SOURCE OF THE PROBLEM

(Point and Non Point Source Pollution)

A Water Resource Education Unit

CONCEPT: The way we live can affect the quality of our water especially when our actions contribute to point and non-point source pollution.

PURPOSE: This unit teaches students about different types of pollutants, how they get into our water sources, and ways to reduce, minimize or eliminate water pollution.

OBJECTIVES: Students will be able to:

1. define what point and non-point source pollution is
2. identify items that can contribute to point and non-point source pollution
3. state how water pollution can affect them

CURRICULUM ACTIVITIES:	SUBJECT AREAS:
1. Deadly Waters	Language Arts
2. Point and Non-Point Source Pollution (ranger program)	Language Arts, Science
3. What is Threatening Our Water?	Reading
4. Water Journal	Writing, Language Arts
5. Poison Pump	Social Studies, Health
6. Water Monitoring	Science, Math

Water Resource Education
New River Gorge National River

SOURCE OF THE PROBLEM

(Point and Non Point Source Pollution)

OVERVIEW

What Is Point and Non Point Source Pollution?

Pollution that enters our water resources are grouped into two catagories, point source pollution, and non-point source pollution. These catagories contain many types and sources of pollutants and are based on the method in which the pollution enters or is released into a water source.

Point source pollution comes from a specific place that can be pinpointed as the source of the pollution contaminating a waterbody. One example is an industrial site with a pipe directly dumping untreated or improperly treated pollutants into a water source. Another point source would be a wastewater treatment plant that cannot handle all the incoming wastewater and discharges raw sewage into a local stream or river. Point source pollutants are most often minerals, chemicals, and sewage.

Non point source (NPS) pollution is the pollution of water resources from a wide variety of human activities that take place over a large geographic area. NPS pollution comes from farms, cities, forests, mining operations, construction sites, and our homes.[1] It occurs when runoff from rain and snowmelt picks up pollutants left or dumped on the ground and carries them into our streams, rivers, lakes, and groundwater. These pollutants include sediments (soil), fertilizers, and nutrients, oils and grease, pesticides, toxic chemicals, road salts, domestic animal waste, untreated sewage from homes not hook-up to a city or community wastewater treatment plant, and other contaminants. The most common NPS pollutants are sediments, nutrients, and sewage.

The Issue of NPS Pollution

Point source pollution of our nation's river, lakes, and coastal waters has been greatly reduced over the past three decades. Thanks mainly to the Clean Water Act passed by the U. S. Congress in 1972 and amended in 1977, (Water Pollution Control Act, Public Law 92-500). This Act seeks to eliminate the discharge of any pollutant from a point source into any U.S. water body. It has made the dumping of untreated wastewater from a point source illegal and set penalties for violations. A lot of progress in reducing point source pollution has been made in the United States and we need to continue to improve upon past success.

This success; however, is at best only a partial one. If we really want to continue making progress in water quality, we must also focusing on NPS pollution. The task of reducing and eliminating NPS pollution is more difficult than controlling point source pollution. Because NPS pollution is diffuse, it is very difficult to pin point its origin. Pollutants from NPS pollution usually enter water sources in sudden surges, often in large quantities, during rainfall, thunderstorms, or snowmelt.[2]

Reducing NPS pollution will require educating individuals and communities about the NPS pollution and its effects on the environment. We must also find ways to minimize NPS pollutants, manage stormwater runoff, and minimize the amount of pollutants that enter our rivers, lakes, and groundwater. It is essential to convince individuals, and society as a whole, that there is a problem and a compelling need for action. Changes in lifestyles and behaviors will be needed to prevent this type of pollution. Non point source pollution is everyone's problem.

It is the responsibility of farmers to grow their crops and graze their animals in ways that protect nearby streams and groundwater. It is the responsibility of those who harvest timber to do so in ways that prevent soil runoff. It is the responsibility of backyard mechanics to take used motor oil to collection or recycling centers. It's the responsibility of homeowners to apply lawn care chemicals and fertilizers carefully and safely or use environmentally friendly products. It's the responsibility of car owners to keep their vehicles maintained so they don't leak oil or grease onto the roadway or pollute the air with their exhaust.

The task will not be easy, nor can it be accomplished quickly. It will not be inexpensive, but the price of avoiding the issue grows daily. It is measured in terms of the nation's health, and in the degradation of our irreplaceable water resources.[3]

Significant Sources and Effects of NPS Pollution

Sewage contamination from homes, towns, and cities is a threat to water resources world wide including the New River watershed. Contamination results from improper treatment and disposal of human sewage, poor maintenance or overflow of sewage treatment plants, lack of sewage treatment facilities all together, pipes that dump untreated sewage directly into a water source, and leaky systems. Raw sewage harms the natural environment and carries unhealthy bacteria that transmit diseases to humans.

The striping of vegetation from a site for development of a new home, shopping center, industrial site, parking lot, road construction, or for crop production increases soil erosion into nearby streams, rivers, and lakes. When bear soil is exposed, natural erosion rates can accelerate to 100 times the normal rate. The deforestation of woodlands and construction of logging roads also allows large amounts of sediments to erode into streams, rivers, and lakes. The increase in sediment blocks sunlight needed by aquatic plants (plants die), clogs the gills of fish, and macroinvertebrates (animals die), covers aquatic habitats (destroys homes), and increases the cost of cleaning and purifying drinking water (higher water bills).

In our desire to want our crops, lawns, trees, shrubs, and flowers to grow large and pretty, we use many chemicals — pesticides, herbicides and fertilizers. If used improperly and in large quantity, pesticides and herbicides are washed by rainwater runoff into nearby streams where they harm macroinvertebrates, such as stoneflies. They can bioaccumulate (build up over time) in the tissues of fish and crustaceans. People and bird species who eat these creatures can be harmed.

Fertilizers harm aquatic environments by adding increased levels of nutrients (nitrates) when they enter a water source. These nitrates cause algae (simple aquatic plants) to grow and reproduce rapidly. Once the additional nutrients are used up, the algae dies and is decomposed by

Bacteria uses oxygen in the decomposition process, which quickly rob a stream of oxygen needed by fish and other aquatic species, resulting in fish kills.

Paints, solvents, cleaners, and other home care products as well as motor oil and antifreeze are harmful to the environment. These chemical based products are a source of runoff pollution, especially if they are used, stored or disposed of improperly. There are people who dump used oil into storm drains or directly on to the ground where it is washed by rainwater into nearby streams and rivers. One quart of used motor oil can contaminate up to two million gallons of water.

Livestock and pets carry pathogenic organisms in their intestines and manure. These pathogenic organisms can cause diseases in humans. Animal manure contaminates water resources when livestock are allowed to wade in streams and ponds or when rainwater carries their manure from feed pens, pastures, and yards into nearby streams.

Landfills and illegal dumps can affect water quality. The trash people throw out, i.e., pesticides, paint thinners, metal polish, old batteries, and thousands of other potentially damaging waste products mix together in dumps and landfills. These products produce leachate (toxic liquids) that drains to the bottom of the dump or landfill. Older landfills and illegal dumps that have no liner or have begun to leak have no way of stopping leachates. These toxins leach into the groundwater and into nearby streams and wells.

Urban runoff from streets, parking lots, sidewalks, and buildings contributes to NPS pollution. Pollutants found in urban runoff include salts, oils and grease, and toxins, as well as litter and trash (cans, bottles, plastic, etc.) dumped, thrown, or leaked along our roadways. When it does rain, the buildup of these pollutants washes into streams all at once, which can have a devastating effect on the quality of the water. Even though it may flow through a pipe, urban runoff is considered NPS pollution. In most areas, urban runoff goes unregulated and unaddressed.

