Environmental Pathways—

Youth Investigating Pollution Issues In Illinois

A Fifth/Sixth Grade Guide
To the Environment

Illinois Environmental Protection Agency
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

November 2006

/Development Team

Coordinator:	• Janet Hawes-Davis, IEPA Environmental Education Coordinator
Agency Staff:	• Kathleen Davis, Project Manager, Bureau of Land • Barb Lieberoff, Nonpoint Source Education Coordinator, Bureau of Water • Annette McCarthy, Outreach Coordinator, Office of Pollution Prevention • Elizabeth Tracy, Manager, Division of Vehicle Inspection and Maintenance, Bureau of Air
Contributors:	• Darwin Burkhart, Manager, Mobile Source Emissions Unit, Bureau of Air • Alexander J. Casella, Ph.D., Professor of Physics & Environmental Studies and Director of Energy Studies, University of Illinois at Springfield • Terri Holland, Lakes Unit, Bureau of Water • Tom Huber, Reference Librarian, State of Illinois Library • Sam Long, Air Quality Planning, Bureau of Air • Terry Sweitzer, Manager, Air Monitoring Section, Bureau of Air
Material Development:	• Mary Vymetal-Taylor, Environmental Education Specialist
Editor:	• Joan Muraro, Public Information Officer
Design:	• Gloria Ferguson / Rusty I. Downs, Graphic Designers

Material Reviewers

Jan Aschim
Teacher
Rockford Environmental Science Academy

Michelle Covi
Director
Ecology Action Center

Nancy Kerr
Teacher
Egyptian Community Unit 5

Christy Ganson
Teacher
Dunlop Elementary School

Bill Hammel
Community Relations Coordinator
IEPA

Karen Hoffman
Training Coordinator
IEPA

Dennis McMurray
Manager of Public Information
IEPA

Suzanne Saric
Environmental Education
Program Manager
U.S. EPA Region 5

Dear Educator:

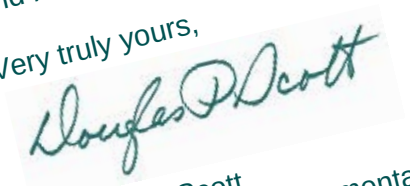
Please join me as we renew the commitment to educate our young people in the importance of environmental awareness and stewardship. We have made significant progress to improve our air, land and water quality and it is essential that we continue to emphasize the need for a healthy environment as we train the next generation of leaders.

The Illinois EPA offers one of the best tools to assist in the achievement of our common goal; our fifth-sixth grade teacher's guide to the environment, *Environmental Pathways – Youth Investigating Pollution Issues in Illinois*. This guide meets the criteria of the North American Association for Environmental Education's *Environmental Education Materials: Guidelines for Excellence* and is correlated with the Illinois Leaning Standards.

The packet is designed to develop critical thinking skills, encourage students to think constructively about environmental issues and to make informed decisions about our natural resources. I believe that you will find this an outstanding resource for your classroom and that it will also offer valuable information for those of you who are teaching in an informal setting.

It is my hope that this guide will be a valuable tool as you develop your environmental curriculum. I appreciate your continued interest in environmental protection and thanks to all of you who are helping to shape the environment consciousness of our elementary and middle school students.

Very truly yours,



Douglas P. Scott
Director, Illinois Environmental Protection Agency

Table of Contents

APPENDICES

INTRODUCTION

Overview

Environmental Pathways—Youth Investigating Pollution Issues in Illinois builds on the "Air, Land, and Water" program developed by the Illinois Environmental Protection Agency (IEPA). Although they share a common heritage, this is not simply an updated edition of that earlier work. This curriculum represents a comprehensive approach to environmental education and to teaching about pollution issues. It draws from 30 years of experience by the IEPA, as well as the collected experience of national educators who have established standards for environmental education.

The intent of this material is to develop critical thinking skills which will enable students to understand and make independent decisions regarding both current and future environmental issues. *Environmental Pathways* was developed to help provide students with the information and skills they will need throughout their lives to address pollution issues.

The first step on this pathway is building students' awareness of pollution around them: what it is, where it can be found, what forms it takes. The next step involves developing students' investigatory skills and deepening their understanding of how pollution can affect them. In order for students to respond effectively to pollution problems, they must understand them. This is the focus of the third step. Finally, the students need to develop an understanding of what can be done about pollution issues and how they can have an impact on these issues. The intent is not to have students learn a set of facts about pollution, or to familiarize them with a single set of remedies, but to enable them to think and develop solutions on their own which may impact their local areas.

This packet attempts to integrate pollution studies in two related but separate ways. The first is to develop an awareness of pollution across disciplinary lines. Pollution is looked at and studied using science, mathematics, art, language arts, social studies, and technology. The second is to encourage schools to integrate and to utilize the community in the curriculum. Both are based on the recognition that pollution is best taught by making use of real-world situations to develop critical and creative thinking skills, citizenship skills, and informed decision making.

Who Should Use This Book

This book has been designed to be of value to the widest possible audience. The lessons are targeted for students at the fifth and sixth grade levels. However, the materials are not limited to those who teach this age group in formal settings. We have tried to provide enough variety so that non-formal educators, such as naturalists, interpreters, Scouts and club sponsors, can also benefit.

It should be noted that this is not simply a collection of science activities. Issues regarding the environment are not simply science issues. Education about these topics spreads

across disciplines, and one can and should approach them from a variety of standpoints.

How to Use This Book

Environmental Pathways is divided into four sections. Each section begins with an overview of the themes and concepts to be taught, and provides general background information. The first page of each activity is highlighted with a sidebar, which spells out:

- the subject(s) involved in the activity;
- the skills utilized by the students;
- how the activity is connected to the conceptual framework (described below);
- the objectives of the activity;
- how it connects to Illinois Learning Standards;
- important vocabulary words;
- setting;
- materials required; and
- the time involved.

Every activity begins with an overview along with more specific background information. Instructions for the preparation and procedure are given, as are suggestions for assessment. Throughout the book, important vocabulary words are printed in **bold type** the first time they appear in an activity.

The resources section provides lists of helpful print information or websites. Ideas for extensions have been provided for each activity. Generally, there will be four extensions, involving: the outdoors, technology, multidisciplinary approaches and community connections. If the activity itself is strongly rooted in one of these areas—for example, if an activity involves community-based investigations, or requires significant outdoor activity—then there will not be a specific extension for that area.

The activities contained in *Environmental Pathways* do not constitute a curriculum. However, they have been selected, designed and arranged according to a conceptual framework. This framework allows knowledge and understanding to build from the basic and general to the more specific and precise. Educators can select activities from throughout the book to develop or enhance a curriculum to meet the particular needs of their students.

The conceptual framework on which these activities were built recognizes three main types of pollution: air, land, and water. Within these three, there are several subtopics which are discussed, such as global climate change and nonpoint source pollution. Although these three are not the only types of pollution that affect Illinois (radiation and noise pollution are two others), they do form the backbone of the conceptual framework, and are the most important for students of this age group to understand.

The structure of the framework can be seen in the naming of the four sections. Section 1, "What is Pollution?" introduces students to the terms and kinds of pollution commonly encountered today. Section 2, "Why is Pollution an Environmental Issue?" discusses why people are concerned about pollution and why the solutions to it are sometimes controversial. The focus becomes local in Section 3, "What Kinds of Pollution Issues Affect Illinois?" The activities in this section discuss pollution issues that may be found elsewhere, but which are known to affect Illinois communities. Finally, Section 4, "What Can We Do About Illinois Pollution?" offers activities in which students can develop their own ideas about how to solve these problems. The intent throughout is to provide students with information and with tools to analyze that information, so that they can make educated decisions for themselves, rather than being told what the correct responses to these issues should be.

It should be noted that there are graphics assigned to each section of the guide to help make the divisions clearer to the user. These

graphics can be found in the page footer.

The symbol for Section 1 is a question mark (for inquiring and increasing awareness);

the symbol for Section 2 is a globe (for effects of pollution on systems);

the symbol for Section 3 is a magnifying glass (for looking locally);

and the symbol for Section 4 is a map of Illinois (for acting locally).

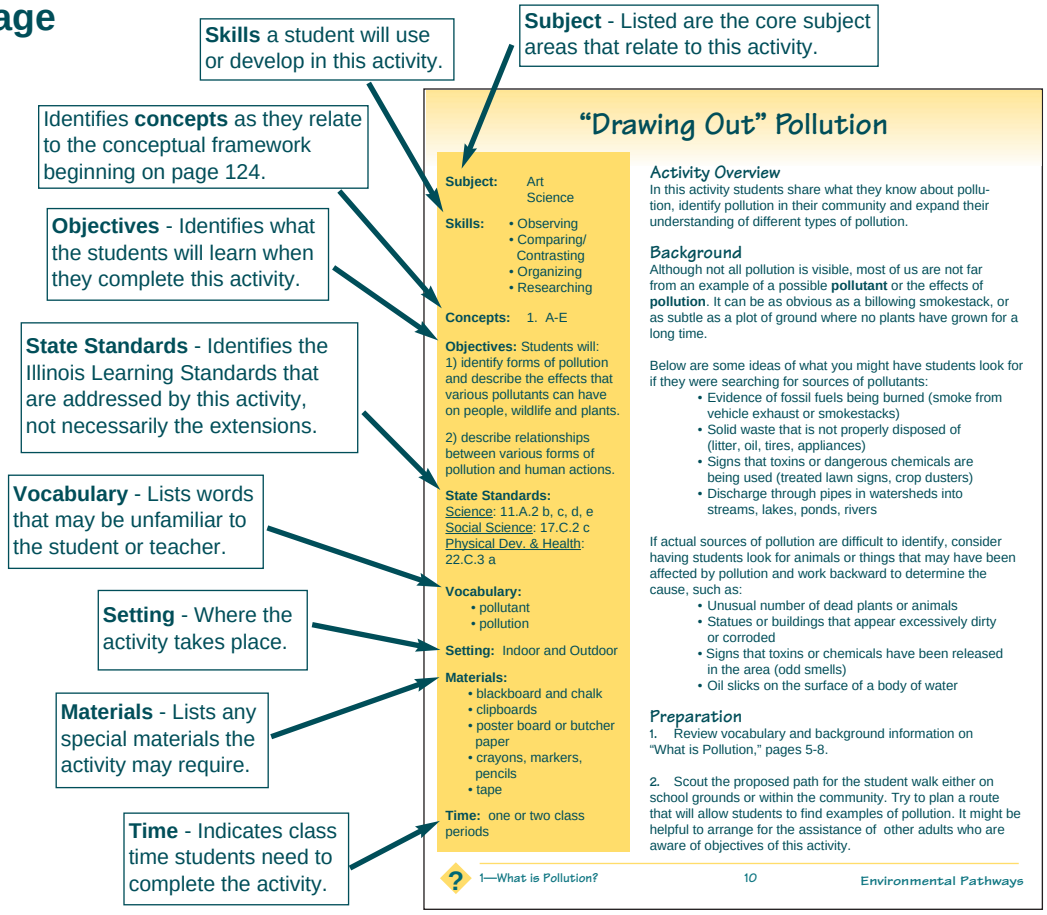
The appendices include resource materials that teachers may find beneficial. The contents include:

- a glossary of all **bolded** vocabulary words
- the full conceptual framework for the collection
- charts which cross-reference the activities by subject, skill and objective
- correlations with the Illinois State Learning Standards and the North American Association for Environmental Education's Guidelines for Learning
- a full bibliography
- an order form for all IEPA documents mentioned in this document
- a feedback form to be used in the development of future editions.

Support

The IEPA hopes you have great success in using *Environmental Pathways— Youth Investigating Pollution Issues in Illinois*. If you have questions regarding this packet or about the IEPA education program contact: Kristi Morris-Richards, Education and Outreach Coordinator, at 217-558-7198 or e-mail her at kristi.morris-richards@epa.state.il.us.

Sample Page



BACKGROUND

What is Environmental Education?

Environmental education is a process that aims to develop an environmentally literate citizenry that can compete in our global economy, that has the skills, knowledge and inclinations to make well informed choices concerning the environment, and that exercises the rights and responsibilities of members of a community. Additionally, environmental education contributes to an understanding and appreciation of society, technology and productivity and the conservation of Illinois' natural and cultural resources.

Why Teach Environmental Education?

Environmental education has the ability to successfully address many societal needs. Cries can be heard from corporate leaders saying we need a workforce of problem solvers, critical thinkers and cooperative workers. Pleas of parents and community leaders can be heard saying we need quality education that will help students cope with the challenges of today and prepare them for the future. Contamination and loss of natural resources can be seen and the need for future generations to appreciate, understand and solve environmental problems is apparent. The public's concern can clearly be seen in the National Environmental Education & Training Foundation's *1997 National Report Card: Environmental Knowledge, Attitudes and Behaviors*. This survey found that fully 95 percent of adult Americans and 96 percent of American parents support the teaching of environmental education in schools.

Environmental education is interdisciplinary in nature. It does not solely adhere to the tenets of science teaching. Students can learn about the natural and built environment through projects that cross disciplines, as well as the boundaries of the school building and school yard. This approach to teaching may seem overwhelming at first, but it brings on meaning when partnerships are developed between schools, non-formal education institutions (nature centers, museums, zoos, historical societies, etc.) and other public and private entities.

Goals and Objectives of Environmental Education as established by the Belgrade Charter and the Tbilisi Declaration (1970).

Goals of Environmental Education

- To foster clear awareness of and concern about economic, social, political, and ecological interdependence in urban and rural areas.
- To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment.
- To create new patterns of behavior by individuals, groups, and society as a whole towards the environment.

Objectives of Environmental Education

Awareness - To help social groups and individuals acquire an awareness of and sensitivity to the total environment and its allied problems.

Knowledge - To help social groups and individuals gain a variety of experiences in, and a basic understanding of, the environment and its associated problems.

Attitudes - To help social groups and individuals acquire a set of values and feelings of concern for the environment, and the motivation to actively participate in environmental improvement and protection.

Skills - To help social groups and individuals acquire the skills to identify and solve environmental problems.

Participation - To provide social groups and individuals an opportunity to be actively involved at all levels in working toward resolution of environmental problems.

Standards and Environmental Education

More and more, teachers are being asked to demonstrate their ability to achieve the educational outcomes identified in state and nation-

al standards. These standards are meant to ensure that students are receiving the kind of education that their communities demand, and that graduates possess the skills needed to function and prosper in the modern world. Environmental education has a role to play, both in helping teachers to meet those standards, and in helping to identify the expectations that communities have regarding the skills and knowledge students need to make informed decisions around environmental issues.

Currently, the only environmental education standard that is tied to national standards in core curricular areas is *Excellence in Environmental Education—Guidelines for Learning (K-12)*, developed by the North American Association for Environmental Education. These standards are unlike any of the core curricular standards due to the multidisciplinary nature of environmental education. Opportunities are provided for students to demonstrate their efficacy, their understanding of local and global issues, and their mastery of the skills and content areas of the core disciplines in ways not otherwise possible. Environmental education enhances these disciplines while remaining distinct.

Environmental Values

Values are human preferences and moral decisions which usually lead to certain behaviors. They guide choices and are usually reflected in a person's lifestyle. Environmental values are a part of all values which consider the care and use of natural resources and maintenance of ecological cycles. These values are sometimes in competition with other values such as human comfort, convenience, safety, sanitation, or enjoyment. It is not possible to act only upon environmental values all of the time.

Educational activities can be designed to encourage awareness and analysis, and can be the impetus for students to examine their own values. "Teaching" an environmental value does not imply forcing it on students. A better approach is to provide the proper conditions for a meaningful indoor or outdoor experience which may result in the realization of a new value or the modification or reaffirmation of one presently held.

Carl Rogers, the late educator and psychotherapist, proposed that persons who move toward greater openness and sharing of their experiences arrive at a commonly held set of values which enhance self, community, and the survival of the human species. The key to values education is that the study, discussion, debate, and resolution of conflicts centered around environmental issues will result in a set of values that sustain planet Earth. The following tools can accomplish these goals without imposing a set of "right" values upon students.

- *Clarification* - Activities can be structured in such a way that people interact, express and explore their personal values as they relate to environmental questions or problems. For example, students can explore whether they feel that a parcel of land should be left undeveloped for habitat or developed to provide shelter or jobs.

- *Writing* - Writing exercises based on environmental issues and experiences can lead to values development. Writing forms can include journals, short stories, essays, or poetry.

- *Action Projects* - Hands-on projects directed toward solving or minimizing environmental problems can affect values. For example, activities such as cleaning up litter, controlling erosion, or planting trees can transform perceived values into repeated patterns of action.

- *Games and Simulations* - Role playing is a powerful tool for shaping values. Games and simulations that use elements from nature, demonstrate ecological relationships, or pose

environmental dilemmas can contribute to the process of valuing, especially when they are reflected upon and shared.

• *Reading* - Poems and stories can serve as springboards and sources of motivation for valuing experiences. Written text by authors such as Dr. Suess, Robert Frost, Aldo Leopold and many others can provide stimuli for values development.

• *Asking Questions* - Sometimes by asking the right questions people can become clearer about their values. Activities can be developed using questions as the main component or as follow-ups to a structured experience.

• *Finding Examples* - One teaching technique is to provide learners with a list of value terms and to ask students to find examples of them in their environment. For example, these value terms can cover such areas as harmony, good/bad changes, balance, or categories such as nature as a teacher, creative force, or something to control.

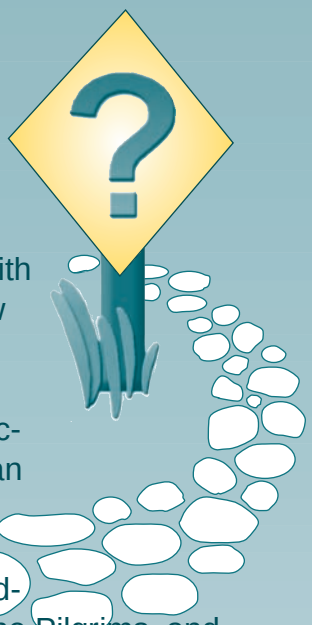
Using the Outdoor Classroom

Contemporary education places many demands on teachers and students alike. With the pressure for teachers to teach more and more with less and less, there is a growing assumption that the brick and mortar classroom is the only place where legitimate learning can occur. This results in many lost opportunities for learning.

Using the outdoor environment does not require traveling great distances. The best classrooms can be found right within your own neighborhood. The school ground, a nearby park, a pond, the downtown, a vacant lot, even a paved parking area may all serve to enhance learning when incorporated into instructional experiences.

The environment and people's interactions with it are the subject for most of the activities contained in *Environmental Pathways—Youth Investigating Pollution Issues in Illinois*. Many of the activities in this packet incorporate or require the use of the outdoors as a learning environment.

1 What is Pollution?



OVERVIEW

Think about all the things you used or touched today: water, clothes, carpeting, the plastic wrapper of a loaf of bread, newspaper, television set, a car or school bus, and many others that make our lives safer, easier, and more comfortable. Although all these things have benefits, there are consequences of producing, using, distributing, and disposing of these items.

When human activities release harmful substances into the environment, in quantities or concentrations that can cause harm to humans or other living things, the result is called **pollution**. Pollution is created, and can be found in, almost any setting (residential, industrial, commercial, institutional, and agricultural) and any type of community (urban, rural or suburban). These types of pollution are not separate and distinct but affect each other. For example, pesticide or herbicide applied to farm fields may eventually find their way into groundwater, while components of automotive exhaust can combine with moisture in the air and come back to the earth as acid precipitation.

Although there are many kinds of pollution (noise, light, radiation to name a few), this packet will primarily look at air, land and water pollution. The following background will provide more information about the movement of harmful substances in the environment and the three main types of pollution that impact the Earth's closed system.

BACKGROUND

Earth's Closed System

It may seem to us that things that happened a long time ago are very foreign to us, or that we have nothing in common with people from the past. We know that people lived in our town before us, maybe even a long time before us. But our connection with the past is greater than that. You are breathing the same air and drinking the same water that your grandparents, great-grandparents, the Pilgrims, and even the dinosaurs breathed and drank!

This is because the Earth is a **closed system**. The air that the dinosaurs breathed did not disappear after they breathed it—the particles of air came back together and reentered the atmosphere to be breathed by other animals. The water they drank has gone through the **water cycle** countless times before coming to your local well or water supply.

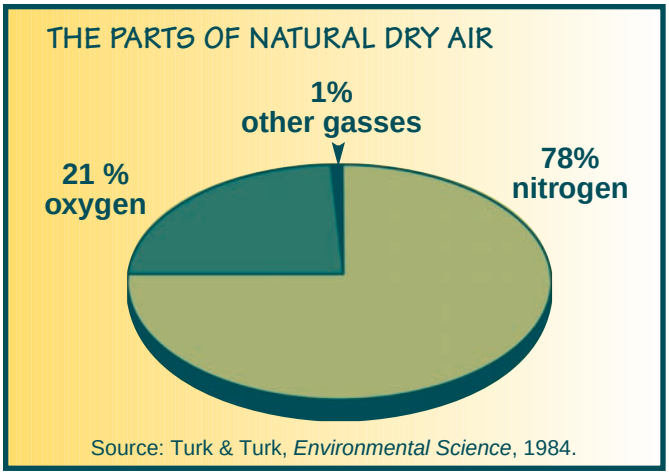
Earth is sometimes compared to a spaceship. Aside from the occasional meteorite and receiving energy from the sun, it does not get new supplies of water, air or any other substances. It must rely on and recycle the matter and energy it has. The basic elements that the Earth had millions of years ago will still be here millions of years from now, although perhaps in a different form.

Cycles, Cycles, & Recycles

Nature uses air, water and land over and over again. This is nature's form of recycling. Energy in the form of sunlight provides the power for these processes to occur.

The Air (Oxygen) Cycle

No new air is added to the earth. When we breathe we exhale carbon dioxide. Green



plants grow by using sunlight, water, and the carbon dioxide gas that people and other animals breathe out, and in turn they produce the oxygen we need to breathe in. This process is known as **photosynthesis**. Without green plants all the oxygen in the air would eventually be used up and the earth would no longer be able to support life.

The Air We Breathe

No matter where you go or what you do, there is something that you have in common with every other living person. When you are walking to school or eating lunch, whether you are awake or asleep, you are doing it. You are breathing.

Whether outside playing or in the classroom learning, everyone has to breathe. In your lifetime you will breathe about 625,000,000 times. What will you be breathing? Air. Take away your supply of air and you could live for only a few minutes.

Air is one of our most valuable resources. Clean air is a mixture of different gases, such as nitrogen and oxygen, with small amounts of water vapor, argon, carbon dioxide, neon, helium and hydrogen. Unfortunately, there can be pollution in the air we breathe. Air pollution occurs when harmful things are present or released into the air. These harmful things are called pollutants and they come from many sources.

School buses and your family's car produce emissions that can pollute the air. The factories that make things such as desks, books and bicycles can also produce emissions that go into the air. In fact, all over the world, millions of vehicles and factories release air pollutants. Still more of these pollutants come from things that ordinary people do every day. Here is a partial list of common things which contribute directly to pollution in the air:

- Burning paper, plastic, leaves and trash
- Heating homes with wood, coal and oil
- Using air conditioners
- Smoking cigarettes, pipes and cigars
- Driving cars, trucks, motorcycles, air planes and motor boats
- Using lighter fluid to start outdoor grills

All of these activities can pollute the air. Sometimes you can smell the pollution, and sometimes, when the air looks hazy or smoky, you can see it. However, even air that looks and smells clean can be polluted.

The Cycling of Materials (Decomposition)

Wood, cotton and other materials produced by living things are broken down into atoms (simpler particles that are too small to be seen) by microscopic plants and animals such as bacteria and fungi. We call this process **decomposition**. The atoms will combine to become new substances or new living things. This is nature's way of recycling matter and turning it from one form to another. Decomposition is particularly important in maintaining our soil.

The Land We Depend On

Soil, dirt, land—no matter what you call it, it's the material that makes up the top layer of the Earth. We build our homes on it, we raise food in it, we mine resources such as coal beneath it, we bury our garbage in it.

Soil is a mixture of minerals (clay, silt, sand, gravel), water, air and living and dead organic matter. As you dig down into the ground, topsoil will generally make up the first foot or so of depth. If you were to dig beneath the topsoil you would find layers of subsoil, bedrock, clay, or sand, depending on local geography.

Soil appears to be unchanging and lifeless, but soils are really full of life and are always changing. A teaspoon of healthy soil can contain billions of organisms ranging from simple bacteria and fungi to more advanced forms of life such as earthworms, insects and spiders. The decomposition of organic matter is what makes the soil rich and fertile.

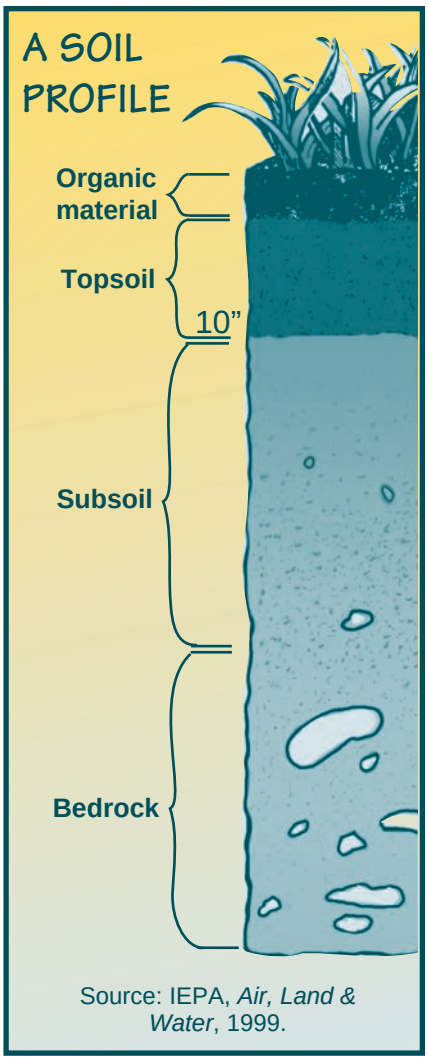
The quality of the land can be damaged or polluted by human actions. This usually occurs because people do not understand soils and make poor decisions about how to use the land. Land pollution can occur in both rural and urban areas. Here are some examples of land pollution:

- Litter or trash on the land.
- Pesticides or other chemicals building up in the soil.
- Oil dumped or spilled onto land.
- Residue from mines or industry piled up.
- High concentrations of animal waste from farms.
- Chemicals leaking from underground tanks or landfills.

These can either make the land itself toxic, and so harm the animals or nutrients in the soil so that it cannot support life. Land can also be damaged by **erosion**, which occurs when the topsoil is blown away by wind or washed away by water.

The Water Cycle

Did you ever wonder where water comes from, where it goes, and how it gets there? In nature, water circulates endlessly through a system called the water cycle (**hydrologic cycle**). The cycle begins when heat from the sun causes water to evaporate. This water comes from the land, lakes, rivers and especially the oceans. The sun-warmed water vapor rises into the atmosphere where it cools and condenses into water drops that form clouds and rain or snow.



Source: IEPA, *Air, Land & Water*, 1999.

Plants are also part of the water cycle. The water that plants take up from the ground through their roots is passed through their leaves by a system called **transpiration**.

Eventually moisture returns to earth as precipitation. The water changes its form from liquid, to gas, to liquid or solid (ice), and its location from the lake or ocean to the air, to the land, and back again.

Some of the moisture that falls onto the land in the form of rain or snow evaporates back into the air. Some runs off into lakes, streams, and rivers (**surface water**). The rest soaks into the soil and becomes **groundwater**.

Water in the soil that is not used by plants is collected in the spaces between soil particles and fills in the cracks and fractures in under-

ground rocks. The special rock formations that hold and transmit water are called aquifers. The water in aquifers is referred to as groundwater; the top of the groundwater level is known as the **water table**.

Water, the Liquid of Life

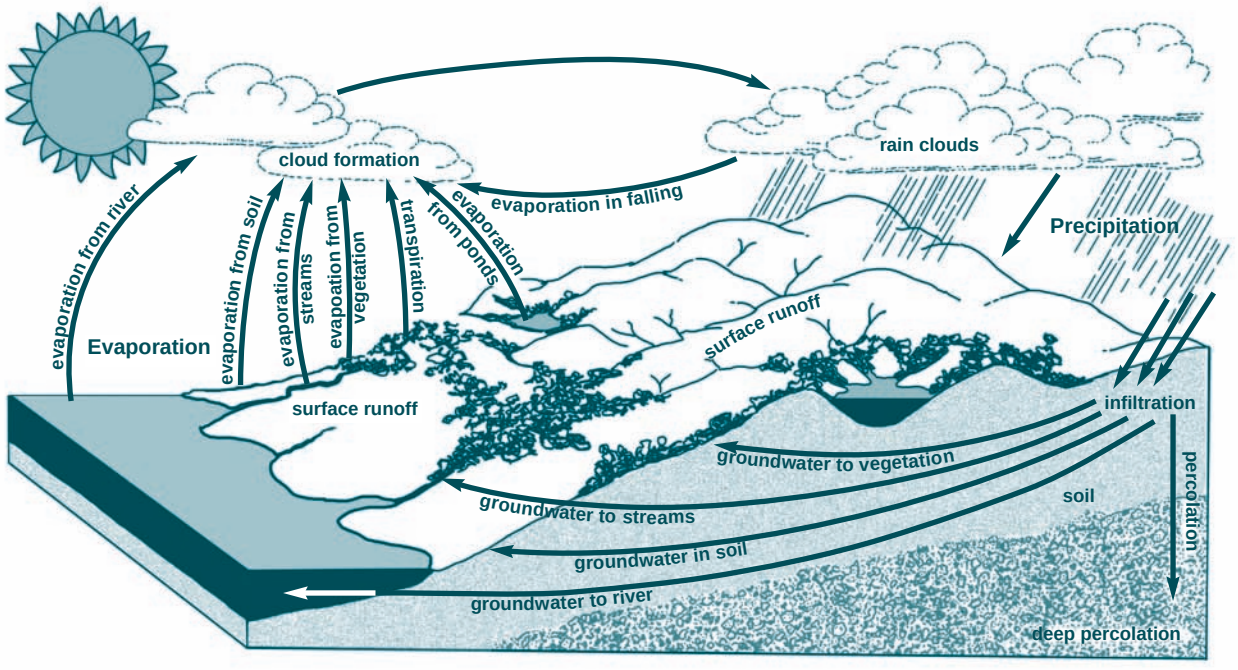
Although it is the most common substance found on earth, water should never be taken for granted. You cannot live without it. Your own body is two-thirds water, and you need about eight cups every day to stay healthy. Take away your supply of water and you could survive for only a few days.

Water is also needed to produce the food you eat. Farmers need water to grow crops and to raise animals. It takes about 15 gallons of water to grow the wheat for one loaf of bread, and about 4,000 gallons to produce a pound of beef. You also need water for bathing, washing dishes and clothes, and brushing your teeth. Industry must have water to make all kinds of things that people use, such as the clothes you wear, the paper in this packet, the steel, plastic and glass to make a car and the items used to build your home.

There is a lot of water on Earth. Eighty percent of Earth's surface is covered with water, but only a tiny portion of it is usable as drinking water. Ninety-seven percent of the earth's water is salt water; another 2 percent is frozen. All of our drinking water comes from the remaining 1 percent. Much of that is hard to reach and exists in aquifers and underground wells. Some of this water is already polluted.

Water is considered polluted when it contains substances that are harmful to people or other life forms, or if its temperature or oxygen content renders it dangerous to living things.

The Hydrologic Cycle



Source: Miller, *Environmental Science: Introduction*, 1986.

Here are just a few examples of water pollution:

- Oil or fertilizer runoff from streets or fields
- Laboratory chemicals dumped down drains
- Soil runoff into rivers, lakes and streams
- Release of heated water into waterways
- Raw sewage or animal waste entering waterways during floods or heavy rains

CONCLUSION

These three types of pollution may seem to be separate, but in reality they are not. Air, land and water constantly come into contact with each other. Water molecules spend time suspended in air, traveling through and joining with other water molecules in rivers, lakes and streams. In the same way, pollutants can move from one medium to another. For example, toxic chemicals in the soil can leach into aquifers and pollute drinking water.

Furthermore, when we try to clean up pollution after it has been generated, we sometimes end up just moving it from one location or medium to another. For example, the air filters used in cars help keep air clean, but must eventually be disposed of themselves in landfills. Types of pollution are connected just as air, land and water are connected.

General EE Resources

- *Association of Illinois Soil and Water Conservation Districts (AISWCD)*
Lists resources and programs available through the AISWCD which includes contests, projects, education tools and a Local Outreach/Education Directory. www.ilconservation.com/

- *(QYLURQP HQWDO'DWDF\ &RXQFLO*
Offers a number of teacher resources as well as a wealth of information on the environment. www.enviroliteracy.org/index.php

- *,OOLQRLV' HSDUWPHQWRI $JULFXOWXUH*
www.agr.state.il.us

- *,OOLQRLV' HSDUWPHQWRI &RPP HUFHDQG(FRQRP LF 2 SSRUWXQLWLV* www.istep.org

- *,OOLQRLV' HSDUWPHQWRI 1DWXUDO5HVRXUFHV*
www.dnr.state.il.us/lands/education/index.htm

- *,OOLQRLV' HSDUWPHQWRI 3XEOF+HDOWK*
www.idph.state.il.us

- *,OOLQRLV(QYLURQP HQWDO3URWHFWLRQ $JHQF*
www.epa.state.il.us

- *Illinios Recycling Association*
www.illinoisrecycles.org

- *Illinois State Geological Survey*
Provides information on Illinois geology and online publications and maps such as the Illinois Surface Topography map. www.isgs.uiuc.edu

- *National Resources Conservation Service 15&6 6RLO(GXFDWRQ*
Provides information regarding soil facts, state soils, tools for educators and much more. http://soils.usda.gov/education/

- *8QLYHUVLWLV RI,OOLQRLV([WHQVLRQ Schools Online*
An interactive web site, targeted towards third through fifth grades, can be used by parents and students to learn about the world around them, as well as a useful tool for teachers. www.urbanext.uiuc.edu/schoolsonline/

- *8 6 (3$*
www.epa.gov

‡2 IILFHRI 6RQG: DVWH(GXFDWRQDO5HVRXUFHV ZZZ HSD JRY HSDRVZHUHGXFDWRQ LQGH[KWP
‡7HDFKHU&HQWHUZZZ HSD JRY WHDFKHUV

- *U.S. Geological Survey*
http://education.usgs.gov/

"Drawing Out" Pollution

Subject: Art
Science

Skills:
- Observing
- Comparing/ Contrasting
- Organizing
- Researching

Concepts: 1. A-E

Objectives: Students will:
1) identify forms of pollution and describe the effects that various pollutants can have on people, wildlife and plants.

2) describe relationships between various forms of pollution and human actions.

State Standards:
Science: 11.A.2 b, c, d, e
Social Science: 17.C.2 c
Physical Dev. & Health: 22.C.3 a

Vocabulary:
- pollutant
- pollution

Setting: Indoor and Outdoor

Materials:
- blackboard and chalk
- clipboards
- poster board or butcher paper
- crayons, markers, pencils
- tape

Time: One or two class periods

Activity Overview

In this activity students share what they know about pollution, identify pollution in their community and expand their understanding of different types of pollution.

Background

Although not all pollution is visible, most of us are not far from an example of a possible **pollutant** or the effects of **pollution**. It can be as obvious as a billowing smokestack, or as subtle as a plot of ground where no plants have grown for a long time.

