can be harmful because these chemicals travel through the watershed, poisoning life and damaging natural ecosystems.

Watersheds can also have an effect on people. Many communities use rivers and streams as their source of drinking water. Water treatment prepares water for human consumption, but if the water is laden with chemicals and microorganisms, it can be difficult to treat effectively. Floods are one of the major events in a watershed. Homes built on flood plains, low lying areas adjacent to rivers, are susceptible to flooding conditions when heavy precipitation exceeds the watershed's capacity to absorb water. Rivers, streams, and lakes overflow, threaten human lives, and damage or destroy roads, buildings, and flood control measures. Watersheds can also become dry, causing water shortages for those who depend on their lakes and rives for drinking water.

It is clear that people have a close relationship to watersheds. The responsible planning of watershed use and development is important to ensure that the ecosystems sustained by them are not destroyed, and to protect the health and safety of our communities.

DURATION 2-4 hours

LEARNING OBJECTIVES

1. Understand how the placement of buildings, roads, and parking lots can be important to watershed runoff.
2. Recognize human carelessness in the disposal of harmful contaminants that can have a serious effect on downstream watershed denizens.

MATERIALS

- 1 large Tupperware container (about 1.5'W x 3'L x H)
- 2 lbs. of modeling clay
- 3 lbs. of sand (any type of sand will do)
- 2 lbs. of aquarium gravel
- 1 roll of wax paper (or any other impervious, water repellant surface, tin foil, plastic wrap, etc.)
- ¼ cup of cocoa mix, iced tea mix, or other flavored drink mix (to represent chemicals)
- 1 spray bottle or bucket full of water

PROCEDURE

1. Wash the aquarium gravel carefully to remove any powdery residue that may add cloudiness to the water. Fill the container to about 2 inches from the bottom with the gravel. Slope the gravel slightly so, that at one end (downslope), the gravel is only about ½ inch deep and, at the other end (upslope), the gravel is about 3 inches deep. This gravel layer will represent the aquifer.
2. Mix the clay and the sand. The consistency of this mix should be gritty, with slightly more clay than sand. This mixture should allow water to run freely over it, but if left standing, the water should slowly permeate the surface. Add this mixture to the container carefully, so as not to disturb the slope of the aquifer already placed. The slopes should be similar, with about 2 inches of sand/clay mix overlying the gravel already placed, and on the downhill end there should be about 3" of gravel left exposed.
3. Carve a channel in the middle of the clay/sand layer, about ½ inch deep and about 1 inch wide. This channel will represent the main river of the watershed. Near the top of the slope, split the channel into two or three separate channels to represent tributaries. You may wish to add other tributaries along the main branch of the "river" to further illustrate other watersheds.
4. With some extra clay/sand mix, build little hills between the tributaries. These hills separate the smaller watersheds, but when looked at as a whole, the entire "river" system is one watershed. You may also wish to add some small model

trees or green felt to represent forests or fields. Buildings can be represented with small blocks of wood.

5. Along the main river, flatten out an area that is about 8 inches. Cut out a piece of wax paper to be about 4 inches by 3 inches in size. Stick this down onto the clay sand mix, sloping slightly towards the river. If necessary, use some clay to hold the edges down. Explain to the students that this wax paper represents the impervious surface of a parking lot.
6. Fill the bottom of the aquarium up to about 2 inches from the bottom with water. The water should fill all of the aquarium gravel "aquifer" area, and should just reach up to the lowest extent of the clay/sand mixture. Explain to students that the aquifer captures and transports water that seeps down through the soil.
7. Using the spray bottle, simulate rain over the flattened soil area and the parking lot. Ask the students to note that the "rain" soaks through the soil, but runs off the parking lot to the river. Ask them what the effect would be if the entire watershed was "paved."
8. Sprinkle some cocoa mix over the sides of one of the smaller watersheds. Tell the students that the cocoa represents pollution. Cause some rain with the spray bottle over one of the unpolluted "watersheds," (*it may be necessary to cause more rain by pouring water). Note that the runoff from the rain is clean. Now, make it rain over the polluted area. Ask the students to note how the pollution travels down through the watershed, contaminating all downstream areas. Discuss with the students why the pollution is a problem, and what can be done to fix the problem.

ASSESSMENT

1. What are some possible sources of watershed pollution in your community?
2. What other impervious surfaces besides parking lots can cause excessive runoff in a watershed?
3. What can be done to reduce our impact on watersheds and their environment?
4. Using a map of the area around your house and EPA's "Surf Your Watershed," identify where the runoff from your driveway will end up. Can you track the path of potential pollution to a large body of water (*i.e.*, ocean or bay)?