Mining causes a variety of pollution problems depending on the type of mining, the type of material being mined, and the sensitivity of the watershed to mining impacts. One such problem is the many mines that have been abandoned without being reclaimed. Acid drainage from these abandoned mines, mill tailings, and waste piles contributes NPS to streams and rivers. The effects of acid mine drainage often kills the plant and animal life.

Acid rain poses a serious problem for streams and rivers. Industry is responsible for a wide variety of air pollutants (specific to the industry) that are filtered out of the atmosphere by rain. For example, coal-burning power plants release sulfur and nitrogen oxides into the atmosphere that, when mixed with moisture, form acids. These acids return to earth as acid rain. Car exhaust also contributes to air pollution and acid rain.

1. *Water matters: Every Day, Everywhere, Every Way*. Washington, DC: National Geographic Society.
2. *The World Around Us.* The Garden Club of America.
3.__*EPA Journal - NPS Pollution*. Washington, DC: Environmental Protection Agency
4.__*The Quality of Our Nation's Water: 1994*. Washington, DC: Environmental Protection Agency, 1995.

SOURCE OF THE PROBLEM

Pre-Visit Activity

Activity	**Deadly Waters**
Setting	Classroom and Homework
Duration	30 - 45 minutes
Subject Area	Language Arts
Skills	Thinking, Research, Team work
Grade Level	6-8

Objectives:

Students will be able to:
1. enjoy playing a game to learn words related to the pollution of water resources
2. identify different forms of water pollution
3. research and learn what each of these pollutants are

WV-CSO's:

Language Arts - RLA.O.6.1.01, RLA.O.6.1.03, RLA..7.1.01, RLA.O.8.1.01, RLA..8.1.03
Social Studies - SS.6.4.4, SS.7.4.1, SS.8.4.4

MATERIALS

1 copies of "Deadly Waters, Word Search Worksheet"
2. page of "Deadly Waters, Word Phrases and Definitions"

BACKGROUND

There are many types of pollutants that enter our water resources as a result of human activities. This activity will help students learn the names associated with these pollutants and understand what the pollutants are. Knowledge of these terms will enable students to better participate in the water resource program and other activities within this unit.

PROCEDURES

1. Have students work independently or in small groups.

2. Make a copy of the "Deadly Waters, Word Search Worksheet" for each student or group.

3. Students should complete the worksheet by finding and circling each of the word phrases listed at the bottom of the worksheet page.

4. Once the word search worksheet is completed, discuss with students the meanings of each word phrase (use "Deadly Waters, Word Phrases and Definitions).

NOTES

EVALUATION

Include some of the word phrases as part of a test at the end of the week to review and re-enforce their meanings.

EXTENSION

Have students use as many of the words phrases as possible when writing in their water resource journals.

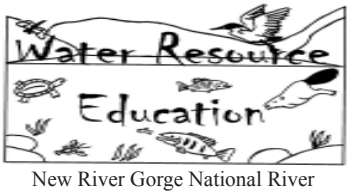
SOURCE OF THE PROBLEM

Deadly Waters — Words Search Worksheet

Directions find and circle each of the word phrases listed at the bottom of the page.

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

Point Source Pollution
Non Point Source
Raw Sewage
Acid Rain
Urban Runoff
Acid Mine Drainage
Agricultural Pollution
Construction Erosion
Landfill Leachates
Thermal Discharge



SOURCE OF THE PROBLEM

Deadly Waters — Words Search Answer Key

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

Point Source Pollution
Non Point Source
Raw Sewage
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Construction Erosion
Landfill Leachates
Thermal Discharge

Summers County Middle School

Water Resource Education
New River Gorge National River

SOURCE OF THE PROBLEM

Deadly Waters — Word Phrases and Definitions

Directions discuss the meaning of each word phrase below with students.

Point Source Pollution	Pollution that can be traced to a specific source.
Non Point Source Pollution	Widespread pollution that comes from a number of activities and sources.
Acid Mine Drainage	Rainwater runoff that has leached through abandoned coal mines and refuse piles, picking up sulfur and forming sulfuric acid.
Raw Sewage Contamination	Untreated human and animal waste (feces and urine) carries pathogenic (disease producing) organisms from the intestinal track that wash into a water source.
Agricultural Pollution	Runoff of fertilizers, pesticides, sediments, and manure into nearby streams from croplands and livestock areas.
Acid Rain Pollutants	Sulfur and nitrogen oxides released into the atomsphere by factories, when mixed with moisture, form strong acids and return to earth as acid rain.
Urban Runoff	Stormwater runoff that washes trash and toxic compounds through storm drains into nearby streams and rivers.
Construction Erosion	Erosion of large quantities of sediments into nearby streams and rivers from land stripped of trees and vegetation for the purpose of building roads and buildings.
Landfill Leachates	Toxins that leach out of landfills as rainwater trickles through the fill cover and waste.
Thermal Discharge	Heated water released back into the environment from industry and power plants.

Water Resource Education
New River Gorge National River

SOURCE OF THE PROBLEM

Post-Visit Activity

Activity **What is Threatening Our Water?**
Setting Classroom
Duration 45 minutes - one hour
Subject Area Language Arts, Reading
Skills Reading, Thinking, Team work, Public speaking
Grade Level 6-8

Objectives:

Students will be able to:
1. read and discuss information about types of pollutants that threaten our water resources
2. prepare and give a short presentation

Language Arts - RLA.O.6.1.05, RLA.O.6.1.06, RLA..6.1.09, RLA.O.6.2.01, RLA..6.3.01, RLA.O.7.1.04, RLA..7.1.06, RLA.O.7.2.01, RLA..8.1.05, RLA.O.8.2.01, RLA..8.3.01, RLA.O.8.3.04
Science - SC.O.6.2.09, SC.O.6.3.06, SC.O.7.3.06, SC.O.8.2.26

MATERIALS

1. articles "Threats to Our Water"
2. paper and pencil

BACKGROUND

The material for this activity is taken from the *West Virginia Save Our Streams, Water Quality Assessment Report, 1989-1991* and the *Save Our Streams Educational Packet*. There are many types of pollutants that are significant contributors to water quality problems in West Virginia.

This activity looks at the general types of pollutants that enter and affect West Virginia's rivers and streams, the ways that they may impact the water, and how these pollutants might be reduced or brought under control.

1. Divide the class into eight groups.

2. Give each group one of the "Threats to Our Water" article and have them read and discuss the material.

3. Have each group

   a. list the type of pollutant (s) covered in their article
   b. list ways that these pollutants can impact our water
   c. list how these pollutants can successfully be reduced or controlled.

Each student in the group should have input into the group answer.

NOTES

PROCEDURES continued

4. Upon completion of steps 1-3 have each group prepare and present a 3-5 minute presentation on their topic to the class. They can use the questions and answers as a guide for what material to include in the presentation.

EVALUATION

Have groups turn in a written draft of their presentation for a grade or extra credit.

EXTENSION

Students can keep an eye open within their community and watershed for sources of point and non-point pollution. They can report to the class on their observations and discuss the possible threats to our water resources that these pollutants will cause.