Below are some ideas of what you might have students look for if they were searching for sources of pollutants:
- Evidence of fossil fuels being burned (dark smoke from vehicle exhaust or smokestacks)
- Solid waste that is not properly disposed of (litter, oil, tires, appliances)
- Signs that toxins or dangerous chemicals are being used (signs saying a lawn has been treated with weed killer or fertilizer, crop dusters)
- Discharge through pipes in watersheds into streams, lakes, ponds, rivers

If actual sources of pollution are difficult to identify, consider having students look for animals or things that may have been affected by pollution and work backward to determine the cause, such as:
- Unusual number of dead plants or animals
- Statues or buildings that appear excessively dirty or corroded
- Signs that toxins or chemicals have been released in the area (odd smells)
- Oil slicks on the surface of a body of water

Preparation

1. Review vocabulary and background information on "What is Pollution," pages 13-17.

2. Scout the proposed path for the student walk either on school grounds or within the community. Try to plan a route that will allow students to find examples of pollution. It might

be helpful to arrange for the assistance of other adults who are aware of objectives of this activity.

Procedure

1. Ask students to imagine what life would be like without clean air, land or water.

2. Have students brainstorm a list of as many things as they can that might contaminate, or make unsafe, the air we breathe, the land we live on, or the water we drink. Have students share their ideas and write their suggestions on the board. Ask students if they know what word people use to describe the types of things they have listed.
Answer: Pollution or Pollutants.

3. Discuss what the term pollution means and explain the three basic types.

4. Take students on a walk outdoors to look for pollution or pollutants. Have the students bring paper, clipboards and a pencil. During the walk have students find examples of pollution on land, in the air and in water. As students spot different examples, have them explain how each one could pollute, and what kinds of plants or animals could be affected by each one. For example, oil in the parking lot could wash into a storm drain which empties into a creek or river; aquatic insects, fish, frogs, turtles, and plants could be affected. Also, ask students what might have caused each form of pollution. For example, how did the oil get on the parking lot in the first place?

5. Have students record what they find and have them indicate how many times they see certain types of pollution.

6. Back inside, have students draw pictures of pollutants they spotted on the walk. They can continue to research examples of pollution by looking through magazines, newspapers, and the Internet. Students should try to find at least one example for each type of pollution: air, land and water.

7. Create a large chart on posterboard or butcher paper with columns for each of the three categories of pollution. Have students take turns placing their pictures into the different categories.

Ways to Classify Pollution

Air Pollution	Land Pollution	Water Pollution

8. As a group, review and discuss the finished chart. Ask students the following questions:
- Do any items appear in more than one category?
- Can something pollute two different things, such as air and water, or land and water? If so, how?
- Can people always see, hear and smell pollution?
- Which examples might affect people's health?
- Which examples might affect plants or animals?

9. Return to the answers given in step one. Do students feel they are living in a clean environment? Why or why not?

Wrap Up

Assessment

• Distribute copies of the Urban, Suburban and Rural Assessment of Drawing Out Pollution, pages 21, 22 and 23. Students should circle items in the pictures that are

potential sources of pollution. They should explain how each item circled might cause pollution and what or whom it might affect. Possible answers can be found on page 24.

Extensions

Interdisciplinary

• Read aloud the story "The Cat in the Hat Comes Back" by Dr. Suess (available through most public libraries). Although generally considered appropriate for younger audiences, this is an excellent example of a book with deeper meanings for students to explore. Ask students what represents pollution in the story (the pink stuff). Have students discuss the various ways that the cat tries to get rid of the pollution (moving it from one place to another, breaking it into little pieces). Ask them if people sometimes think about pollution this way. Have them consider how the cat finally got rid of the pollution (a voom, a mysterious machine that gets rid of anything). Ask students if they understand how it works. Do they think such a machine exists to get rid of pollution, why or why not? (Answer: No, once pollution is generated, it generally takes time, energy and effort to remove it. Also, some trash is reused or recycled, not simply disposed of.)

Community

• As a part of step 8, have students list pollution prevention solutions for each of the pollutants or pollutions identified. For example, if oil is found in the parking lot, students could suggest checking vehicles for oil leaks and providing routine maintenance. Then have students determine if the solution will cause more harm than good.

Technology

• Have students research information on types of pollution and local pollution sources on the Internet. One resource for information on local pollution sources is Enviromapper at http://www.epa.gov/enviro/html/em/index.html

Resources

• *Lake Notes - Septic Systems Fact Sheet*
Information on how a septic system works, signs of problems, suggestions for avoiding pollution. IEPA (see order form in appendix)

• *Lake Notes - Fertilizers and Pesticides: Options for Lawn and Garden Use Fact Sheet*
Information on safe fertilizer application, integrated pest management, and safe use of pesticides. IEPA (see order form in appendix)

• *Lake Notes - Home and Yard Fact Sheet*
Information on what you can do in your home and yard to prevent pollutants from getting into lakes and streams. IEPA (see order form in appendix)

• *World of Fresh Water* (PDF Version)
Use these activities to help your students understand the effects of pollutants on lakes, rivers, and streams. Grades 4-6 (66 pages)
http://www.epa.gov/ORD/WebPubs/fresh/fresh.pdf

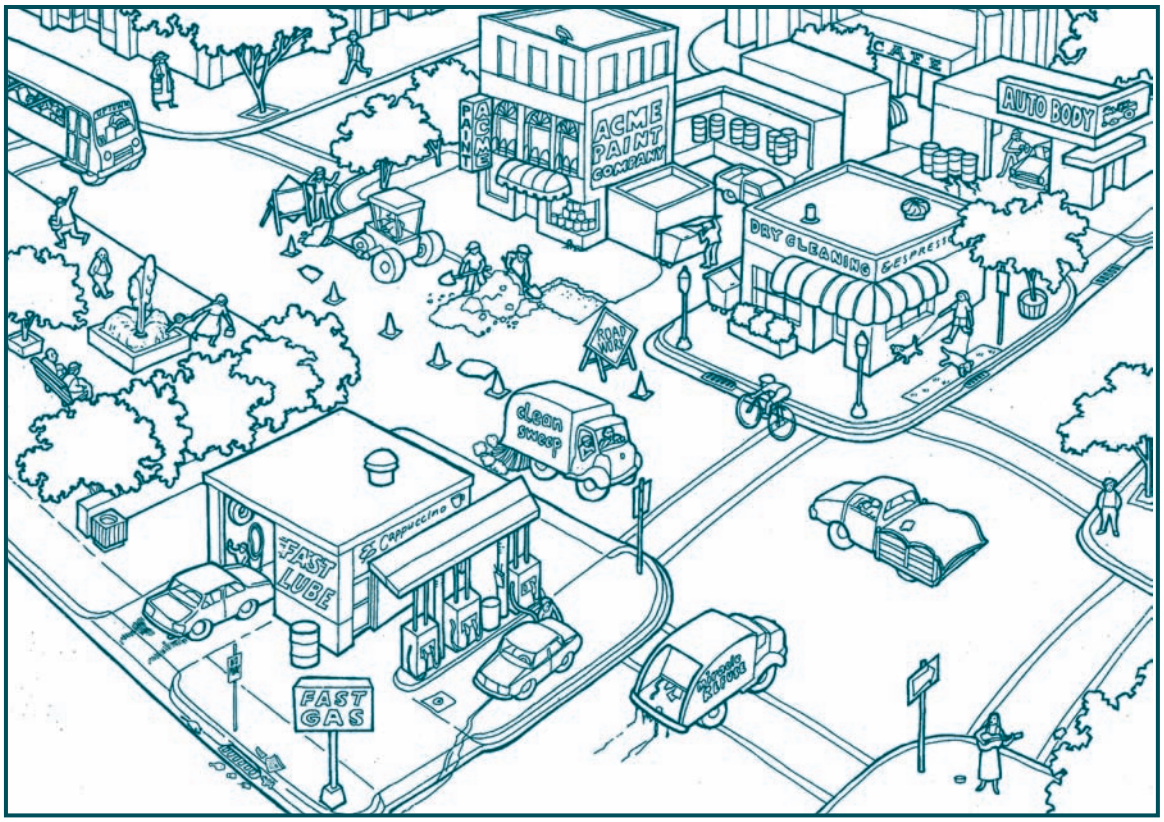
• *Project A.I.R.E - Air Pollution Background Information* (PDF Version) Fact sheet on air pollution and ways to detect and prevent it.
http://www.epa.gov/region01/students/pdfs/rd_airpol.pdf

• *Desdemona's Splash!* (CD-ROM)
Interactive game on water quality and the environment, specifically how activities in a watershed affect water quality.
CTIC, 1220 Potter Drive, #170, West Lafayette, Indiana 47906, 765/494-9555

• *Environmental Education Holdings*
The EPA Region 5 library contains a variety of environmental education materials to assist teachers in the classroom. For a listing of EPA's Region 5 environmental education holdings, please visit the following web site:
http://www.epa.gov/region5/library/collection/enved.htm.

Urban Assessment of "Drawing Out" Pollution

Directions: Circle the items which are potential sources of pollution. Explain how each item you circled might cause pollution and whom or what it might affect.



Source: *Desdemona's Splash!* 1997 (Adapted)

Item Circled	How it Might Cause Pollution	Whom or What it Might Affect
Example: *motor oil stains at Fast Lube*	*rain can wash oil into storm drain that empties to lake or stream.*	*humans, animals*

Suburban Assessment of "Drawing Out" Pollution

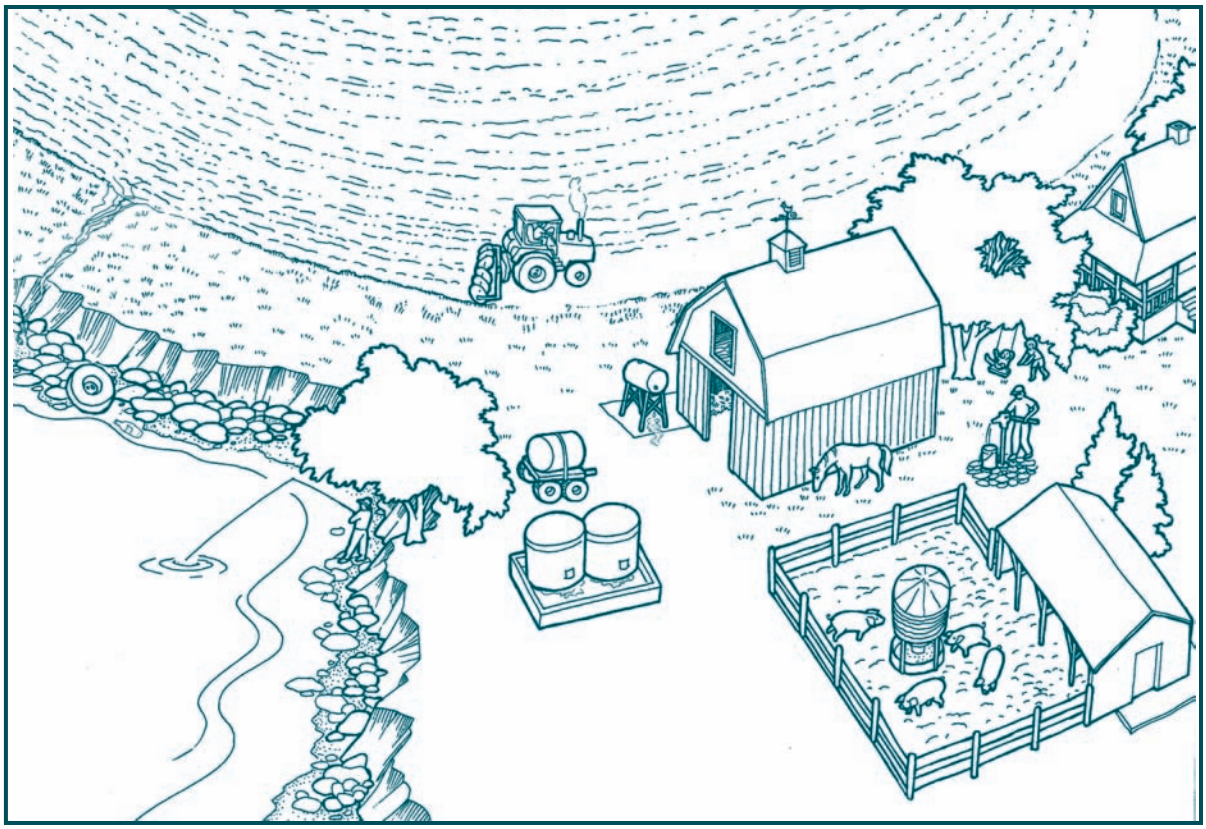
Directions: Circle the items which are potential sources of pollution. Explain how each item you circled might cause pollution and whom or what it might affect.

Source: *Desdemona's Splash!* 1997 (Adapted)

Item Circled	How it Might Cause Pollution	Whom or What it Might Affect
example: *person spraying garden pesticides*	*toxic chemicals may get into water supply.*	*humans, good insects, animals*

Rural Assessment of "Drawing Out" Pollution

Directions: Circle the items which are potential sources of pollution. Explain how each item you circled might cause pollution and whom or what it might affect.



Source: *Desdemona's Splash!* 1997 (Adapted)

Item Circled	How it Might Cause Pollution	Whom or What it Might Affect
example: *trash dumped along river bank*	*can pollute lakes or streams, toxic chemicals may get into water supplies.*	*humans, animals*

Possible Answers for (this is not meant to be an inclusive list):

Urban Assessment of "Drawing Out" Pollution

Item Circled	How It Might Cause Pollution	Whom or What It Might Affect
example: motor oil stains at Fast Lube	rain can wash oil into storm drain that empties to lake or stream.	humans, animals
gasoline pump	nozzle may release toxic fumes, underground storage tanks may leak.	humans, plants, animals
truck or car exhaust	releases pollutants into the air.	fish, animals
litter	may get into storm drain, ugly.	fish, aquatic insects
exposed soil at construction site	rain can wash soil into storm drain that empties to lake or stream.	humans, fish
pet waste	rain can wash nutrients and bacteria into storm drain that empties to lake or stream.	humans, fish, aquatic insects
leaking cans from autobody and paint shops	rain can wash chemicals into storm drain that empties to lake or stream.	humans, good insects, animals

Suburban Assessment of "Drawing Out" Pollution

Item Circled	How It Might Cause Pollution	Whom or What It Might Affect
example: person spraying garden pesticides	toxic chemicals may get into water supply.	humans, good insects and animals
person applying lawn chemicals	toxic chemicals may get into water supply.	humans, animals
person cleaning paint rollers	toxic chemicals can wash into storm drain that empties to lake or stream.	humans, plants, animals
car exhaust	releases pollutants into the air.	humans, fish, aquatic insects
motor oil on driveway	rain may wash oil into storm drain that empties to lake, or stream.	fish, animals
litter	may carry chemicals that can get into storm drain, ugly.	humans, fish
dogs	rain can wash nutrients and bacteria into storm drain that empties to lake or stream.	humans, birds, fish, animals

Rural Assessment of "Drawing Out" Pollution

Item Circled	How It Might Cause Pollution	Whom or What It Might Affect
example: trash dumped along river bank	can pollute lakes or streams, toxic chemicals may get into water supplies.	humans, animals
farm chemicals leaking on ground	rain may wash into lakes or steams.	humans, aquatic insects, animals
exposed soil on stream bank	rain may wash into lakes or streams.	aquatic insects, fish
motor oil on the ground	oil may get into the groundwater, can wash into lakes or streams.	humans, fish, aquatic insects
animal waste	rain may wash waste into lake or stream.	humans, fish, aquatic insects
tractor	releases pollutants into the air.	humans, plants, animals
farming area (exposed soil)	rain may wash eroded soil into lake or stream.	animals, plants, aquatic life

"Sock It" to Air Pollution

Subject: Science

Skills:
- Predicting
- Interpreting

Concepts: 1. A, C, N, R
3. A, F, G

Objectives: Students will:
1) be able to describe different sources of air pollution and some of the effects of air pollution.

2) recognize that some types of air pollution are invisible or visible only under certain circumstances.

State Standards:
Science: 11.A.2 b, c, d
13.B.2 b

Vocabulary:
- air pollution
- particulates

Setting: Indoor and Outdoor

Materials:
- three to five new white tube socks
- access, keys, and permission to run three to five different vehicles
- an adult assistant
- copies of the "Sock It" to Air Pollution Automotive Prediction Grid (p.26)
- clip boards

Time: One class period

Activity Overview

In this demonstration students will observe that **air pollution** is not always visible and that not all vehicles produce the same amount of pollutants.

Background

Motor vehicles—cars, trucks, buses—are a major source of air pollutants in North America today.

The United States Environmental Protection Agency has established national air quality standards for six specific air pollutants: sulfur dioxide, carbon monoxide, oxides of nitrogen, ozone, particulate matter and lead.

These pollutants can cause health problems if they are breathed at high enough concentrations. The national air quality standards are meant to ensure that levels in the free air never get high enough to cause any such problems. Standards at levels low enough to protect both human health and welfare were set after much scientific research.

Carbon monoxide interferes with the transfer of oxygen in the body. Lead, absorbed through the lungs, interferes with cell metabolism. Ozone, sulfur dioxide, oxides of nitrogen, and **particulates** all irritate the lungs and nasal passages in various ways.

Motor vehicles contribute directly or indirectly to all of those air pollutants in varying amounts. The exhaust from a car that is running properly is essentially colorless. It contains mostly carbon dioxide and water vapor formed by fuel combustion, and these are harmless. But vehicle exhaust also

Emissions from Internal Combustion Engines

contains small amounts of the other pollutants mentioned above.

Motor vehicles are the main source of carbon monoxide in the air. It is an invisible, odorless, poisonous gas created by incomplete burning of fuel in a car's engine. It can build up to dangerous levels in an enclosed space like a garage, so be sure to perform the experiment in this section outdoors, where the carbon monoxide and other pollutants can blow away harmlessly.

Vehicles also emit oxides of nitrogen. Some of this is in the form of nitrogen dioxide, a toxic gas which in higher concentrations is brownish-red. It also is involved in the formation of ozone. Vehicles emit small amounts of sulfur dioxide due to sulfur in the fuel as well.

Vehicles emit particulates—solid particles smaller than dust. Most such particulates are the result of incomplete fuel combustion. Diesel engines are especially prone to emit particulates. Formerly, most gasoline contained lead additives to help control the combustion process, and motor vehicles would emit lead particulates from their tailpipes. Leaded gasoline is no longer sold, however, and airborne lead levels have fallen dramatically in the last two decades. The experiment in this section has to do with particulates.

Ozone is not emitted directly into the air. It is formed by the action of sunlight on oxygen in the air, in the presence of hydrocarbons, oxides of nitrogen, and carbon monoxide. Of these "ozone precursors," hydrocarbons are the most active in ozone formation, and this is why they are important. Motor vehicles emit unburned or partially burned hydrocarbons from their tailpipes. Hydrocarbons also evaporate from fuel tanks and systems.

Preparation

NOTE: Student safety needs to be considered during this activity! Do not allow students to inhale or stand in the direct path of exhaust. Do not allow students to touch the tailpipe during or after this activity. The metal will be extremely hot and can burn skin and clothing. Use extreme caution and think through all aspects of this activity before beginning!

1. Locate three to five vehicles (school bus, diesel, new, old, alternative energy) that the teacher can start or have started during class.

"Sock It" to Air Pollution Automotive Prediction Grid

Make (Chevy, Ford, etc.)	Model (Blazer, Taurus, etc.)	Year (2000, 1965, etc.)	Engine Type (V8, 4 cylinder, etc.)	Fuel Used (Unleaded, diesel, natural gas, etc.)	Rank (Predicted)	Reason/Rationale	Rank (Actual)

2. Make copies of the prediction grid, one per student or group.

3. Create identification labels for the socks.

Procedure

1. Ask the students to identify sources of air pollution in the community. List these on the blackboard. The list should include automobiles, power plants, wood or coal burning stoves, factories, farming, and natural sources such as brush fires.

2. Explain to the students how a vehicle burns gasoline or diesel fuel. Some of the fuel is changed into energy to move the vehicle. By-products of the process include heat and air pollutants which exit the vehicle through the exhaust system via the tailpipe.

3. Use the background information to discuss the types of pollutants in vehicle exhaust.

4. Have the students assemble in the parking lot. Distribute prediction grids (one per student or team). Have students rank which car they predict will produce the most particulate matter (i.e., the dirtiest sock). Have them explain their choices. Place a white tube sock over the tail pipe of each vehicle. The elastic sock tops should fit snugly over the tailpipes; if they do not, secure them with rubber bands.

5. Ensure that the students are standing away from the vehicles and start the engines. While the engines run have students compare their predictions.

6. After five minutes turn off the engines and remove the socks from the tailpipes using oven mitts or heavy gloves. CAUTION: Tail pipes may be extremely hot; do not have students perform this step.

7. Turn the socks inside-out and attach the appropriate label. Arrange socks from most to least dirty.

8. Compare the students' predictions to the actual results. Remind the students that they are only seeing particulate matter, and that cars also produce large amounts of invisible air pollutants such as carbon monoxide and oxides of nitrogen.

Wrap Up

Assessment

• In small groups, have the students review the findings and compare them to their predictions. Have the groups come up with written answers to the following questions, using complete sentences:

1. How closely did your predictions match the actual results?

2. What could have affected the differences in findings between the different vehicles? (Possible answers: type of fuel used, engine type, age of vehicle, maintenance).

3. Are the cars with the cleaner socks always the best choice? What else might you look for in selecting a car? (Answer: No, because this test does not measure all kinds of emissions, only particulate matter. Also, cars are selected for different uses and to fulfill different needs; the 'cleanest' car in your test may be too small or expensive for some people, or may not have acceptable fuel efficiency.)

Extensions

Community

• Find out if emission inspections are required in your area. Hypothesize and investigate why emissions testing is required and if it is required all over the state. Plan a field trip to a vehicle inspection site, if feasible.

Technology

• Discuss alternative modes of transportation and alternative fuels. How do they differ in terms of emissions produced?

Multidisciplinary

• In small groups, have students research the amount of unleaded and diesel fuel that is sold in their neighborhood or town each month. Have teams compile their results and determine how many gallons of each type of fuel are burned every month/year. If students determine this number is high, have them research ways in which to reduce the amount of fuel consumption in their lives.

Resources

• *Air Facts - Criteria Pollutants Fact Sheet*
Information on six criteria air pollutants recognized by the U.S. EPA. IEPA (see order form in appendix)

• *AIRNow*
Provides a wealth of information nationwide, including hourly data on ozone and particulates.
www.airnow.gov

• *Alternative Fuels Data Center*
This site provides useful information about alternative fuel and alternative fuel vehicle (AFV) technologies, programs, funding, regulations, contacts, and more.
www.eere.energy.gov/afdc

• *$XWRP RELOH V DQG $LU 3ROOXWLRQ* (PDF)
Background information on the causes and consequences of pollution caused by automobiles.
www.epa.gov/region01/students/pdfs/rd_auto.pdf

• ** OREDO DUP LQJ*
This web site offers information on several topics regarding global warming, such as the following: climate, emissions, impacts, actions and a resource center. www.epa.gov/globalwarming/ (or) http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html

• *,(3$ %XUHDX RI $LU $LU 7HDP*
This site provides information on emissions testing and the vehicle inspection process.
www.epa.state.il.us/air/vim/index.html

• *Illinois Green Fleets*
www.illinoisgreenfleets.org

• *,QYHQWLQJ D 0 RQLWRU 3')*
An activity from Project A.I.R.E. that has students devising and testing methods to monitor air pollution.
www.epa.gov/region01/students/pdfs/activ7.pdf

• *3DUWQHUV IRU &OHDQ $LU*
www.cleantheair.org

• *3URMHFWV $, 5 (.*
Offers several different air-related warm-up exercises, activities and reading material.
www.epa.gov/region01/students/teacher/aire.html

Adapted From: "Let's Sock Car Exhaust," Environmental Resource Guide - Air Quality. Air and Water Management Association. Pittsburgh, PA. 1991.

Charting the Water

Subject: Mathematics
Science

Skills:
- Classifying
- Comparing/ Contrasting
- Computing
- Matching

Concepts:
1. A, D, F, J, N, P, R
2. B 3. R

Objectives: Students will:
1) identify forms of pollution and describe the effects that pollutants can have on people, wildlife and plants.

2) describe relationships between various forms of pollution and human actions.

State Standards:
Mathematics: 10.A.2 a, c
Science: 11.A.2 c, d
13.B.2 e, f
Social Science: 17.C.2 c
Physical Dev. & Health: 22.C.3 a

Vocabulary:
- inorganic
- organic
- sediment
- thermal
- toxic

Setting: Indoor

Materials:
- 100 tokens each of eight different colors
- large container
- Types of Water Pollution handout (p. 32)
- graph paper

Time: One class period

Activity Overview

Students classify and graph the pollutants found in a fictional river and hypothesize what caused the pollution in the first place.

Background

Water can be polluted in a number of different ways. One way is for bathroom and factory wastes to flow through pipes into waterways with no treatment. Another is for soil, animal wastes, fertilizers and pesticides to wash from farms into waterways. Soil, oils, chemicals and other substances can be washed in from city streets and construction sites. Some wastes are diluted by water and others can be eaten by bacteria. However, nature can only do so much. The wastes that remain are sometimes poisonous; others can cause diseases such as cholera, or change the makeup of streams so that animals or plants cannot survive.

There are many types of substances that can be pollutants: oil products, poisonous chemicals, decaying plants, even leaves. Many things that are not harmful by themselves or in small quantities become pollution under proper circumstances or in high concentrations. Generally, these can all be classified into the following five causes of water pollution:

- **Organic** includes human, animal and plant wastes and chemical substances created by or made from them;
- **Inorganic** includes litter and chemical fertilizers;
- **Thermal** refers to changes in the temperature of water (either warmer or colder);
- **Toxic** includes herbicides, insecticides, lead, and other chemicals that are directly harmful to humans or animals;
- **Sediment** includes the buildup of silt, clay, and other particles in ways that affect the survival or health of an ecosystem.

It is easy to think that pollution is only caused by humans, but this is not the case. Volcanic eruptions are a source of acid precipitation, and naturally occurring erosion can contribute to sedimentation. It is important to understand that what makes pollution is not the source (whether it is natural or caused by humans) but what kind of effect it is having on living things that depend on water.

Preparation

1. Make 100 tokens each of eight different colors of construction paper. Tokens should be shaped into 1/2 inch squares. Put all of the tokens into a large container and stir so the colors are thoroughly mixed.

2. Make one copy of the Types of Water Pollution Worksheet for each student.

Procedures

1. On the chalkboard list the five major types of water pollution: organic, inorganic, thermal, toxic and sediment. Discuss each, referring to the background information if necessary.

2. Distribute the Types of Water Pollutants Worksheet to each student (p. 32). Discuss them in detail, and have the students match each of the pollutants with one of the five causes of pollution. Explain how some of the pollutants can fit into more than one category (for example, animal waste can have characteristics of organic and sediment pollution because it can oversupply an ecosystem with nutrients and cause a buildup of particles in the waterway possibly affecting the health of the ecosystem).

3. Assign one of the eight colors of construction paper to each of the eight pollutants (e.g., red = petroleum, yellow = acid precipitation).

4. Divide the students into three groups. Explain that each group will be a research team and will analyze the pollution content of a fictional river. Give each team a piece of graph paper and a small amount (about one tablespoon) of the 1/2 inch square tokens.

5. Instruct the teams to separate the tokens by color. Have them count the number of each pollutant and construct a simple bar graph showing the relative concentration of the pollutants. Make sure that each team lists the colors on the chart in the same order.

6. Explain that more than two units or tokens of any pollutant is considered harmful to the aquatic environment. Ask them to determine which pollutants in their river would be likely to cause the most damage to humans and environment.

Wrap Up

Assessment

• Have students hypothesize what may have caused types of pollution in their river.

• Have students debate the following: Water is taken from a river, treated, used by people of the community, sent to a city sewage treatment plant, and then returned to the river. Do you think this is a form of water pollution or recycling? Explain your answer.

Extensions

Community

• Have students visit a wastewater treatment plant to deepen their understanding of the process of water purification and their own place in the water cycle.

Multidisciplinary

• Have students obtain and write a report on current national and state laws protecting water quality.

Outdoor

• Have students visit a nearby body of water and conduct water quality tests. Have them hypothesize, based on their findings, what kinds of pollutants are affecting that area.

Technological

• Have students research how fertilizers, pesticides and other chemicals are tested for safety before they are available for sale.

Resources

• *Getting to Know Your Local Watershed*
Provides overview information on "What is a watershed?" Explains different sources of pollution that affect watersheds, and uses of watersheds' natural resources. http://lanshark.ctic.purdue.edu/KYW/Brochures/GetToKnow.html

• *Illinois Water Quality Report*
This report provides an assessment of the quality of the state's surface and groundwater resources, including waterbody specific information and maps. www.epa.state.il.us/water/water-quality

• *Drinking Water & Ground Water Kids' Stuff*
This web page offers several games and activities relating to groundwater and drinking water, including the water treatment cycle. KWWS ZZZ HSD JRY VDIHZDWHU NLGV NGVB KWP O

• *Water Quality: Potential Sources of Pollution, Middle School Edition*
This 24" x 36" color poster depicts point and nonpoint sources of pollution. The reverse side contains two activities, Dispersion of Nonpoint Pollutants and How Substances Are Measured in Water. Available online at: http://water.usgs.gov/outreach/OutReach.html

• *Wetlands, Oceans and Watersheds*
Provides information on watersheds, different types of waterbodies and how to protect our resources. www.epa.gov/owow

• *EnviroMapper for Water*
This interactive tool is a web-based Geographic Information System (GIS) application that displays information about bodies of water in the U.S. It allows you to create customized maps and can display the health of a river near you. www.epa.gov/waters/enviromapper/index.html

• *Living Lands and Waters*
This non-profit organization offers wonderful educational workshops with an up-close river experience. Learn how one person with a passion for a cleaner river environment is making quite a difference in our rivers today. www.livinglandsandwaters.org

• *Project WET (Water Education for Teachers)*
Project WET is a K-12 national water education program that teaches about people's relationship to water, including the history of water, uses of water and water management. The activity guide contains hands-on water-related activities that give teachers and students opportunities to investigate our most precious natural resource. These activities have been correlated to the Illinois Learning Standards.

Teachers can obtain a copy of the activity guide by attending a Project WET workshop in their area. Project WET is co-sponsored by the IDNR and the IEPA. For information about the program go to: http://dnr.state.il.us/lands/education/CLASSRM/WILD/INTRO.HTM or http://www.projectwet.org/.

• *Get Involved*
Learn how to participate with students around the world in World Water Monitoring Day http://www.worldwatermonitoringday.org/ Celebrate Water Monitoring Month and order outreach and educational materials. www.epa.gov/owow/monitoring/volunteer/monitoringmonth.html

• *Lake Education Assistance Program (LEAP)*
The Illinois EPA offers a $500 grant available to all Illinois schools and not-for-profit organizations for the study of lakes/ponds and their watersheds. This money can be used to purchase lake-related educational materials, field trips, equipment and activities. Application deadlines are September 30 and January 31. www.epa.state.il.us/water/conservation-2000/leap.html. 217-782-3362.

Adapted From: "Deadly Waters," Project WILD Aquatic. Western Regional Environmental Education Council. Bethesda, MD. 1992.

Types of Water Pollutants Handout

Sediments
Small particles of sand, soil, clay, and other minerals are washed into rivers, lakes and streams from the land. Often these come from construction projects or paved areas, but they can also come from natural runoff or erosion. Stream channels and harbors that have been filled with sediment often need to be dredged. Sediment can harm wildlife by covering nests of fish or by clogging the gills of fish and shellfish.

Petroleum (gas/oil) Products
Oil spills, such as the Exxon Valdez spill, kill fish, seabirds, shellfish, and aquatic plants. However, there are many other ways that petroleum products (such as oil, gasoline, and kerosene) can contaminate water. They can seep into groundwater from damaged or corroded underground storage tanks, be washed into waterways from driveways, streets or service stations, or be released from ships, refineries, or drills. Petroleum products are poisonous to many animals. Additionally, waterbirds cannot fly if they get oil on their feathers.

Heated or Cooled Water
Electric power plants generate large amounts of heated water. This warm water can't carry as much oxygen as cooler water. If oxygen cannot be returned to the water, fish and other aquatic animals can be harmed. Cooler water is sometimes released by deep dams; this too can damage aquatic animals and plants that require warmer temperatures to survive.

Organic Wastes
Other organic wastes can also get into the water. These include natural animal and plant products such as wood pulp or food by-products. These products also contain nutrients for bacteria and algae. The concentration of bacteria will increase if too much organic waste gets into the water. These bacteria will then use up the oxygen in the water, and fish will die.

Animal/Human Wastes
Untreated sewage and runoff from farms, stockyards, and barns can contain viruses and bacteria that are very dangerous to humans. People can contract cholera, typhoid fever, dysentery, hepatitis, and other diseases if they drink or come into contact with water that has been polluted this way, or if they eat fish or shellfish from polluted water. Human and animal wastes also contain nutrients and act as a fertilizer in water. Bacteria feed on the nutrients and use up all of the oxygen in the water. This kills many aquatic animals and plants.

Inorganic Compounds
Detergents, pesticides, herbicides, salts, mineral compounds, and other inorganic compounds are harmful to water ways. They come from factories, mines, agriculture, factories, households, and sometimes from natural sources as well. Many of these chemicals are poisonous to fish and other animals or cause damage to structures, such as boats or water purification equipment.

Fertilizers
Runoff from farms, gardens, lawns and golf courses sometimes contains excess fertilizers. When high concentrations of these fertilizers get into water, they cause large amounts of algae to grow. The algae feed on the nutrients in the fertilizer, just as crops would; once they use up all of the nutrients, the algae die and are themselves eaten by bacteria. The bacteria use up all the oxygen in the water, which makes the water unsuitable for fish, shellfish, and other animals.

Acid Precipitation
Normal water is not usually acidic. However, plants and animals can be harmed or killed by water that has been made acidic by inorganic chemical pollution.

2 Why is Pollution an Environmental Issue?

OVERVIEW

Mark Twain once noted that "People always talk about the weather, but nobody ever does anything about it." People have much to say about the weather: it's too hot, too cold, we don't like thunderstorms, one person predicts drought, another predicts flooding. Weather is a problem for some people, but it is generally not an issue, because there is generally no disagreement about what is to be done about it. There is nothing we can do, other than prepare for what may come.

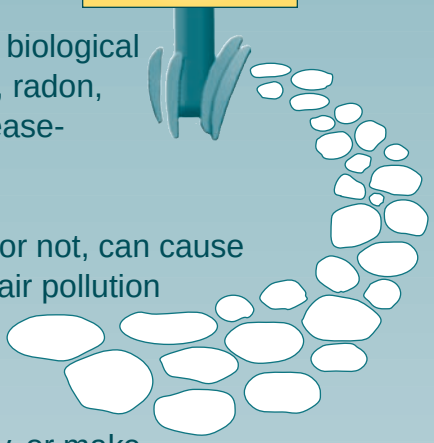
There are things that we can do about pollution, but people disagree about what actions to take. This is what makes pollution an issue: different people or groups of people have disagreements over what to do to solve the problem. Some people even disagree about how big the problem is, or whether it is a problem at all.

This section deals with helping students develop the skills they will need to look at issues, to solve problems, and to work with others to find common ground and solutions. These include analysis and problem solving skills. We will also look at some of the reasons why pollution is a problem, and what kinds of negative effects it can have on people, communities, and the environment.