LESSON 10 Water Filtration

GRADE LEVEL 6-12

SUBJECT Science/ Ecology

DESCRIPTION Water in lakes, rivers, and swamps often contains impurities that make it look and smell bad. The water may also contain bacteria and other microbiological organisms that can cause disease. Consequently, water from surface water sources must be "cleaned" before it can be consumed by people. Water treatment plants typically clean water by taking it through the following processes: (1) **aeration**; (2) **coagulation**; (3) **sedimentation**; (4) **filtration**; and (5) **disinfection**. Demonstration projects for the first four processes are included below.

DURATION 2 hours

LEARNING OBJECTIVES To understand the water treatment processes and their importance in ensuring healthful drinking water.

MATERIALS

- 5 liters of "swamp water" (or add 2 ½ cups of dirt or mud to 5 liters of water)
- 1 two-liter plastic soft drink bottle with its cap (or cork that fits tightly into the neck)
- 2 two-liter plastic soft drink bottles – 1 with the top removed, 1 with the bottom removed
- 1 one-and-one-half-liter (or larger) beaker (or another soft drink bottle bottom)
- 20 grams of alum (potassium aluminum sulfate – approximately 2 tablespoons)
- fine sand (about 800 ml in volume)
- course sand (about 800 ml in volume)
- small pebbles (about 400 ml in volume)
- 1 large (500 ml or larger) beaker or jar
- 1 coffee filter
- 1 rubber band
- 1 tablespoon
- 1 clock with a second hand (or a stopwatch)

VOCABULARY

1. **Aeration-** the addition of air to water. It allows gases trapped in the water to escape and adds oxygen to the water.
2. **Coagulation-** the process by which dirt and other suspended solid particles are chemically "stuck together" into floc so that they can be removed from water.
3. **Sedimentation-** the process that occurs when gravity pulls the particles of floc (clumps of alum and sediment) to the bottom of the cylinder.

PROCEDURE

1. Pour about 1.5 liters of the swamp water into a 2-liter bottle. Have students describe the appearance and smell the water.
2. Aeration- Place the cap on the bottle and shake the water vigorously for 30 seconds. Continue the aeration process by pouring the water into either one of the cut-off bottles, and then pour the water back and forth between the cut-off bottles 10 times. Ask students to describe any changes that they observe. Pour the aerated water into the bottle with its top cut off.
3. Coagulation- With the tablespoon, add 20 g of alum crystals to the swamp water. Slowly stir the mixture for 5 minutes.
4. Sedimentation- Allow the water to stand undisturbed in the cylinder. Ask students to observe the water at 5 minute intervals for a total of 20 minutes and write their observations with respect to changes in the water's appearance.
5. Construct a filter from the bottle with its bottom cut off as follows:

    a. Attach the coffee filter 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 filter will prevent the pebbles from falling out of the neck.
    b. Pour the coarse sand on top of the pebbles.
    c. Pour the fine sand on top of the coarse sand.
    d. Clean the filter by slowly and carefully pouring through 5 liters (or more) of clean tap water. Try not to disturb the top layer of sand as you pour the water.

6. Filtration through a sand and pebble filter removes most of the impurities remaining in water after coagulation and sedimentation have taken place. After a large amount of sediment has settled on the bottom of the bottle of swamp water, carefully—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) swamp water back into the collection container. Compare the treated and untreated water. Ask students whether treatment has changed the appearance and smell of the water.

ADVISE STUDENTS THAT THIS WATER IS UNSAFE TO DRINK!!

Appendix B. Water Testing- List and Prices

Water Testing- List and Prices

Lab: Environmental Systems Service, Ltd.
Address: 8321 Leishear Rd
Laurel, MD 20723
Phone: 301.617.9582
Fax: 301.617.3426
URL: Http://www.ess-services.com

Contact: Kunle Aladeselu

Indoor Samples

TEST	**COST PER SAMPLE**	**TOTAL PER TEST**
Lead	$20 x 16	$320
Turbidity	$15 x 16	$240
pH	$10 x 16	$160
Choliform	$40 x 16	$640
Total Per Sample	**$85**	
Total Testing Costs		**$1360**

Public Waterway Samples

TEST	**COST PER SAMPLE**	**TOTAL PER TEST**
Lead	$20 x 6	$120
Copper	$20 x 6	$120
Chromium	$20 x 6	$120
Zinc	$20 x 6	$120
Iron	$20 x 6	$120
Manganese	$20 x 6	$120
Metal #7	$20 x 6	$120
pH	$10 x 6	$60
Nitrates	$25 x 6	$150
Turbidity	$15 x 6	$90
Choliform	$40 x 6	$240
Total Per Sample	**$230**	
Total Testing Costs		**$1380**

$25- pick up per location