SOURCE OF THE PROBLEM
Threats to Our Water

Abandoned Mine Drainage

Mining is the process of extracting materials from the land. Mining can be done to recover precious metals such as gold, titanium, silver or minerals needed for energy production, such as coal. Mining can take two general forms: strip mining or deep mining. Strip mining removes the top surface layer of land to recover materials close to the surface. Deep mining usually involves tunneling underground to reach minerals and metals.[1]

Mining can cause a variety of pollution problems depending on the type of mining conducted (surface or strip), the type of material being mined, and the sensitivity of the watershed to mining impacts. For instance a strip mining project may cause more severe (or obvious) damage to a watershed than a deep mining project.[1]

There are problems associated with mining and mining practices that affect the environment. One such problem is the many mine sites that have been abandoned and are in the process of being reclaimed or are awaiting reclamation. The Abandoned Mine Lands Program is a federally funded program that allows states to clean up abandoned mine sites by revegetating sites, plugging up sources of acid drainage, and regrading slopes to reduce erosion and runoff.[1]

Drainage from abandoned mines is a non-point source pollutant that was noted as the most serious water quality problem facing the state of West Virginia. A water quality assessment report stated that abandoned mine drainage affects a minimum of 477 streams totaling at least 2,427 miles of the state's 29,000 total river miles. Much of West Virginia's geology has a high sulfur content and when this sulfur is exposed to air and rain, such as when mine tailings are exposed, potent sulfuric acid is formed. As a result, runoff from these abandoned mines and old gob piles (mine refuse) is very acidic. As water becomes more acidic, metals such as aluminum, iron, and mercury become more soluble and are leached from the soil and transported into streams. Abandoned mine drainage can also contain other toxic metals such as copper and zinc.[2]

Acid mine drainage sometimes colors water a light orange or yellow but it may cause a stream to run crystal clear. To many people this clear stream would appear pristine, but the stream may be completely devoid of life. Water may appear clear because there is no life in it. Most healthy streams in West Virginia are usually slightly cloudy because millions of tiny organisms are floating along in the flowing water. Of equal concern, as these pollutants wash downstream they become diluted but can still cause serious damage to the aquatic community. Sensitive organisms (like hellgrammites or mayflies) are the first to

disappear from the impacted stream. Great distances downstream from abandoned mines, aquatic communities can be severely reduced or altered by the acid drainage.[2]

Another problem with abandoned mine drainage is the fact that it can be difficult to locate abandoned mine sites while conducting land use inventories. If healthy populations of macroinvertebrates are not present and a stream looks pristine or has a slight yellow/orange tint, acid mine drainage should be suspected. West Virginia's Rural Abandoned Mines Program is commissioned to list, prioritize, and reclaim abandoned mine sites. Lack of funding and low program priorities have slowed progress on reclaiming abandoned mine sites.[2]

Reporting any suspected abandoned mine sites to the Department of Environmental Protection is a start toward cleaning up this threat to our waters. By learning about the issue and informing citizens and community organizations, attention can be brought to the problems created by abandoned mines. Educating politicians and local and state officials on the issue can also help address the problem. Monitoring streams and encouraging others to get involved in stream monitoring, and carefully documenting stream conditions, can help streams get the attention they deserve. Involving many people in monitoring will help more people learn about the problems and become active in solutions.[2]

Others ways to help include: Lobbying your state and federal government to regulate and monitor surface mining practices and supporting state efforts to fund and reclaim mining sites through grading and revegetation of sites to reduce runoff and erosion.

[1] Firehock, Karen. Hands On Save Our Streams: The Save Our Streams Teacher's Manual. Gaithersburg, MD: The Izaak Walton League of America. 1994.

[2] Kellogg, Loren. West Virginia Save Our Streams Water Quality Assessment Report; 1989-1991. Gaithersburg, MD: Izaak Walton League of America, 1992.

SOURCE OF THE PROBLEM
Threats to Our Water

Raw Sewage from Failing Septic Systems

Many homeowners are unaware that they may be contributing to the pollution of our water resources through the disposal of their wastewater and sewage. In some neighborhoods where hookups to sewage treatment plants are not available, people dispose of sewage and wash water into septic systems. Septic systems rely on underground tanks where solids can settle and decompose. Wastes are broken down further by soil microorganisms. Unfortunately, some septic systems are put in soils where drainage is inadequate. Water from these systems containing sewage pollutants such as bacteria, nutrients, and ammonia bubbles up into the backyard and drains into nearby streams. It may also seep into and contaminate the home's well water.[1]

Septic systems also need to be cleaned out every two to five years depending on the volume the systems receives and the size of the tank. Many people do not regularly have their systems cleaned out. Over time, septic lines and the tank get old and deteriorate, which can eventually lead to raw sewage leaking directly into the ground or seeping into a water source.[1]

Faulty septic systems and lack of domestic sewage treatment is one of the most reported, serious threats to West Virginia's streams. Many rural areas of West Virginia, particularly those with depressed economies, have no sewage treatment plants. In these areas, old or failing septic systems, inappropriately-sited outhouses, or even direct discharge, cause raw human waste to enter streams. This raw waste carries with it pathogenic (disease producing) organisms from the human intestinal track, organic waste, and household chemicals that are toxic to aquatic life. Human contact with sewage contaminated water (i.e. for drinking, swimming or fishing) may result in illness.[2]

Also, areas that lack domestic sewage treatment are often located in narrow mountain valleys along small streams that cannot assimilate this organic waste without severe water quality consequences. Typically, decomposition of large amounts of organic waste will deplete a stream of its oxygen, devastating fish and other aquatic populations, and will cause algae blooms.[2] Algae blooms occur when excessive amounts of nutrients, from organic waste and fertilizer, enter a water source causing aquatic plants to grow rapidly. As these nutrients are depleted, plants no longer have enough nutrients to support a large plant population causing many plants to die.

While properly functioning septic systems may do an adequate job of reducing pathogenic organisms and organic materials, often these systems are not properly maintained. If the sludge is not removed regularly, the septic tank fills up with solids, and these solids are carried into the drainfield where they

plug the soil and cause the septic system to fail.[2]

Educating citizens about the adverse affects of raw sewage can be one of the most important ways to make a difference. Letting citizens know that they may be making themselves sick or are harming the fish in their streams (and hence cannot eat them) by failing to maintain septic systems can be an important pollution prevention tool. Because of a depressed economy and a reduction in federal low interest loans available to the state for building new sewage treatment facilities, solving the sewage treatment problem will take some time. Citizens can make a difference by banding together to focus attention on the issue and voicing support to make sewage treatment available to everyone by making sewage treatment funding a priority. In addition, developers proposing to build new housing developments should have to pay the increased costs of hooking up new users to existing sewage treatment plants. Sewage treatment plants may have to be expanded to meet new demands.[2]

Other helps to help include: Installing a home septic systems to treat your sewage instead of running a disposal pipe straight from your sink, shower, and toilet to a nearby stream or river; constructing home septic systems at least 100 feet away from a water source and outside of the floodplain to provide a buffer zone between your septic system and the water; having your home septic system cleaned every five years; replace the tank and lines that are found to be leaking to eliminate raw sewage from seeping into a nearby water source or your well water; conserving water where you can because the less water used results in less water needing treatment and lower water and sewer bills.

[1] Firehock, Karen. Hands On Save Our Streams: The Save Our Streams Teacher's Manual. Gaithersburg, MD: The Izaak Walton League of America. 1994.

[2] Kellogg, Loren. West Virginia Save Our Streams Water Quality Assessment Report; 1989-1991. Gaithersburg, MD: Izaak Walton League of America, 1992.

SOURCE OF THE PROBLEM
Threats to Our Water

Agricultural Impacts

Agriculture is important to our very existence. It provides the food we need to survive. The United States is a world leader in providing food needed for this country as well as many other parts of the world. Many Americans depend on agriculture as a livelihood. Since the country was founded, many smaller farms have gone out of business or been consolidated into larger farms, often run by national or multinational corporations. Large scale agriculture influences management practices used to control weeds, pests, and diseases.[1]

Overtime, we have realized that many of the chemicals we use for modern agriculture—pesticides, herbicides and fertilizers—can have detrimental effects on people, wildlife and aquatic ecosystems. Some pesticides, such as DDT, have been banned because they persist in the environment and harm wildlife, such as birds and other waterfowl and eventually people who eat them. Pesticides are designed to target specific crop pests, but they may end up in streams, where they harm macroinvertebrates, such as stoneflies. Pesticides can bioaccumulate (build up over time) in the tissues of fish and crustaceans, such as crayfish or blue crabs. People who eat these creatures can be harmed.[1]

The non-point source pollutants associated with agriculture generally arise from two main sources: crop production and livestock production. Crop and livestock production can impact streams with nutrients and sediment runoff. Crop production also uses pesticides which may be toxic to aquatic life.[2] Many West Virginia streams and rivers are affected by agricultural sources of pollution.