BACKGROUND

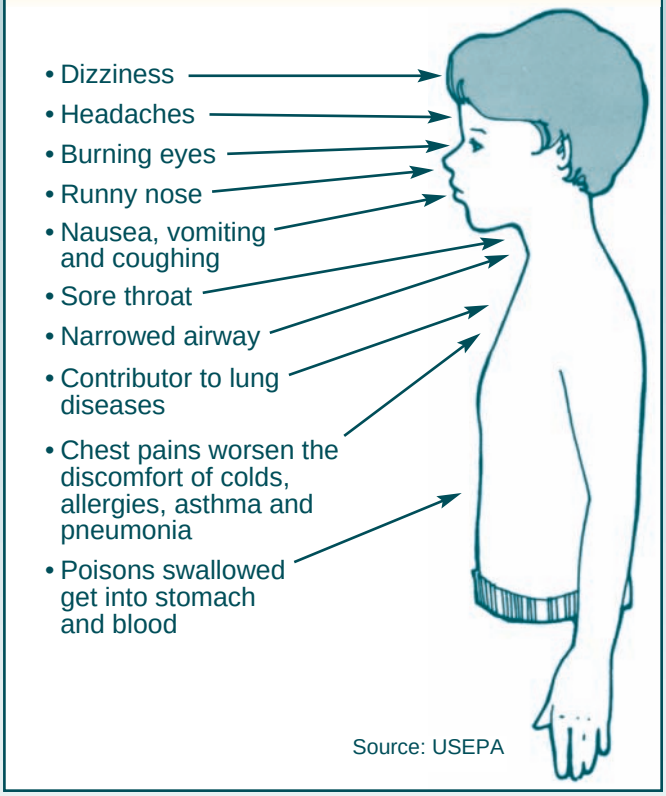
Pollution Effects on Human Health

Pollution can affect humans in a number of different ways. People exposed to air pollution for long periods of time may suffer from lung irritation, headaches or runny noses, develop asthma and allergies, or face even more serious problems such as lung cancer or reduced immune system strength. Polluted water can carry chemical or biological hazards such as lead, radon, bacteria, or other disease-causing agents.



Air pollution, invisible or not, can cause damage. Even a little air pollution can make your eyes burn and your head ache. It can blur your vision, make you dizzy, or make you tired. Many people find it difficult to breathe when pollution is in the air. Air pollution can even make it easier for you to catch a cold or the flu, and some air pollutants have been linked to serious diseases such as lung cancer and heart trouble.

Possible Effects of Air Pollution



Source: USEPA

People aren't the only things hurt by air pollution. Animals, plants and even buildings can be affected. Plants surrounded by polluted air may not grow, and fish and animals may die. Statues and building materials can be discolored or corroded.

Pollution Effects on Communities

In addition to its effects on individuals, pollution can affect whole communities. The town of Love Canal, in New York, essentially became a ghost town after hazardous waste, buried years before, began to seep up through the ground and affect local citizens. Even if individuals are not harmed, communities may endure the consequences if pollution destroys their economic base (for example, if water pollution closes a beach or if agricultural land is made useless due to a hazardous waste spill).

Pollution Effects on Economy

Pollution cleanup has become a very expensive undertaking. Millions of dollars are spent every year on toxic waste dumps, oil spills, litter collection, emission testing of vehicles and other pollution controls. When the costs are borne by businesses or individuals, they cut into profits or personal wealth; when covered by governments, they account for large tax burdens.

Pollution Effects on Ecosystems

Pollution can change or damage whole ecosystems and threaten species. The pesticide DDT, used to kill a large variety of insects and pests from 1939 to 1973, caused widespread environmental damage. Although the intent was to control harmful pests and diseases, its use resulted in the deaths of large numbers of songbirds. The chemical accumulated in the bodies of other animals, including bald eagles and peregrine falcons, who were then unable to produce young. The numbers of these species declined significantly as a result. Although it is no longer used in the United States, DDT continues to be produced here for sale to other countries.

SUMMARY

As stated in Section 1, pollution can adversely affect air, land and water. Similarly, it can affect individuals, communities, and ecosystems. The recent appearance of MTBE as an environmental issue is an example of how these are connected. MTBE (Methyl tertiary-butyl ether) was first used as a gasoline additive in 1979 as a way to improve air quality. It was later found to be a possible human carcinogen and it also has an unpleasant odor. Because it is highly soluble in water, it spreads quickly through soil if spilled on roads or leaked from underground tanks. Communities across the country, including some in Illinois, have lost some drinking water sources due to contamination by MTBE. Responding to national concerns, the United States EPA has ordered that MTBE be phased out of gasoline. This phase-out could take several years to implement.

When considering pollution, it is important to keep all possible effects in mind.

Leggo My Ozone

Subject: Art
Physical Education
Social Studies
Science

Skills:
- Measuring
- Creating Models
- Critical Thinking
- Classifying
- Role Playing

Concepts: 1. A, C, F, J
2. B, F 3. C, D, E, G

Objectives: Students will:
1) understand the different layers of the atmosphere and the importance of each,

2) understand the difference between good and bad ozone and where each is located,

3) understand how choices made on Earth affect the atmosphere.

State Standards:
Science: 11.A.2 c, 12.E.2 b, 13.B.2 b, e, f
Social Science: 17.B.2 c, 17.C.2 c
Physical Dev. & Health:22.C.2

Vocabulary:
- chlorofluorocarbons
- exosphere
- hydrocarbons
- ionosphere
- mesosphere
- Air Pollution Action Day
- ozone layer
- smog
- stratosphere
- thermosphere
- troposphere

Setting: Indoor & Outdoor

Materials:
- one sheet per student of white 1x1 meter paper
- a metric ruler
- pencil and colored pencils
- small jar lid or milk cap

Time: Two class periods

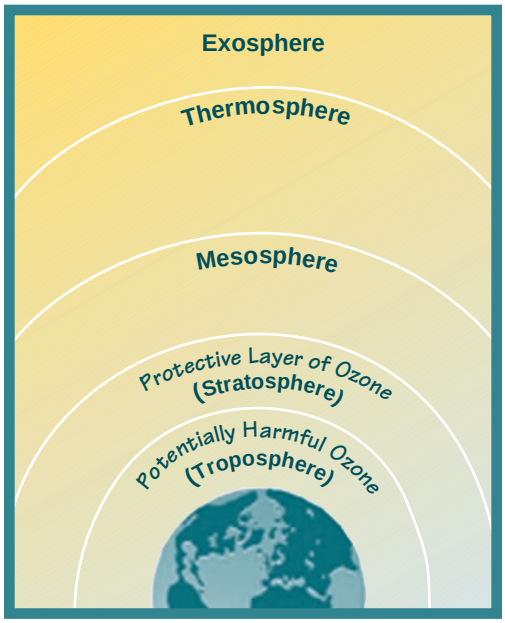
Activity Overview

Students first develop a model of Earth's atmosphere and then participate in a simulation which illustrates the difference between "good" and "bad" ozone.

Background

When trying to understand air quality, it is necessary to learn how our atmosphere operates. It is helpful to think of the Earth as being surrounded by four different layers. The first layer, the **troposphere**, is about 6-8 miles thick; it contains the air we breathe and is where we find clouds, storms and other weather events. This is also where birds fly.

The next layer is called the **stratosphere**. It is about twice as thick as the troposphere. The stratosphere is where many jet aircraft fly. In the upper Stratosphere we find a thin layer called the **ozone layer**. Ozone is a molecule made up of three oxygen atoms, and is very rare; in every million molecules of air fewer than 10 are ozone. However, the ozone layer is crucial to life on Earth because it shields us from harmful ultraviolet rays from the sun. This is commonly known as "good" ozone.



Source: Environmental Resource Guide, Air Quality, 1991.

The next layer up is the **mesosphere**. It is where we see trails left by meteors as they pass near the Earth. Above this is the **thermosphere**, which contains a region called the **ionosphere**. The ionosphere is important because radio signals "bounce off" the ions in this layer and return to Earth; this allows us to hear radio broadcasts from around the world. The final layer, the **exosphere**, is the upper limit of our atmosphere.

"Good" and "Bad" Ozone

The ozone located in the stratosphere is referred to as "good" ozone because it helps protect the Earth from ultraviolet radiation from the sun. If this layer were to be destroyed, more ultraviolet radiation would reach Earth. The results could include higher temperatures, damage to plants, and skin cancer in humans. Recently, scientists have discovered a hole in the ozone layer over Antarctica. Many scientists believe that the ozone layer is thinning or disappearing altogether. Many chemicals produced by humans are known to break down the ozone layer. These include halons and **chlorofluorocarbons** (CFCs), sometimes called freons. CFCs and related chemicals are found in or are involved in the production of many common products, including refrigerators, air conditioners, fire extinguishers, aerosol sprays, and styrofoam. Many companies now try to produce these items without using or producing CFCs.

AIR + HYDROCARBON + SUN = BAD OZONE

Some ozone is also found in the troposphere. This ozone is created by the action of sunlight on oxygen in the air in the presence of "ozone precursors"—chiefly **hydrocarbons**, and to a lesser extent, oxides of nitrogen, and carbon monoxide. Ozone is one of the primary ingredients of **smog**.

Smog can make the air look hazy. High ozone days occur chiefly on hot sunny days with little wind. Although ozone and air both contain oxygen, ozone is toxic to humans if inhaled. It is colorless and odorless at the levels you find it in the atmosphere, but can cause coughing, wheezing, shortness of breath, and irritation to the eyes and nose.

When the chance of high ozone concentrations in the air is especially great, extra steps are taken in some metropolitan areas to alert the public to the possible health risks. In Chicago, the Illinois EPA and the Partners for Clean Air declare "**Air Pollution Action Days**" and encourage people to take specific actions to reduce the amount of fossil fuels they burn. In the East St. Louis metropolitan area, the Clean Air Partnership joins the IEPA in declaring an "Ozone Alert" for the same purpose. The Partners for Clean Air organization suggests the following tips to help reduce ozone formation.

- Limit driving: combine errands, eliminate trips, rideshare, use I-Pass, carpool, bike or walk if possible.
- Take public transportation.
- If you must drive, use your newest vehicle, avoid excessive idling and abrupt starts, and keep your vehicle well-maintained.
- Refuel your car after 7 p.m., when sunlight is not strong enough to form smog.
- Delay using gasoline-powered recreational vehicles, especially on Action Days.
- Defer lawn mowing until late in the day or until the next day. The U.S. EPA estimates that 5 per cent of all air pollution nation-wide comes from our 89 million lawn mowers, garden tractors and other gas-powered equipment.
- Choose water-based paints instead of oil-based.
- Use a charcoal chimney or electric starters rather than lighter fluid when using a barbecue grill.
- Defer use of household consumer products that release fumes or evaporate easily.
- Conserve energy in your home to reduce needs from power plants.
- Do not burn leaves and other yard waste.
- Postpone burning wood in fireplaces on Action Days.

Preparation

1. Review background material.
2. Make copies of the Earth Atmosphere Model Instruction Sheet, (page 40) one per student.
3. Make two sets of Leggo My Ozone cards for the activity on day 2 (pages 41 and 42).
4. Create the outdoor playing field (page 37) for the Leggo My Ozone activity on day 2.

Procedures

Day 1

1. Ask the students if they have heard the term "atmosphere," and if they know what it refers to. Explain that the atmosphere surrounds Earth and is divided into layers. Explain some of the highlights of the different layers, for example that most of the weather occurs in the first layer, or that the ozone layer filters out the sun's harmful ultraviolet radiation.

2. Refresh (or instruct) students on the metric system and on how to use a metric ruler.

3. Provide each student with a copy of the Earth Atmosphere Model Instruction Sheet (page 40) and the necessary materials. Explain that they will be working on their own to produce models of Earth's atmosphere.

4. Allow students an appropriate amount of time to construct and decorate their models. These models could be used as an assessment and be based on accuracy, measurement, content, detail and neatness.

Day 2

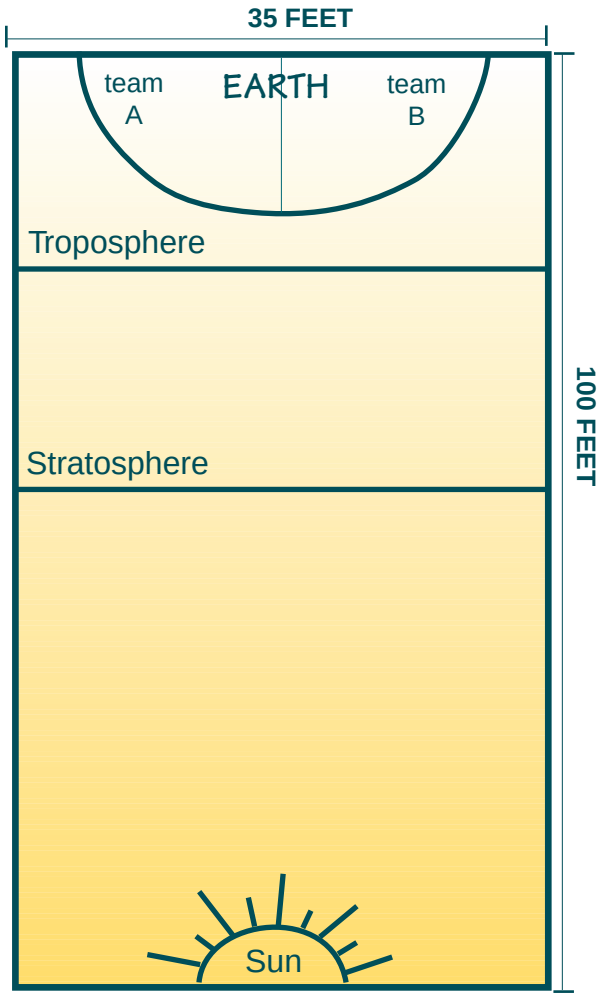
5. Review the five layers of the atmosphere with the students. Pay particular attention to the two layers closest to the earth, the troposphere and stratosphere. Inform them that today they will be focusing primarily on these two layers.

6. Introduce the concepts of "good" ozone and "bad" ozone. Explain that they are chemically the same, but are called good or bad depending on their location in the atmosphere and their effect on human health. Refer to the background information on page 35 for more information. Discuss the different human behaviors that can affect the amounts of good or bad ozone in the atmosphere.

7. Take the class outside to the prepared activity area. Point out the boundaries and features to the students:
   - Earth (different bases for teams A and B)
   - troposphere
   - stratosphere/ozone layer
   - distance (not to scale) between the stratosphere and the sun

8. Select students to fill different roles (numbers are based on a class size of 24, and can be adjusted):
   - earthlings (10, divided into two teams of five)
   - tropospherians (bad ozones) (six)
   - stratospherians (good ozones) (six)
   - ultraviolet rays (two)

Students should pay attention to the instructions for all roles, as they will have an opportunity to play most if not all roles during the simulation.



9. Explain the rules of the simulation: Each earthling team will have its own set of Action Cards (pages 41 and 42). Teams will draw cards at their own pace, independent of each other.

Each card represents a particular human action. For each action, the team must agree on the impact the action has. In this simulation, there are four possible impacts:

1) add bad ozone to the troposphere;
2) have a positive impact on the troposphere;
3) destroy good ozone in the stratosphere;
4) have a positive impact on the stratosphere.

Once the team has reached a decision, the person who drew the card will take it to the monitor (teacher) to verify the answer. If the team gets the answer wrong, they must go back to their team, insert the card back into the deck, and allow the next student on their team to pick another card. If they have answered correctly, they leave the card with the monitor and proceed as follows:

- If they do something to reduce or prevent bad ozone, they choose one person from the troposphere to join their team.
- If they do something to add bad ozone, then that person joins the troposphere.
- If they do something positive for the stratosphere, the player joins the stratosphere.
- If they do something to destroy good ozone, they select one person from the stratosphere to join their team.
  It may be helpful for the monitor to hold a small sign reminding students what answers result in what actions.

10. If someone picks an Air Pollution Action Card, the person picking the card must yell out "Air Pollution Action Day!" At this point, all action stops. However, the action taken by whatever card the other team is working on is doubled. So, if the other team was to add a player to the stratosphere, they would instead add two; if they were to take one person from the troposphere, they would take two.

11. The two Ultra Violet rays will begin at the far end of the activity area. They will begin counting off the weeks of the year, starting with December, at the monitor's signal. (For example, first week of April, second week of April, etc.) They are to recite these weeks slowly. When they reach the first week of August, they are to run towards the "Earth." Their mission is to get past the stratosphere without being tagged by the good ozone; if any of the good ozone tags them as they run through, they must return to their beginning point. If any of them makes it through, that student changes places with a member from team A or B. The team member they replace becomes an Ultra Violet ray for the next round.

The monitor writes down how many Ultra Violets got through the ozone layer, if any, and how much bad ozone is in the troposphere. Play then continues.

12. The players who begin as or who become bad ozone wait to be replaced by team members; otherwise, they are largely inactive. The players who are good ozone must also wait, but they must remain in line and be alert to stopping the Ultra Violet rays when they arrive. As the Ultra Violets run towards them, the good ozone must try to "tag" each Ultra Violet without moving from their location. The Ultra Violets only need to be tagged once to be stopped.

Wrap Up

Assessment

Have a few students share the various roles they played in the activity. Have all students reflect on the following:

• How did the stratosphere (good ozone) change during the course of the simulation?

• What effect did this have on the ability of ultraviolet rays to get through?

• What actions did they discover were either beneficial or harmful to the "good ozone"?

• How did the troposphere (containing bad ozone) change during the course of the simulation?

• What actions did they discover were either beneficial or harmful to the troposphere (where "bad ozone" resides)?

• In what ways was the activity similar to what really happens in the atmosphere? (What people do has an effect on the atmosphere; the stratosphere really does deflect most ultraviolet rays; things that people do on Air Pollution Action Days really have an impact).

• In what ways was the activity different from what really happens in the atmosphere? (Good and bad ozone don't become the opposite; ultraviolet rays don't strike Earth once a year—they are prevalent at different amounts throughout the year; and helpful activities don't take bad ozone away—they just don't produce as much or more of it.)

Extensions

Community

• Research various things that people can do to protect the "good ozone" and reduce the "bad ozone" in their community. Have students create posters of these activities that can be displayed in the public library or in store fronts.

Multidisciplinary

• Collect different media articles (a good source is to check online newspapers) about air pollution action days, the hole in the ozone and related topics. Have students analyze and compare how these topics are addressed in different sources and under different circumstances.

Technology

• Have students visit the Partners for Clean Air web site (http://www.cleantheair.org/). There they can find out if the Chicago area is having an Air Pollution Action Day. They can also get information on different ozone concentrations in different Illinois counties by going to the IEPA web site (www.epa.state.il.us/air/iaqdan/o3high.html) or they can get information from across the country at the AIRNow web site, http://airnow.gov/.

Resources

• *Cycles of the Earth and Atmosphere, A Web site for Teachers.*
Online teaching module for middle school science teachers. The content focus is climate change and issues related to both stratospheric and tropospheric ozone.
www.ucar.edu/learn/index.htm

• *Air Curriculum Resources*
A variety of online resources available for both students and teachers.
www.epa.gov/teachers/air.htm

• *3URMHFW$,5($LU3ROOXWLRQ%DFNJURXQG ,QIRUPDWLRQ3')9HUVLRQ*
Fact sheet on air pollution and ways to detect and prevent it.
www.epa.gov/region01/students/pdfs/rd_airpol.pdf

Earth Atmosphere Model Instruction Sheet

Materials Needed

- one sheet of white paper 1 meter by 1 meter in size (bulletin board paper works well)
- a metric ruler
- pencil and colored pencils
- a round object such as a jar lid or milk cap

Activity

Check off each instruction after you have completed it. Remember, when drawing a new layer of the atmosphere, you should measure from the Earth's surface, not the layer before it.

❑ Obtain a 1 meter by 1 meter piece of paper.

❑ Use a pencil to trace a round object in the middle of the paper. This is Earth. Color Earth blue and green to represent oceans and continents.

❑ The first layer of Earth's atmosphere, the troposphere, extends 10-15 km above earth. Using a scale of 1 mm for 1 km, place a series of dots around Earth, 20 mm from the planet's surface. Connect the dots to form a circle around Earth. Label the inside of this circle 'troposphere.' Draw pictures to indicate that this is the area in which airplanes fly and weather happens.

❑ The second atmospheric layer, the stratosphere, extends 50 km above Earth's surface. Measure and draw a circle 50 mm from Earth's surface. Label this layer 'stratosphere.' The jet stream occurs between the troposphere and the stratosphere, so draw arrows to represent this fast moving current of air on the borderline between the two layers.

❑ The third layer of the atmosphere, the mesosphere, extends 90 km from Earth's surface. Measure, draw, and label this layer. This is the coldest layer, so draw a thermometer to represent the very cold weather.

❑ The ozone is between the stratosphere and mesosphere. Ozone is made of three atoms of oxygen. Along the border of the stratosphere and mesosphere, draw molecules of ozone - three connected dots - leaving a tiny area empty to represent the 'hole' in the ozone layer.

❑ The fourth layer of the atmosphere, the thermosphere, extends 480 km above Earth's surface. Measure, mark, and label this layer. A thin region in the thermosphere, called the ionosphere, contains charged atoms. Label the ionosphere and draw + and - signs to represent those atoms. (Remember, this is not a layer, just a region in the thermosphere.) When meteoroids enter Earth's atmosphere, they enter the thermosphere. Because of the heat caused by friction with molecules in the atmosphere, most meteoroids burn up. A meteoroid falling through Earth's atmosphere is called a meteor. Draw and label a meteor.

Cards for Day 2 - Leggo my Ozone - Make two sets of cards.

Shout "Air Pollution Action Day"	**Shout "Air Pollution Action Day"**
Driving a car that gets poor gas mileage.	**Riding your bike whenever possible for transportation.**
Leaving your car running when you stop at a friend's house or when running an errand.	**Using public transportation (buses or trains).**
Using gas-powered tools when hand tools will do.	**Sharing rides when going to the same place.**
Leaving cans or jars of paint, stains, glues or other solvents and chemicals open to evaporate.	**Insulating your house to save energy.**

Cards for Day 2 - Leggo my Ozone - Make two sets of cards.

Using an air conditioner that cools with freon gas containing CFCs.	**Inventing a type of styrofoam that does not contain CFCs.**
Disposing of a CFC-cooled refrigerator.	**Using CFC styrofoam peanuts to fill packages.**
Buying an air conditioner that cools with ammonia or some other non-CFC coolant.	**Avoiding fast-food that comes in CFC packaging.**
Buying and using a spray can labeled CFC-free.	**Using lighter fluid to start a barbecue.**

Playing with Food...Waste

Subject: Language Arts
Science
Social Studies

Skills:
- Analyzing
- Problem Solving

Concepts:
1. G
2. F, G
3. H
4. L, M

Objectives: Students will:
1) recognize there are costs associated with pollution remedies.

2) analyze and compare their values regarding pollution issues.

State Standards:
English Language Arts: 2.B.2 a
Science: 12.E.2 c, 13.B.2 d,f
Social Science: 15.B.2 c

Vocabulary:
- composting
- incineration
- landfilling
- non-hazardous solid waste
- recycling
- reusing
- source reduction

Setting: Indoor

Materials:
- six copies of the "Playing with Food...Waste" script (p. 46)

Time: One class period

Activity Overview

Students analyze a pollution issue dealing with the trash generated by a school cafeteria, and consider the obstacles to reducing the amount of trash and food waste.

Background

In general, there are six possible ways of dealing with **non-hazardous solid waste**. These are listed in the order that they should be considered:

- **source reduction** (limiting the amount of waste produced by an activity or not creating waste in the first place);
- **reusing** (using the waste materials over and over, or using them for another purpose);
- **recycling** (breaking the waste down into basic substances which can then be remade into other items);
- **composting** (the process of breaking down organic materials, such as fruit, vegetables, grass clippings or leaves, to be used as fertilizer for plant growth);
- **landfilling** (burying waste materials);
- **incineration** (burning waste).

Each of these options generally has some kind of cost associated with it. Incineration can result in additional air pollution, and still leaves behind residue which must be landfilled. Recycling requires energy and may produce wastes, depending on the process. Even composting has an associated cost in that it requires energy and land to maintain the decomposition process.

This does not mean that these are poor options or that they should never be used. There may be situations when each is the preferred means of handling waste. However, there is no simple formula for determining which method to choose. The choice will depend upon technology, economics, local conditions, and values. For example, one community may determine that landfilling is too risky because of frequent flooding, and may instead choose incineration or shipping its waste to another county's landfill. Another community may have ordinances against composting for fear of attracting potentially

dangerous animals or due to the fear of unpleasant odors. A poor community may choose whichever option is cheapest so that it can put more of its resources into health care or education.

Preparation

1. Make six copies of the story so that each of the volunteers has one to read.

Procedures

1. Ask students if they understand the concept of cost. Explain that when speaking of pollution, it refers not only to money, but also to the amount of water, electricity, space, or time that a process may require.

2. Explain the six methods of dealing with municipal solid waste. Make sure that they understand how they differ and what is involved with each.

3. Tell the class that they are going to hear a story about choices and decisions. Tell them that they will have to explain which decisions they agreed with, and why, following the activity.

4. Ask for six volunteers and have them read the story.

5. Have the students break into groups of four or five. Tell them that each group is to discuss the story and answer the following questions:

- Why were the students concerned about the amount of waste?
- What were the choices for dealing with the waste issue at school?
- What were the benefits of each one?
- What were the drawbacks or costs of each one?
- Which option do you feel is the best one?
- If your preferred option cannot be approved, what would be your group's second choice?
- What would your group definitely not choose?
- Can you think of any options that the school did not consider?

Remind the students that there is no right or wrong answers, but that they must be prepared to defend their choices.

6. While the groups are working, draw a chart on the board with seven rows and four columns. In the top row, write "Choice," "Benefit," "Cost" and "Rank."

7. After the groups have finished their discussions, have everybody get together and discuss their findings. Ask the class to name the different options, and write them on the board in the column labelled "Choice." (They should name: cloth napkins, reusable trays, recyclable trays, milk canisters, composting, and 'do nothing.') Ask each group to report on their discussion. Under "Rank" assign 1, 2, and 0 to the choices the groups recommend, with 0 being the options the groups would not choose.

8. Allow the class to discuss any disagreements and note any patterns in how they voted. If there are serious disagreements, ask the students to brainstorm how they might try to come to a common decision.

Wrap Up

Assessment

• Ask the students to consider what would have to happen for the list of choices to change. (Answers could include: new recycling ability in area, the landfill closing, etc.)

• Ask the students if there were any options that the students did not discuss, such as having students bring their own napkins, or requiring students to take their own trash home with them.

Extensions

Community

• Have the students arrange to weigh the amount of waste produced in their cafeteria during a typical day. Establish this as the school's baseline. Then, schedule a "waste-free lunch," where the goal is to have no waste produced in the cafeteria at all. (This will require coordination with parents, students and others.) Have students come up with ideas for minimizing their waste for this one day. They can also make the day a competition with another school, a nursing home, or a local business.

Multidisciplinary

• Have the students research how other cultures and civilizations deal or dealt with their waste: what they reused or recycled, how they disposed of it. Have them consider other contemporary cultures as well as historical ones.

Outdoor

• Identify an area on or near the school grounds where the students can construct a compost bin. Have them construct a simple design. Use the compost pile to experiment with the length of time it takes for different substances to decompose. Additionally, have students analyze the critter content of the bin to determine which microorganisms are aiding in the decomposition process.

Technology

• Identify a local business or industry that has a state-of-the-art recycling process or has been successful in reducing waste production. Arrange for a field trip to their site, or invite a guest speaker to give a presentation explaining how their program works, what technology is involved, and any plans for future improvements.

Resources

• *Environmental Education Holdings*
The EPA Region 5 library contains a variety of environmental education materials to assist teachers in the classroom. For a listing of these materials, visit online at: www.epa.gov/region5/library/collection/enved.htm

• *IEPA Bureau of Land, Landfill Capacity Report*
The site contains the annual report on the status of sanitary landfill space. www.epa.state.il.us/land/landfill-capacity/index.html

• *IEPA, Bureau of Land - Waste Management Programs*
Information is provided regarding household hazardous waste collections, used tire management, waste management requirements and open dump reporting. www.epa.state.il.us/land/waste-mgmt

• *DCEO's Vermicomposting Kit: EEEK! There's a Worm In My Room*
Contains lesson plans, a video and all the information you would need to know about setting up a vermicomposting (food composting with worms) bin of your own! (Free Rental!) To reserve an educational kit, contact Brett Ivers at DCEO, Recycling Unit, 217-524-5859 or brett.ivers@illinois.gov. www.istep.org

• *DCEO's The Case for Investigating the 4Rs:* (Grades K-adult) contains videos, lesson plans, and a variety of products made from recycled materials. (Free Rental!) To reserve an education kit, contact Rebecca Enrietto at DCEO, Recycling Unit, 217-785-7440 or rebecca.enrietto@illinois.gov. www.istep.org

Adapted From: "Case of the School Cafeteria" Energy, Economics and the Environment. Indiana Department of Education. Indianapolis, IN. 1994.

Story: Playing with Food...Waste

NARRATOR: Dean and Marlene had been through a discussion of solid waste just before lunch. As they sat in the cafeteria, they both noticed how much trash was being put into the waste baskets, just in the cafeteria alone.

DEAN: Look at that. I can't believe how full the cans are getting! Look how much we're throwing away!

MARLENE: Well, what do you expect? Everything here is disposable. The trays get thrown out, the forks and spoons are plastic, the napkins are paper. I hadn't noticed it before, but we don't reuse anything here.

DEAN: Yeah, but it's not just us. Doug brought his lunch, and he threw most of it away -the paper bag, the plastic bag his sandwich was in, and the celery sticks he never eats.

MARLENE: You'd think if they at least gave us reusable trays and silverware, we could do a lot better.

NARRATOR: Then Ahmed, who was sitting nearby, overheard their conversation and chimed in.

AHMED: Unfortunately, it's cheaper right now for them to buy things that are disposable. If they were going to wash everything, they'd have to buy dishwashers, pay people to load and unload them, and pay the cost of the water and soaps.

DEAN: And, more than likely, people would steal or lose some of the silverware, so they'd have to replace it from time to time.

AHMED: So they might have to raise the costs of the lunches here to cover the extra expense.

NARRATOR: Marlene was looking intently at the lunch tray.

MARLENE: You know, why can't they just recycle these? We recycle other plastics at home.

AHMED: I don't think this is one of the types of plastic we can recycle around here. They might have to send it a long way off to be recycled. That may not be worth the fuel it takes to transport it.

MARLENE: Then why can't they start getting trays made of recyclable plastic?

NARRATOR: Denise also overheard part of the conversation and joined in at this point.

DENISE: You know, there's something else, too. At my sister's college dorm, they have a cafeteria too. But they have big dispensers of milk instead of these little cartons. People can just line up and take as much milk as they need. And they don't have to throw away all the cartons—they just wash the cups afterward.

AHMED: Yeah, but you still need to have dishwashers.

MARLENE: Besides, you know how slowly the lines move around here. If we had to wait for people to pour themselves a glass of milk, we'd be here all day.

DENISE: So? Wouldn't it be worth it to have less litter thrown away?

MARLENE: I don't think that's the problem. Look how much food gets thrown away here. Most of this stuff could be composted.

DEAN: Why don't we ask if we can put a can or a bucket out for people to put in all the things we can compost? They did that at a camp I went to for a week.

AHMED: Yeah, and then the school could have its own compost pile.

MS. WINTHROP: Not so fast, kids, it's not that easy.

NARRATOR: It was Ms. Winthrop, the principal.

MS WINTHROP: Those are all good ideas, but you're forgetting a few steps.

DENISE: Like what?

MS. WINTHROP: Well, a lot of the food here can't go in a compost bin. You can't put in milk or meats, for instance. If any of those got into the compost bucket by mistake, because somebody wasn't paying attention or just felt like being a snot, everything in the bucket would have to be thrown out. Unless one of you wants to pick through it and sort it out...?

DEAN: Ugh, no, I think I'll pass on that.

MS WINTHROP: Besides, we don't have a good spot for a compost pile here. Our school is pretty cramped. I think the only place that we could put a compost pile would be on the south wall, right outside of your classroom window.

AHMED: That might be a problem on hot days.

MS WINTHROP: Plus, I'd need someone to turn the pile, someone would have to be responsible for taking the food wastes out after every lunch.

MARLENE: I can't believe there's nothing we can do.

MS. WINTHROP: I'm not saying you can't do something, I'm saying you have to recognize that there will be a cost. It could be more expensive lunches, longer lines, later dismissal times because lunch runs over, less room for playgrounds if we make a compost pile, detergents in the water. Are any of these worth it to you?

DENISE: But, wait, there's a cost to doing nothing, also. These paper napkins come from somewhere, and all this paper that gets thrown out is paper we can't use for other things. Besides, as it is the school pays for someone to bring new napkins, trays, and milk cartons every week, and pays someone to take all this trash away. And I know that our landfill isn't going to last forever. I know because they're already talking about using the land across from my house as a landfill when the one we're using can't take any more.

AHMED: So what do we want to do?

On Illinois Pond

Subject: Language Arts
Science
Social Studies

Skills:
- Public Speaking
- Problem Solving
- Planning
- Comparing/ Contrasting

Concepts: 2. C, D, E, H, I
3. A
4. H, I, J

Objectives: Students will:
1) understand that different land uses can affect the types of pollution in a given area.

2) recognize that people have different and sometimes conflicting interests in how land is used.

State Standards:
English Language Arts: 4.B.2 b, 5.C.2 b
Science: 13.B.2 f
Social Science: 14.D.2, 15.B.2 c, 17.C.2 b,c

Vocabulary: • water pollution • watershed • wetlands

Setting: Indoor

Materials:
- scissors • tape
- copies of the pond map (p. 51) and the town parts sheet (p. 52) for each team
- one sheet of 18X24 paper for each team

Time: One class period

Activity Overview

Students take part in a role playing exercise in order to understand the interests of different groups and different causes of pollution in a land development issue.

Background

Every human use of land affects wildlife habitat, positively or negatively. What humans do with land is a reflection of their priorities, lifestyles, and options. Some people see undeveloped areas of land as little more than raw material, a type of supermarket from which humans can take resources for their own use. Others believe that natural areas are to be preserved without regard to human needs. Some see the land as a treasure which must be cared for with a spirit of stewardship; still others try to strike a balance between economic development and habitat protection. Well-meaning people can have strong differences of opinion on how land should be developed, and even on the question of whether land should be developed at all.

Wetlands provide a good example of how different positions on growth can be. Human involvement with wetlands can be disastrous for the animals and plants that rely on this habitat. Wetland habitats are home to many species of fish, birds, frogs, insects, and plants. They play an important role in supporting migratory species and assisting in flood prevention. Their importance, however, has not always been appreciated. Historically, swamps were often drained to provide land for building or agriculture. While this continues today, wetlands are also affected by pollution and disruption in the flow of water.

Issues dealing with **water pollution** frequently result from disputes over land use. Even a parcel of land that seems far from any body of water is part of a **watershed**. A watershed is composed of all the land that drains into a river, stream or pond. How pollution gets into water depends on where the polluting source is located on the watershed, how it is structured, and how many stresses the body of water must endure at once. For that reason, land use issues may also be water pollution issues.

Preparation

1. Prepare copies of the two student worksheets (the Illinois Pond map and the land use cutouts).

2. Write the names of each of the interest groups on small pieces of paper (see procedure #3, below). Place them in a hat, box, or some other container that students can reach into without seeing the contents.

Procedures

1. Review the concept of watersheds with the students. Explain that wetlands are part of a watershed, and discuss some of their functions and benefits. Ask them to name some of the kinds of organisms that rely on wetlands for survival.

2. Hand out copies of the Illinois Pond map (p. 51). Explain to students that there are several industries and groups that are interested in developing the area, and that they will have to make some decisions about how the land is going to be used. Their overall goal will be to arrange the development in such a way as to minimize the impact on the pond.

3. Divide the class into five to seven groups, with three to five people in each. Have one person from each group pick the name of an interest group from the box or container. The interest groups should include some of the following:

- Homeowners - want to live in the area and have a good school.
- Farmers - want to use the land to raise food and livestock.
- Business Interests - want to use the land for business.
- Gas Station Owner - wants to make a living servicing the cars of residents and business people.
- Parks Department Personnel - want people to have a place for recreation.
- Hunters and Birdwatchers - want the land to be a habitat for migratory birds.
- Highway Department Personnel - want to maintain access to the area.
- Bleach Factory Personnel - want to preserve jobs and commerce.