Fertilizers, such as nitrates, are widely used to increase crop productivity, but can be a threat to water quality when washed by runoff into nearby streams. Pesticides are used on croplands to "control" (kill) insects, fungal diseases, and weeds. By definition they are toxic and usually can kill many other types of life other than the ones they are suppose to kill. When these compounds get into streams and rivers, they may kill aquatic life. Agricultural livestock, such as cows and pigs, carry pathogenic organisms in their intestines and manure. These pathogenic organisms may cause diseases in humans. They also contaminate water resources when livestock are not fenced out of streams, or rain water carries their manure from land into nearby streams.[2]

High levels of oxygen are critical for healthy fish populations and macroinvertebrates in a stream. When nutrients from fertilizers and manure wash into a water source, they cause algae (simple aquatic plants) to grow quickly. As algae dies it is rapidly broken down (decomposed) by bacteria. This process uses up oxygen and can quickly rob a stream of oxygen, which may result in fish kills and large reductions in the numbers and kinds of stream-dwelling organisms.[2]

Excess sediment (from erosion) is a serious problem in West Virginia. Aquatic vegetation produces oxygen and serves as a food source for aquatic organisms. When the sun can't penetrate muddy water, submerged aquatic vegetation dies. Muddy water can kill fish and macroinvertebrates by clogging their gills and covering their habitat.[2]

An increase in stream sediments results from poor agricultural management practices that allow soil erosion from crop lands and over-grazed pastures. Conservation practices known as Best Management Practices (BMPs) can help reduce or eliminate agricultural pollutants. Leaving a vegetative strip (buffer zone) of 50+ feet along the land bordering a stream is an example of BMPs. A natural buffer of trees, grasses and shrubs along a stream will slow runoff allowing sediments and other pollutants to settle out. Also, as the runoff slows down in the buffer zone, it has a chance to filter through the soil where chemicals can be broken down and fertilizers can be taken up by stream-side vegetation.[2]

Other ways to help include: Fencing livestock out of streams and ponds which will reduce manure contamination to streams and rivers as well as stream bank erosion; diverting rainwater runoff from feed lots and livestock pens into treatment ponds or wastewater treatment facilities so that raw manure is not washed directly into water sources; removing livestock manure from pens, feed lots, and stalls and steading it on fields as a source of free fertilizer; and rotating farm crops to increase soil productivity and reducing the need for additional fertilizers and not allowing the soil to become over depleted of any specific plant nutrient.

[1] Firehock, Karen. Hands On Save Our Streams: The Save Our Streams Teacher's Manual. Gaithersburg, MD: The Izaak Walton League of America. 1994.

[2] Kellogg, Loren. West Virginia Save Our Streams Water Quality Assessment Report; 1989-1991. Gaithersburg, MD: Izaak Walton League of America, 1992.

SOURCE OF THE PROBLEM
Threats to Our Water

Construction, Road Building, and Logging

Construction sites may cause a great deal of harm to aquatic life and habitats. When people see a construction site, they often do not realize the amount of damage that can be caused by land-disturbing activities. For example, when bulldozers expose soil, natural erosion rates can accelerate to 100 times the normal rate. Where does that soil end up after it erodes? Soil washes into low-lying areas, often a river or lake. [1]

Improper logging practices also causes excessive erosion. Trees naturally slow rainfall and hold soil in place; however, during logging operations the natural vegitation is removed leaving bare soil which is easily washed away.

Why is sediment harmful to streams? Excess sediment clouds water and aquatic plants do not receive enough sunlight. Plants need sunlight for photosynthesis. An important byproduct of photosynthesis is oxygen, which is needed by aquatic organisms such as fish and macroinvertebrates. When aquatic plants do not receive enough sunlight, they die and stop producing oxygen.[1]

An excess of sediments can clog fish gills and smother spawning beds. Sediment settles and smothers macroinvertebrates living on the bottom of the stream, destroying a food source for fish. Sediments also cause problems for navigation. Rivers, lakes, and harbors increasingly need to be dredged because they become too shallow for navigable traffic such as barges, tankers, or even recreational boats. Dredging causes sediments to be resuspended in the water column and destroys bottom-dwelling organisms. It is more effective and less costly to prevent sediment from reaching rivers and lakes rather than dredging every couple of years.[1]

Until recently, most sediment and erosion control was voluntary in West Virginia. As a result, in areas undergoing rapid growth, water quality was significantly impaired. A new law has given the state regulatory authority over construction stormwater runoff and requires all construction sites that are three acres or larger to obtain a permit. Sites smaller than three acres are still unregulated. This stormwater permit program may play a key role in reducing the amount of sediment entering West Virginia streams and rivers.[2]

There are simple techniques designed to prevent runoff of sediment from construction sites. One of the more common is the silt fence. These are made of filter fabric and are designed to allow runoff to flow through while trapping sediment. Silt fences work best when no more than ¼-acre

of land drains into 100 feet of fence. The reasonis that once the area of land draining into the fence is larger than this, the volume of water flow becomes too great and the fence falls or becomes buried in silt. Another technique to prevent runoff is the use of straw bales. Straw bales must be buried several inches into the ground to keep sediment from washing under them and securely held in place using wooden stakes. However, they must be replaced every three months because they break down and decay.[1]

Seeding and spreading mulch over a bare area when not in use can stop large amounts of dirt from leaving a site. Other ways to minimize erosion are to reduce the number of trees cut and limit the amount of land disturbed at any one time. Vegetation and trees along streams and lakes should be preserved so runoff is filtered, water is shaded, and streambanks remain stable.[1]

Unfortunately, even when proper structures are put in place, they often are not maintained. If structures are not inspected regularly after or during a rainstorm to make sure they are functioning properly, sediment may leave the site and pollute local waterways.[1] Learning about sediment pollution and ways to prevent sediment runoff can be vital to the life of a stream, river, or lake. By educating citizens about the importance of erosion control, the affect sediment can have on our water resources, and prevention techniques, significant improvements to water quality can be achieved.[2]

Other ways to help include: Reporting water pollution resulting from soil erosion to agricultural and conservation agencies so that the problem can be fixed and the pollution reduced; recycling all used paper and cardboard products reducing the amount of trees being cut down to make new paper; and demanding that logging operations on your land uses selective cutting practices, does not clear-cut steep slopes, leaves a wide natural buffer next to streams and rivers, and rehabs skid roads to reduce soil erosion.

[1] Firehock, Karen. Hands On Save Our Streams: The Save Our Streams Teacher's Manual. Gaithersburg, MD: The Izaak Walton League of America. 1994.

[2] Kellogg, Loren. West Virginia Save Our Streams Water Quality Assessment Report; 1989-1991. Gaithersburg, MD: Izaak Walton League of America, 1992.