Other interest groups can be added as well.

4. Pass out the town parts sheet and 18" X 24" paper to each group. Have them cut out the land use pieces and the diagram of the pond and the wetland. Instruct them to paste the pond onto the center of the larger sheet of paper. Tell them that they will need to find a way to put all of the land use pieces on the same piece of paper. The different cards may touch, but not overlap. Farm and parkland can be cut into smaller pieces, but all others must remain the original size. Tell them that they will have to decide what goes where based on the identity and interests of the special interest group.

5. Before they begin, have the class list the benefits of each of the land use items, along with the possible pollutants it will create. Record the answers on the chalkboard.

6. Give students most of a class period to come up with their solutions. Have them tape or paste their land-use cards to the 18" X 24" paper so that the sheets can be held up for class view.

7. Have each interest group report to the class on what they did. Remind them to be prepared to defend their placement of different items. Give other groups the chance to question and challenge the proposals. However, remind the students that they must remain in character, and they must be able to explain their comments in terms of what their interest group would want.

8. During the presentations, focus the discussions on how the land use will affect the pond, and on what types of pollution the different options will create. What are some possible consequences of this type of pollution?

9. With the groups still in character, ask them to try to agree on a plan that suits everybody. Remind the students in advance that several people, if not everybody, will have to compromise to accomplish this goal.

10. Attempt to end the activity on a positive note, thinking about solutions. Are there things that the land developers can do to minimize the pollution risks from their land use? If so, what?

Wrap Up

Assessment

Have each student write a composition stating what their character in the role play heard the other interest groups say and how their arguments were viewed.

Extensions

Community

• Learn more about environmental impact statements. Obtain an actual copy of statements prepared for your local area, if available. Identify the concerns that are addressed and discuss these with students.

Multidisciplinary

• Draw an additional version of the map showing the larger watershed, where water comes from and where it goes from the pond. Does this view change the options that are available?

Outdoor

• Trace any stream or river system that passes through your community from its source to its final entrance into the ocean. List all the sites that you can identify where the quality of the water might be lowered.

Technology

• Using the Internet or the World Wide Web, collect articles about local or state water related or land use issues.

Resources

• *Aquatic Illinois*
This CD-ROM contains lessons and activities on wetlands, rivers and streams, ponds and lakes, surface and groundwater, exotic species, aquatic history, water as resource and watersheds.

For more information and access to the CD-ROM please contact The Illinois Department of Natural Resources at (217) 524-4126 / e-mail: dnr.teachkids@illinois.gov, or visit http://www.dnr.state.il.us/lands/education/classrm/kits.htm to access online (pdf).

For an online order form for DNR's educational materials, visit http://www.dnr.state.il.us/lands/education/index.htm

• *Getting to Know Your Local Watershed*
Provides overview information on "What is a watershed?" Explains different sources of pollution that affect watersheds, and uses of watersheds' natural resources. To order call 765-494-9555 or view online at http://lanshark.ctic.purdue.edu/KYW/Brochures/GetToKnow.html.

• *Lake Notes - Determining Your Lake's Watershed*
Explains watershed boundaries and gives helpful information on reading watershed maps. IEPA (see order form in appendix)

• *Water Quality: Potential Sources of Pollution, Middle School Edition*
This 24" x 36" color poster depicts point and nonpoint sources of pollution. The reverse side contains two activities, Dispersion of Nonpoint Pollutants and How Substances Are Measured in Water. Available online at: http://water.usgs.gov/outreach/OutReach.html

• *Groundwater and Land Use in the Water Cycle*
This 24" X 36" color poster graphically displays various land use practices and geologic formations. Order online at: http://www.dnr.state.wi.us/education/

• *Water Where You Live*
Click on the state you're interested in, and find out all about the streams, rivers, and lakes. You can even find out about the beaches. www.epa.gov/OW/states.html

• *Wetland Teaching Kit*
This teaching kit was developed by the Illinois State Museum for teachers of grades fifth through eighth. It is available for lending at no charge. The resources and activities in the kit include soil and freshwater study sets, a variety of posters, original video and audio cassettes featuring songs and stories on Illinois wetlands, field guides, and activity sets. For information on borrowing "The Wetland Teaching Kit" please visit the following web link for a lending site near you: www.museum.state.il.us/ed_opp/wetland-kit.html

• *Illinois State Water Survey*
Provides a wealth of information regarding Illinois water and atmosphere. www.sws.uiuc.edu

• *Wetlands, Oceans and Watersheds*
Provides information on watersheds, different types of waterbodies and how to protect our resources. www.epa.gov/owow

• *The Water Sourcebooks*
This activity guide contains numerous activities about the water management cycle and how it affects all aspects of the environment. It is available in four sections: K-2, 3-5, 6-8 and 9-12, and each section consists of five chapters: Introduction to Water, Drinking Water and Wastewater Treatment, Surface Water Resources, Ground Water Resources, and Wetlands and Coastal Waters. www.epa.gov/safewater/kids/wsb/index.html

• *Lake Education Assistance Program (LEAP)*
The Illinois EPA offers a $500 grant available to all Illinois schools and not-for-profit organizations for the study of lakes/ponds and their watersheds. This money can be used to purchase lake-related educational materials, field trips, equipment and activities. Application deadlines are September 30 and January 31. www.epa.state.il.us/water/conservation-2000/leap.html. 217-782-3362

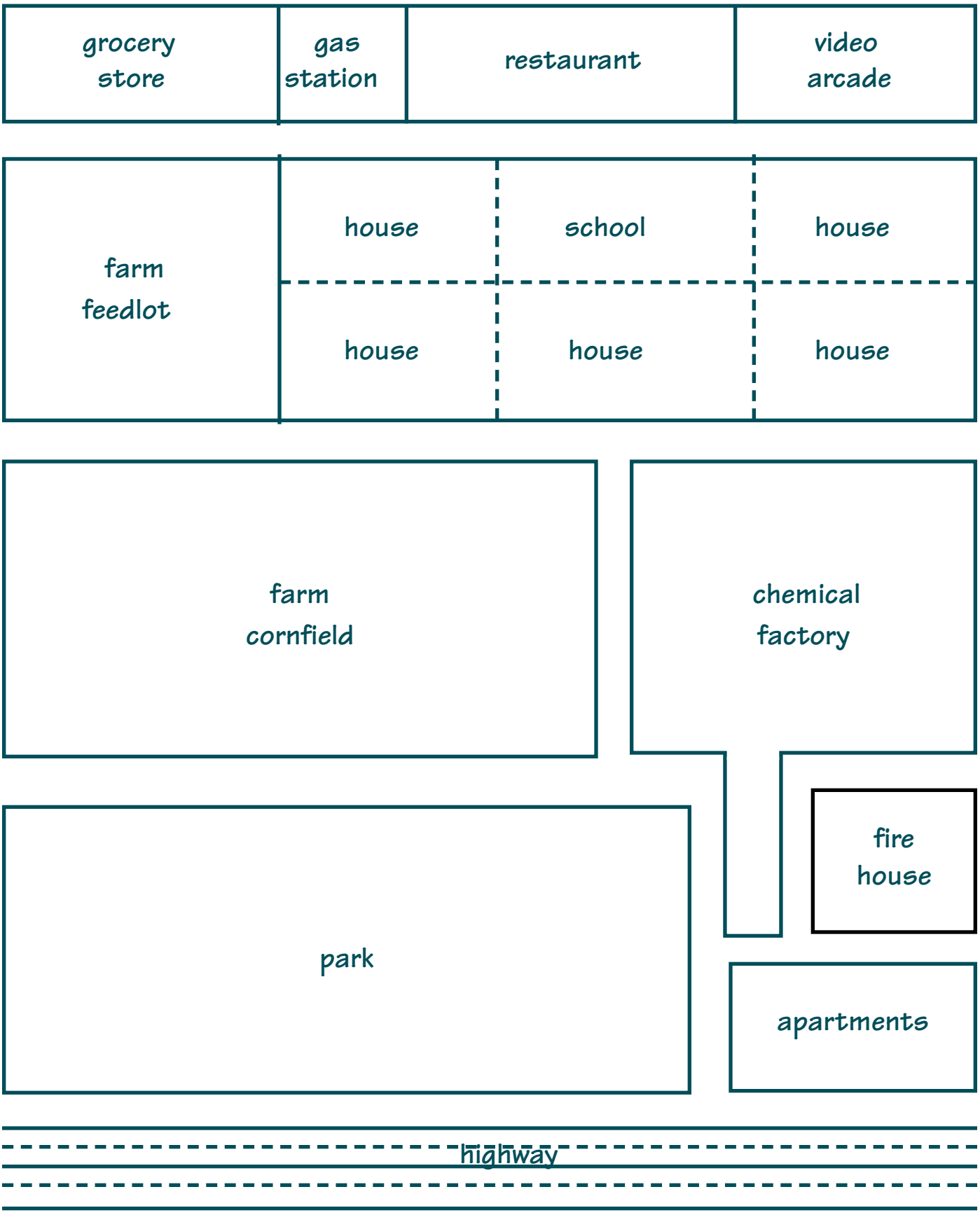
• *Educating Young People About Water*
This Wisconsin-based web site offers guides and a water curricula database to assist you in tailoring your specific water education needs. www.uwex.edu/erc/eypaw

• *The Electronic Naturalist*
This free electronic newsletter is a weekly educational series that provides information on animals, plants and environmental issues. www.enaturalist.org

• *(GHQV / RVW DQG) RXQG*
The Chicago segment of *(GHQV / RVW DQG) RXQG* showcases determined, ordinary Illinois citizens, as well as professionals and government officials, who developed innovative "best practices" that address the widespread problems facing many of America's urban environments. These "best practices" can be adapted in any size community. For this reason the Illinois Sustainable Education Project (ISTEP) is providing a DVD (Chicago, "City of Big Shoulders") to Illinois educators and community leaders wishing to promote an integrated approach to restoring and supporting the environment at a local level with broad-based community participation, and to use as an educational resource in the classroom. For more information about Edens Lost and Found, contact Brett Ivers at DCEO, Recycling Unit, 217-524-5859 or brett.ivers@illinois.gov.

Adapted From: "Dragonfly Pond," Project WILD Aquatic. Western Regional Environmental Education Council. Bethesda, MD. 1992.

Town Parts Sheet



3 What Kind of Pollution Issues Affect Illinois?

OVERVIEW

Earth's Closed System Revisited

It is easy for people to think that what we do does not affect other people or the world around us. However, much of what we do consumes energy or resources, and much of it does or can produce pollution.

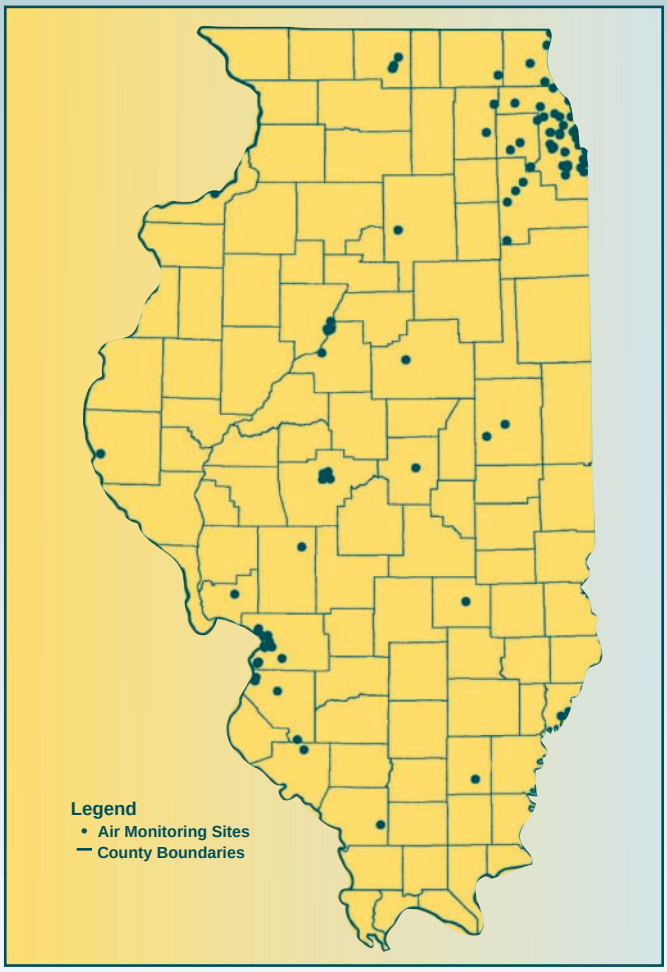
When you are at home and turn on the TV or the computer, or turn up the heat or the air conditioning, you are using energy - electricity, gas, or oil. When you eat a handful of french fries from a fast food restaurant, you benefit from the work of farmers who raised the potatoes, the industries that made the packaging, and the truckers who transported them to your town. The farmers, industries, restaurants and transporters all used energy.

How people use and produce food, energy and other resources that you enjoy can keep your environment safe and clean—or, they can contribute to making it dirty and polluted. The way that you use these resources can also affect the environment. You decide what to buy, what to repair or recycle, and what to throw away. You can help make the environment cleaner or dirtier, depending on your decisions.

BACKGROUND

Air Quality in Illinois

The IEPA uses air quality monitors to take samples of air throughout Illinois and test them for levels of six pollutants. These six pollutants are: ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. Other pollutants, such as hydrocarbons, are measured too. Each of these pollutants has a safe level that can be in the air. The IEPA issues pollution advisories when the air quality is expected to be unhealthy. Air monitoring in Illinois shows that the Chicago and East St. Louis metropolitan regions do not meet national air quality standards for gound-level ozone (smog), which is formed when oxygen in the air reacts with sunlight in the presence of hydrocarbons and other emissions from industrial, vehicular and other sources. Also, portions of the southern Chicago and western Cook County areas do not meet national air quality standards for particulate matter.



Particulate matter is small solid particles produced by several types of sources including power plants, wood burning stoves, leaf burning, automobile exhausts, incinerators, rock quarries, coal processing plants, farming and roadways. Particulate matter can bother people with respiratory diseases such as asthma, and may irritate the eyes.

Carbon monoxide is a colorless, odorless, poisonous gas from the incomplete burning of fossil fuels such as coal, oil and gas. Carbon monoxide is produced chiefly by automobiles but also by power plants and other sources. When a person inhales carbon monoxide, the supply of oxygen to the body is reduced; this can cause vision problems and headaches. Exposure to large amounts of carbon monoxide can stress the heart, affect the brain, and even cause death.

Overall, the quality of air in Illinois is improving each year. The IEPA continues to work to change and improve the methods of testing and controlling air pollution in Illinois, so that the air we breathe is clean.

Nitrogen dioxide is released into the air from burning fossil fuels at high temperatures. Some nitrogen dioxide occurs naturally in the soil and atmosphere. High levels of nitrogen dioxide can strain the heart and respiratory system and increase the chances for breathing problems and illness.

Sulfur dioxide is formed when fossil fuels and other substances that contain sulfur are burned. Major sources of sulfur dioxide emissions are factories and power plants that burn coal and other fossil fuels. Many people experience eye, nose and lung problems when they are exposed to high sulfur dioxide levels.

Perhaps the greatest success story in reducing air pollution concerns lead. Lead is classified as a heavy metal. Very small particles of lead can be found in the air we breathe, in the water we drink, in the food we eat, and in some soils. Once taken into the body, it tends to remain there. Lead in the air comes primarily from the burning of leaded gasoline, from iron smelters (places where ore is melted to separate metal) and from car battery manufacturing plants. Health effects related to lead poisoning (especially in young children) include brain damage, muscle cramping, and anemia. Since a law was passed in 1975 that required cars and trucks to use only unleaded fuel, the amount of lead in air has decreased by 85 percent.

Water Quality in Illinois

Illinois is rich in surface water resources with approximately 900 rivers and streams having an estimated total of 87,110 stream miles and 91,400 inland lakes and ponds, 3,256 of which have a surface area of six acres or more. About three-fourths of Illinois inland lakes are man-made. The state is bordered by three major rivers, the Mississippi to the west, and the Ohio and Wabash to the southeast. The other large rivers in Illinois include the Rock, Fox, Des Plaines, Kankakee, Illinois, Sangamon, Kaskaskia and Big Muddy.

Nearly one million acres of Lake Michigan stretch along Illinois' northeastern border. Lake Michigan is the third largest of the Great Lakes and is the largest body of freshwater entirely within the United States (portions of the other four Great Lakes are on the U.S.-Canada border).

The majority of Illinois' lakes are artificial. Illinois lakes serve many purposes such as providing drinking water, flood control, industrial plant cooling water, fish and wildlife habitat, and opportunities for fishing and boating.

River and stream water quality in Illinois has improved considerably since 1972. (In 1972, the **Clean Water Act** was passed to protect the water in the United States.) The number of rivers and streams with poor quality has declined, while the number of rivers and streams with good water quality has increased. Water is tested at more than 3,000 monitoring stations throughout Illinois to determine water quality conditions.

Most of the pollution that enters Illinois rivers and streams comes from nonpoint sources (pollution that cannot be traced to one source). The common nonpoint source pollutants come from:

• habitat change (removing plants such as trees from stream banks or changing the course of a river or stream),
• runoff (oil, chemicals, soil and other pollutants that are washed from streets, parking lots and driveways) and
• resource extraction (removing resources such as coal from the land). The other major causes of pollution in Illinois rivers and streams are point sources. These are pollutants discharged from a pipe such as from a factory or waste-water treatment plant, or some other identifiable source.

Portions of the DesPlaines, Sangamon, Illinois, and Mississippi rivers contain fish whose flesh contains high levels of pollutants. Fish consumption advisories have been issued for parts of these rivers. A fish consumption advisory identifies species of fish within certain bodies of water that contain enough contamination that the public should limit the amounts they eat, or in some cases, not eat them at all.

The IEPA and the city of Chicago monitor (test) Lake Michigan's water quality. Information from Lake Michigan water testing has shown that the water quality of Illinois' portion of Lake Michigan has improved over the last 20 years. For example, the amount of pollutants such as phosphates and ammonia has declined. Phosphates and ammonia are found in sewage, industrial waste, and runoff from agricultural fields. In general, Lake Michigan water quality conditions are good.

Most of the pollution in lakes consists of sediments and nutrients that wash into lakes. Lakes function as traps or sinks for pollutants from watersheds (the area drained by a river or river system). The water in polluted lakes may have bad taste and odor, be overgrown with aquatic plants and/or look dark brown or green. The water quality problems in lakes limit the use of the lake for fishing, boating and swimming, and affect the aquatic life. If the lake is filling in with sediment, its life will be shortened. Those lakes showing improvement are part of special restoration projects to reduce the amount of pollution that reaches them.

Contaminant levels in fish are monitored through a cooperative effort between the Illinois Departments of Agriculture, Natural Resources, Nuclear Safety, Public Health and the Illinois EPA, which is commonly referred to as the "Fish Contaminant Monitoring Program." Meal advisories are issued when fish are found with elevated levels of contaminants, such as chlordane, methylmercury and polychlorinated biphenyls (PCBs). In 2005, the methylmercury advisory applied to predator fish, which includes all species of black bass (largemouth, smallmouth and spotted), striped bass, white bass, hybrid striped bass, walleye, sauger, saugeye, flathead catfish, muskellunge and northern pike – IN ALL ILLINOIS WATERS. Current Illinois fish

Land Cover in Illinois

27.5 million acres	agricultural land (crops, such as corn and soybeans, and rural grassland)
4.1 million acres	forested land (upland, partial canopy and coniferous)
2.3 million acres	urban and built-up land
1.4 million acres	wetlands
0.7 million acres	other (surface water, and barren and exposed land)
36 millions acres	

Source: The Illinois Interagency Landscape Classification Project, Land Cover of Illinois 1999-2000.

advisories can be viewed on IDPH's web site at http://www.idph.state.il.us/envhealth/factsheets/fishadv.htm.

The northeastern portion of Illinois' border is formed by 63 miles of the shoreline of Lake Michigan. The lake provides drinking water for Chicago, as well as many of its suburbs. Fifty miles of Illinois shoreline are suitable for swimming.

There are pollutants which are found attached to sediments in several Illinois harbors on Lake Michigan. These include such pollutants as polychlorinated biphenyls (PCBs). For example, sediments in Waukegan Harbor were found to be contaminated with PCBs. As a result, a cleanup project was done to remove nearly one million pounds of contaminated sediments. Pollutants such as PCBs are also found in Lake Michigan fish. These pollutants bioaccumulate in fish, which means that older and larger fish tend to have higher levels of pollutants.

More than four million people in Illinois use groundwater as a source of drinking water. Approximately 400,000 residents in the state are served by their own private wells. Seventy percent of Community Water Supply (CWS) systems in the state withdraw water from confined aquifers that have natural geologic protection from surface and near-surface activities. This means the remaining 30 percent of the communities withdraw water from unconfined aquifers that are susceptible to pollution from land use and other surface activities.

Groundwater quality is a major concern in Illinois. Water quality degradation or contamination results from point and nonpoint sources throughout the state. In many industrialized areas, including the metropolitan areas of Chicago, Rockford, and St. Louis, groundwater has been degraded by improper storage or disposal of chemicals. In many agricultural areas, the quality of groundwater in shallow aquifers has been reduced by the routine application of agricultural chemicals. Nearly 10 percent of the CWS wells in the state are estimated to have water quality which is either susceptible to pollution, or of poor quality, as a result of impacts by agricultural runoff. Approximately 22 percent of the CWS wells using unconfined aquifers and 2 percent of the CWS wells using confined aquifers have been affected.

Land Quality in Illinois

Illinois contains 56,349 square miles. (just over 36 million acres). This includes land and water surface areas within its boundaries. There are currently 27.5 million acres of rural land. In 1996, 21.6 million of the rural acres were cultivated for agricultural purposes. Forested land makes up about four million acres of land within Illinois. Urban areas and transportation routes (highways and railroads) cover 2.3 million acres of Illinois. The remainder of the land in Illinois is wetlands, rivers and lakes, and barren and exposed land.

Before 1970, pollution control efforts were directed only toward the most extreme violations of the state's public health laws. Since its establishment in 1970, the IEPA has made excellent progress in closing open dumps (not the same as legal landfills) and managing solid and hazardous waste.

One of the biggest problems in rural areas is erosion of soil. About 17 percent of our rural land (roughly four million acres) needs some form of treatment to control soil erosion. Overall, Illinois is losing approximately 57 million tons of soil each year due to erosion. The goal in Illinois is to reduce soil erosion until all agricultural land is at tolerable soil loss levels. Tolerable soil loss is the amount of soil that can be lost while retaining the productive capacity of the soil for an indefinite period of time.

In Illinois, a total of 16.2 million tons of municipal waste was generated and 6 million tons of waste was recycled in 2003. According to the Illinois Recycling Association, the average American will throw away 600 times his or her adult weight in garbage in a lifetime. Thus creating as much as 100,000 pounds of trash for his or her children.

Land quality in Illinois can be affected by many things. Our national throwaway society discarded 231.9 million tons of municipal solid waste, or garbage, in 2000. Homes, industry, businesses, government and schools all contribute to this growing waste problem.

In our state, 1.1 million tons of hazardous waste is generated annually. In 2002, 4,772 drums of hazardous waste were collected from 24,134 Illinois households. These hazardous wastes present a special challenge. To protect the environment and the public's health, cleanups are needed at thousands of properties contaminated with petroleum products (gas, oil, etc.) from leaking underground storage tanks.

Due to stronger state and federal environmental regulations, the number of solid waste landfills in Illinois declined from 146 in 1987 to 58 in 1999, a 60 percent decline. This will result in fewer, larger landfills to handle the disposal of waste. How we manage the waste we generate has a direct effect on our quality of life and the land we depend on.

What's Blowin' in the Air

Subject: Mathematics
Science

Skills:
- Analyzing
- Comparing / Contrasting
- Drawing Conclusions
- Collecting
- Hypothesizing

Concepts: 1. C, J, L, R
2. I
3. A , F

Objectives: Students will:
1) analyze collected particles and draw conclusions about them.

2) identify areas of the school where air pollution might be a problem.

State Standards:
Mathematics: 10.B.2 c
Science: 13.A.2 b,c

Vocabulary:
- parts per million (ppm)

Setting: Indoor & Outdoor

Materials:
- class tally sheet
- graph paper
- scissors
- pencils
- tape
- student air particle worksheet (p. 62)
- hand lenses
- microscope (optional)

Time: Two class periods one week apart

Activity Overview

Students collect particulate matter from the air at different locations around the school and analyze particles collected.

Background

Air pollution is any visible or invisible gas or particle which is not part of the natural composition of air. Natural air pollution, such as pollen, natural fires, and smoke and gases from volcanoes, has existed for millions of years. Since the 1800s, pollution caused by humans has become a concern.

Solid particles of soot and dust are sometimes in the air we breathe. They are called particulate matter. These particles come from burning fuel and leaves, construction projects, harvesting crops such as corn and soybeans, and from natural sources such as volcanoes and forest fires. Eventually, these particles can be inhaled by people and other animals, fall into the water, or settle on the surface of buildings or cars as dust or grime.

Since these particles and gases can be harmful to humans and other animals, many communities have programs in place to monitor air quality. The amount of particulate matter in air (measured in ppm, or **parts per million**) will vary depending on many factors including wind, precipitation, and the amount of fossil fuel being burned. Monitoring consists of examining samples of the air to determine if there is enough pollution in it at any given time to be dangerous. In many areas, monitoring helps officials warn the public prior to the air becoming harmful, and thus is an important public health tool.

What is One Part Per Million?

One part per million is:
- **one second in 12 days of your life;**
- **one penny in $10,000;**
- **one inch in 16 miles.**

Preparation

1. Explain to fellow faculty and staff, in particular janitorial staff, that your class will be conducting a scientific experiment. Ask them please to not disturb the monitoring devices.

2. Prepare a class tally chart, like the one shown below, on a chalkboard or overhead.

Team	Location	Particle Average	Types of Particles

Procedure

1. Explain to the students that they will be conducting an experiment to measure air quality within their school.

2. Focus the students by discussing the following air pollution questions:
   - What is air pollution?
   - What do you know about air pollution?
   - How do we know air pollution exists? Are air pollutants visible or invisible?
   - What is air pollution made of? (Help students understand that there are many kinds of air pollution, including different gases and particulate matter.)
   - What are some sources of air pollution?
   - Where in the school might you find more or less pollution?
   - What ideas do you have about how the class can monitor or look for signs of pollution?

3. Ask students if they think there are particles in the classroom air right now. Do they think those particles are visible or invisible? Both answers are correct, but the class will be focusing on those particles in air that are visible. To demonstrate this, darken the room so no light is seen and turn on a very bright light, like that from a slide projector or a very bright flashlight. Ask students to look through the beam of light and see if they notice dust or lint particles floating though the air.

4. Explain that the students will be monitoring the air around the school for particulate pollution, and that they will be constructing scientific monitoring devices. Ask students for their ideas on where to put pollution monitors so that they won't be disturbed by people or weather for a week. List possible locations on the board.

5. Group students in pairs and give each pair a milk jug cap or similar circular item about an inch in diameter, a piece of graph paper, and a Student Air Particle Worksheet. Pairs should choose a location to place their monitor. Have them fill out the Hypothesis portion of the worksheet, explaining what kinds of particles they expect to find at the location they have chosen, and why. The teacher should make a model in front of the class, explaining each step.

6. Have the students fold the graph paper lengthwise with the lines on the inside of the fold. Have them draw three circles on one of the outside surfaces of the paper using the milk cap, being sure that they leave at least one inch between circles and an inch on each side. Have them unfold the paper and cut out the three circles. Have them fold the paper back; on the side that has not been cut, have the students write their names, the date, and the location they have chosen for their monitoring device, being as specific as possible.

7. On the front side where the circles are cut, have them write **"Scientific Experiment-Do Not Remove"**.

8. Next, have them trace around the inside of the circles they have cut, so that drawn circles appear on the inside flap. Have them open the paper, like a greeting card, and lay it flat.

Distribute clear cellophane tape to each pair. Have them rip off pieces of tape longer than the drawn circles (they may need two strips per circle). Instruct them to have one student hold the strip, adhesive side up, at the edges without touching the tape in the middle of the circle. The other person is to tear off strips of tape and tape the first piece down at the edges, again making sure not to touch or tape over the adhesive in the circle. Repeat for all three circles.

9. Have them tape or staple the card closed. Make sure that the grids of the graph paper are visible through the tape on the circles.

10. The teacher should record the locations that the students have chosen. Allow students to hang or place their monitors in the locations they have chosen. Some may need to tape their monitors to walls or other items; others may need to attach them to coat hangers so that they can hang from pipes or branches without being damaged.

11. Have the students turn in their worksheets to the instructor.

12. The instructor's monitor is not to be placed for monitoring, but is to be kept as a control. Place it in an envelope, box, or other container where it will not be exposed to ambient air.

13. After one week have the students collect their air monitoring devices and bring them to class. As a class, decide what unit of measure to use so that everyone's data can be compared. Discuss why it is important to analyze and report data in common measures.

14. Distribute a hand lens to each pair. Have them count the total number of particles in each square (or whatever unit has been selected). Ask them to list and describe the different types of particles they observe on their graph paper. Particles should differ in shape, color, and size. (You may choose to have students use microscopes instead of or in addition to hand lenses.)

15. Have the students take readings from each of the three circles. Instruct them to draw an average of the number of particles they find, using the Student Air Particle Worksheet. One student will then record their average on the class chart.

As students are working on their worksheets, the instructor should complete one for the control strip as these results will be compared in step 16.

16. Have the pairs complete the last portion of the worksheet, where they compare their results to their hypotheses. Discuss as a class.

17. Discuss the results:
- Were you surprised at your results?
- Did you expect more or less particulate pollution?
- How did your results compare with the control strip?
- What did the particles look like?
- Where do you suppose the particles came from?
- Are there any differences in particles based on where the strips were placed?
- Where were the dirtiest places? Where were the cleanest?
- Why do you think you got the results you did? Was wind a factor? Was there something close by that affected the results?
- Do you think you would have received the same results at different times of the year? Why or why not?

Wrap Up

Assessment

Have students brainstorm a list of possible sources of the air pollution they found. Divide the list into natural and man-made sources. Ask them if they think any of the pollutants are preventable.

Have each student pick a pollution source and develop a way of preventing or reducing the pollution that comes from it. Their results can be in the form of a model or a written paper.

Extensions

Community

• Do the experiment a second time, and have the students take the strips home or to places within the community. Have them do a comparison to the results they had at the school.

Multidisciplinary

• Allow students to design posters to show the steps they took to acquire the data. Create a bulletin board where students can display their posters and monitoring strips so that the class can compare all results.

Technology

• *Daily Air Quality Report*
An air quality index is available online for major air pollutants that are monitored throughout the state.
www.epa.state.il.us/air/aqi.

The Illinois Annual Air Quality Report is also available online at www.epa.state.il.us/air/air-quality-report.

Resources

• *Air Facts - Air Quality Monitoring*
Information on levels of air pollution in Illinois and how they are monitored.
IEPA (see order form in appendix)

• *$LU) DFWV &ULWHULD 3ROOXWDQWV*
A fact sheet on the six criteria air pollutants and how they are regulated and controlled.
IEPA (see order form in appendix)

• *$LU) DFWV 1RQDWWDLQPHQW) DQGQJ 6KRUWRI Air Quality Standards*
A fact sheet on the steps being taken to improve air quality in regions in Illinois that fall below national standards.
IEPA (see order form in appendix)

• *3URMHFW$, 5 ($LU3ROOXWRQ%DFNJURXQG ,QIRUP DWRQ* (PDF Version)
Fact sheet on air pollution and ways to detect and prevent it. www.epa.gov/region01/students/pdfs/rd_airpol.pdf

• *The No Waste Anthology - A Teacher's * XLGH WR (QYLURQP HQWDO3 FWLWLHV .*
Department of Toxic Substance Control Public Education and Information, 1991.

To order, contact: Environmental Education Coordinator D.T.S.C., 1001 I Street, P.O. Box 806, Sacramento, CA 95812-0806. To download online, visit www.dtsc.ca.gov/Education/upload/OEA_FLY_NWA.pdf.

• *Indoor Air Quality (IAQ) Tools for Schools Kit*
This kit is available free of charge. To order call 1-800-483-4318 (document number 402-K-95-001), or visit www.epa.gov/iaq/schools/toolkit.html.

Adapted From: "Air Strips," Environmental Resource Guide. Air Quality Air & Waste Management Association. Pittsburgh, PA. 1991.

Student Air Particle Worksheet

Names: _____ **Location:** _____

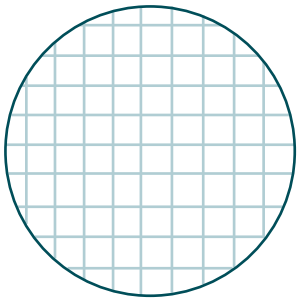
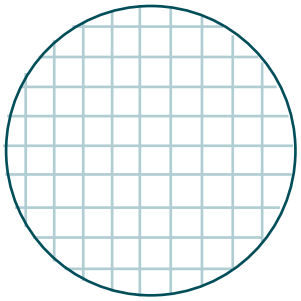
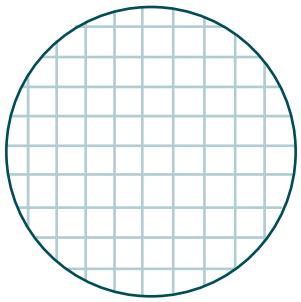
_____ _____

Hypothesis - What types of particles do you think you will collect with your air monitor? Why? _____

_____

_____

_____

Draw the Particles	Number of Particles Found in One Grid Square	Describe the Particles
	☐	_____ _____ _____ _____
	☐	_____ _____ _____ _____
	☐	_____ _____ _____ _____

Add the numbers in the boxes. _____
Divide the total by 3. _____
This is the average number of particles you found.

Conclusion - Was your hypothesis correct? Why or why not?

_____

_____

It's Warm in Here, or Is It?

Subject: Language Arts
Science
Social Studies

Skills:
- Analyzing
- Comparing / Contrasting
- Drawing Conclusions

Concepts: 1. C, F, J,
2. C, F, E, G
3. A, E
4. B

Objectives: Students will:
1) judge the strengths and weaknesses of information.

2) discuss the causes and possible effects of global climate change.

State Standards:
Language Arts: 2.B.2 a
5.B.2 a
Science: 13.B.2 b,c
Social Studies: 17.C.2 b, c

Vocabulary:
- chlorofluorocarbons
- greenhouse gas
- ozone

Setting: Indoor

Materials:
- copies of the scientist position papers for each student (pp. 66 & 67)

Time: One class period

Activity Overview

Students read two differing articles on the concept of global climate change and determine how or if air pollutants may be affecting our climate.

Background

Chlorofluorocarbons (CFCs) or freons were discovered in the 1930s. They are chemical compounds made of chlorine, fluorine and carbon. They are nonreactive, nontoxic, non-caustic, noncorrosive and nonflammable. These properties make CFCs perfect for use as coolants in refrigerators and air conditioners, propellants in aerosol sprays, plastic foam blowing agents (used in making some types of styrofoam) and cleaning solvents used in the electronics industry. But in 1974, scientists discovered that the same stable qualities that make CFCs useful can result in major environmental problems when these gases drift (without breaking down) into the stratosphere.

The stratosphere contains a thin layer of a gas called **ozone**, and forms what we know as the ozone layer. Ozone gas forms when oxygen molecules interact with ultraviolet rays from the sun. Under normal circumstances, the ozone layer varies in thickness since it is continuously being lost and regenerated. The ozone layer is an important protective screen for life on earth, filtering out more than 99 percent of the ultraviolet rays (the ones that can cause skin cancer, immune deficiencies and cataracts) before they can reach the ground.