SOURCE OF THE PROBLEM
Threats to Our Water

Landfills and Dumps

Many people do not think of landfills when they think of water pollution. However, landfills, depending on their age, design, location, and waste content can affect water quality of nearby rivers, lakes, and groundwater.[1] Anything people throw out can end up in a sanitary landfill or dump. Pesticides, paint thinners, metal polish, old batteries, and thousands of other potentially-damaging waste products can be mixed together in dumps and landfills.[2]

Most landfills have a liner that consists of a layer of clay that is so dense that water cannot move easily through it. A plastic material called a liner also covers the clay layer. A layer of soil (called a cap) is placed over the landfill to prevent trash from blowing away.[1] In West Virginia, the 1991 landfill regulations required a plastic liner 60 mm thick and a soil layer 18 inches thick.[2]

However, there are some older landfills that do not have plastic liners or have liners that have decayed over time and are no longer effective.[1] These landfills have begun to leak. When rain falls in the landfill, it trickles through the fill cover and into the waste, where it picks up toxins. These toxins (called leachate) may leak out of the holes, flow into groundwater and then into a nearby stream. Although this process may take time, the inevitable result is a release of pollutants into the surface and groundwater.[2] Most landfills leak over time. Even today's designs are still somewhat experimental and only time will tell whether or not landfill designs actually can prevent groundwater contamination.[1]

In September 1991, the U.S. Environmental Protection Agency issued new national standards to control pollution cause by municipal solid waste landfills. The new standards called for monitoring groundwater quality and installing a leachate collection system at landfills as well as establishing procedures to protect water quality.[2] In hazardous waste landfills, leachate must be collected and treated to clean it of harmful pollutants. If contamination of surface water or groundwater occurs, actions must be taken to clean up the problem. However, the cost of cleanup is factored into decisions affecting cleanup. It is possible that cleanup costs in some cases are too great. Landfills not meeting existing standards must be closed. Some states have granted extensions to their municipal landfills so they will have more time to either come into compliance or close down.[1]

Why are more landfills needed? Landfills are needed to handle the tremendous amount of trash generated by people. *What is in landfill waste?* Surprisingly,

For example, organic materials, such as yard waste and table scraps, comprise 12 to 18 percent of landfill volume. A whopping 50 percent of landfill volume is taken up by paper, including paper packaging and newspapers. Both could be recycled and reduce our need for new landfills. In addition, more items could be made from paper, which is recyclable and renewable, rather than from plastic, which is more difficult to recycle and requires petroleum, a non-renewable resource.[1] *What else can be recycled or reused instead of being sent to a landfill?*

Other ways to help include: Becoming a responsible citizen and dispose of your trash and waste products properly; composing yard waste and vegetable food waste, it reduces your throwaway garbage and is good fertilizer for gardens and flowerbeds; reporting to your local authorities anyone you see dumping trash and waste illegally; calling on your local, city and state governments to pass regulations and laws supporting strict penalties for illegal dumping; and encouraging local, city and state governments to set new standards for the construction and monitoring of safe landfills.

[1] Firehock, Karen. Hands On Save Our Streams: The Save Our Streams Teacher's Manual. Gaithersburg, MD: The Izaak Walton League of America. 1994.

[2] Kellogg, Loren. West Virginia Save Our Streams Water Quality Assessment Report; 1989-1991. Gaithersburg, MD: Izaak Walton League of America, 1992.

SOURCE OF THE PROBLEM
Threats to Our Water

Urban Runoff

Urban runoff is composed of a wide variety of materials from trash to toxic compounds. Streets, sidewalks and buildings in urban areas prevent the rain that falls from filtering into the ground. In urban areas, rain usually flows over impermeable surfaces downhill into the nearest storm drain and then directly into a stream or river. During periods of low rainfall, toxic materials like waste oil, antifreeze, paint thinner, and an assortment of other compounds can build up on the road surface. When it does rain, the build up of toxins are washed into the stream all at once, which can have a devastating effect on aquatic life.[2]

The Clean Water Act Amendment of 1987 requires runoff from urban areas populated by 100,000 people or more to have storm water management plans to deal with urban runoff. Storm water management usually involves wet and dry ponds and storm collector systems. These systems have a direct discharge into nearby streams and rivers, but runoff can also be diverted through existing sewage treatment facilities. During a heavy storm a sewage treatment plant can be overloaded, which results in the release of a pulse of raw sewage and untreated urban runoff into the receiving water source. More wastewater treatment facilities with greater capacities will need to be built to handle the increased storm water volume.[2]

Many West Virginia cities and towns are not large enough (less than 100,000 people) to fall under these requirements. They still contribute a great deal of polluted urban runoff to local waters.

Even though it may flow through a pipe, urban runoff is considered non-point source pollution. In most areas, urban runoff goes unregulated and unaddressed. As a result, very little is known about the total amount of pollutants flowing into a stream. If drainage pipes from urban areas were treated as point sources of pollutants, they could be regulated and permitted under the West Virginia National Pollutant Discharge Elimination System. In addition, monitoring programs could be established to maintain water quality specifications.[2]

A storm drain monitoring program could help to document the extent and nature of the pollutants, identify serious threats, and would make early detection of problems possible. This would help set priorities for controlling urban runoff and would inevitably result in significant improvements in water quality.[2]

Other ways to help include: Sweeping and picking up trash before it can wash into a storm drain; cleaning up chemical spills (oil, antifreeze, gas, etc) no matter how small so that as little as possible is washed into a storm drain; properly

maintain your vehicles for longer life and so that little or no fluids leak onto the roadways and parking lots; disposing of household, garage, and garden chemicals properly instead of pouring them down a storm drain or directly onto the ground; and shoveling your sidewalk and driveway and using sand, cat litter, or calcium chloride instead of salt, road salt is harmful to many plants and animals.

[2] Kellogg, Loren. West Virginia Save Our Streams Water Quality Assessment Report; 1989-1991. Gaithersburg, MD: Izaak Walton League of America, 1992.

SOURCE OF THE PROBLEM
Threats to Our Water

Residential Impacts

Many people do not realize that pollution can come from their own backyards. It is easier to spot pollution from a factory or to see that trash dumped along a stream is causing pollution. However, residential neighborhoods can be a serious source of pollution. Rain falling on a neighborhood washes pollutants from yards, homes, and streets into nearby streams and rivers.[1]

Some people dump used oil into storm drains or directly on to the ground, which is washed by rainfall into nearby streams and rivers. One quart of used motor oil can contaminate up to two million gallons of water. Used motor oil can be recycled; check at your local recycling center or service stations.

Professional lawn care services and many homeowners use chemicals to keep their lawns green and weed-free. At times these chemicals are used far too much. Most of the excess is washed by rain into nearby streams and rivers. People and their pets can also develop allergic reactions to these chemicals. Pesticides that reach a water source kill macroinvertebrate populations (a source of food for fish) and will accumulate in the tissue of fish, making the fish harmful to eat. Fertilizers cause algae blooms to occur that results in a depletion of oxygen needed by aquatic organisms. A residential neighborhood may contribute more harmful chemicals to a stream than farmland. Chemicals used in moderation and properly applied can significantly reduce the amount that finds its way into streams, rivers, ponds, and lakes. You can also use organic, non-toxic fertilizers or pest controls that are just as effective as well as environmentally safe.[1]

Paints, solvents, cleaners, and other home care products used on the exterior and around the house are also a source of runoff pollution, especially if they are stored improperly allowing them to leak. Weed killers and paint thinners are very toxic to aquatic life.

Pet waste (feces and urine) is another form of pollution that can affect nearby water sources. When this waste is washed into nearby streams or into stormdrains and then into streams, it contributes disease organisms to the water. These organisms are harmful to people. Manure in streams also causes oxygen depletion when levels of organic wastes are more than the stream normally can handle. Pet waste can be scooped and disposed of in a bag or put in your home toilet.[1]

Other ways to help include: Properly use and store household chemicals, paints and cleaners, doing so will help prevent or reduce them from getting into our water sources; disposing of all hazardous household products in special hazardous waste collection sites rather than with the regular garbage;

and using some of these alternative cleaners instead of harmful chemicals: water and baking soda mix to scour sinks, toilets, ovens and pots; a little vinegar, baking soda, or potpourri in a dish to absorb odors; phosphate-free soaps for doing laundry; sponge-mop floors with a ½ cup vinegar in a gallon of water; mix two tablespoons of olive or vegetable oil, one tablespoon of vinegar or lemon juice, and one quart of water to clean finished wood furniture.

You can also maintain a buffer of natural vegetation (at least 50 feet) around your garden and flowerbed to slow runoff and trap nutrients before they get to the stream, river, or lake; leave grass clippings on your lawn and mulch your garden with leaves, these are "free" fertilizers and help shade the soil reducing the need for watering; and eliminate the use pesticides and herbicides by pulling weeds instead of using costly and harmful herbicides.

[1] Firehock, Karen. Hands On Save Our Streams: The Save Our Streams Teacher's Manual. Gaithersburg, MD: The Izaak Walton League of America, 1994.

SOURCE OF THE PROBLEM
Threats to Our Water

Thermal Impacts

Thermal impacts on water resources can come from a wide variety of sources including urban runoff from pavement, point sources, stream sections where stream-side vegetation has been extensively removed, or where water has been impounded. When the temperature in a stream goes up, the water's ability to absorb oxygen decreases. Many stream organisms, such as trout and hellgrammites, require high levels of oxygen to survive. Any time the temperature is pushed above its normal range, such as when stream-side vegetation is cut, more sunlight reaches the stream and oxygen levels decrease.[2]

A number of industries use water to cool machinery or products and power plants heat water to make steam for power production. When this superheated water is released back into the environment, it warms up the natural water temperature impacting the aquatic life.

Leaving buffer zones intact along streams and rivers is one obvious solution toward limiting thermal impacts. In areas where land alterations have resulted in a significant loss of stream-side vegetation, organized tree planting events may be an important step to speed stream recovery. Become an energy conservationist, using energy wisely can reduce the amount of energy produced. This can save money and cut down on the amount of watered needed for power production.

Acid Rain and Air Pollutants

Acid discharges from precipitation are a serious problem for West Virginia's streams and rivers. The effects are significant in the infertile, high-altitude streams in the mountainous areas of eastern West Virginia. Coal burning electric power plants are a major source of sulfur and nitrogen oxides that, when mixed with moisture in the atmosphere, form strong acids. These acids are returned to Earth as acid rain. Industry is responsible for a wide range of air pollutants (specific to the industry) that are filtered out of the atmosphere by rain and make their way into our streams and rivers.[2]

Filters in industrial smokestacks can reduce the amount of particles released into the atmosphere. Chemical treatments can reduce gas emissions. Energy conservation and wise use of our natural resources are healthy ways to reduce air pollution. The 1990 Clean Air Act requires industries to

reduce the amount of acid rain producing emissions of sulfur and nitrous oxides as well as airborne particles.[2]

Other ways to help include: Driving less, take public transportation, cycle or walk, it saves gas and money and reduces air and water pollution. Replacing older vehicles with more fuel-efficient or alternative-fuel vehicle. Keeping your vehicle well maintained to minimize pollution.

You can also make sure your home and business is well insulated against cold and heat, it saves energy and reduces the amount of air pollution created by power plants; purchase refrigerators and air conditioners with environmentally friendly coolants that if released are not as harmful to the atmosphere; plant trees and shrubs which to reduce the amount of carbon dioxide and other pollutants in the atmosphere; compost leaves and brush or leave them in the woods to decompose rather than burning them, it reduces air pollution and acid rain; and pressure politicians to support cleaner industrial technologies and to legislate mandatory environmental standards

[2] Kellogg, Loren. West Virginia Save Our Streams Water Quality Assessment Report; 1989-1991. Gaithersburg, MD: Izaak Walton League of America, 1992.

SOURCE OF THE PROBLEM
Post-Visit Activity

Activity **Water Journal**
Setting Classroom or Homework
Duration 30 minutes
Subject Area Language Arts, Writing
Skills Thinking, Writing, Sentence structure
Grade Level 6-8

Objectives:

Students will be able to:
1. keep a log of what they are learning about water resources
2. express their feelings about water resources
3. describe how they can integrate what they have learned in the water resource curriculum into their personal lives

WV-CSOs:

Language Arts - RLA.O.6.1.06, RLA.O.6.2.03, RLA..7.2.05, RLA.O.8.2.05
Science - SC.O.6.1.06, SC.O.6.2.09, SC.O.7.1.06, SC.O.8.1.08, SC.O.8.2.26

MATERIALS

1. notebook or writing pad
2. pen

BACKGROUND

The water journal allows students an opportunity to reflect on and record what they are learning about their water resources. Students can also use the journals to express their personal thoughts and feeling about Earth's water resources and how their lives are impacted by what happens to the water around them.

This activity is most effective if conducted at the end of the week. Other activities within the unit will be completed and students can incorporate the information learned through all the activities into thoughtful writings.

Students should be encouraged to follow proper writing styles, sentence structure, and grammar when making entries in their journals.

PROCEDURES

1. Have each student create their own journal to permit personal style and creativity.

2. Have students write daily or weekly to record their thoughts on the day or week's water resource program and related activties.

Water Resource Education
New River Gorge National River

NOTES

PROCEDURES continued

3. Have students address the following items when recording their thoughts:

    1. What concepts did he/she learn from this week's water resource program and activities.

    2. Which of the water resource activities did he/she enjoy and why.

    3. From what I learned this week, I can have a positive impact on our water resources by making these changes in my personal life.

NOTE:

Have students fill up the front and back of each page with their writings (they do not have to start a new page for each entry.) This will save paper.

EVALUATION

Periodically evaluate and grade each student's journal based on content, sentence structure and grammar.

EXTENSION

Encourage students to integrate self-expression and creativity in their journals through poetry, song writing, art work or an article for a newpaper.

SOURCE OF THE PROBLEM

Post-Visit Activity

Activity **Poison Pump**
Adapted From "Poison Pump" - Project Wet
Setting Classroom
Duration 45 minutes
Subject Area History, Life Sciences, Health
Skills Analyzing, Identifying, Interpreting facts
Grade Level 6-8

Objectives:

Students will be able to:
1. apply investigative methods used by epidemiologists to trace the source of contagious diseases
2. learn how pollutants that find their way into water sources can effect humans

WV-CSOs:

Science - SC.O.6.1.06, SC.O.6.1.08, SC.O.6.1.12, SC.O.6.2.09, SC.O.7.1.06, SC.O.7.1.08, SC.O.7.1.12, SC.O.8.1.08, SC.O.8.2.26, SC.O.8.3.01
Health Education - HE.6.1.3, HE.6.3.3, HE.8.7.2

MATERIALS

1. copies of " Broad Street Area Map"
2. copies of "Poison Pump - Victim Cards"
3. copies of "Poison Pump - Clue Cards"
4. colored marking pens

BACKGROUND

Of the world's leading diseases, over half depend on water for their transmission. Through following the clues used by scientists in the past, students use investigative and analytic skills to locate the source of a killer disease.

Cholera is a disease caused by the Vibrio cholerae bacterium. The bacterium travels through untreated water contaminated by human or animal feces. Cholera is spread by sharing contaminated water or by eating contaminated food. Cholera is characterized by rapid dehydration resulting from vomiting, diarrhea, and profuse perspiration. As victims dehydrate, their skin darkens, shrivels, and loses its elasticity. Cholera victims may suffer only mild symptoms or can die in less than an hour.

In 1854 hundreds of people living in London died during a cholera epidemic. The disease spread from India to London on ships that carried contaminated drinking water. The water was dumped into the Thames River, London's water source. London was served by competing water companies in 1854. At least one, in an effort to cut costs, failed to filter adequately the river water being pumped into the city. Many in London depended on public pumps for their water needs.