Environmental problems at a global level may also be caused by so-called **greenhouse gases**, most notably carbon dioxide (CO_2) and methane. The levels of both of these gases in the atmosphere have increased since the beginning of the industrial revolution. These gases absorb and reradiate heat from the earth which would otherwise escape into space. In so doing they perform the functions of a greenhouse. Many scientists believe that their increased presence in the atmosphere is already disrupting climate and weather patterns worldwide. The 1995 Kyoto Protocols attempted to address this concern on an international level. However, some scientists disagree with the predictions of global warming and see recent fluctuations as part of a

natural cycle. Many people feel more research must be done before taking any action.

Preparation

1. Make copies of the student worksheet (p. 68) and the scientists' statements (pp. 66 and 67).
2. Review background material.

Procedure

1. Ask the class what they know about global climate change, often referred to as "global warming." Discuss with them the greenhouse effect and greenhouse gases, such as carbon dioxide and CFCs.

2. Explain that most scientists agree that the increasing amounts of carbon dioxide, CFCs, methane, and other greenhouse gases in the atmosphere will affect the world's climate. However, there is some disagreement about whether these changes have already begun and how serious the effects will be. Scientists also disagree on how we should react to global climate change.

Wrap Up

Assessment

Give each student a worksheet and both of the scientists' statements. Give them time to read the articles and answer the questions on the worksheet. Discuss their answers.

Ask students the following questions:

1) What are the main points brought up by each scientist?
2) What are the advantages and disadvantages of the alternative presented by Scientist 1?
3) What are the advantages and disadvantages of the alternative presented by Scientist 2?
4) Can you think of a course of action that is a compromise between the two plans presented by the scientists?
5) What do you think the best course of action is? Why do you feel this is the best thing to do?
6) Do you think it's important to stay informed about scientific issues? Why or why not?

Potential Answers:

1) Scientist 1 thinks that global warming is already happening and we need to cut carbon dioxide and CFC emissions now to slow it. Scientist 2 believes that we can't be sure yet if the world's climate is warming as a result of increased CFC and carbon dioxide levels and that we need to do more research before we take any drastic action.
2) ADVANTAGES: Would help cut down on the possibility of causing further global warming; would cut down on pollution in general due to decreasing use of fossil fuels; would increase energy efficiency, and the use of alternative energy sources; would save money due to use of more energy-efficient appliances.
   DISADVANTAGES: Would cost more in the short term to develop more energy-efficient cars, factories, and appliances; might eliminate some jobs or cut profits; could reduce crop production or industrial efficiency; may focus resources and talents toward the wrong problem.
3) ADVANTAGES: Would result in more knowledge about our atmosphere; would cost less in the short term; would not inflict economic hardships on U.S. businesses and people in developing countries.
   DISADVANTAGES: Would not reduce pollution; would cost more in the long run; would increase the possibility that, later on, it might be too late to stop the warming trend.

4) A possible compromise might include making some of the changes suggested by Scientist 1 to help increase energy conservation, while continuing to do research as Scientist 2 suggested.
5) Opinions will vary. Note that decisions about climate change, like decisions about many complicated environmental issues, are often based on information that may not be as complete as people would like. Values that people have also influence their decisions.
6) It's important to stay informed about scientific issues so that you can better understand problems and can change your daily behaviors to help solve problems.

Extensions

Community

• Have students contact local auto dealers, appliance showrooms, and heating/cooling repair services and determine if their products still contain CFCs. Find out what steps are being taken or have been taken to phase out CFC use in their community. Alternatively, the instructor could locate these individuals in the community and invite them into the classroom for a presentation/discussion.

Multidisciplinary

• Have students research the topic further, exploring different people's points of view. With this expanded information, hold either a debate or a town hall meeting and have students take on the point of view they researched.

Technology

• Have students locate a scientist via the internet and research the methods that he/she used or could use to study the effect(s) of CFCs.

Resources

• *Air Facts - Air Quality Monitoring*
Information on levels of air pollution in Illinois and how they are monitored.
IEPA (see form in appendix)

• *Benefits of the CFC Phaseout*
The CFC phaseout is already producing benefits for the environment, businesses, and individuals.
http://www.epa.gov/ozone/geninfo/benefits.html

• *Cycles of the Earth and Atmosphere, A Website for Teachers*
On-line teaching module for middle school science teachers. The content focus is climate change and issues related to both stratospheric and tropospheric ozone.
http://www.ucar.edu/learn

• *Global Warming: Early Warning Signs*
A science-based world map depicting the local and regional consequences of global climate change.
http://www.climatehotmap.org/index.html

• *Illinois Annual Air Quality Report*
This report highlights information obtained from the Bureau of Air's statewide air monitoring network.
http://www.epa.state.il.us/air/air-quality-report

• *Ozone Depletion: Myth vs. Measurement*
A series of responses to the most common misunderstandings about ozone depletion
http://www.epa.gov/ozone/science/myths.html

• *Project A.I.R.E - Air Pollution Background Information* (PDF Version)
Fact sheet on air pollution and ways to detect and prevent it.
http://www.epa.gov/region01/students/pdfs/rd_airpol.pdf

Adapted From: "A Heated Controversy," Environmental Education in the Schools. North American Association for Environmental Education/Peace Corps. Washington D.C. 1993.

Scientist 1—It's Warm in Here or is It?

One Point of View on Global Climate Change by Scientist 1

It's time to face the facts—the increasing amounts of carbon dioxide and CFCs in the atmosphere are making our planet's climate warm up. We see the warning signs in our increasing world temperatures. The 1990s was the hottest decade in recorded history. While this isn't proof that global warming has begun, it certainly should warn us that something is happening to our climate.

Over the past 100 years, average world temperatures have risen by about 1°F. That may not seem like much of an increase, but keep in mind that temperatures today are only about 9°F warmer than they were during the last ice age. It takes only a small change in temperature to cause big changes in our world. If we continue to put as much carbon dioxide into the atmosphere as we do now, the world's average temperature may increase by 3° to 10°F within 50 years. If temperatures do rise, we can expect some drastic changes to take place. As temperatures go up, polar ice caps will melt, sea levels will rise and many coastal areas will become flooded. The warming could make droughts occur more often in certain areas. Some places, like the Midwest, could become so hot and dry that many crops couldn't grow there anymore. All over the world, plants and animals may not be able to adapt quickly enough to the sudden changes in their habitats. Some species could even become extinct.

Some people claim that we should wait until we're absolutely sure of global warming before we do anything to control it. I disagree. If we wait too long, it may be too late to prevent damage from the warming trend. Besides, many adaptation policies make good sense even without climate change. They preserve resources, diversify our sources of fuel, and increase our general quality of life.

We should cut carbon dioxide production by at least 20 percent and phase out CFCs now. Since people in the United States produce a lot of the carbon dioxide and CFCs that go into the air, we have to set an example for the rest of the world. We must develop safer chemicals to replace CFCs. We have to switch to solar power and other alternative energy sources. Until we make that switch, we have to use less fossil fuels. Industries that continue to use coal and other fossil fuels must become more energy efficient. These industries should be taxed for the excessive carbon dioxide they release. A higher tax should also be placed on gasoline to encourage people to drive less. Car makers should be required by law to make cars that get better gas mileage. Agriculture and waste disposal processes must change so that we release less methane into the atmosphere.

Individuals must do their part, too, by using cars less and public transportation more, and by buying more energy-efficient appliances and cars. The burning of the tropical rainforest must stop as well. By preserving these forests, we can reduce carbon dioxide emissions caused by the burning and save the trees and other vegetation that help absorb carbon dioxide.

It will cost money to make some of these changes. But it's better to pay the price now—not later, when the effects of global warming can't be reversed.

Scientist 2—It's Warm in Here or is It?

Another Point of View on Global Climate Change by Scientist 2

There's been a lot of concern lately that the world's climate is warming up. Some scientists say that the increased amounts of carbon dioxide and CFCs in the atmosphere are causing this global warming. According to them, the only way to avoid global disaster is to cut carbon dioxide emissions by at least 90 percent—a move that would affect people all over the world.

I say there's not enough scientific evidence to back up this call for drastic action. Let's consider the facts. It's true that there's more carbon dioxide in our atmosphere than there used to be and that we have added gases, such as CFCs, that were never part of our atmosphere before. But there's just not enough evidence to prove that these gases are making the world warm up. In the past 100 years, average world temperatures have risen by only 1°F. This hasn't been a constant rise. Between 1940 and 1970, world temperatures actually dropped, and some scientists suggested that another ice age might be on the way. This latest rise could be just another small change in a natural climate cycle.

There is also some evidence that the temperature differences that are being documented are not as widespread as first believed. For example, although ground temperatures have risen slightly, there does not appear to be a corresponding rise in temperatures in the upper atmosphere, according to satellite data. This could mean that the weather patterns we are seeing are caused by changes on earth, rather than by greenhouse gases.

It's very important to keep in mind that many of the predictions about the effects of global warming are based on various theories. Scientists have come up with these predictions by plugging information about our atmosphere into computer models. The models make predictions about what will happen if we add certain amounts of carbon dioxide and other gases. The problem is, different computer models can give you different answers! Some models have predicted that the increase in carbon dioxide will cause more clouds to form. These clouds would block sunlight and cancel out much of the warming. And according to other models, it's possible that the earth's huge oceans will absorb any extra heat. We just don't know enough yet about how our atmosphere works.

Because of this uncertainty about what is really happening in our atmosphere, I believe we need to do more research before we make any big changes. To significantly cut the amount of carbon dioxide we put into the atmosphere would make life harder for many people—especially those living in less developed countries. How can we ask them to cut back on releasing carbon dioxide when they're just now getting cars and factories that people in more developed countries have had for so long? In the United States, cutting carbon dioxide production would cost billions of dollars each year. Forcing industries to stop using fossil fuels might drive smaller firms out of business and hurt people in regions where coal mining provides many jobs. We must do more research before we make any changes that, in the end, may cause more harm than good.

Name: _____

It's Warm in Here or is It? - Student Worksheet

After reading the statements of the two scientists, answer the following questions:

1) What are the main points brought up by each scientist?

The main point of scientist 1 is _____

_____

The main point of scientist 2 is _____

_____

2) What are the advantages and disadvantages of the alternative presented by Scientist 1?

Advantages:_____

_____

Disadvantages: _____

_____

3) What are the advantages and disadvantages of the alternative presented by Scientist 2?

Advantages:_____

_____

Disadvantages: _____

_____

4) Can you think of a course of action that is a compromise between the two plans presented by the scientists? _____

_____

_____

5) What do you think the best course of action is? Why do you feel this is the best thing to do?

_____

_____

6) Do you think it's important to stay informed about scientific issues? Why or why not?

_____

_____

Where Water Wanders

Subject: Language Arts
Science

Skills:
- Creative Thinking
- Reporting/ Presenting
- Researching
- Collaborating
- Evaluating

Concepts: 3. M, P, R

Objectives: Students will:
1) understand where their domestic water originates, how it reaches them and where it goes after use.

2) be able to explain the movement and management of water in their own words.

State Standards:
Language Arts: 4.B.2 b
5.C.2 b
Science: 11.A.2 c, d, e

Vocabulary:
- aerobic bacteria
- aquifers
- coagulation
- floc
- groundwater
- surface water

Setting: Indoor & Outdoor

Materials:
- access to informational resources

Time: One week or more

Activity Overview

Students will research, create and develop a presentation in which they explain how water gets to them and where it goes after being used.

Background

Safe drinking water is something most people take for granted. It's easy to see why. What could be more simple than turning on the tap and getting a drink of water? But behind each gallon, behind each drop, are the efforts of scientists, engineers, legislators, water plant operators and regulatory officials. It is their job to keep the water clear, clean, abundant and safe.

Our drinking water supply comes from two sources—**groundwater** and surface water. Groundwater comes from the reserves of water hidden underneath the earth in **aquifers**. **Surface water** is the water in rivers, streams and lakes.

Where Does Our Drinking Water Come From?

In Illinois and many other states, many early settlements were near surface water sources. As communities grew, people were forced to move farther away from rivers and lakes. Those people who lived some distance from lakes and rivers also needed a good, clean and easily obtainable supply of water. To get a steady supply of water, people dug wells. Most wells today are dug with powerful drills, but for hundreds of years they were dug by hand. Wells continue to provide water for many communities and individuals.

What Happens to Water Before It Comes Out of the Faucet?

The answer to this question depends on where you live. Of those people who live in rural areas, many get their water from a private well drilled on their own property. These wells may range from 40 to several hundred feet deep to reach suitable water, depending upon the local geology. People with private wells generally have a water treatment unit in their home, such as a water softener or a filtration system.

About 1,800 community public water supply systems deliver more than 1.77 billion gallons of safe, clean drinking water to Illinois water consumers each day. The majority of public water suppliers (water companies) pump water from wells

for treatment and distribution to customers. People living in the Chicago area receive treated drinking water from Lake Michigan.

The Drinking Water Treatment Process
The drinking water treatment process can be broken down into seven steps. Here is how a water treatment plant works.

Intake: Water from a surface source, such as a lake or a river, is channeled into a treatment plant. Intake screens strain out large debris such as fish, plants and sticks. If the source is groundwater, the screening process is done by nature because the water is cleaned by travelling through layers of sand and rock, so water is pumped directly to the plant.

Pre-Treatment: Chemicals such as chlorine, alum, and lime are added to the water to remove impurities, soften the water, and destroy bad taste, colors and odors. Lime is added to remove minerals, which leave deposits called "scale."

Mixing: The water is next stirred by large mechanical mixers to blend the chemicals through the water.

Coagulation and Flocculation: The water then travels to a large basin. Some of the chemicals cling to the impurities in the water (**coagulation**), forming large, heavy particles. These particles are called **floc**. They settle to the bottom of the sedimentation tank.

Filtration: From the sedimentation basin, where most of the floc has settled to the bottom, the water travels through sand beds which filter the water to remove any impurities that are left.

Chlorination: Chlorine is added to kill bacteria and prevent more bacteria from growing as the water travels to the consumer. Most water treatment plants also add fluoride at this point (to prevent tooth decay).

Distribution: After the water is cleaned, it is stored in large, elevated tanks (water towers), or covered reservoirs. The water then travels through large pipes called "mains" to houses, schools, and businesses.

Rural Wastewater Treatment
In rural and some suburban areas with suitable soils, wastewater or sewage from each house is usually discharged into a septic tank. In the septic tank, larger solids settle to the bottom while grease and oils rise to the top and are trapped. These are periodically removed by pumping to prevent overflow and backup into the house. Connected to the septic tank is a drain field that allows the soil to filter out microorganisms and particles from the wastewater.

Urban Wastewater Treatment
In urban areas, wastewater is carried by sewer pipes to a wastewater treatment plant. These plants can provide up to three different levels of purification.

Primary Sewage Treatment
In this level of treatment, large debris such as sticks or garbage are eliminated by large screens. The remaining water is held in a tank where suspended solids are allowed to settle to the bottom and are later removed. Bacteria are killed by treating the water with chlorine.

Secondary Sewage Treatment
This level incorporates all of the steps of primary treatment but also exposes the wastewater to biological processes. Water is held in a tank where **aerobic bacteria** remove organic wastes.

Advanced Sewage Treatment
This type of treatment includes the use of

special chemical or physical mechanisms to remove pollutants from wastewater. This more expensive treatment is usually necessary to protect Illinois streams.

Preparation

1. Review the background information.

2. Arrange for a field trip or a visit from a guest speaker to take place two days after giving the students the assignment. The field trip can be to a reservoir, water treatment plant, or water pumping station; guest speakers could include representatives from your local water utility or businesspeople involved in the drilling of private wells.

Procedure

1. Ask the students if they know where their drinking water comes from. Try to have them get as specific as possible in their answers. (For example, is the water stored in a reservoir prior to coming to their homes? Do they know where their well is located on their property? Does the community get its water from a lake or river?) Ask them if they know what happens to water in their homes after it goes down the drain: does it wind up in a septic tank, or is it connected to a municipal sewer system?

2. Give the students the assignment of discovering and learning the exact steps and processes that water goes through on its way to their homes. Remind them that different homes may have different water supplies, and that they are to answer regarding their own homes, not their friend's or classmates'. Instruct them to determine every step along the way: how water is purified, how it is transported, where it is kept, and so forth. They are to write their findings in a one- or two-page composition.

3. Two days after giving the assignment, take the students on a field trip to a water-related facility, or have a guest speaker come to class. Try not to announce the speaker to the class in advance. Encourage them to ask questions and to use this as an opportunity to determine the accuracy of the research they have completed thus far.

4. Give the students one more day to finish their research. When the students turn in their papers, ask them in class to explain how water first gets to their homes. As they provide answers verbally, elaborate on their answers and diagram the process on a chalkboard. Do the same with the question of where water goes.

5. Divide the class into groups of four or five students. Tell the class that each group is going to develop a creative way to communicate the water purification cycle that they have just diagrammed. Each group must select how they wish to communicate the information. They are allowed to use any means they want to, as long as it can be shared with the rest of the class. Also, each member of the group must have a role in the performance. For example, if a group decides to write a story, then each member should be involved in reciting the story. Assign a reasonable time in which groups can create their presentations.

6. Give students time over two to three days to prepare and practice their presentations.

7. Have the groups present their original presentations in front of the class (or possibly to another class or grade level.)

Wrap Up

Assessment

Prior to the presentations, instruct the students that they will be rating each other's work on set criteria. Have them grade each presentation in the following areas: Creativity; Accuracy; Completeness; and Clarity of Communication. Each student must also state what they liked about each presentation, what

they learned from each one, and what they would have the team improve upon.

Extensions

Multidisciplinary

Have the class (or some of the groups) research how wastewater was handled historically, either by settlers or by Native Americans. Have them do a similar type of presentation to the class.

Technology

Have the students discuss water conservation. Briefly review some of the technology that is available to help consumers conserve water. Have the students think of new products or mechanisms that will reduce the amount of water that is consumed in their homes or the community.

Outdoor

Have the students visit a local wetland. Use the visit as an opportunity to discuss, compare and contrast how nature and humans purify and recycle water.

Resources

• *Groundwater Protection Education Materials*
A list of groundwater brochures, booklets, audiovisuals, displays, and other materials available from several state agencies.
IDNR, Clearing House, One Natural Resources Way, Springfield, IL, 62702, 217-782-7498. To order online, go to http://dnr.state.il.us/publications/Freebies1.htm.

• *H2O Below: An Activity Guide for Groundwater Study*
An educational curriculum for grades 3-12 developed as part of the Illinois Middle School Groundwater Project.
IDNR, Clearing House, One Natural Resources Way, Springfield, IL, 62702, 217-782-7498. To order online, go to http://dnr.state.il.us/publications/Freebies1.htm.

• *Water Quality: Potential Sources of Pollution*
This 24" x 36" color poster depicts point and nonpoint sources of pollution. The reverse side contains two activities, Dispersion of Nonpoint Pollutants and How Substances Are Measured in Water. Available online at: http://water.usgs.gov/outreach/OutReach.html.

• ** URXQGZDWHUDQG/DQG8VHLQWKH:DWHU&\FOH*
This 24" x 36" color poster graphically displays various land use practices and geologic formations. Order online at: www.dnr.state.wi.us/education.

• *There's More Than One Way to Save Water*
A pamphlet that lists methods of conserving water. IDNR, Division of Education, One Natural Resources Way, Springfield, IL, 62702, 217-524-4126. To order online, go to http://dnr.state.il.us/publications/Freebies1.htm or www.dnr.state.il.us/lands/education/index.htm.

• *Kids' Stuff*
USEPA's Office of Groundwater and Drinking Water has compiled resources especially for kids to learn more about drinking water, including games, activities and experiments. www.epa.gov/safewater/kids

• *Consumer Confidence Reports*
Provides an Annual Drinking Water Quality Report that is broken up by public water supplies. It includes detection of regulated contaminants, if there is a violation or concern for each contaminant, and the likely source of contamination. http://epadata.epa.state.il.us/water/bowccr/ccrselect.aspx

Pointing to Point and Nonpoint Pollution

Subject: Science
Language Arts

Skills:
- Analysis
- Reading
- Deductive Reasoning
- Problem Solving

Concepts: 1. A , E 2. J, K
3. A, D, J, O,P

Objectives: Students will:
1) understand the difference between point and nonpoint source water pollution.

2) identify types of point and nonpoint source water pollution.

State Standards:
Language Arts: 1.B.2 b, d
1.C.2 d
Science: 13.B.2 b, f
Social Studies: 17.B.2 f

Vocabulary:
- nonpoint source pollution
- point source pollution
- sediments

Setting: Indoor

Materials:
- a copy of the Genuine Water Who-Done-It worksheet for each student (p. 79)

Time: One class period

Activity Overview

Students will read a mystery story involving numerous types of water pollution and will use their knowledge and reasoning skills to solve the mystery.

Background

The sources of water pollution can be divided into two main categories. These categories are point sources and nonpoint sources. **Point sources** are those where the pollution comes from a single identifiable source, such as a sewage treatment plant or an industry. These sites can be easily managed because you can tell who is creating the pollution.

Unfortunately, much of our water pollution comes from a multitude of different sources; there is no one point where the pollutants come from. This is called **nonpoint source pollution**. Some nonpoint sources are:
- runoff from farms
- runoff from city streets
- erosion from construction sites and stream banks
- overflows from city sewers

Nonpoint source (NPS) pollution may not be a familiar word to most of us. The symptoms, however, are familiar: green, weed-choked lakes, muddy rivers, and eroding banks of rivers, streams and lakes. In Illinois, some 35 percent of the streams and 84 percent of lakes have suffered from NPS pollution.

Effects of Sediments on Lakes, Rivers and Streams

Sediments are soil particles that erode from cropland, construction sites and stream banks. Sediments also include flakes of metal and broken pavement that wash off city streets. When these particles reach lakes, rivers and streams they do more than turn the water brown.

Sediments:
- Cause the water to become cloudy, making it difficult for fish to see and feed properly. Sediments also can damage fish gills and the feeding and breathing of aquatic insects.

- Flow into the water and build up on the river and stream bottoms. They cover spawning habitat where fish and

aquatic insects lay their eggs on the gravel bottom.

- Contain millions of soil particles. In moving water, these particles can act like a scouring pad and remove aquatic plants and animals from their habitat.

- Cause streams and rivers to become shallower and wider, which leads to flooding problems. The shallow water is also heated more by the sun. This causes water temperatures to rise; in time, cold water fish such as trout cannot survive, and only warm water fish, such as carp, are found.

- Increase the chances of boats and swimmers getting stuck in the mud of a lake or river. Muddy swimming areas can be dangerous as well as ugly.

- Cloud the water, reducing the amount of sunlight that reaches into the water. This affects the process called photosynthesis. Without photosynthesis, plants, including algae, cannot survive. This reduces the amount of oxygen available and leaves no place for fish and small organisms to live or find food.

- Harm duck and goose populations by filling in wetland areas that are used for breeding.

- Carry toxic materials that can contaminate small organisms. When fish and waterfowl eat these small organisms, the toxins build up in their bodies and can cause illnesses, birth defects and even death.

Effects of Nutrients on Lakes, Rivers and Streams

Nutrients cause the over-fertilization of lakes, rivers and streams. This leads to an increase in plant and algae growth. Plants are needed in water, but too many plants and algae are harmful to fish and make a lake less attractive for swimming, boating and other activities. Nutrients come from sediments, manure (including pet wastes) and the fertilizers used on lawns or farm fields. When these nutrients reach our lakes, rivers and streams they do more than turn the water green with plants and algae. Excess algae can reduce the amount of bottom-rooted plants by blocking sunlight. Bottom-rooted plants provide food and habitat for fish and waterfowl.

When algae and aquatic plants die they are broken down by bacteria through a process called decomposition. Bacteria take in oxygen during decomposition, which removes oxygen from the water. This makes it difficult for fish and other aquatic life to survive.

When materials such as manure, leaves and grass clippings enter a lake, river or stream, they too are broken down by bacteria. The decomposition of these materials reduces the amount of oxygen in the water and may release a gas called ammonia. Low oxygen levels and ammonia combined with warm water temperatures can kill fish.

Preparation

1. Make enough copies of the student worksheet “A Genuine Water Who-Done-It” (p. 79) so that there is one per student.

2. Review background material.

Procedure

1. Have students brainstorm what water pollution is and where it comes from. Explain the difference between point and nonpoint source water pollution, and give some examples of each. Have them organize their thoughts on water pollution and where it comes from according to these two main categories.

2. Hand out the student worksheet and tell the students that they are to refer to it as you read them the story “A Genuine Water Who-Done-It.” Explain that they should not attempt to solve the mystery without hearing the com-

plete story. It may be helpful for them to take notes on the back of the worksheet to help them organize the information and keep track of the suspects.

3. Have students read the story or read the story aloud to the class, pausing at times to allow them to reflect on the information or to write down notes.

4. After hearing the story, students should circle on the worksheet who they think the culprit or culprits are and indicate why.

5. Ask the students to list all of the suspects or possible causes of pollution in the lake. The list will probably include some or all of the following: Ms. DeRose, Mr. Penn, Mr. Who's bakery, Farmer Tress, Acme Widget, the construction site, the disposal company, the snow plow.

6. Assign each of the suspects to a different place in the classroom (for example, Mr. Penn by the window, Ms. DeRose under the clock). Instruct the students, at your signal, to get up and stand in the part of the room which corresponds to the person they think was most responsible for the lake being polluted. Tell them they must go to the place they circled on their worksheet. If there are students who believe there was more than one cause, have them form a separate group.

7. Have the groups which have assembled by each suspect decide on a single main reason why they believe that person (or cause) is most responsible. Have each group select a spokesperson to explain their reason to the rest of the class. (If there is a group of students who felt there was more than one person responsible, have that group present last.)

8. Read the following answer, discuss it with the class and get their responses.

"A *Genuine* Water Who-Done-It" Answer:
What Findit discovered is that the lake has been contaminated by pollutants from a number of sources. The factory, though, was not one of them.

The sources that Findit identified during his ride were these:
1. Waste oil dumped onto the ground.
2. Oil, gasoline, and other pollutants from the road washed onto the soil and down the slope to the lake.
3. Possibility of leakage from underground storage tanks below Mr. Who's bakery shop.
4. Pesticide runoff from the farm fields.
5. Fertilizer runoff from Ms. DeRose's garden.
6. Sediment from the construction site.
7. Runoff from Well's ducks' wastes.

Findit did not have time to research the company that handled Acme's hazardous waste. If this was a reputable and law-abiding firm, there should have been no connection to the pollution in the lake. However, if the company disposed of the wastes illegally (such as dumping them down a storm drain or storing them in corroded or insecure containers), then it too could have contributed.

Wrap Up

Assessment:

• Have the students select one character (possible culprit) from the story. Instruct them to research the particular kind of pollution that the character contributed, and develop a way that the character could keep that pollutant from entering the lake. (Note: having the characters move or go out of business are not acceptable answers.) Have them write or draw their ideas or present them to the class.

Extensions

Community

• Find out if there is a similar mystery at a lake, river, or stream in your community. Take the students on a field trip for a water body

clean up. While there, have them try to identify possible sources of water pollution in the area. Have them perform a water quality assessment by checking for indicator species or performing chemical tests for dissolved oxygen, phosphates, and nitrates.

Multidisciplinary

• Have the students turn the story into a brief play, which they can then present to other classes. Alternatively, they can put on a mock trial with one of the characters as a defendant.

Outdoor

• Have students develop a list of possible nonpoint sources of pollution in and around the school. From this list each student is to develop one or two bingo-type cards, with potential pollution sources in the place of numbers. Students trade cards with each other so that no student has his or her own card. The class then goes on a walk around the school ground, getting tokens each time they pass a source mentioned on their card. The winner is the first one who gets four or five in a row.

Technological

• Have a local water quality professional (water well inspector, water utility representative, state water scientist with the IEPA or IDNR, etc.) visit the classroom. Have them explain how they monitor and protect fresh water supplies. Ask him / her to bring some of the tools and equipment they use for water quality measurement so students can see how technology plays a part.

Resources

• *Water Quality: Potential Sources of Pollution, Middle School Edition*
This 24" x 36" color poster depicts point and nonpoint sources of pollution. The reverse side contains two activities, Dispersion of Nonpoint Pollutants and How Substances Are Measured in Water. Available online at: http://water.usgs.gov/outreach/OutReach.html

• *Illinois Water Quality Report*
Provides information on Illinois watersheds and compares water quality of each area to statewide data.
www.epa.state.il.us/water/water-quality

• *Clean Water Act*
A historical overview of the Clean Water Act, the primary federal law that protects our nation's waters, including lakes, rivers, aquifers and coastal areas.
www.epa.gov/region5/water/cwa.htm

• *Nonpoint Source Pollution*
A fact sheet about nonpoint source pollution, the nation's largest source of water quality problems.
www.epa.gov/OWOW/NPS/facts/point1.htm

• *Water Science for Schools*
This site provides extensive background information on a wide variety of water topics. It also includes on-line activities, data tables, maps and a glossary of terms.
http://ga.water.usgs.gov/edu/

• *World of Fresh Water (PDF version)*
Use these activities to help your students understand the effects of pollutants on lakes, rivers, and streams. Grades 4-6.
www.epa.gov/ORD/WebPubs/fresh/fresh.pdf

A Genuine Water Who-Done-It

Inspector Findit's lunch was interrupted by an urgent call from his old friend, Don D. Well, a retired Hollywood duck trainer.

"Findit, come quickly!" Don said over the phone. "I need your help right away!"

Findit finished his sandwich and hopped on his bicycle. He quickly rode the two miles down the road to Well's house. Well lived on the shore of Lake Pez, where he had a small fishing lodge and duck training center.

"What's the problem?" asked the inspector.

"Here's the problem," Don said, "Someone has poisoned my lake!"
"What? Are you sure?"
"Absolutely. Look at this. I keep finding fish washing up on the shore or floating in the water." He showed Findit a bucket full of fish, both large and small. "I found all of these just this morning. Fish don't just die like this. Something weird is going on here!"

"But why would someone poison your lake? You don't have any enemies here, do you?"

"Not that I know of, but there may be some people out there who are jealous of my ducks. They were quite a big hit at the Oscars last year. Unless it's the widget people."

"Who?"

"That widget factory on the other side of the lake. You should see their smokestacks— always billowing smoke and steam and stuff."

"But what has that got to do with your fish, or your ducks? And why would they pick on you?"

"With all that pollution coming out of the stacks, there must be something going on there. I don't know why they'd single me out for this treatment, but that's what I want you to find out."

Findit left and went back to his bicycle, almost stepping in several piles of duck droppings along the way. He decided to ride around the lake and see if anyone had seen anything unusual. The first person he came across was Mr. Penn, who was working on his car.

"No, I haven't seen any suspicious people around here," said Penn in response to Findit's question. "And I'd probably see somebody, too. I change my oil a lot, so I'm out here working on my car frequently."

Findit noticed that while he was talking, Penn was pouring a pan of used motor oil on the ground next to his driveway. "Say, are you sure you're supposed to do that?" Findit asked.

"What do you mean?" said Penn, "It's my property, and so far I haven't noticed it hurting the grass or the flowers. Besides, it's not as though I was dumping it down the storm drain or anything."
"Hmm," thought Findit as he walked away, "I might have a suspect."

The next person he met was Ms. DeRose, who was in her garden.

"No, I haven't seen anybody either," she replied, "and I'm out in my garden a lot these days, so I'd see somebody suspicious."

"Those flowers are quite large," said Findit. "How do you get them to grow in this area? Isn't the soil too harsh?"

"Oh, heavens yes. That's why I use so much of this special fertilizer. I practically have to pour it on, but as you can see it works wonderfully." Findit noticed that, as Ms. DeRose watered, the garden plots overflowed somewhat, and a mixture of fertilizer and water spilled out into her yard.

"Hmm," he thought, "another suspect."

Farther down the street, he decided to stop in at Mr. Who's bakery for a donut. He asked Mr. Who if he had seen anybody suspicious in the area.

"No, I haven't seen anybody like that around here. In the year since I built this place, most of the customers I've had have been regulars—you know, people from the area, commuters stopping in on their way to work, or Well's usual customers."

"So, a lot of people drive by here, huh?"

"Oh yes, quite a few. And you know what bothers me? Some of these people leave their cars running while they come in here to buy donuts. I look outside and see all that smoke in the parking lot—icck!"

"You know, I don't think I noticed your shop last time I came here. You say you just built this place last year?"

"Yes, it used to be a gas station, but it went out of business. I bought the property, put up this shop, and things have been going well."

"A gas station, you say. Did they remove the storage tanks when they moved out?"

"Hmm, I don't think so. There really wasn't time."

"Another suspect," thought Findit as he walked out munching on a bear claw.

Next on his journey he came across Farmer Tress, who was getting ready to get into his cropduster.

"Now that's odd, 'cause if anybody was trying to poison Don's lake, I'd know it."

"How?" asked Findit.

"My cousin Rick owns the cornfield across the lake from Well's place. I fly the plane over there a lot to spray. I can see the whole lake from up there. If somebody was there, I'd see it."

"Hmm," thought Findit as he rode away. "Another suspect."

Finally, he arrived at the Acme Widget Plant. He asked to speak with the plant manager about how wastes were handled.

"We have a very elaborate system for that," the manager, Ms. Robinson, explained. "Of course, we're connected to the local sewer system, so most of our organic wastes go there. We do generate a small amount of toxic waste, though. We try to keep it to a minimum, but we do have paints and solvents involved in our work. We keep those in a special area of the plant, and then have them removed once a week and taken to a hazardous waste disposal site."

"And who does that?" asked Findit.

"We have a contract with a disposal company. They pick it up and make all of the arrangements."

After taking a brief tour of the plant, Findit got back on his bicycle and rode back to Well's house. As he rode along, he noticed a construction project on the road that wound around the lake. A large number of trees had been pulled out, and there appeared to be soil and dirt eroding the slope down to the water.

As he rode along, he noticed several other places where the grass and vegetation on the side of the road closest to the lake was either dead or browned. He thought he noticed a slight grade in the road, making it slant slightly toward the water.

This might be another clue, he thought.

"Hey, Don," he said as he came back to the house, "I have a question. Does this road out in front get plowed in the winter?"

"It gets plowed and salted both. That's a real busy road there. Sometimes they plow so much they scrape everything off the road, snow, sand, oil, you name it."

Findit spent a few minutes looking at his notes and then said, "Well, I've solved the mystery."

Who poisoned the lake? And how did Findit know?

An Original Story by: John Vymetal-Taylor, 2000.

Student Worksheet for A Genuine Water Who-Done-It

Hasting to Waste

Subject: Science

Skills:
- Observing
- Hypothesizing
- Measuring
- Comparing/ Contrasting

Concepts: 1. D, P, R
3. H, J, L

Objectives: Students will:
1) design a landfill and observe what happens to materials when placed in it.

2) recognize that materials and design can affect the integrity of a landfill.

State Standards:
Science: 11.B.2 c, d, e
11.A.2 a, b, c, d, e

Vocabulary:
- incinerate
- leachate

Setting: Indoor

Materials:
- clear 2-liter bottles (one for every three students)
- rulers
- scale(s)
- soil, sand, clay
- assorted trash items (organic and inorganic)
- graduated cylinder
- plastic wrap
- plastic gloves
- food coloring
- Student worksheets (pp. 85 and 86)

Time: One class period for set up, one period three weeks later and 10 minutes every other day

Activity Overview

In this activity students will design models of leakproof landfills and will observe how each functions.

Background

Waste Management - A Problem for All of Us

Garbage! It's a problem all right, but someone else's—not mine. That's the reaction that some of us have. And yet, have you ever counted how many garbage bags and trash cans your family puts out on collection day, or noticed how much trash you and your classmates throw away each week?

Food scraps, newspapers, candy wrappers, milk cartons, and cardboard boxes are among the hundreds of items that people throw away. The average person in Illinois throws away 6.6 pounds of garbage every day. About a third of that is packaging waste, and about 10 percent of it is food waste. This adds up to two tons of food waste generated by the average person by the time he/she is 18 years old, five tons by age 45 and eight tons by age 74.

Even more garbage or waste is generated each time we eat at a restaurant, go to the ball park or visit the doctor. Industries that make the things we like to use, such as bicycles, toys, baseballs and computers, add to the mountains of trash. We wouldn't have many of the things we buy or use without producing this waste.

Solid Waste

Solid waste is paper, food scraps, old stoves and other garbage that people throw away, personally take to the landfill and set out at the curb for garbage trucks to haul to landfills. Each year in the United States 209.7 million tons of municipal solid waste is generated. What should we do with it?

Litter

If we toss garbage away carelessly, it litters the roads, ravines, ditches and waterways. Litter is a form of land pollution and open dumping is illegal.

During a three year research project done by Keep America Beautiful, Inc., it was found that people litter for one of three reasons:

- they feel no sense of ownership for the property
- they believe someone else (a park maintenance or highway worker) will pick up after them
- litter has already accumulated

Although motorists and pedestrians are most often blamed for litter, Keep America Beautiful, Inc. identified seven sources that contribute to the problem: commercial refuse sources, including dumpsters; household trash handling; construction/demolition sites; uncovered vehicles; loading docks; motorists; and pedestrians. From these sources, litter is carried in every direction by wind, water and traffic. It moves until trapped by a curb, wall, fence, a row of trees or other stationary object. Once trapped, litter becomes not only an eyesore, but an invitation for people to add more.

Sanitary Landfills or Landfilling

If we dump trash in open areas, it smells bad, looks ugly, attracts rats and insects, and may be hazardous. Since 1970, when the IEPA was created, most open dumps have either been closed or turned into modern sanitary landfills. Such landfills have been constructed to hold wastes and to keep them from contaminating surface and ground waters and soil.

A sanitary landfill is lined with clay and thick plastic sheeting to prevent leakage. Rainwater can mix with other liquids created by decomposing garbage to produce leachate. Leachate can contaminate water supplies if it leaks out of the sanitary landfill. To prevent this, landfills are constructed so that **leachate** drains into collection pipes, then is pumped into a collection system to be treated. As trash slowly decomposes, gases, chiefly carbon dioxide and methane, are produced. These gases can build up and eventually escape into the air. To prevent this from happening, the gases are vented safely through pipes or energy recovery systems. Every day as garbage is brought to the landfill, it is spread and crushed by a bulldozer or compactor. At day's end, the garbage is covered by a layer of soil to cut down on odors and to keep insects and rodents away. Groundwater monitoring wells are dug near the landfill to check water for contamination.

When landfills reach their capacity (become filled), they are capped with a seal of clay and two to five feet of soil, and grass is planted on the site. Some closed landfills are turned into parks, playgrounds, golf courses and even ski slopes. Landfills are tested for leachate and gas control for many years after they have been closed.

Unfortunately, there are a few problems at landfills. If landfills are not properly designed, managed and inspected, they can cause pollution problems. It is hoped that in the future, there will be less need for new landfills, as people use less, and reuse and recycle more.

Incineration

To **incinerate** means to burn something to ashes. The ashes from waste burned in an incinerator take up less space in our landfills than unburned waste; this extends the life of our existing landfills. Burning waste can create heat, which may be used to produce steam. The steam can generate electricity for homes and businesses. Incinerators such as this are referred to as waste-to-energy plants.

Ash from the incinerator must be tested for hazardous qualities and disposed of in a landfill. Some special landfills are made just for ash disposal. Gases produced by incineration must be controlled through complex filter systems to control air pollution. Not all materials can be incinerated.

Preparation

1. Make copies of the student worksheet, so that there is one per team. (pp. 85, 86)

2. Carefully cut the tops from the clear 2-liter bottles so that you form a cylinder open at one end.

3. Pour two inches of sand in each of the bottles.

4. Gather a small amount of garbage, both organic and inorganic. The lunch room may be a good source of identical garbage that is the same age (banana peel, juice box, straw, potato chip, paper clips, tooth picks, etc.).

Procedure

1. Ask the students to explain what garbage is. Ask them for examples of what goes into their garbage at home. Have them explain why these things are thrown away. Ask them if they know where their garbage goes once it leaves the dumpster or curb. Once the concept of "dump" or sanitary landfill has been mentioned ask students to explain:
   - Why do we use landfills? Why don't we just leave garbage in plain view?
   - How is a landfill formed? Is garbage just thrown in or are there special processes to consider?

2. Explain to the students that they will replicate how landfills work and will perform experiments to check for effectiveness and design. Explain to the class how a sanitary landfill is structured and discuss the components that are necessary for its success.

3. Divide the class into three teams. Assign each a number from 1 to 3. Tell teams with the number 1 that they will build a "no-frills" dump without any sort of liner. Team 2s are asked to design a landfill with a plastic liner. Team 3s are asked to design a landfill with a clay liner.

4. Give each team a student worksheet.

Have the teams draw their landfill models. Teams should be sure to include the necessary layers and indicate the thickness of each layer in inches on the worksheet (for example, 2 inches of sand, 1/2 inch liner (if provided) 2 1/2 inches of soil, 2 inches of garbage, 1 inch of soil to top it off). Teams can be creative; the thickness and number of the layers can vary, but they must all start with a two-inch base of sand and must have all of the following:

a) clay or plastic (if provided) = liner
b) garbage (organic- food or plants, and inorganic - plastic or synthetic)
c) soil = daily cover layer

Have students develop a hypothesis to state what they think will happen to the garbage in their landfill.

5. Distribute the two-liter bottles with the two inches of sand already in them. Distribute the plastic and clay to the appropriate groups. Have a supply of soil and garbage for all groups.

6. Have teams write their names on the bottles with tape or permanent markers. Have teams assemble their landfills based on their drawings.

7. Teams should weigh their models and record the weight on their worksheets.

8. Models should be stored in a warm area away from sunlight.

9. Every other day, give the students time to inspect their landfills for any sign of change. Have them measure the weight and changes in height and record these findings on their worksheets. Once a week, have students pour in 50 ml of water (to simulate rain). Make sure

to have students weigh their models before adding the water.

10. After three weeks, have students discuss the following:

- What changes have they seen in the garbage in their landfills?
- What, if anything, has started to decompose?
- Is there any mold or fungus growing in your landfill?
- Has the weight or size of the landfill or any of its layers changed? If so, what do you think this means?
- Are all the layers of your landfill the same as when you started? Why or why not?
- How do your results compare with your hypothesis?
- How does your landfill compare with the results of the other teams?
- Do you think your landfill could withstand a heavy rain or an illegal toxic dumping?

Wrap Up

Assessment

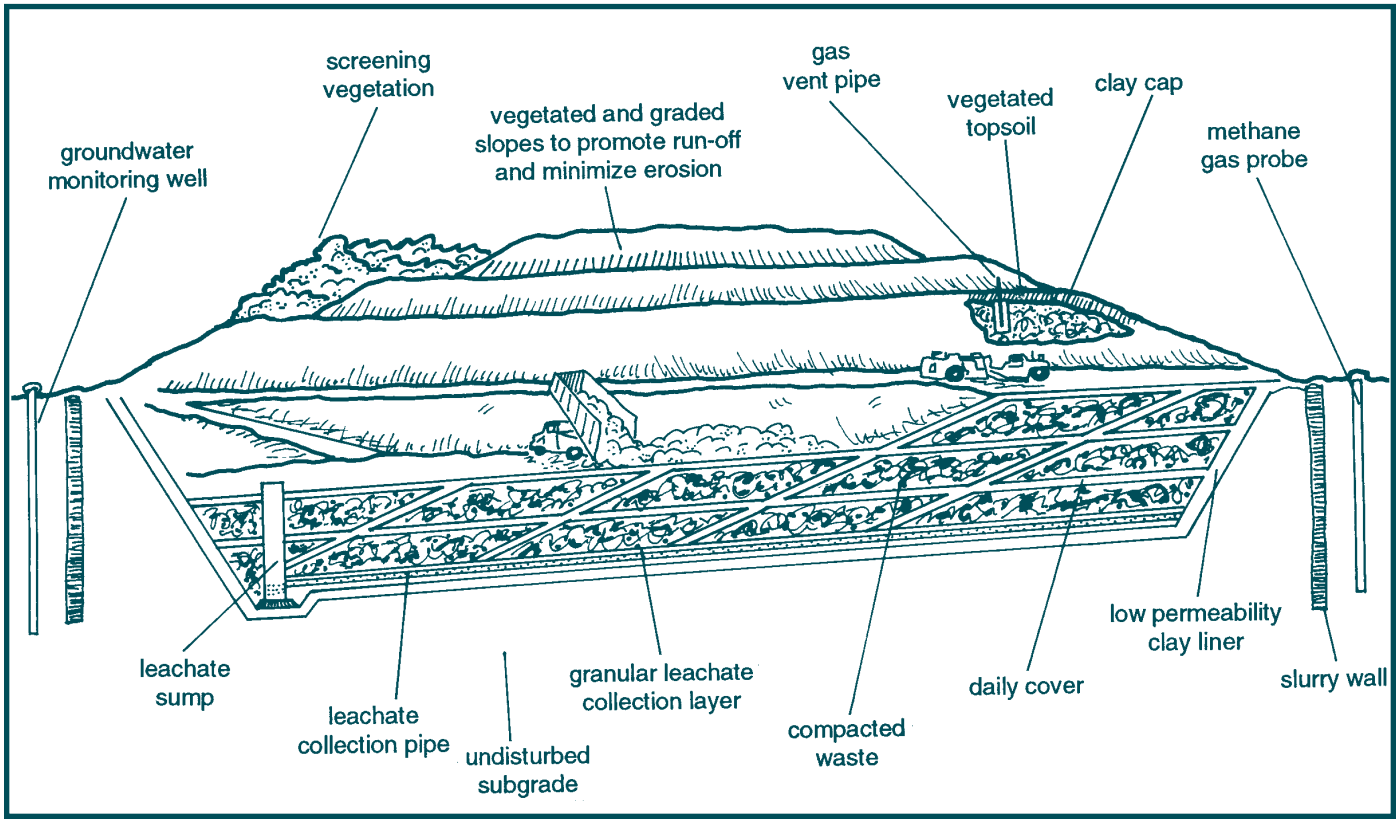
• Have students make one last hypothesis - Which of their landfills, if any, would not allow leachate to escape. Have them write down their predictions.

Test their predictions with the following simulation. Fill a beaker with 100 ml of water and six drops of food coloring (avoid yellow, as it does not show very well) for each model. Dump this "toxin" into each of the landfill models and have teams report if any of it reached the sand layer. Have the class review the results. Were any types of landfills more successful in resisting the toxin? What's the big deal if a landfill leaks anyway? Discuss leachates and the impacts of a landfill's contents seeping into groundwater.

Extensions

Community

• Visit a local landfill. Before going, have students hypothesize what they think it will be



like (will it have an odor, how large or small will it be, will garbage be visible). Additionally, have them prepare a list of questions for the landfill representative.

Multidisciplinary

• Have students keep a journal during the entire activity. Have them look closely (maybe with a magnifying glass) at their landfill model and compare it with the other models. Ask them to record and/or draw any changes that they may see during the process.

Outdoor

• Have students do a quick inventory of the things that are being taken to the curb in their neighborhoods on trash pick-up day. Ask them to determine if there are any items that could be disposed of in another manner (composting, recycling, donating to charity, buying items with less packaging, etc.). Have students brainstorm ways that they could educate others about where the trash goes.

• Do a more in-depth study in which students weigh the garbage they or their families throw out in one week. How does that compare to the amounts that could be recycled or composted?

Technology

• Invite someone who designs and/or builds landfills as their occupation to come speak to the class. Have students develop questions to ask him or her that are relevant to their landfill development experience.

Resources

• *IEPA Bureau of Land - Open Dumps*
Provides information about the laws and hazards of open dumps.
www.epa.state.il.us/land/open-dumps/index.html

• *IEPA Bureau of Land - Landfill Capacity Report*
The site contains the annual report on the status of sanitary landfill space.
www.epa.state.il.us/land/landfill-capacity/index.html

• *Household Waste Disposal Solutions*
An online guide for proper disposal of common household items that require special treatment.
www.epa.state.il.us/land/hazardous-waste/household-haz-waste/hhw-disposal.html

• *Consumer's Handbook for Reducing Solid Waste*
This site describes how people can help solve a growing problem...garbage! www.epa.gov/epaoswer/non-hw/reduce/catbook.htm

• *DCEO's Vermicomposting Kit: EEEK! There's a Worm In My Room (Grades K-adult)*
Contains lesson plans, a video and all the information you would need to know about setting up a vermicomposting (food composting with worms) bin of your own! (Free Rental!)

To reserve an educational kit, contact Brett Ivers at 217-524-5859 or brett.ivers@illinois.gov. www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Education/ISTEP_cases_program.htm or www.istep.org.

• *DCEO's The Case for Investigating the 4Rs (Grades K-adult)*
Contains videos, lesson plans and a variety of products made from recycled materials. (Free Rental!)

To reserve an educational kit, contact Rebecca Enrietto at 217-785-7440 or rebecca.enrietto@illinois.gov. www.istep.org www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Education/ISTEP_cases_program.htm

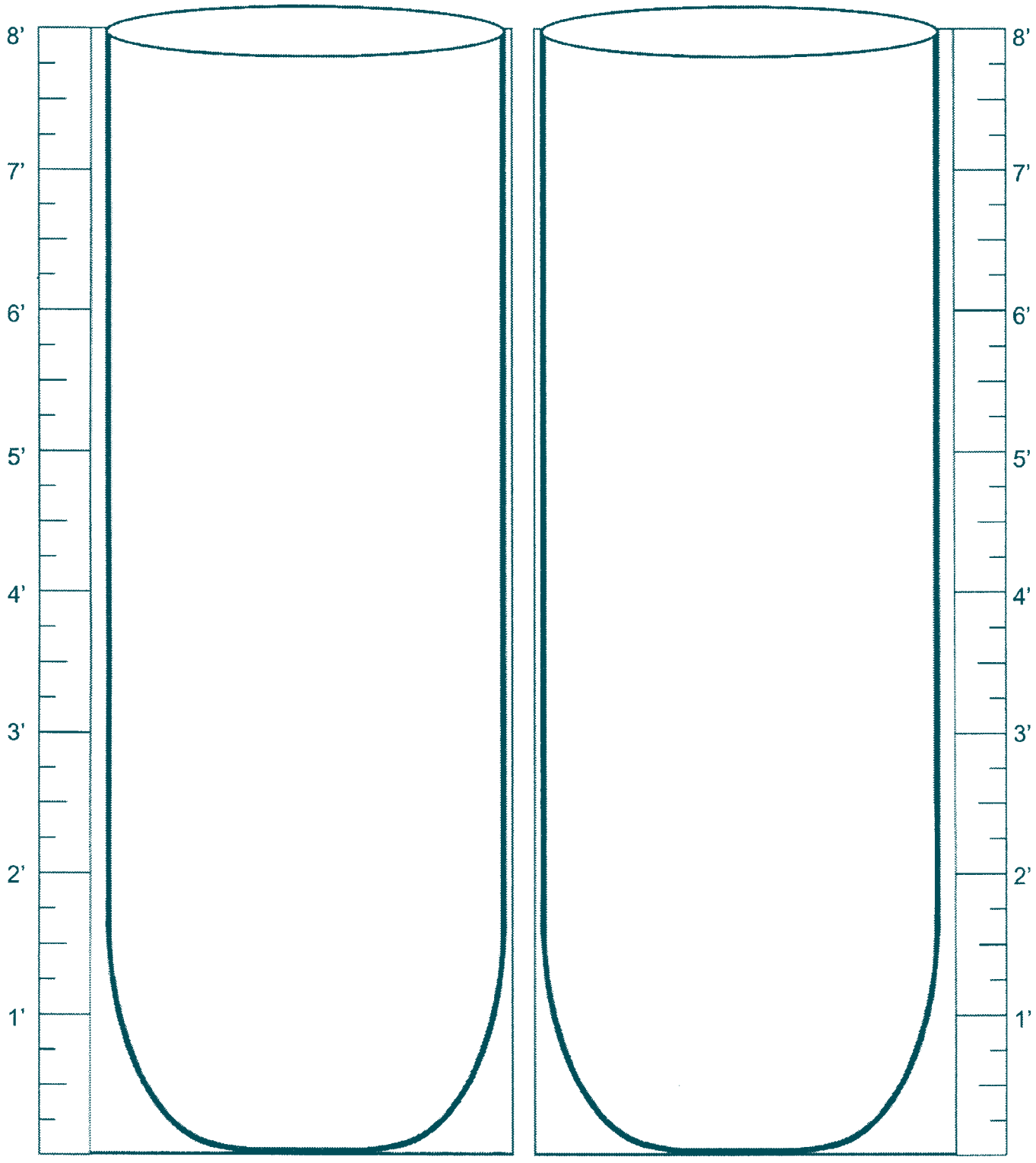
Adapted From: "Leachate Legacy," Environmental Resource Guide—Nonpoint Source Pollution Prevention. Air & Waste Management Association. Pittsburgh, PA. 1992.

Hasting to Waste Student Worksheet

Landfill Model

Directions: Draw and label the layers of your landfill. Record the thickness of each layer

Begin - Today	End - In 3 weeks



HYPOTHESIS - What do you think will happen to the garbage in your landfill?

OBSERVATION CHART

Day / Date	Weight	Measurement	Changes / Observations
1			
2			
3			
4			
5			

Water

6			
7			
8			
9			
10			

Water

11			
12			
13			
14			
15			

Conclusion - Was your hypothesis correct? Why or why not?

Common Household Hazardous Waste

Subject: Science
Social Studies

Skills:
- Researching
- Classifying
- Analyzing

Concepts:
1. E, P
2. B
3. K, L

Objectives: Students will:
1) be able to identify common household products that contain hazardous waste properties.

2) identify proper storage and disposal methods for household hazardous waste.

State Standards:
Language Arts: 1.A.2 a
Science: 11.A.2 b 13.A.2 a 13.B.2 a, f
Social Studies: 17.C.2 c

Vocabulary:
- corrosive
- flammable
- household hazardous waste (HHW)
- hazardous
- ignitable
- reactive
- toxic

Setting: Indoor & Home

Materials:
- blackboard
- "Home Inventory of Potentially Hazardous Household Products" for each student (p.90)

Time: Two class periods

Activity Overview

Students identify and discuss various types of **household hazardous waste (HHW)** and disposal methods. They then complete a home inventory with the help of their parents or guardians.

Background

Many of the chemicals and products we have in our homes are potentially harmful. Most of these are safe if used correctly. However, disposal of these items or of their empty and almost-empty containers may become a problem. Because of their properties, they should not simply be dumped down kitchen or storm drains or placed in a regular landfill. Disposal in this manner is not illegal, but it is not the best disposal option. Whenever possible, purchase only what you need of these items and use them according to label instructions. Any leftover contents should be donated or shared with someone who can use them. Some hazardous items require special treatment and disposal to protect the environment and the public.

Household wastes are considered **hazardous** if they have any of the following properties: **Corrosive** (able to eat away the containers they are in, or the walls of trash cans or landfill liners); **Toxic** (poisonous to humans or animals); **Ignitable** or **Flammable** (able to catch fire and burn); or **Reactive** (able to explode). Some hazardous wastes are in more than one category. For example, fingernail polish is both toxic and ignitable.

Labels are often put on hazardous items to indicate just how dangerous they are. The chart below explains the three most common labels and their common meaning.

Warning	Toxicity	Example
CAUTION	Moderately toxic, Lethal dose: 1 ounce to 1 pint	ammonia, paints, floor polishes
WARNING	Very Toxic, Lethal dose: 1 tsp. to 1 tbsp.	antifreeze, bleach, some fertilizers, many pesticides
DANGER	Extremely Toxic, Lethal dose: a taste to a tsp.	rat poison, mercury batteries, some pesticides, paint thinner, drain opener, some oven cleaners

Preparation

1. Review background material related to types of household hazardous waste and their disposal.
2. Generate one copy for each student of "Home Inventory of Potentially Hazardous Household Products" (p.90).

Procedure

1. Write the words "household hazardous waste" on the board. Ask if anyone knows what the phrase, or individual terms, refer to. Discuss with them the various categories of hazardous wastes.

2. Ask the students if they think they have any such substances at their own homes. If so, where are they kept? Create the following chart on the board. Have students give examples of HHW that is stored in each location.

HHW Examples	
Kitchen:	**Basement:**
Bathroom:	**Garage:**

As products are mentioned, ask students the following: Why do they think they have them? What are they used for? What safety precautions do their parents take?

3. Ask the students what they think is the best way to dispose of these items. Can they think of any reasons why they should not be put in with the regular trash? (For example, corrosives could eat through cans, reactives could explode if they come in contact with other chemicals.)

4. Discuss the different types of warnings that might be found on labels. The most common labels, increasing in level of hazard, will be: Caution, Warning, and Danger.

5. Distribute the "Home Inventory of Potentially Hazardous Household Products." Instruct the students to complete the survey at their own homes, with the assistance of an adult. Make it clear to them that they are not to handle any of these products without the permission and supervision of an adult. Instruct them to wash their hands after completing the survey.

Wrap Up

Assessment

•The following day, have the students report their findings. On the board or on an overhead, prepare a tally sheet to determine which hazardous substances were found most often, and where they were stored. Look for common answers regarding: Where were they stored? What was the most common warning on the labels? Which products had instructions for safe disposal? What did they think were the most appropriate disposal means for these items? Was there any disagreement? (Be sure to correct any obviously incorrect answers, with explanations.)

Extensions

Community

• Have the class perform an inventory of the school janitorial supplies (with the permission of the principal and/or janitor). Students should then research and suggest alternatives for the school to use that will do the following: 1) clean as efficiently, 2) pose less of a hazard to the janitor, 3) save the school money. Students may wish to share their findings with the school administration.
• Have students research what they should do if they come in contact with one of the substances on the worksheet. What are the local numbers for poison hotlines or emergency numbers?

Multidisciplinary

• Have students research non-hazardous alternatives to the items listed on the work-

sheet. Have them create a list of ingredients necessary for each alternative. Have them go to the store and obtain the prices for each ingredient and the price for the product to be substituted. For example, a non-hazardous alternative to drain cleaners consists of baking soda and white vinegar. Students would determine the cost for the two items as well as a common commercial drain cleaner.

Outdoors

• Visit U.S. EPA's "Make A Difference in Your School: A How to Guide for Engaging Students in Resource Conservation and Waste Reduction" for ideas and examples on how to engage students in hands-on activities. www.epa.gov/epaoswer/education/pdfs/mad-guide.pdf.

Technology

• Have students visit the U.S. EPA's interactive web site "Learn About Chemicals Around Your House." www.epa.gov/kidshometour

This site allows students to choose a room in a house and then select those products that contain pesticides or toxic substances.

Resources

• *IEPA, Bureau of Land - Household Hazardous Waste (HHW) Collections*
This site provides information on the collection schedule and the accepted HHW waste types. www.epa.state.il.us/land/hazardous-waste/household-haz-waste/index.html

• *8 6 (3$ V0 DNH$ ' LIIHUHQFH&DP SDLJQ for Middle School Students*
This web site provides a wealth of information and resources as well as examples and guides on how to make a difference at your school. www.epa.gov/epaoswer/education/mad.htm

• *&HDQ6ZHHS8 6 $*
. HHS$P HULFD%HDXWLIXO(Grades 5-8)
An interactive web site that provides background information and six different lesson plans regarding waste management, source reduction, composting, recycling, trash as a source of energy and landfills. www.kab.org/kids/educators.htm

• *. HHS$P HULFD%HDXWLIXO*
Learn how you can get involved in cleaning up your community. The three focus areas of this nonprofit public education organization consist of the following: litter prevention, beautification and community improvement, and waste reduction. www.kab.org

• *Earth 911*
Provides community specific information on recycling, pollution and the environment. www.1800cleanup.org or www.earth911.org

• *Consumer's Handbook for Reducing Solid Waste*
This site describes how people can help solve a growing problem...garbage! www.epa.gov/epaoswer/non-hw/reduce/catbook.htm

• *DCEO's The Case for Investigating the 4Rs Investigating the 4Rs.*
This kit contains videos, lesson plans and a variety of products made from recycled materials. Grades K-adult (Free Rental!)

To reserve an educational kit, contact Rebecca Enrietto, Illinois Department of Commerce and Economic Opportunity (DCEO), Recycling Education Unit, at 217-785-7440 or rebecca.enrietto@illinois.gov. www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Education/ISTEP_cases_program.htm
www.istep.org

Name:_____

Home Inventory of Potentially Hazardous Household Products Student Sheet

Take this worksheet home and with your parent's or guardian's help try to locate the 10 items listed below. On the item's package or label, you should be able to find the hazard characteristic. In the column labeled Proper Disposal, write the number or numbers of the way you think the item should be disposed of:

1) Buy only what you need.
2) Use it up for its intended purpose.
3) Donate it to someone who can use it.
4) Recycle it.
5) HHW (Household Hazardous Waste) collection.

Do You Have?	Item	Where Is It Stored?	Warning Labels	Hazard Characteristics	Proper Disposal
	Car Battery				
	Shaving Cream Can				
	Used Motor Oil				
	Empty Spray Paint Can				
	Drain Cleaner				
	Ant & Roach Killer				
	Furniture Polish				
	Rug Spot Remover				
	Flashlight Battery				
	Ammonia				

Name:_____

Home Inventory of Potentially Hazardous Household Products Answer Sheet

Take this worksheet home and with your parent's or guardian's help try to locate the 10 items listed below. On the item's package or label, you should be able to find the hazard characteristic. In the column labeled Proper Disposal, write the number or numbers of the way you think the item should be disposed of:

1) Buy only what you need.
2) Use it up for its intended purpose.
3) Donate it to someone who can use it.
4) Recycle it.
5) HHW (Household Hazardous Waste) collection.

Proper Disposal is listed in rank order. The first number listed is the most appropriate answer.

Do You Have?	Item	Where Is It Stored?	Warning Labels	Hazard Characteristics	Proper Disposal
	Car Battery	Answers	will vary	Corrosive, Toxic	4
	Shaving Cream Can	Answers	will vary	Reactive	2 & 5
	Used Motor Oil	Answers	will vary	Flammable, Toxic	4
	Empty Spray Paint Can	Answers	will vary	Reactive	2 & 5
	Drain Cleaner	Answers	will vary	Corrosive, Toxic	1, 2, 3 & 5
	Ant & Roach Killer	Answers	will vary	Toxic	1, 2, 3 & 5
	Furniture Polish	Answers	will vary	Flammable, Toxic	1, 2, 3 & 5
	Rug Spot Remover	Answers	will vary	Flammable, Toxic	1, 2, 3 & 5
	Flashlight Battery	Answers	will vary	Toxic	4 & 5
	Ammonia	Answers	will vary	Corrosive, Toxic	1, 2, 3 & 5

Illinois Pollution Jeopardy

Subject: Language Arts
Science
Social Studies

Skills:
- Teamwork
- Researching
- Comparing/ Contrasting
- Public Speaking
- Problem Solving

Concepts: 1. A-F 2. C 3. A, E, G, I, M, O, R

Objectives: Students will:
1) identify and research different forms of pollution.

2) present a short report on their own research.

3) understand how different types of pollution are related to and different from each other.

State Standards:
Language Arts: 4.A.2 b 4.B.2 b 5.A.2 a, b
Science: 12.E.2 a & 13.B.2 f
Social Studies: 17.B.2 a 17.C.2 a
Physical Dev. & Health: 22.C.2

Vocabulary:
- air pollution
- global climate change
- groundwater
- hazardous waste
- non-hazardous waste
- pollution prevention
- surface water

Setting: Indoor

Materials:
- 4 inch x 6 inch index cards (two per student)
- tape
- stopwatch
- six copies of the Group Planning Student Page (p.96)
- six copies of the Question / Answer Worksheet (p.97)

Time: Five class periods

Activity Overview

Students take part in developing a game that will help the entire class to understand what types of pollution affect Illinois.

Background

Pollution can be categorized and classified in many different ways. In this activity, students will research pollution based on the following definitions.

Pollution Prevention focuses on ways to avoid producing pollution by changing or modifying plans, practices or habits. It also includes activities that protect natural resources through conservation or efficient use.

Air Pollution consists of particulates, nitrous oxides, carbon monoxide and other harmful chemicals which make the air itself harmful or dangerous for people, animals, plants or structures.

Global Climate Change addresses pollutants which appear to have an effect on Earth's weather and climate.

Hazardous Waste refers to solid wastes which are inherently toxic to humans or other animals and plants. It includes toxic chemicals, medical waste and radioactive wastes.

Non-hazardous Wastes includes all other solid wastes, those which are not immediately toxic but which are still harmful in large concentrations or quantities. These include some organic wastes, garbage, unrecyclable packaging and litter.

Surface Water and **Groundwater** are more accurately locations for pollution rather than types, but are separated to clarify the different kinds of problems they face. Surface water includes rivers, lakes and streams, and the focus is on the pollutants released into them. Groundwater comes from the reserves of water hidden underneath the earth in aquifers. Both surface water and groundwater are affected by nonpoint source pollution: pollutants which find their way into water from a number of different sources including industries, residences, leaking underground tanks and runoff from streets and farms.

Preparation

1. Make copies of the group planning worksheet, so that there is one per team.

2. Gather resources that may be helpful in the students' investigation of their topic area.

3. Arrange for students to visit the library on the second day of research.

4. For the fifth day prepare a "Jeopardy" game board. Using 8 1/2 x 11 inch paper create the category titles (Air Pollution, Global Climate Change, Hazardous Waste, Non-Hazardous Waste, Surface Water Pollution, Ground Water Pollution).

5. For the fifth day put together the "Jeopardy" game board. Tape the six categories horizontally to the chalk board or a wall with enough room underneath for six index cards to be taped vertically. Upon receiving the cards from the students select six cards from each category. Label the backs of these cards with point values from 10 through 60. Tape these cards to the blackboard or wall under the appropriate category from 10 through 60.

6. With the remaining two cards, create a "Double Jeopardy" game board with the same topics as the first. This time value the cards 100 and 120. Tape the double jeopardy cards under the appropriate category.

Procedure

Day 1

1. Have students brainstorm what they know about pollution and what causes pollution (it may be helpful for students to participate in the other activities in this section, if they haven't already). As they name the types and causes of pollution, write their answers on the board. Ask them what their answers have in common and categorize them under the following six headings: Air Pollution, Global Climate Change, Hazardous Waste, Non-Hazardous Waste, Surface Water Pollution and Groundwater Pollution.

2. Divide the class into groups of four. Explain to the class that they will be creating a "Jeopardy" game which they will then play. The game will focus on questions and answers about pollution found in Illinois.

3. Ask each group to choose which of the six pollution categories they would like to investigate. On a piece of scratch paper, have them indicate a first and second choice. Collect the sheets and designate a category for each group, making sure that each group has a different assignment.

4. Give each group a Group Planning Student Page (p. 96) and instruct the students to use the page to organize their group and plan their investigation.

5. Each group begins to carry out their plan. Suggest that they should be collecting ideas for their questions and answers as they gather information.

Day 2

6. Groups should continue to carry out their plans, gathering information from a variety of sources, analyzing and evaluating the data.

Day 3

7. Groups finish their research. Instruct the groups to prepare a brief (two to five minutes) report to share with the rest of the class.

Day 4

8. Ask the research groups to give their brief reports. After each report, the teacher should clarify content, if necessary, and ask for questions from the other groups.

9. After all groups have shared their reports, ask students if they are familiar with the TV game show "Jeopardy." Make sure they under-

stand that players are given answers to questions and that they must come up with the question that fits the answer. For example, a player may be given the answer "Soda cans made of this metal are recyclable" and must come up with the question "What is aluminum?" Point out that a good answer has enough information in it so that only one right answer fits. Teachers may wish to ask students for examples of answers that do not have enough information and for examples of those that do.

10. In groups, have students decide on eight answers in question form that represent the type of pollution researched: two questions on natural causes, two questions on human causes, two questions on the natural system, and two questions on pollution prevention or other remedies for that topic.

11. Give the groups the master question/answer worksheet. Have the students write their answers in the left column and the correct question on the right.

12. Give each group eight 4x6 inch index cards. On the first line of each card, have students write the pollution topic they investigated (Air Pollution, Global Climate Change, Hazardous Waste, Non-Hazardous Waste, Surface Water Pollution, Groundwater Pollution). Have the groups write each of the eight answers on a card below the pollution topic heading. See example below.

Surface Water Pollution
This petroleum product is often washed off
roads or parking lots into creeks, rivers, or lakes.

13. Collect the cards and the master question/answer worksheet.

Day 5

14. Prepare the Jeopardy gameboard as noted in #4 under Preparation.

15. Create new groups so that each group has one member from each of the research teams. (Basically, you should have four teams of six participants if you have a class size of 24 students.)

16. Either assign each team a number or allow them to select a team name. Make a scoreboard on the blackboard for recording each team's points and penalties.

17. Display and explain the "Jeopardy" rules.
- After the teacher reads the answer, the first team to have all team members raising their hands will be called on by the teacher to guess the question. All team members must say the question together. Or, you may wish to use nosiemakers or push button lights.
- If the team guesses the right question, they will earn the points given to that question.
- If they guess incorrectly, the point amount is subtracted from their team's score and the next team to have all members raising their hands gets to guess. This continues until one team guesses the right question or until all teams pass. If no team guesses the right question, the teacher reads the correct question from the master list.
- When called on, a team has five seconds to guess the question.
- Within a team, players rotate picking the category and point amount for the next answer.
- Play continues until all answers are revealed.

18. Play the first round of the game. As a team selects a category and point amount,

turn that card over, tape it again to the board with the answer side showing, and read the answer. Consult the master list to verify the "right" question. If a team guesses correctly, place the point amount on the scoreboard: if they guess incorrectly, place the point amount with a minus sign. At the end of the round tally the scores.

19. Play "Double Jeopardy," adding the team scores from this round to the scores from round one. Rules do not change, only the points per question increase.

20. After the game has ended, ask students the following questions.

- What similarities were there between the types of pollution?
- What were the major differences?
- What type of pollution do you expect to find in our community? Why?
- What types of things can be done to prevent or reduce pollution?

Wrap Up

Assessment

- Use all of the student-generated questions in a formal assessment, such as a quiz or test, to confirm individual student comprehension.

Resources

- Illinois Environmental Protection Agency
http://www.epa.state.il.us

- United States Environmental Protection Agency
http://www.epa.gov

Adapted From: "Community Jeopardy," Community Connections. The Oakland Museum. Oakland, CA. 1992.

Date: _____ **Group Members:** _____
_____
_____
_____

Group Planning Student Page

1. The type of pollution we will investigate: _____

2. Research

Your group must have someone investigating the following research areas. Write your name next to the research area you will investigate. Do your research for the questions listed on a separate page.

_____ **Natural Causes:**
- Find at least two natural causes of this type of pollution.
- What type of natural or human communities does it affect?
- What type of harm or damage can it cause?

_____ **Human Causes:**
- Find at least four human causes of this type of pollution.
- What type of natural or human communities does it affect?
- What type of harm or damage can it cause?

_____ **Natural Systems:**
- What natural systems are involved in this type of pollution?
- Can this type of pollution affect other natural systems (air, land, and water)?

_____ **Possible Remedies:**
- Find at least three ways in which this type of pollution could be prevented or reduced.
- Identify at least one strategy that is controversial or that different people will disagree about. Why will they disagree?

3. Resources

What resources do you plan to use for your investigation?

4. Roles

Your group must have someone responsible for the following roles. Write your name next to your role. Everyone must have a role.

_____ **Research Coordinator:** Makes sure each person has something to research and helps to find resources.

_____ **Question / Answer Coordinator:** Makes sure each person in the group completes their question/answers on time.

_____ **Card Coordinator:** Makes sure the group creates eight cards and that all have the pollution topic listed on each.