Dr. John Snow is credited with tracking and identifying the source and transmission agent of the 1854 cholera epidemic. The agent for spread of the disease was found to be the Broad Street pump. Many people doubted and disapproved Snow's contaminated

NOTES

BACKGROUND continued

water theory; however, Dr. Snow persuaded the authorities to remove the Broad Street pump handle. This simple act saved the lives of many people and marked the beginning of the end of a tragic situation.

We now know that people can aviod cholera infection by making sure their water supplies are clean. Cholera has been absent from the Western Hemisphere for most of this century. Unfortunately in developing countries where only 35 percent of the population has access to clean water, cholrea epidemics continue.

PROCEDURES

1. Tell students that in 1854 a cholera epidemic broke out in the slums of London. Without mentioning water describe the symptoms of cholera. (Let students know that this disease has killed millons of people and that hundreds died in the 1854 epidemic. One man, Dr. John Snow, discovered the source and stopped the epidemic.)

2. Inform the class that they will be given the same informa
- tion that Dr. Snow possessed and will try to solve the mysterious epidemic.

3. Divide students into groups and give each group a:

   - Broad Street Area Map
   - set of Victim Cards
   - marking pen

4. Allow the class 20 minutes to fill out the map, study the Victim Cards, and write down all common characteristics.

5. Ask if any group has located the source of the epidemic. (Without telling the groups whether they are right or wrong, ask how they arrived at their conclusion.)

NOTES

PROCEDURES continued

6. One at a time, have different students read the Clue Cards aloud. (The cards reveal additional information uncovered by Dr. Snow. As more information is given, students will either confirm or revise their conclusions.)

7. Make sure the contaminated source of the cholera epidemic is identified. Have students discuss how water from the pump became contaminated. Tell them that the disease broke out in India prior to the London epidemic. Point out that since ships travel to many countries, they often transport diseases.

EVALUATION

Ensure that each group traced and identified the source of the cholera epidemic.

EXTENSION

Students can research how pathogens are prevented from entering their water supplies and how people can avoid contracting them. Have them report to the class and make a poster or write an article for the local newspaper on their findings.

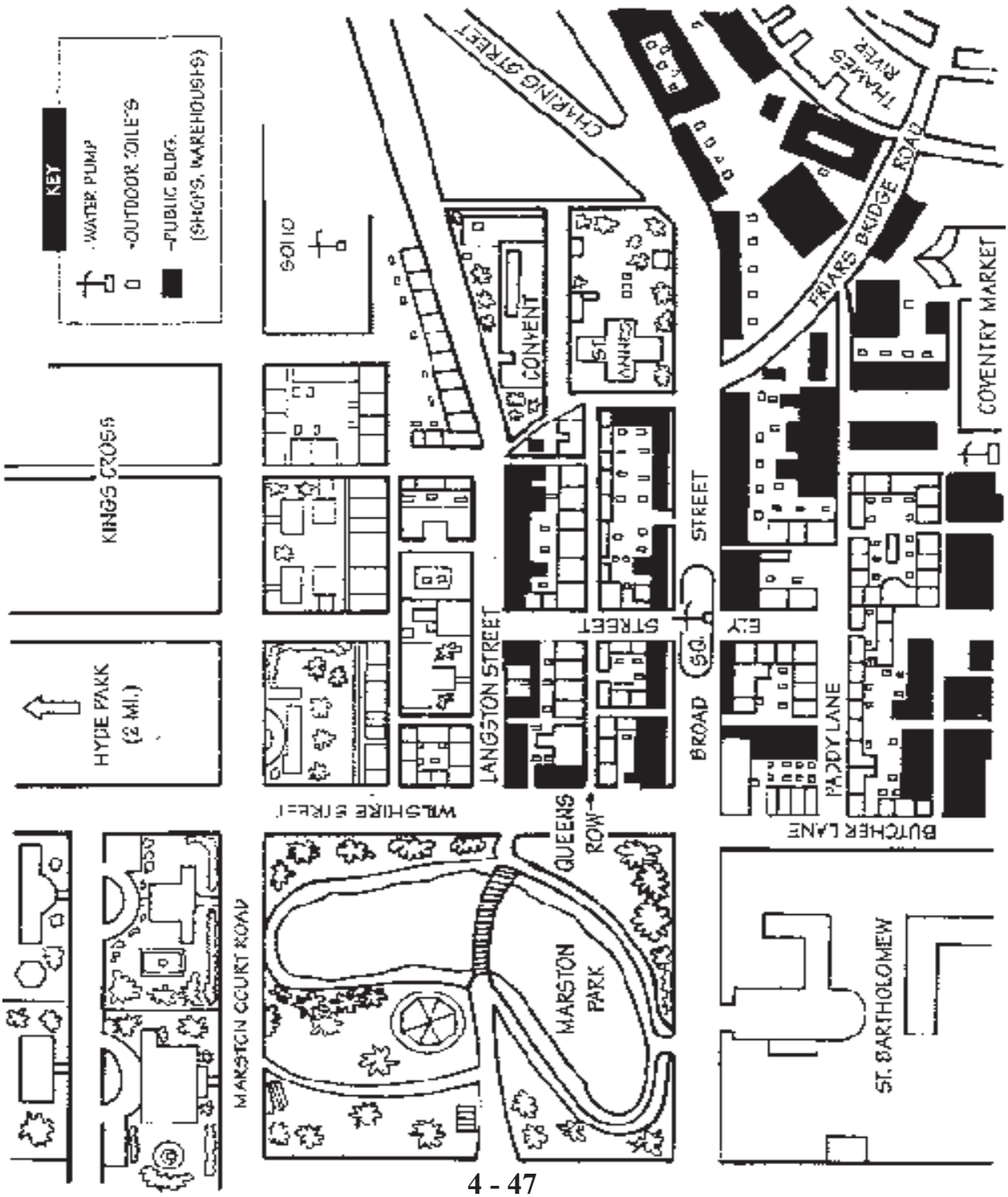
SOURCE OF THE PROBLEM

Broad Street Area Map

Directions Copy and give one to each group

Water Resource Education

New River Gorge National River



SOURCE OF THE PROBLEM

Poison Pump — Victim Cards

Directions copy and give a set to each group

New River Gorge National River

Victim Card **Thomas Sutterfield, Esquire,** Lawyer: ◆ lives in Hyde Park with wife and two children ◆ only member of his immediate family to contact cholera ◆ won most recent case, defending a Broad Street butcher accused of selling spoiled meat ◆ recovering	Victim Card **Marilda Wright,** wealthy 90-year old: ◆ lived alone (with her three servants) in the family mansion in Marston Court ◆ great-aunt of Thomas Sutterfield ◆ only member of the household to contract cholera ◆ died in a matter of hours
Victim Card **Mucky Johnson,** 18, delivery boy from Coventry Circle: ◆ delivered fresh seafood from Coventry market to wealthy homes in Marston Court ◆ often stopped to eat lunch and talk to people on Broad Street Square; said the water from the Broad Street pump was the best in the city ◆ died of cholera	Victim Card **Tolly Martin,** 10, professional pickpocket: ◆ homeless orphan who slept in door ways around Soho Square ◆ roamed quite far from Soho looking for wealthier citizens to rob ◆ died of cholera two days after a fist fight with another boy at Broad Street Square
Victim Card **Owen and Obedience Turner** and their three children: ◆ lived on Paddy Lane behind butcher shop on Broad Street ◆ Owen Turner, who was lame, earned small change cleaning up the day's slop at the butcher shop ◆ entire family died of cholera	Victim Card **Twenty-five Families** ◆ live on Queens Row ◆ 89 individuals died ◆ 31 recovering