_____ **Facilitator:** Takes any group questions to the teacher for clarification. (Do this after making sure that no one in the group knows or agrees on the answer to the question).

Date: _____ Group Members: _____

Master Questions / Answer Student Worksheet

Pollution Topic: _____

Answers:	Questions:
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.

4 What Can We Do About Pollution Issues?

Overview

This final section builds on the knowledge and skills developed earlier in the curriculum. Students have looked at what pollution is, where it comes from, and how it affects them. In the next few activities they will continue to learn how to think about pollution issues, how to recognize and research them, and how to make decisions and choices about them. Using issues in their own communities, students begin to think about action steps and action projects that they can undertake.

Background

Most pollution results from human behavior. Some of its consequences are permanent, and some of its effects can be remedied by other kinds of behavior. To prevent pollution or work to clean up what already exists, people first must understand which types of behavior result in pollution, and which kinds minimize it. By learning how to behave in ways that prevent the air, land, and water from being polluted in the first place, students are taking steps toward reducing pollution's harmful effects on people, wildlife and habitats.

As students learn about pollution, they naturally begin to ask what can be done—by the government, by business, by their parents, or by themselves. Some may have asked for ideas for action projects or for personal behavior change at earlier points in the curriculum. Discussion of these steps has been left until now to make the point that actions should be well-researched and carefully considered. Any actions that students undertake have the potential for affecting large numbers of people. As a result, it is important that students learn the importance of obtaining relevant facts about a situation, understand how to develop proposals and plans, and begin to consider the consequences of their own efforts.

Although a few individual actions are included in this section's activities, most focus on group activities—efforts that can be made in cooperation with their classmates or others in the community. This emphasis is employed in part because it gives students the opportunity to share and explore different ideas, to learn about sharing success (or failure) with a group, and to help them recognize that some solutions have a better chance of success when large numbers of people are in support. However, this should not cause anyone to lose sight of the importance of individual behavior as well. For those students (or their teachers) who remain interested in what they can do as individuals, the following items are suggested.

Individual "Can Do's"

Each of us has the power to use resources wisely or foolishly, to create waste and pollution that we will later have to live with, or to choose not to use or consume resources in ways that produce pollution. Our choices today can help determine how healthy our world will be tomorrow and the next day. The following pages provide some basic actions that we can take that will help us see the significance of our own choices.

Be Water Wise

We all need water to live. The average person uses 80 to 100 gallons (300 to 379 liters) of water every day. But the amount of water that

you actually need to survive is two and a half quarts (a little more than a two liter bottle full)! The rest of the water we use every day isn't necessary for our survival; it just makes our lives a lot easier.

How Much Water Do You Use?

You use water throughout the day for many different tasks. In the morning, your water use starts when you flush the toilet, take a shower, and brush your teeth. After breakfast you may start the dishwasher or wash the family's morning dishes in the sink. At school, you drink water from the fountain and wash your hands after recess or a messy art project.

After school you may realize that your sports uniform is dirty and that you need to wear it for a game tonight. So, you throw your uniform into the washing machine. Later, you probably brush your teeth again and wash your face before you go to bed. Believe it or not, you may have used more than 80 gallons (300 liters) of water during that day!

Make Every Drop Count

There are many ways to conserve water or to reduce the amount of water we use at home, school, work and places we visit. It's important that we think before we turn on the water, so that every drop we use counts. Look at these examples:

- Waiting to fix a leaky faucet
- Watering the lawn at noon
- Using the garbage disposal all the time

These are examples of behaviors that result in the excess use of water.

The following is a list of activities people could undertake if they wanted to reduce the amount of water they use.

♦ Check for leaky faucets and toilets. If you wait a week to fix a leaky faucet, the faucet can drip up to 140 gallons of water. If you wait to fix a leaking toilet, up to 200 gallons of water a day could be lost.

♦ Turning the lawn sprinkler on at noon is not a good idea. The hot sun evaporates the water your lawn needs. It is usually better to water early in the morning when water evaporates more slowly.

♦ A garbage disposal uses one gallon of water per minute. Many food scraps can be composted. This not only saves water, but produces a rich material to put on your flowers and garden.

♦ Taking shorter showers or using less water in the bathtub can save a lot of the 35 gallons of water you could be using currently to bathe yourself. To save additional water, turn off the water in the shower while soaping up and shampooing your hair.

♦ By turning off the faucet and not letting the water run continuously when you brush your teeth or wash your face, you can save up to five gallons of water a minute.

♦ Run the washing machine and the dishwasher only with full loads.

♦ Install water-saving shower heads.

♦ Install toilet devices that reduce the amount of water used to flush waste; when replacing a toilet purchase a low-flow toilet which uses less water per flush.

Leaking faucets, hoses, and pipes are the biggest water wasters in the home. Proper maintenance is one way to stop this waste, and there are also many devices that can help save water. These devices will more than pay for themselves in the amount of water (and

money) they will save. Items that help save on the amount of water used by toilets, showers, washing machines and lawn sprinklers are usually inexpensive and easy to install.

The other way you can conserve involves the way you think about water. Be creative in looking for ways to cut back on the amount of water you use. Good examples include: keeping a pitcher of water in the refrigerator so you don't have to run the tap water to get it cold; using a bucket of water to wash and rinse the car instead of running water from a hose; or planting drought resistant grass, flowers, shrubs and trees that require little water in your yard, school, or park.

Nonpoint Source Pollution and You

As we learned in Section 3, nonpoint source pollution is polluted water that runs off from places such as agricultural fields, livestock feedlots, construction sites, city streets, mines and logging operations. Each of us, whether we know it or not, contributes to nonpoint source pollution through our daily activities. Because of this, nonpoint source pollution is the biggest threat to many of Illinois' wetlands, rivers, streams and lakes.

In our everyday activities we can help prevent or stop nonpoint source pollution and keep our environment clean. Small changes in your life can make a big difference in the quality of Illinois' water resources. Most nonpoint source pollution in your neighborhood is caused by the runoff of stormwater (rain and melting snow that flow across the ground and pavement in urban areas). The stormwater can pick up and carry pollutants into storm sewers. Storm sewers carry this water, untreated, through miles of pipes to nearby rivers, streams and lakes. Here are a few ways that nonpoint source pollution can be reduced in your neighborhood. Making even a couple of these changes can help reduce nonpoint source pollution and result in cleaner water in Illinois.

❑ *Litter* - Litter, including extinguished cigarette butts, belongs in trash containers. Never throw litter in streets, yards, playgrounds, or down storm drains.

❑ *Fertilizers* - Fertilizers contain nitrates and phosphates that, in abundance, cause too much algae in rivers, streams and lakes. This can lead to fish kills. Avoid overuse of fertilizers. Do not apply them on your lawn or garden when it seems likely to rain and the fertilizers can easily wash away. Mulching grass and leaving it on the lawn returns nutrients to the lawn and lets you avoid bagging and disposing of yard waste. Unused fertilizer can be taken to a permanent collection site or a one day Household Hazardous Waste (HHW) collection event.

❑ *Pesticides* - Many products made to kill pests in your home or yard are also toxic to humans, other animals, aquatic organisms, or plants. Carefully follow the directions on the labels of these products. Do not overuse pesticides. Consider using nature's own "pesticides," such as ladybugs and praying mantises, in place of chemical pesticides. If possible, avoid using a potentially toxic substance (one that says poison, caution, danger or warning on the label). If you have to purchase this type of product, buy only the amount you need and use it all. Unused pesticides can be taken to a permanent collection site or a one day HHW collection event.

❑ *Household Hazardous Waste* - Many common household products (paint thinner, moth balls, oven cleaners, etc.) contain hazardous ingredients. Never pour these products on your driveway, yard, or down the sink or storm drain. Try to reduce the amount of hazardous products you use by substituting less hazardous alternatives (e.g., cedar chips for mothballs, using baking soda and a little elbow grease instead of oven cleaner). Always be on the lookout for ways to reduce the number of hazardous products you use. If you have to purchase this type of product, buy only the amount you need and use it all. Unused products of this sort can also be taken to a permanent collection site or a one day HHW collection event.

❑ *Motor Oil* - Motor oil contains chemicals that are harmful to animals, including humans and fish. When oil in a car is changed, the used motor oil should not be poured down storm drains, on the driveway or the ground. Put motor oil in a clean container with a top (an empty milk jug is handy) and take it to a service station for recycling. This product can also be taken to a permanent collection site or a one day HHW collection event. Another alternative is to take your car to service stations that perform oil changes. They are required by law to dispose of dirty oil properly.

❑ *Car Washing* - Many car detergents contain phosphates that can pollute water. Use only non-phosphate detergents when washing a car.

❑ *Pet Waste* - Animal waste contains bacteria and viruses that can contaminate aquatic organisms and cause swimming areas in lakes and rivers to be closed. Pet owners should clean up animal waste with newspaper or a scooper and place it in the garbage.

❑ *Leaves and Grass* - Never dump leaves or grass into the street where the rain will wash them into a storm drain and clog it. When the leaves and grass enter a body of water, their decomposition could cause a fish kill by using up the oxygen.

❑ *Lakes, Rivers and Stream Banks* - If you live near a stream, river or lake, you can protect it from nonpoint source pollution by removing trash from the water and keeping humans, cars, and farm animals away from the edge of the water. Building steps or a ramp to the water protects the bank from erosion and planting vegetation on the banks holds the soil in place. These activities protect a stream or lake from the nonpoint source pollution caused by the runoff of soil into the water.

Everything Deserves a Second Chance - Even Tires

Nearly everyone has heard of recycling used aluminum cans, glass, plastic and newspaper. Many people recycle at home, school, or at work. However, the majority of people do not know that scrap tires are a recyclable product as well. Used tires are being recycled, reused, or made into different products to serve a variety of uses.

Every year in the United States 270 million tires, or about one tire per person, are scrapped. The state of Illinois produces more than 12 million of these used tires. Since they do not easily or quickly degrade or decompose, piles of tires become a real problem.

Used tires can pose a serious threat to humans and the environment when disposed of improperly. Piles of scrap tires collect rain water and become a perfect breeding ground for mosquitoes and other disease-carrying organisms. Open burning of tires produces air pollution and can release toxic oils into the

soil and groundwater. For these reasons, used tires must be carefully disposed of.

The IEPA is responsible for the transport, storage, disposal and recycling of used tires in Illinois. As of July 1994, whole used tires cannot be disposed of in a landfill. So what can be done with all those tires?

Shredded scrap tires can be used as tire derived fuel (TDF) to burn with coal in power plants and factories to produce energy. Air pollution is reduced when TDF is blended and burned with coal.

When the steel belting is removed from shredded steel-belted tires, the material can be used as playground turf instead of gravel, concrete, asphalt, or wood chips. This rubber turf provides a much safer play area because of the cushioning properties of the rubber. When a glue is added to this material and it is pressed and flattened, the result is "elastocrete," a flooring material that can be used for playgrounds and exercise rooms.

Rubber that does not contain wire can be ground into a sand-like material. This "crumb rubber" is used in rubberized asphalt (an experimental pavement for roads), railroad crossing mats, ink pens, rulers, and in the manufacture of many other products. Used tires can be refurbished and reused through a process called retreading. Retreading a tire involves replacing the grooved surface of a tire with new rubber. Planters, swings, playground equipment and sandboxes can also be made from scrap tires.

Alternative Fuels

Since the 1990s, federal and state policies have been directed toward cleaner air and energy independence. Alternative fuels provide both a reduction in vehicle emissions and a use of domestic energy resources. The United States has been accustomed to importing a majority of its petroleum for transportation uses and consuming seven million barrels of oil per day more than it produces. Other countries, including Brazil, the Netherlands, New Zealand, Italy and Japan have established their own fuel programs utilizing domestic resources to gain a larger degree of energy independence.

Listed below are some alternative fuels that are technologically and economically feasible. The only major problem with alternative fuels at this time is the lack of widespread refueling infastructure, but that is a solvable problem.

For current information on alternative fuels, such as E-85, please visit IEPA's Illinois Green Fleets web page at http://www.illinois-greenfleets.org/, or the U.S. Department of Energy, Energy Efficiency and Renewable Energy's web page at http://www.eere.energy.gov/afdc/altfuel/altfuels.html.

All alternative fuel information comes from the "Alternative Fuels Resource Guide For Fleet Managers," IEPA, Springfield, IL, 1998. http://www.epa.state.il.us/air/clean-fuel-fleet/index.html

Natural Gas****

Natural gas is used as a vehicle fuel in nearly 40 countries around the world. Natural gas vehicles are much cleaner than conventional gasoline burning cars, having 95 percent less tailpipe emissions. Carbon monoxide, nitrous oxides and hydrocarbons are all much lower than the emissions from gasoline engines.

Natural gas does not have to be manufactured as other types of fuels do. It requires no refining and very little processing. Natural gas is retrieved under pressure from an underground field, cleaned and purified to meet specifications and distributed through an existing pipeline network.

Contrary to popular belief, natural gas is not a highly explosive fuel and in fact is less hazardous than gasoline. This is because its ignition temperature is twice that of gasoline and it does not burn as well in open air. The only perceived disadvantage of a natural gas vehicle is the added weight and size of special large fuel tanks to hold the natural gas.

Liquid Petroleum

Liquefied petroleum gas (LPG), or propane, has been used as a motor vehicle fuel for more than 80 years. It became more popular in the 1950s as a fuel to power indoor factory equipment such as forklifts, so as to reduce harmful carbon dioxide emissions and workers' exposure to them.

LPG is a by-product of natural gas or petroleum refining. The chemical and physical properties of it offer several advantages over gasoline. It has an octane of 104, which reduces "knocking" of the engine. Propane engines have been reported to experience less wear and require less maintenance than gasoline engines, because of its cleaner burning properties—a characteristic of natural gas as well.

The primary air quality benefit of LPGs as a motor fuel is lower hydrocarbon and carbon dioxide emissions compared with conventional gasoline. It burns clean and produces virtually no particulates or sulfur emissions. LPG is a nontoxic gas. No long-term effects have been reported from exposure to propane vapors.

Ethanol

Many of the harmful pollutants that automobiles emit into the air are caused by the burning of fuels. A special fuel made from corn and other high-starch content crops called ethanol is being used in cars and trucks. Brazil leads the world in experience with ethanol as a transportation fuel. It has been producing ethanol from sugarcane since the 1930s. Currently, more than four million vehicles run on ethanol in Brazil as a result of a government program to make ethanol from sugar cane.

Ethanol can be used alone as a fuel, or it can be blended with gasoline. Each bushel of corn that is processed can make two and a half gallons of ethanol. Over 17 percent of the corn grown in Illinois, or one out of every six rows of corn, goes to the production of ethanol in the state.

Electricity

Electric cars are not a new concept for today's auto manufacturers. General Motors has maintained some type of electric vehicle program since the early 1900s. Prior to World War I, more than one-third of the motor vehicles in the United States were electric, many of them powered by Thomas Edison's nickel-iron battery. The advances of gasoline engines eventually caused electric cars to be phased out.

Electric vehicles do not have any direct emissions and so have the distinction of being "zero emission vehicles" or ZEVs. They are powered by electricity stored in a rechargeable battery pack.The electricity comes from the electric grid; the emissions come from somewhere, but not the car.

Problems associated with ZEVs are technology, price, production and availability of the vehicles. The biggest obstacle facing electric vehicles is the development of batteries that are capable of holding an electric charge for long distance travel.

Pollution Prevention Opportunities in the Home

How many throwaway conveniences have you come to enjoy—even taken for granted—in your home, at school, or when you're out

having fun? So many that experts have called the United States a "disposable society." Those disposable products and other trash have also helped us to set a world record for the mountain of garbage that we produce each year.

We all generate waste in our daily activities. There are many ways each of us can help reduce or prevent the pollution we cause – at the same time we can save money, too. Here is a simple list of ways to reduce and reuse. For a more detailed listing visit http://www.epa.state.il.us/p2/p2-at-home.html, or http://www.epa.state.il.us/citizens/green-tips.html.

Reduce

It's easy to reduce the amount and/or toxicity of waste you generate! Here are a few things you can do:

- Look for less packaging in the things you purchase.
- Reduce the water you use.
- Reduce the amount of energy (electricity, gas, etc.) you use.
- Reduce the amount of paper you use.
- Use non-toxic (or less toxic) products.

Reuse

Here are some simple suggestions that will also help lessen the amount of solid waste going to the landfill:

- Use reusable, long-life products.
- Think of creative ways to reuse things.

Recycling—The Next Best Solution to Pollution Prevention

For many people, it doesn't seem right to throw something away that can be salvaged and reused. That's the idea behind recycling. Before materials reach the landfill and take up valuable landfill space, we can intercept them and manufacture new, useful products. In 1998, about 28 percent of Illinois' total waste stream – 4.6 million tons per year – was recycled.

Purchasing items that you can easily recycle in your area is a good way to avoid throwing things away. It is also important that you purchase items packaged in containers that are made of recycled materials.

If your community does not offer curbside recycling, look in the yellow pages of your phone book under "recycling" to find your recycling center.

The Solid Waste Planning and Recycling Act, passed in 1988, requires all counties in Illinois and the city of Chicago to have reached recycling goals of 25 percent of their garbage within five years of adopting their solid waste management plan, depending on the availabilty of recycling markets. All Illinois counties and the city of Chicago have developed and are acting on their solid waste management plans. Everyone can contribute to this goal by making a habit of recycling.

Pollution Prevention Opportunities for Industries

Many of the suggestions given in "Pollution Prevention Opportunities in the Home" apply to industry as well. The industrial environment is much more complex than the home environment and deals in higher volumes of materials. Because of this, there are additional pollution prevention opportunities in this setting. On the next page are examples from Illinois companies that have implemented pollution prevention. These suggestions were supplied by college level students recruited by the IEPA Office of Pollution Prevention to assist industries in implementing pollution prevention projects. These are only a few of the internships. For more information contact Richard Reese, Program Coordinator, Illinois EPA - Office of Pollution Prevention, (217) 782-8700. http://www.epa.state.il.us/p2/index.html

Eli Bridge Company

Jacksonville, Illinois

Eli Bridge Company has been in the business of manufacturing amusement park rides since 1900. Currently it manufactures the Ferris Wheel, the Scrambler and a new ride for tots called the Construction Zone. Intern Brian Langkan from SIU, Carbondale, was assigned to perform an energy efficiency assessment at the facility and investigate a material substitute for sandblasting.

Brian's results included:

- The design of an alternative heating system for use within the manufacturing areas of the building. This system is estimated to cut approximately $7,600 a year off the natural gas bill.

- The development of a program to use the company's lighting fixtures more efficiently. The estimated savings could equal $220 per year.

- By repairing all leaks in the compressed air lines and combining two compressors, $1,200 could annually be saved in energy costs.

- Developing guidelines for the use of the electrostatic precipitators that would improve efficiencies to at least 97 percent.

- Using an alternative sandblasting material that could be recycled and reused 10 times resulting in a $200 a year savings in disposal costs.

Matsushita Universal Media Services

Pinckneyville, Illinois

Matsushita Universal Media Services manufactures and packages audio compact discs. Intern Robin Holmberg of SIU, Carbondale, investigated ways to reduce approximately 42.5 tons of polycarbonate scrap generated from disc moldings that did not meet specifications and disc cutouts from the center of each disc (sprues).

Robin's results included:

- Proposing the use of an in-house system to grind and repelletize the scrap. By implementing this system, Matsushita could save more than $85,000 per year. The capital needed for this investment would be paid off in less than eight months of savings.

Piecing Together the Future

Subject: Art
Language Arts
Science
Social Studies

Skills:
- Predicting
- Creative thinking
- Comparing / Contrasting
- Creating

Concepts: 2. D
4. F, H, I, M

Objectives: Students will:
1) identify pollution problems in their community.

2) identify steps that can remedy the problems.

3) identify long term consequences if the problems are not addressed.

4) recognize that people may disagree on the problems and the solutions.

State Standards:
Language Arts: 1.C.2 a, b
4.A.2 a,b & 4.B.2 b
Science: 13.B.2 b, d, f
Social Studies: 15.B.2 c
17.C.2 c & 17.D.2 a

Setting: Indoor

Materials:
- old magazines or other discarded publications with photographs
- scissors
- glue
- poster board

Time: Three class periods

Activity Overview

Students speculate what the future will be like if local pollution problems are not remedied.

Background

One of the reasons that pollution has become a problem is that people were not able to predict the consequences their choices would have. Few people predicted that the burning of fossil fuels would eventually bring a rise in acid precipitation; the scientists who developed CFCs had no idea that their invention could eventually harm the ozone layer.

However, some effects of pollution are predictable, and in some cases probable. The first step in getting people to take action to prevent these problems is getting them to recognize what the results of their actions or inactions are likely to be. Most people can identify short-term results or consequences: a certain behavior may be illegal, thus resulting in a ticket or jail time, or it may be expensive, resulting in a loss of money or resources. People are less likely to consider the long-term effects of behavior, such as what the cost will be to themselves or to the environment, over several years or decades.

Some people may still choose a certain course of action, even knowing that the predictable results are damaging or negative. There are many reasons why a person may choose this, some of which students will consider in this activity. What is most important here is not that students come up with a particular course of action to take, but that they begin to consider both the short and long-term effects that pollution can have.

Preparation

1. Have students bring newspapers, magazines, advertising circulars, and other discarded publication materials with photographs and illustrations.

Procedures

Day One

1. Ask students to brainstorm ideas/answers on a piece of paper or in their journals including:

- List at least five common pollution problems found in your community.
- Pick two problems.
- What are some of the possible causes of these problems?

2. Have students form groups of four. Have them share their journal entries and discuss their answers. Then have the group brainstorm, discuss and write down their ideas for the following questions:

- What do you think the future might look like if nothing was done to correct these problems?
- What steps could be taken to solve these problems?

3. Tell the students that each group will be making two collages. The first should depict the group's vision of what the future might look like if nothing was done to correct the problems. The second collage will depict what steps could be taken to solve the problems they have identified. Instruct them to cut out and use photographs and images from the magazines, newspapers and circulars they have brought in. Allow them to draw any images they cannot find in the illustrations.

Day Two

4. Give each group two pieces of poster board or similar paper and the materials for making the collages. Remind them what the collages are supposed to depict. Recommend that they look at both sides of the paper before they cut out any images. Have the students make the collages.

Day Three

5. Have each group share its collages and the problems and solutions they identified with the rest of the class. Have them list their top two predictions and solutions. Write their answers on the board and make note of any similarities or common themes.

Wrap Up

Assessment

After all the groups have presented, the teacher will write the following questions on the overhead or chalkboard. Students should individually prepare their answers and discuss them in either a large or small group setting.

- What similarities do they notice between the answers given by the different groups? Will the proposed solutions affect individual lifestyles? Will they cause people to live in different ways? Will they allow people to do something they want to do, or force people to do things they do not want to do?

- Will the proposed solutions affect people's financial situations? How will these solutions be paid for? Would they affect the costs of goods and services? Will they affect taxes? Would they affect peoples' jobs, either by eliminating old ones or creating new ones?

- Who might be opposed to these solutions? Would they only affect the wants or needs of a few community members?

- What effect will the solutions have on air, land or water quality?

Extensions

Community

- Have students interview a senior citizen from their family or community about a pollution problem they experienced. Students might

want to focus on the details of the problem and what, if anything, was done to solve it. What specific steps were taken? Does the problem still exist? Who is affected?

Multidisciplinary

• Have each student develop a survey based on the pollution problems and solutions they developed in the activity. Students could exchange and complete each other's surveys or they could have other classes or family members complete them.

Outdoor

• Have students participate in a local community or river cleanup day, or participate in your county's adopt-a-highway program. If none are offered, have students with the assistance of community members and organizations plan one.

Technology

• Have students visit one or both of the following websites to determine what types of pollutants are in their town, county or state.

Enviromapper
www.epa.gov/enviro/html/em/index.html

Illinois Water Quality Resource Assessments
http://www.epa.state.il.us/water/water-quality/

Resources

• *Enviromapper*
EnviroMapper is a powerful tool to map various types of environmental information, including air releases, drinking water, toxic releases, hazardous wastes, water discharge permits and Superfund sites. View spatial data at the national, state, and county levels, as well as utilize GIS functionality, such as displaying multiple spatial layers, zooming, panning, identifying features, and querying single points.
www.epa.gov/enviro/html/em/index.html

• *Surf Your Watershed*
A service to help locate, use and share environmental information about your state and watershed. http://www.epa.gov/surf

Adapted from: "Ecotopia/Dystopia," Community Connections. The Oakland Museum. Oakland, CA. 1992.

Living with Wants and Needs

Subject: Language Arts
Mathematics
Science
Social Studies

Skills:
- Analyzing
- Classifying
- Creative thinking

Concepts: 2. F
4. H, J, M

Objectives: Students will:
1) identify the difference between wants and needs in their own lives.

2) learn that they have choices as consumers related to their needs and wants.

State Standards:
Language Arts: 4.A.2 b,c
Mathematics: 6.C.2 a & 7.A.2 b
Science: 11.A.2 c & 13.B.2 f
Social Studies: 15.B.2 a, b, c
15.D.2 a, b & 15.E.2 a

Vocabulary:
- source reduction

Setting: Indoor

Materials:
- copies of the Wants and Needs Cards (p. 113)
- three plates
- three types of cookies
- means of measuring water from a sink

Time: Two class periods

Activity Overview

Students examine the concepts of wants and needs and determine ways that their personal choices can affect pollution.

Background

People have different ideas about what constitutes "wants" and "needs." Generally, people will agree on the definition that needs are what we require for survival, and wants are things we would like to have or which would make our lives easier, but which are not necessary for survival. Opinions and decisions will depend upon a person's culture, background, values and personal situation. For example, millions of people around the world live without electricity, yet most people in America would consider it necessary for survival. A person living in rural Illinois might be totally dependent upon her or his car, whereas someone living in Chicago, where public transportation is common, may not even own one. On the other hand, a spinning wheel might have been thought of as a necessity (need) in most households centuries ago to make clothing, but is a craft item (want) for most of us now.

Although people may classify some of these things differently, there are some items which are common needs for all human beings. All people share basic biological needs for food, water, shelter and air. Other important things for all people are medicine, clothing and transportation. Other "wants" may be classified as "needs" if a person requires them to meet basic biological needs.

Preparation

1. Make one set of copies of the Wants and Needs cards for each pair of students. Keep each set of cards separated in an envelope so that they do not get mixed together.

2. Get three different packages (brands) of one type of cookie (e.g., three different kinds of chocolate chip or peanut butter). One package should have excessive packaging, the other two should be different enough from each other that when compared, there is a difference in the amount of packaging and the cost per cookie (or per ounce of cookie).

3. Obtain three plates and label them A, B, and C.

Procedures

Day 1

1. Pair up the students. Tell the class that each pair will be receiving an envelope. Their task is to arrange the cards in two distinct groups, Things People Want and Things People Need. If the students ask for clarification, tell them that each pair must decide what the two terms mean.

2. After about 15 minutes, have the class discuss the definitions they had for wants and needs. As a class, clarify and define these concepts. (Most groups will define wants as things people would like to have, and needs as those things which are required for survival.)

3. Write "Wants," " Needs," and "Disagree" at the top of the blackboard. Leave enough room to list the cards below each. Ask each pair of students, one at a time, to select one of their cards and state if they felt it was a want or a need. Write it on the board under the appropriate heading. Ask the rest of the class if anyone put that card in the other category. If so, discuss. If the class cannot come to a consensus, write the item under the Disagree heading. Continue asking pairs to discuss their answers until all of the cards have been discussed.

4. Have the class determine which items most living things need to survive. (Food, water, shelter, space are the four primary answers.) Then ask the students to list the things that they may need to acquire a basic survival need (i.e. money, transportation, education).

5. Ask the students if they can think of a reason why it might be important to know the difference between wants and needs. (Answers or discussion points may include: if you need to reduce the things you have, if you want to lessen your consumer habits and simplify, or decide what to take with you on a trip, or if you only have a small amount of money and need to decide what things to spend it on.)

Day 2

6. Tell the students that you are going to look at whether they have a choice over their consumption of things they want.

7. Show the class the three packages of cookies. Remove the packaging from each batch and have students calculate the cost of each cookie by dividing the cost of the package by the number of cookies. (Students may also calculate the cost per ounce or gram.) Which package of cookies offers the best deal for the money? Put the information on the board.

8. Place the cookies from each package on a separate plate, if you have not done so already. Consider blindfolding students, or asking them to keep their eyes closed. Have them sample one of each of the kinds of cookies without knowing which packet they came from. Ask them:
   - Which one tasted the best?
   - What made it taste best?
   - If the best cookie is the most expensive one, is it worth the price?
   - If the best cookie had the most packaging, is it worth the waste?
   - What could you do if you liked the taste of the cookie with the most packaging?

   Potential answers: re-use the packaging; find other cookies that taste as good but produce less waste; get a recipe and make your own cookies; contact the manufacturer and ask that they use less packaging.

9. Revisit the earlier question about the students having control over their consumption. Ask them if this shows that a person has some choice over how much solid waste they generate. Introduce the concept of **Source Reduction**, i.e. reducing the amount of waste before purchasing or consuming.

10. Point out that the cookie demonstration dealt with wants, not needs. Ask them if they think they also have control over their consumption of things they consider needs. If they answer yes, ask them to explain some of the ways. If no, spend a few minutes talking about water, and how they use it. If the students don't mention it, ask if any of them use water for brushing their teeth.

11. If there is a sink in your classroom: demonstrate a wasteful way of brushing your teeth. Leave the water running while brushing, and measure the amount of water that is used.

If there is no sink in your classroom:
Go to the sink in the janitorial area and tell students that you measured how much water you used that morning while brushing your teeth. Tell them that it came to about two gallons.

For both: Ask the students to calculate, given the number you have given them, how many gallons of water are used if you brush your teeth twice a day. Calculate the amount used per week, month, and year, and write the amounts on the chalkboard.

12. Challenge the students to come up with a way that they could still brush their teeth, but use less water. They should be able to get their consumption down to one cup of water per brushing. Have them calculate the amount of water that would be used per day, week, month and year, and write these amounts on the board to contrast the earlier set of numbers.

13. Have students discuss other ways that they can control their consumption. Ask them to consider such areas as electrical power, transportation, clothing, etc.

Wrap Up

Assessment

• Have students develop a personal action plan around source reduction or consumption in general. Determine the length of the personal action plan (at least a week). Have students record daily the things they have done to meet the plan or defeat the plan.

Extensions

Community

• Bring in a guest speaker to talk to the class about recycling, solid waste, or other related concerns, and how they are handled in your community.

Multidisciplinary

• Have students identify other ways of saving water in their homes. Have them calculate how much would be saved by their family if everyone followed their water conservation tactics for a day, week, month, or year.

Outdoor

• Conduct a product life-cycle field trip. Visit an industry that produces a commercially available product. See how the product is made, how it is transported to the store, what happens after the product is purchased, and what happens to the product once it is no longer useful. If possible, visit as many of these steps in the life-cycle as possible during your fieldtrip.

Technology

• Have students explain the difference between reusing and recycling. Then have them use the Internet to research new ways to use old items. Search words might include: recycled building products, recycled home products, recycled products.

Resources

• Contact your local utility or energy services department for speakers or field trips.

Wants and Needs Cards

make a copy for each team and cut along the dotted lines

air	family	medicine	rain
bicycle	friends	milk	school
car	fruit	money	sun
clothes	home	movie theatre	telephone
computer	insects	music	television
cookies	jewelry	park	vegetables
electricity	job	police	water

Looking Locally

Subject: Language Arts
Science
Social Studies

Skills:
- Prioritizing
- Researching
- Evaluating
- Other skills depending on type of research conducted

Concepts: 2. C
4. A, B, C

Objectives: Students will:
1) learn that there are many aspects to an issue

2) develop and implement a research plan on an issue in their community.

State Standards:
Language Arts: 1.C.2 a
3.B.2 a, b 4.B.2 a
5.A.2 a, b & 5.C.2 a, b
Science: 11.A.2 a, b, c, d, e
Social Studies: 14.B.2
15.E.2 a, b & 18.B.2 a, b

Vocabulary:
- primary source
- secondary source

Setting: Indoor

Materials:
- research materials
- students may need A/V equipment such as tape recorders or cameras

Time: Five or more class periods

Activity Overview

Students will research different aspects of a local community issue that they have selected.

Background

Research, by definition, represents a quest for knowledge. It typically involves careful, systematic study and investigation. It does not necessarily involve intervention or experimentation; it may be entirely based on observation and other data-gathering techniques.

The type of research done will depend to a large degree on your sources of information. If you have direct access to the subject of your research (i.e. if you can actually visit the local lake or speak to an employee at the factory), you have the capacity to do basic or fundamental research. You are able to get information directly without relying on the work of a prior researcher. This type of research could include interviewing, experimentation, or observation, among other activities.

If you take information from other sources or from research done by others, it is important to recognize the distinction between primary and secondary sources. A **primary source** of information would be a journal, letter or memoir written by someone who actually witnessed an event, or an article by the scientist who personally conducted the research. A **secondary source** would be one that is at least one step removed. For example, a book on local history that quotes townspeople and paraphrases old documents would be a secondary source.

Preparation

1. Have students brainstorm where they can get information. Let students know that information can obtained from historical documents, town, county and state records and other sources that they may not have considered.

2. Give students information on how to conduct and record research.

Procedures

1. Have the students identify a local community or county issue to investigate. The selection of this issue can be done

in any number of ways. Students can refer back to the problems identified in "Piecing Together the Future" and choose one of the problems from that activity. Alternately, you may wish to open the topic up for brainstorming on a controversial environmental topic. Whichever method is chosen, though, it is important that the students have a voice in selecting an issue that interests them.

2. Identify the different areas that need to be researched. There is no one conclusive list of these areas, as it will depend on the nature of the issue that is chosen. Some of the areas might include the following:

History—What is the history of the issue, or of the location where the issue is involved? What solutions have been tried before? How long has this been an issue?

Psychology—How do local people feel about the issue? What are their values regarding the situation?

Social Science—Who has control over this issue? Who is affected by it? Who contributes to it? Are there authorities outside of the local area who influence the situation?

Agriculture/Industry—What businesses are involved in this issue? Does it involve local or out-of-town businesses? How is agriculture affected?

Biology—What natural cycles are involved with this issue (plants or wildlife affected, water cycle, nutrient cycle, etc.)?

Planning—Who needs to make decisions on this issue? What are the long-terms effects of the issue? What are the long-term effects of the possible solutions?

Economics—What is the cost of this issue? What is the cost of doing nothing about it?

Science—What is known about this issue? Are there disagreements about basic facts? Has previous research been conducted? Is there more information that needs to be acquired before making a decision?

Technology—What technology is involved with this issue? What technology does the resolution of the issue require? Does this issue require changes or advances in technology?

3. Group students into equally sized research teams. Allow each team to select the area of the issue that they want to research. (It may be helpful to ask each group to name a first, second, and third choice.) It may be necessary to break some areas down into smaller or more specific tasks.

4. Have students determine what kinds of questions their team will try to answer. Have them brainstorm how they might get those answers. Alert them that the entire class will be arranging a field trip to the site (or a related site, depending on the issue), and that they should plan what questions they will ask or what research they will do on the field trip.

5. Work with each team individually to sort though and prioritize the items they have come up with. Help them put their ideas into a realistic plan. Have them write down their plans in their own words.

6. Schedule time for the students to conduct research on their issues, either at home or in the school library. Make arrangements for a field trip to the site.

7. Have the students collect information according to their research plans.

8. Allow each group to decide how they are going to present their findings to the class. Some groups may choose to show tables or charts; others may choose to present a skit or

a poster they have constructed. The presentation should not simply be repetition (i.e. they should do more than hand out an agency fact sheet or read an article from the local paper). Discuss after each presentation, and write two or three key points of information on the board for each one.