SOURCE OF THE PROBLEM

Poison Pump — Victim Cards

Directions copy and give a set to each group

New River Gorge National River

Victim Card **Gideon Slye** ◆ Gideon Slye is a Broad Street butcher accused of selling poiled meat ◆ Slye family recently moved to Kings Cross from Broad Street and now have indoor plumbing	Victim Card **Slye Children,** ages 7, 8, and 10: ◆ Three of the eight children of Gide on and Lucy Slye ◆ when not in school, these three often accompanied their father to work and played on Broad Street Square ◆ These three are the only family members to contract cholera ◆ two died; one recovering
Victim Card **Eighteen Families** ◆ live on Paddy Lane ◆ 83 individuals died ◆ 7 recovering	Victim Card **Twelve Families** ◆ live on Ely Street ◆ 60 individuals died ◆ 10 recovering
Victim Card **Nine Families** ◆ live on Butcher Lane ◆ 37 individuals died ◆ 8 recovering	Victim Card **John and Mary Canty,** tinkers from Soho: ◆ pulled their cart through wealthy neighborhoods, mending pots and pans for the well-to-do ◆ often stopped to visit John's ailing mother who lived on Butcher Lane ◆ both died of cholera

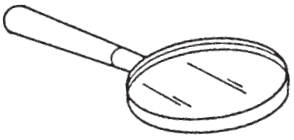
SOURCE OF THE PROBLEM

Poison Pump — Clue Cards

Directions copy a set for use by the class

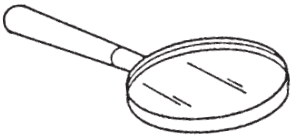
New River Gorge National River

Clue Card



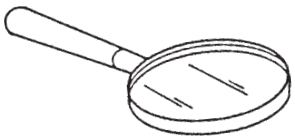
1. The people living around Broad Street are poor. Large families are crowded into one- and two-room apartments. They don't have indoor plumbing. Residents use outdoor toilets and haul their water from the nearest public pump.

Clue Card



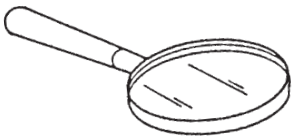
2. Thomas Sutterfield fell ill two hours after stopping off to visit his great-aunt "Tilda." He has tea, biscuits, and sausages with his great-aunt. It was a hot day and he took a drink of cool water before leaving.

Clue Card



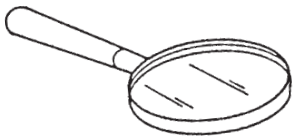
3. Following his fight with another boy, Tolly Martin washed the blood off his mouth at the Broad Street pump and ran off with a sausage stolen from the butcher shop.

Clue Card



4. Matilda Wright refused to drink water from the faucets in her home. She would only drink the sweet-tasting water that her gardner hauled from the Broad Street pump.

Clue Card



5. Ausley and Marthy Brown and their two children are the only people on Ely Street who haven't gotten cholera. Marthy's family lives in Soho. The Browns haul their water from the Soho pump, which allows them to visit their relatives.

SOURCE OF THE PROBLEM

Post-Visit Activity

Activity **Water Monitoring**
Setting Classroom or along a river or stream
Duration 1 hour
Subject Area Science and Math
Skills Data collection, Recording, Graphing, Technical equipment use
Grade Level 6-8

Objectives:

Students will be able to:
1. perform several water quality tests
2. collect and record data about water quality
3. chart data on a graph

WV-CSOs:

Math - M.O.6.5.1, M.O.7.5.3, M.O.8.5.3
Science - SC.O.6.1.06, SC.O.6.1.08, SC.O.6.1.09, SC.O.6.1.11, SC.O.6.1.12, SC.O.6.2.09, SC.O.6.2.12, SC.O.7.1.06, SC.O.7.1.08, SC.O.7.1.09, SC.O.7.1.11, SC.O.7.1.12, SC.O.7.2.14, SC.O.8.1.04, SC.O.8.1.05, SC.O.8.1.06, SC.O.8.1.08, SC.O.8.2.26

MATERIALS

Refer to the equipment and materials list for this activity found in the "water Monitorning" Unit.

BACKGROUND

Water quality is affected directly and indirectly by everything that happens within a watershed. Activities including logging, construction, agriculture, industry, and mining can have a significant impact on the quality of water within the watershed. Water quality is also affected by the daily activities of individuals, neighborhoods, towns, and communities.

Monitoring water quality is necessary in establishing baseline conditions within a river or stream. It also provides a way to determining significant changes and problems, temporary or long-term, in water quality.

This activity allows students to perform several water quality tests on samples taken from a local stream or river. They will collect data, record their findings, graph the data, and track their findings over several weeks to determine the quality of the water being tested. At the end of this data gathering period, they should be able to note any temporary changes that have occurred in the stream or river.

PROCEDURES

Procedures to conduct this activity can be found in the "water Monitorning" Unit.

SOURCE OF THE PROBLEM

Unit Quiz — A

New River Gorge National River

1. What kind of pollution can be traced to a specific point?
   A. non point source pollution (NPS)
   B. point source pollution

2. _____ is widespread pollution that comes from a number of sources.
   A. non point source pollution (NPS)
   B. point source pollution

3. Everyone contributes to NPS pollution
   A. true B. false

4. What type of pollution carries disease-causing bacteria.
   A. acid rain B. erosion
   C. thermal D. raw sewage

5. Toxins that leach out of landfills are called?
   A. chemicals B. fertilizers
   C. leachates D. wastewater

6. Which of the following are sources of non point source pollution?
   A. homes B. farms
   C. towns D. a., b. and c.

7. A leaking septic system is NPS pollution.
   A. true B. false

8. Water pollution cannot harm people.
   A. true B. false

9. I can help reduce NPS pollution by.
   A. disposing of household garbage and chemicals properly
   B. using more electricity

10. What type of NPS pollution comes from construction sites and logging operations?
    A. urban runoff B. pesticides
    C. erosion D. raw sewage

SOURCE OF THE PROBLEM

Unit Quiz — B

New River Gorge National River

1. Everyone contributes to NPS pollution
   A. true B. false

2. _____ is widespread pollution that comes from a number of sources.
   A. non point source pollution (NPS)
   B. point source pollution

3. Water pollution cannot harm people.
   A. true B. false

4. What type of NPS pollution comes from construction sites and logging operations?
   A. urban runoff B. pesticides
   C. erosion D. raw sewage

5. What type of pollution carries disease-causing bacteria.
   A. acid rain B. erosion
   C. thermal D. raw sewage

6. Which of the following are sources of non point source pollution?
   A. homes B. farms
   C. towns D. a., b. and c.

7. Toxins that leach out of landfills are called?
   A. chemicals B. fertilizers
   C. leachates D. wastewater

8. What kind of pollution can be traced to a specific point?
   A. non point source pollution (NPS)
   B. point source pollution

9. I can help reduce NPS pollution by.
   A. using more electricity
   B. disposing of household garbage and chemicals properly

10. A leaking septic system is NPS pollution.
    A. true B. false

SOURCE OF THE PROBLEM

Unit Quiz - (Answer Key)

New River Gorge National River

Quiz A

1. B. point source pollution
2. A. non point source pollution
3. A. true
4. D. raw sewage
5. C. leachates
6. D. a., b. and c.
7. A. true
8. B. false
9. A. disposing of household garbage and chemicals properly
10. C. erosion

Quiz B

1. A. true
2. A. non point source pollution
3. B. false
4. C. erosion
5. D. raw sewage
6. D. a., b. and c.
7. C. leachates
8. B. point source pollution
9. B. disposing of household garbage and chemicals properly
10. A. true