Wrap Up

Assessment

Have the class as a whole discuss the overall process, then have them write a paper in response to the following questions.

- What did you learn about the issue that you did not know before?
- Has your opinion on the issue changed since beginning this project?
- Is there more than one viewpoint on this issue? If so, what are they?
- Did you find any inconsistent information?
- Are there questions that are still unanswered?
- What would you do if you wanted to find out more about this topic?
- Did you find this a worthwhile project? Why or why not?
- Now that we have this information, what next? What can be done?

Extensions

Community

- This activity was designed to be strong in connecting to the community.

Multidisciplinary

- Have students create an oral history of the topic they are studying and present their findings to the local historical society.

Outdoor

- If the issue chosen relates to an outdoor site, have the class visit it and plan what questions they will ask or what research they will do on the field trip (step #4).

Technology

- Have students create a multimedia presentation using a computerized presentation program that combines all of their research. Have students present their program to other students or to members of the community.

Be Your Own Action Figure

Subject: Language Arts
Science
Social Studies

Skills:
- Creative thinking
- Organizing
- Planning
- Other skills dependent on the project chosen

Concepts: 4. F, G, I, L, M

Objectives: Students will:
1) identify a problem involving pollution in their community;

2) use critical and creative thinking to solve the problem or improve the situation;

3) successfully carry out the project;

4) evaluate the process by which they tried to solve the problem or improve the situation.

State Standards:
The basic standards addressed by this activity are noted below. Others will be addressed based on the type of problem chosen and how the students decide to carry out the project.

Language Arts: 1.C.2 a 3.B.2 a 4.A.2 b & 5.A.2 a, b
Science: 11.B.2 b & 13.B.2 f
Social Studies: 14.D.2 & 18.B.2 a

Vocabulary:
- self-efficacy

Setting: Indoor and outdoor

Materials:
- varies, dependent upon the type of project students are doing

Time: dependent on project

Activity Overview

Students will plan and undertake an action project of their choosing that will have a positive impact on their school or local community.

Background

Encouraging students to take part in a local action project can create connections between what they have learned about pollution and how they can have a direct impact in their community. Getting involved in community projects can extend the understanding and knowledge your students have already gained and allow them to experience an increased sense of worth and confidence. When students possess a realistic self-confidence in their effectiveness as citizens, or believe that they are able to have an impact on the world around them, they are said to have a high degree of "self-efficacy."

Self-efficacy can appear on a number of different levels. A student may feel that he or she can have an impact on the beliefs or choices of their immediate family or closest friends; for example, they can be instrumental in selecting what movie their family or friends go to see, where they go out to eat, or how they spend their free time. However, these students may not feel that they can influence a class election or the choice of meals served by the school cafeteria. Some children have felt inclined to take on larger challenges, for example (use local example of a young person who publicized or had an impact on an issue or an Eagle Scout or other civic project that had an impact).

Many things can affect children's self-efficacy. They may have no sense of what opportunities for change exist, or they may believe that they personally are incapable of producing any change. Students who have tried unsuccessfully to have an effect in the past may feel this way. Here are some ideas and tips that teachers can use to help student projects be more successful:

- Encourage student ownership and initiative.
- Encourage involvement and buy-in of parents and other community members.
- Encourage student cooperation, compromise, and understanding.
- Help students evaluate their methods

and adapt their plans if necessary.
- Help students appreciate the value of their work, no matter how small.
- Keep your own opinions and beliefs in perspective; do not allow them to bias or predirect the students' inquiries.

Procedures

1. If the students have already done the activity "Looking Locally" (page 114), have them use the concern they investigated as the problem for this action project. Skip to step 4, otherwise begin at step 2.

2. Have students brainstorm a list of problems in the community caused by pollution, along with possible ways that they could improve the situations.

3. Ask students to select one problem that they could realistically handle and do something constructive about. If there is support for more than one idea, have students vote to decide or have students present short persuasive speeches in support of the problem they want the class to work on.

4. As the students select their project, the teacher should be aware of the following:
   - Where will the focus of the project be? Projects where the focus is on the student or the student's family are more likely to show results quicker than those that involve regional, state, or national behavior changes.
   - Are the students interested in the project? Strong personal interest leads to increased prospects of success.
   - Are time frames realistic? Remember that projects almost always take longer than you expect.
   - Help students understand that working on smaller chunks of a larger problem might be more feasible than tackling a large, complex issue.
   - Do the students need instant results? Some projects will show change more quickly than others.
   - Will students have access to the information and research they will need to complete the action project?
   - Is it clear what success will look like? Will the students be able to measure changes and recognize that improvement has taken place?
   - Will the project require a significant amount of time and help from other people? Consider who outside of the class might need to be involved, and how much of their time might be required.

5. On the chalkboard or a piece of posterboard, write out the following list of characteristics of a good action plan:
   - Should solve the problem it was meant to address
   - Is realistic
   - Is helpful to the school or community
   - Is likely to make a lasting contribution
   - Involves the entire class
   - Has a product or result that we can define

Go over this list with the class to be sure that they understand. Ask if they can think of any other characteristics to add to the list.

6. Once the class has chosen a problem, ask students to work alone or in small groups to generate ideas for possible solutions. Instruct them to keep the characteristics of a good action plan in mind.

7. Reconvene the class and have individual students or small groups present their plans to the rest of the class. Students should be allowed to ask questions of each other to clarify what is being proposed. After all of the presentations are done, the students will select the one plan that best meets the characteristics. (You may want students to select one or more alternates in the event that the option

they have chosen is disapproved by school authorities.)

8. The students should present their proposal to the school principal, the city council, school board, or whichever entity needs to give permission for the project. If the plan is not accepted, have the class identify possible reasons, and develop a new action proposal.

9. Once the proper permission has been received, students should outline the exact steps which need to happen for their plan to work. They should then establish committees or work groups, making sure that everyone has a job and that all of the tasks are assigned. The instructor should monitor the plan to ensure that important steps are not missed, that all students are involved, and that safety is addressed throughout the project.

10. Have the students do their project.

11. Meet with the students at the end of the project to reflect on how things went. Ask the following questions:

- What was the result of the project?
- Did things work out the way that you planned them?
- Were there any surprises?
- Were there any unforeseen obstacles?
- What did you like best about the project?
- What was your biggest frustration?
- If you had it to do over, what, if anything, would you have done differently?
- If you had to do it over or chose to do a different project, what would be the next approach you would try?

Wrap Up

Assessment

Have students keep a journal throughout the process. Give them different questions for reflection at different parts of the project.

Extensions

- Extensions for this activity are dependent on the problem chosen and the method of addressing it. If a teacher would like to extend this activity in any way, it will be up to him/her to do in a way that meets the needs of the class.

Glossary

-A-

aerobic bacteria – bacteria living or occurring only in the presence of oxygen.

air pollution - occurs when harmful things are present or released into the air.

aquifers - rock formations that hold and transmit water.

-C-

chlorofluorocarbons (CFCs) - organic chemicals that are used to create coolants, plastic foam, and other products.

Clean Water Act - the nation's premier environmental law, passed in 1972, to protect U.S. waters including lakes, rivers, aquifers and coastal areas, by reducing discharge of pollutants, with the goal of making these waters fishable and swimmable.

closed system - a system that recycles matter over and over again and that neither gives nor receives matter from the outside.

coagulation - a gathering together of finely suspended matter by the addition of a coagulant.

composting - the practice of collecting organic materials, such as fruit, vegetables, grass clippings, or leaves, to decompose and produce fertilizer.

corrosive waste - waste that is able to eat away the containers they are in, or to eat away at flesh. Lye is corrosive.

-D-

decomposition - the process by which organic materials are consumed and broken down into soil, fertilizer or other compounds.

-E-

erosion - the wearing away of land by the action of wind or water.

exosphere - the outer layer of our atmosphere.

-F-

flammable - having the ability to catch fire and burn.

floc - small, semi-solid masses formed in a liquid when coagulants are added.

-G-

global climate change - the long-term changes in temperature occurring globally as a result of changes in the earth's atmosphere.

global warming - the observed increase in the average temperature of the troposphere, which is believed to be a result of the greenhouse effect.

greenhouse gas - any of several gases that help trap the earth's heat and contribute to the greenhouse effect.

groundwater - water that fills the spaces between rocks and soil particles underground.

-H-

hazardous - potentiality harmful to humans and other animal life.

hazardous waste - ignitable, corrosive, reactive, or toxic waste that needs special care in disposal.

household hazardous waste (HHW) - household waste products that pose a health risk if not handled or disposed of according to special instructions.

hydrocarbons - a waste product from the burning of fossil fuels.

hydrologic cycle - in nature, the cycle that water molecules go through, consisting of evaporation, condensation, percolation, precipitation. Also called the water cycle.

-I-

ignitable - having the ability to catch fire and burn.

incineration - the burning of materials to ashes.

inorganic pollution - includes litter and chemical fertilizers

ionosphere - a thin region of the thermosphere which contains charged atoms.

-L-

landfilling - the burying of waste materials.

leachate - dissolved materials that are carried by water seeping through the soil or waste.

-M-

mesosphere - the layer of the atmosphere that extends from 50 to 90 km above the earth's surface.

-N-

non-hazardous solid waste - waste that does not require special handling or disposal.

nonpoint source pollution - pollution that cannot be traced to individual sources.

-O-

organic pollution - pollution that includes human, animal and plant wastes and chemical substances created by or made from them.

ozone - the main ingredient in smog, produced when sunlight acts on oxygen in the air. A molecule made of three atoms of oxygen.

Ozone Action Days - days when the chance of serious health effects from ground-level ozone are particularly great; people are encouraged to take special steps on these days.

ozone layer - the protective layer of ozone high in earth's atmosphere that filters out much of the harmful ultraviolet light from the sun.

-P-

particulates - dust, pollen and other microscopic solids suspended in air.

particulate matter - see particulates.

parts per million (ppm) - the number of units of a substance found in a million units of surrounding air, water, or soil.

photosynthesis - the process by which plants turn sunlight into energy.

point source pollution - pollution that comes from a single identifiable source.

pollutants - any substance which makes air, land or water unhealthy.

pollution - the release or presence of harmful substances into the environment by natural or man-made means.

pollution prevention - the practice of reducing the generation of pollution and waste by changing or modifying plans, practices, or habits, or by conservation or efficient resource use.

primary source - the originating point of information.

-R-

reactive - having the ability to react with other materials. Reactive materials may explode.

recycling - breaking waste down into basic substances which can then be remade into other items.

reusing - using materials over and over, or using them for another purpose.

-S-

secondary source - a source of information once removed from the original source.

sediment - includes the buildup of silt, clay, and other particles in ways that affect the survival or health of an ecosystem.

self-efficacy - the attitude, belief or confidence that one is able to facilitate or cause change in one's life or surroundings.

smog - chiefly low-level ozone. Particulates, oxides of nitrogen and sulfer, and other pollutants in the atmosphere create a brown haze over cities.

source reduction - limiting the amount of waste produced by an activity or not creating waste in the first place.

stratosphere - the layer of the atmosphere that extends from 15 to 50 km above the earth's surface.

surface water - water in rivers, lakes, streams or ponds; distinguished from groundwater.

-T-

thermal pollution - refers to changes in the temperature of water, either warmer or colder.

thermosphere - the layer of the atmosphere that extends from 90 to 480 km above the earth's surface.

toxic - includes pesticides, insecticides, lead, and other chemicals that are directly harmful to humans or animals.

transpiration - the chemical process of water passing from the roots of a plant to its leaves.

troposphere - the lowest layer of the atmosphere that extends from Earth's surface to a height of 20km.

-W-

water cycle - see hydrologic cycle

water pollution - a change in the composition (or temperature) of water that makes it harmful to living organisms and other resources.

watershed - all of the land that drains water into a body of water such as river, lake, or wetland.

water table - the top of the groundwater

wetlands - ecosystems that are part land and part water.

Conceptual Framework

Pollution, like most environmental issues, is a complex topic. It can be complicated to understand and teach since comprehension requires understanding of a number of concepts from a variety of disciplines. To make this easier the Development Team has designed a framework that breaks the topic down into teachable concepts that help the material developer, teacher and student organize and structure their thinking.

The framework is organized under four question-structured themes that build on one another from ecological knowledge to personal and societal issues. Each of the themes: 1) What Is Pollution? 2) Why Is Pollution An Issue? 3) What Kinds of Pollution Issues Affect Illinois? 4) What Can We Do About Illinois Pollution Issues? is followed by concepts that address the question.

1. What is Pollution?

- Definition of Pollution
- Basic Ecological Principles
- Important Pollution Related Definitions

2. Why is Pollution an Environmental Issue?

- Effects on Human Health and Quality of Life
- Effects on Communities
- Effects on Economy
- Effects on Ecosystems

3. What Kinds of Pollution Issues Affect Illinois?

- Air
- Land
- Water

4. What Can We Do About Illinois Pollution Issues?

- Studying Issues and Innovations
- Skills for Understanding Environmental Issues
- Decision-Making and Citizenship Skills
- Personal and Civic Responsibility

1. What is Pollution?

These concepts will help students understand what pollution is and the different forms it takes.

Definition of Pollution

A) Pollution is the presence or release of substances into the environment in quantities or concentrations that are harmful to living organisms and other resources.

B) Air, land, and water pollution affect and are connected to each other; they are not separate and distinct forms of pollution.

C) Air pollution is a change in the composition of air that makes it harmful to living organisms and other resources.

D) Water pollution is a change in the composition (or temperature) of water that makes it harmful to living organisms and other resources. Water pollution can be further classified as: Organic- living things or their waste products (e.g. animal waste, leaves, nutrients, bacteria); Inorganic - human-made chemicals or products (e.g., synthetic fertilizers, litter); Thermal - a change in the water temperature to the extent that it affects the quality of the ecosystem (e.g., power plant warm water discharge into a lake or river); Toxic - any chemical that causes death or harm to humans, animals or plants (e.g., PCBs, copper, lead, zinc); Sediment - soil, sand, and other minerals from the land that other pollutants can attach to.

E) Waste is something that is discarded or is an unwanted by-product of some activity or process. Waste can be classified as hazardous or non-hazardous. Waste is considered hazardous if it is toxic (poisonous), corrosive (can eat away the container which holds it), ignitable (can catch fire and burn), or reactive (can explode). Non-hazardous waste can be recycled, reused, composted, safely stored in sanitary landfills or incinerated.

Basic Ecological Principles

F) The ecosystem components of water, rock, air and life are continually changing through natural processes and cycles.

G) Energy is required to change components of one form into another.

H) Earth's resources are limited and can be overused or misused.

I) Some resources are renewable whereas other cannot be renewed or replaced.

J) Humans and natural systems can produce harmful by-products, which can enter ecosystems in many forms and whose effects can be local or global.

K) Pollution can affect forms of life and their relationships.

L) Ecosystems possess measurable indicators of environmental health.

Important Pollution Related Definitions

M) ppm - (parts per million) and ppb - (parts per billion) Measures of the amount of a substance (part) found in a million units of air, land or water.

N) Pollutant - Any substance, natural or man-made, that causes pollution.

O) Contaminant - A harmful impurity in the air, land, or water.

P) Toxics or toxins - Substances that are poisonous to some animals or plants.

Q) Closed System - A system that recycles matter over and over again and that neither gives nor receives matter from the outside.

R) Monitoring - Checking air, land and water samples for pollution.

2. Why is Pollution an Environmental Issue?

Concepts in this section can help students understand and investigate how pollution may affect themselves and others.

Effects on Human Health and Quality of Life

A) Pollution can negatively affect people's ability to engage in normal daily activities.

B) Pollution can cause or contribute to a wide range of human ailments (e.g., eye and skin irritation, breathing difficulties, cancer).

Effects on Communities

C) The effects of pollution can be found on local, regional, national and global scales.

D) Pollution affects rural, suburban, and urban areas and all are affected differently.

E) Pollution may affect the economic base of communities.

Effects on Economy

F) The use of technology may have benefits as well as unintended side-effects.

G) Individuals, businesses and governments spend money to research, prevent, control and clean up pollution.

H) Our economic system is based on use of resources, both natural and human. Economic systems may be affected if resources are damaged, unhealthy, or polluted.

Effects on Ecosystems

I) Pollution affects ecosystems, whether they are naturally occurring (e.g., woodlands, wetlands, grasslands, lakes, rivers, streams) or human made (e.g., vacant lots, developed areas).

J) Pollution may affect the reproductive ability of species.

K) Pollution can affect many aspects of an ecosystem due to the cycling of nutrients and other substances.

3. What Kind of Pollution Issues Affect Illinois?

In order for students to be able to respond to pollution issues they must first understand what issues affect their community and state.

AIR

A) Air pollution can be produced by humans (e.g., industrial, mobile [cars, trucks], non-road [bulldozers, boats, lawn mowers])or by natural sources (forest fires, dust storms).

B) Air is composed of colorless, odorless gases, the most prevalent being nitrogen, with oxygen, carbon dioxide and small amounts of other gases and particulates.

C) Earth's atmosphere is composed of different layers of gases which serve different functions.

D) Ozone can be considered either good or bad, depending on where in the atmosphere it is found and how it was formed.

E) Air pollution caused by industrialization (motor vehicles, coal-burning power plants, and other manufacturing processes) has been linked to far reaching environmental problems including global climate change, acid rain and the greenhouse effect.

F) Air is monitored for concentrations of particles and gases that affect the health of humans and other organisms.

G) People have developed and continue to develop ways to try to minimize the production and effects of air pollution.

LAND

H) Waste is generated by nature and as a by-product of human consumption (residental, agricultural, commercial, institutional, industrial).

I) Waste can be categorized as either hazardous or non-hazardous depending upon how it is generated or handled.

J) Non-hazardous waste can be handled through a variety of means including source reduction, recycling, composting, incineration and landfilling.

K) Hazardous waste can be handled either through treatment, incineration or through storage.

L) People have developed and continue to develop ways to try to minimize the production and effects of hazardous and non-hazardous waste.

WATER

M) Our water supply consists of water that is visible (surface water) and water that cannot be seen because it is underground (groundwater).

N) Polluted water can smell or be visibly contaminated, but even clear, odorless water can be contaminated.

O) Water pollution can be classified as point source (pollution that comes from a single clearly identifiable source, such as a pipe which discharges material into a lake, stream or river) or nonpoint source (pollution that originates over a broader area or from a variety of causes).

P) Polluted water can find its way into the water system that is relied on by humans for drinking, bathing, irrigation and recreation.

Q) Water is the original renewable resource. It has its own cycle in which water is naturally moved and purified.

R) Humans have developed ways to prevent and reverse the contamination of water by watershed management and water treatment processes.

4. What Can We Do About Illinois Pollution Issues?

The following concepts help students identify ways that pollution solutions can be approached. For students to willingly and effectively take action to prevent and/or control pollution they must have a thorough understanding of what pollution is, why it is an issue, how it affects them, their community and the state of Illinois, and what people can do to protect the air, land, and water. Students should also begin to understand the ecological, social, economic, and political connections of this important issue.

Studying Issues and Innovations

A) Science, technology, and society contribute to our understanding of pollution and the reasons for its production.

B) We are still learning about ecological systems and the consequences of human actions on these systems. As a result, many people differ in their interpretations of scientific evidence and other data.

C) Because issues related to pollution are complex and require the combination of information gathered by scientists from different fields, pollution research involves professionals with backgrounds in agriculture, biology, botany, engineering, history, planning, psychology, science, and sociology.

D) Historically, environmental protection has controlled pollution after it has been generated. New approaches called pollution prevention are beginning to emerge which seek to anticipate and prevent pollution before it happens.

Skills for Understanding Environmental Issues

E) The better we understand Earth and its many ecosystems, the better we can manage our resources and reduce our impact on the environment.

Decision-Making and Citizenship Skills

F) Individuals develop skills for crystallizing and formulating their beliefs and values regarding pollution issues and ways to address them.

G) Individuals in a democracy have a right and responsibility to participate in the development of policies that influence pollution prevention and production.

H) Individuals, acting on their own or as part of a group or organization, can make lifestyle choices and take actions that affect pollution.

I) Individuals can affect the actions of other individuals, families, groups, or organizations to prevent and reduce pollution.

Personal and Civic Responsibility

J) Choices made today about consumption will affect the future quality of life and the global environment.

K) It takes less energy and fewer resources to prevent pollution than it does to restore an ecological system that has been polluted.

L) Every part of society influences pollution to some extent and can work to prevent it through policy initiatives, media campaigns and other public activities.

M) Individuals understand that what they do or don't do can have far-reaching consequences and that they are responsible for those consequences.

ACTIVITY OVERVIEW

Section 1: What is Pollution?

Activities	Overview	Objectives	Concepts	
"Drawing Out" Pollution (pages 18-24)	Students share what they know about pollution, identify pollution in their community and expand their understanding of different types of pollution.	Students will: 1) identify forms of pollution and describe the effects that various pollutants can have on people, wildlife and plants. 2) describe relationships between various forms of pollution and human actions.	1. A, B, C, D, E	
"Sock It" to Air Pollution (pages 25-28)	Students will observe that air pollution is not always visible and that not all vehicles produce the same amount of pollutants.	Students will: 1) be able to describe different sources of air pollution and some of the effects of air pollution. 2) recognize that some types of air pollution are invisible or visible only under certain circumstances.	1. A, C, N, R 3. A, F, G	
Charting the Water (pages 29-32)	Students classify and graph the pollutants found in a hypothetical river and hypothesize what caused the pollution in the first place.	Students will: 1) identify forms of pollution and describe the effects that pollutants can have on people, wildlife and plants. 2) describe relationships between various forms of pollution and human actions.	1. A, D, F, J, N, P, R 2. B 3. R	

Section 2: Why is Pollution an Environmental Issue?

Leggo My Ozone (pages 35-42)	Students first develop a model of the Earth's atmosphere and then participate in a simulation which illustrates the difference between "good" and "bad" ozone.	Students will: 1) understand the different layers of the atmosphere and the importance of each. 2) understand the difference betwen good and bad ozone and where each is located. 3) understand how choices made on Earth affect the atmosphere.	1. A, C, F, J 2. B, F 3. C, D, E, G	
Playing with Food...Waste (pages 43-46)	Students analyze a pollution issue dealing with the trash generated by a school cafeteria, and will consider the obstacles to reducing the amount of trash and food waste.	Students will: 1) recognize there are costs associated with pollution remedies. 2) analyze and compare their values regarding pollution issues.	1. G 2. F, G 3. H 4. L, M	
On Illinois Pond (pages 47-51)	Students take part in a role playing exercise in order to understand the interests of different groups and different causes of pollution in a land development issue.	1) understand that different land uses can affect the types of pollution in a given area. 2) recognize that people have different and sometimes conflicting interests in how land is used.	2. C, D, E, H, I 3. A 4. H, I, J	

	Skills	Time	Location	Subject	Illinois Learning Standards
	• Observing • Comparing/ Contrasting • Organizing • Researching	One or two class periods	Indoor and outdoor	Art Science	Science: 11.A.2 b, c, d, e Social Science: 17.C.2 c Physical Dev. & Health: 22.C.3 a
	• Predicting • Interpreting	One class period	Indoor and outdoor	Science	Science: 11.A.2 b, c, d 13.B.2 b
	• Classifying • Comparing/ Contrasting • Computing • Matching	One class period	Indoor	Mathematics Science	Mathematics: 10.A.2 a, c Science: 11.A.2 c, d 13.B.2 e, f Social Science: 17.C.2 c Physical Dev. & Health: 22.C.3 a
	• Measuring • Creating models • Critical thinking • Classifying • Role playing	Two class periods	Indoor and outdoor	Art Physical Education Science Social Studies	Science: 11.A.2 c, 12.E.2 b, 13.B.2 b, e, f Social Science: 17.B.2.c, 17.C.2 c Physical Dev. & Health: 22.C.2
	• Analyzing • Problem solving	One class period	Indoor	Language Arts Science Social Studies	English Language Arts: 2.B.2 a Science: 12.E.2 c, 13.B.2 d, f Social Science: 15.B.2 c
	• Public speaking • Problem solving • Planning • Comparing/ Contrasting	One class period	Indoor	Language Arts Science Social Studies	English Language Arts: 4.B.2b, 5.C.2 b Science: 13.B.2 f Social Science: 14.D.2, 15.B.2 c, 17.C.2 b,c

ACTIVITY OVERVIEW Continued

Section 3: What Kind of Pollution Issues Affect Illinois?

Activities	Overview	Objectives	Concepts	
What's Blowin' in the Air (pages 58-62)	Students collect particulate matter from the air at different locations around the school and analyze particles collected.	Students will: 1) analyze collected particles and draw conclusions about them. 2) identify areas of the school where air pollution might be a problem.	1. C, J, L, R 2. I 3. A , F	
It's Warm in Here, or Is It? (pages 63-68)	Students read two differing articles on the concept of global climate change and determine how or if air pollutants may be affecting our climate.	Students will: 1) judge the strengths and weaknesses of information. 2) discuss the causes and possible effects of global climate change.	1. C, F, J, 2. C, F, E, G 3. A, E 4. B	
Where Water Wanders (pages 69-72)	Students will research, create and develop a presentation in which they explain how water gets to them and where it goes after being used.	Students will: 1) understand where their domestic water originates, how it reaches them and where it goes after use. 2) be able to explain the movement and management of water in their own words.	3. M, P, R	
Pointing to Point and Nonpoint Pollution (pages 73-79)	Students will read a mystery story involving numerous types of water pollution and will use their knowledge and reasoning skills to solve the mystery.	Students will: 1) understand the difference between point and nonpoint source water pollution. 2) identify types of point and nonpoint source water pollution.	1. A , E 2. J, K 3. A, D, J, O,P	
Hasting to Waste (pages 80-86)	In this activity students will design models of leakproof landfills and will observe how each functions.	Students will: 1) design a landfill and observe what happens to materials when placed in it. 2) recognize that materials and design can affect the integrity of a landfill.	1. D, P, R 3. H, J, L	
Common Household Hazardous Waste (pages 87-91)	Students identify and discuss various types of household hazardous waste (HHW) and disposal methods. They then complete a home inventory with the help of their parents or guardians.	Students will: 1) be able to identify common household products that contain hazardous waste properties. 2) identify proper storage and disposal methods for household hazardous waste.	1. E, P 2. B 3. K, L	
Illinois Pollution Jeopardy (pages 92-97)	Students take part in developing a game that will help the entire class to understand what types of pollution affect Illinois.	Students will: 1) identify and research different forms of pollution. 2) present a short report on their research. 3) understand how different types of pollution are related to and differ from each other.	1. A-F 2. C 3. A, E, G, I, M, O, R	

	Skills	Time	Location	Subject	Illinois Learning Standards
	• Analyzing • Comparing/ Contrasting • Drawing conclusions • Collecting • Hypothesizing	Two class periods one week apart	Indoor and outdoor	Mathematics Science	Mathematics: 10.B.2 c Science: 13.A.2 b, c
	• Analyzing • Comparing/ Contrasting • Drawing conclusions	One class period	Indoor	Language Arts Science Social Studies	Language Arts: 2.B.2 a 5.B.2 a Science: 13.B.2 b,c Social Studies: 17.C.2 b, c
	• Creative thinking • Reporting/ Presenting • Researching • Collaborating • Evaluating	One week or more	Indoor and outdoor	Language Arts Science	Language Arts: 4.B.2 b 5.C.2 b Science: 11.A.2 c, d, e
	• Analysis • Reading • Deductive reasoning • Problem solving	One class period	Indoor	Language Arts Science	Language Arts: 1.B.2 b, d 1.C.2 d Science: 13.B.2 b, f Social Studies: 17.B.2 f
	• Observing • Hypothesizing • Measuring • Comparing/ Contrasting	One class period for set up, one period three weeks later and 10 minutes every other day	Indoor	Science	Science: 11.B.2 c, d, e 11.A.2 a, b, c, d, e
	• Researching • Classifying • Analyzing	Two class periods	Indoor and home	Science Social Studies	Language Arts: 1.A.2 a Science: 11.A.2 b 13.A.2 a 13.B.2 a, f Social Studies: 17.C.2 c
	• Teamwork • Researching • Comparing/ Contrasting • Public speaking • Problem solving	Five class periods	Indoor	Language Arts Science Social Studies	Language Arts: 4.A.2 b 4.B.2 b & 5.A.2 a, b Science: 12.E.2 a & 13.B.2 f Social Studies: 17.B.2 a 17.C.2 a Physical Dev. & Health: 22.C.2

ACTIVITY OVERVIEW Continued

Section 4: What Can We Do About Illinois Pollution?

Activities	Overview	Objectives	Concepts	
Piecing Together the Future (pages 107-109)	Students speculate what the future will be like if local pollution problems are or are not remedied.	Students will: 1) Identify pollution problems in their community. 2) Identify steps that can remedy the problems. 3) Identify long term consequences if the problems are not addressed. 4) Recognize that people may disagree on the problems and the solutions.	2. D 4. F, H, I, M	
Living with Wants and Needs (pages 110-113)	Students examine the concepts of wants and needs and determine ways that their personal choices can affect pollution.	Students will: 1) identify the difference between wants and needs in their own lives. 2) learn that they have choices as consumers related to their needs and wants.	2. F 4. H, J, M	
Looking Locally (pages 114-116)	Students will research different aspects of a local community issue that they have selected.	Students will: 1) learn that there are many aspects to an issue. 2) develop and implement a research plan on an issue in their community.	2. C 4. A, B, C	
Be Your Own Action Figure (pages 117-119)	Students will plan and undertake an action project of their choosing that will have a positive impact on their school or local community.	Students will: 1) identify a problem involving pollution in their community. 2) use critical and creative thinking to solve the problem or improve the situation. 3) successfully carry out the project. 4) evaluate the process by which they tried to solve the problem or improve the situation.	4. F, G, I, L, M	

	Skills	Time	Location	Subject	Illinois State Standards
	• Predicting • Creative thinking • Comparing/ Contrasting • Creating	Three class periods	Indoor	Art Language Arts Science Social Studies	Language Arts: 1.C.2 a, b 4.A.2 a,b 4.B.2 b Science: 13.B.2 b, d, f Social Studies: 15.B.2 c 17.C.2 c 17.D.2 a
	• Analyzing • Classifying • Creative thinking	Two class periods	Indoor	Language Arts Mathematics Science Social Studies	Language Arts: 4.A.2 b,c Mathematics: 6.C.2 a & 7.A.2 b Science: 11.A.2 c & 13.B.2 f Social Studies: 15.B.2 a, b, c 15.D.2 a, b 15.E.2 a
	• Prioritizing • Researching • Evaluating • Other skills depending on the type of research conducted	Five or more class periods	Indoor	Language Arts Science Social Studies	Language Arts: 1.C.2 a, 3.B.2 a, b, 4.B.2 a, 5.A.2 a, b & 5.C.2 a, b Science: 11.A.2 a, b, c, d, e Social Studies: 14.B.2 15.E.2 a, b 18.B.2 a, b
	• Creative thinking • Organizing • Planning • Other skills dependent on the project chosen	Dependent on project	Indoor and outdoor	Language Arts Science Social Studies	The basic standards addressed by this activity are noted below. Others will be addressed based on the type of problem chosen and how the students decide to carry out the project. Language Arts: 1.C.2 a, 3.B.2 a 4.A.2 b & 5.A.2 a, b Science: 11.B.2 b & 13.B.2 f Social Studies: 14.D.2 18.B.2 a

ACTIVITY BY TOPIC AREA

Pollution Effects On Our Environment (Overview)

Activities	Overview	Objectives	Concepts	
"Drawing Out" Pollution (pages 18-24)	Students share what they know about pollution, identify pollution in their community and expand their understanding of different types of pollution.	Students will: 1) identify forms of pollution and describe the effects that various pollutants can have on people, wildlife and plants. 2) describe relationships between various forms of pollution and human actions.	1. A, B, C, D, E,	
Illinois Pollution Jeopardy (pages 92-97)	Students take part in developing a game that will help the entire class to understand what types of pollution affect Illinois.	Students will: 1) identify and research different forms of pollution. 2) present a short report on their research. 3) understand how different types of pollution are related to and differ from each other.	1. A-F 2. C 3. A, E, G, I, M, O, R	
Piecing Together the Future (pages 107-109)	Students speculate what the future will be like if local pollution problems are or are not remedied.	Students will: 1) identify pollution problems in their community. 2) identify steps that can remedy the problems. 3) Identify long term consequences if the problems are not addressed. 4) recognize that people may disagree on the problems and the solutions.	2. D 4. F, H, I, M	
Living with Wants and Needs (pages 110-113)	Students examine the concepts of wants and needs and determine ways that their personal choices can affect pollution.	Students will: 1) identify the difference between wantts and needs in their own lives. 2) learn that they have choices as consumers related to their needs and wants.	2. F 4. H, J, M	
Looking Locally (pages 114-116)	Students will research different aspects of a local community issue that they have selected.	Students will: 1) learn that there are many aspects to an issue. 2) develop and implement a research plan on an issue in their community.	2. C 4. A, B, C	
Be Your Own Action Figure (pages 117-119)	Students will plan and undertake an action project of their choosing that will have a positive impact on their school or local community.	Students will: 1) identify a problem involving pollution in their community. 2) use critical and creative thinking to solve the problem or improve the situation. 3) successfully cary out the project. 4) evaluate the process by which they tried to solve the problem or improve the situation.	4. F, G, I, L, M	

	Skills	Time	Location	Subject	Illinois Learning Standards
	• Observing • Comparing/ Contrasting • Organizing • Researching	One or two class periods	Indoor and outdoor	Art Science	Science: 11.A.2 b, c, d, e Social Science: 17.C.2 c Physical Dev. & Health: 22.C.3 a
	• Teamwork • Researching • Comparing/ Contrasting • Public speaking • Problem solving	Five class periods	Indoor	Language Arts Science Social Studies	Language Arts: 4.A.2 b 4.B.2 b & 5.A.2 a, b Science: 12.E.2 a & 13.B.2 f Social Studies: 17.B.2 a 17.C.2 a Physical Dev. & Health: 22.C.2
	• Predicting • Creative thinking • Comparing/ Contrasting • Creating	Three class periods	Indoor	Art Language Arts Science Social Studies	Language Arts: 1.C.2 a, b 4. A. 2 a, b 4.B. 2 b Science: 13.B.2 b, d, f Social Studies: 15.B.2 c 17.C.2 c 17.D.2 a
	• Analyzing • Classifying • Creative thinking	Two class periods	Indoor	Language Arts Mathematics Science Social Studies	Language Arts: 4.A.2 b, c Mathematics: 6.C.2 a & 7.A.2 b Science: 11.A.2 c & 13.B.2 f Social Studies: 15.B.2 a, b, c 15.D.2 a, b 15.E.2 a
	• Prioritizing • Researching • Evaluating • Other skills depending on the type of research conducted	Five or more class periods	Indoor	Language Arts Science Social Studies	Language Arts: 1.C.2 a, 3.B.2 a, b 4.B.2 a, 5.A.2 a, b & 5.C.2 a, b Science: 11.A.2 a, b, c, d, e Social Studies: 14.B.2 15.E.2 a, b 18.B.2 a, b
	• Creative thinking • Organizing • Planning • Other skills dependent on the project chosen	Dependent on project	Indoor and outdoor	Language Arts Science Social Studies	The basic standards addressed by this activity are noted below. Others will be addressed based on the type of problem chosen and how the students decide to carry out the project. Language Arts: 1.C.2 a, 3.B.2 a 4.A.2 b & 5.A.2 a, b Science: 11.B.2 b & 13.B.2 f Social Studies: 14.D.2 18.B.2 a

ACTIVITY BY TOPIC AREA Continued

Pollution Effects On Air

Activities	Overview	Objectives	Concepts	
"Sock It" to Air Pollution (pages 25-28)	Students will observe that air pollution is not always visible and that not all vehicles produce the same amount of pollutants.	Students will: 1) be able to describe different sources of air pollution and some of the effects of air pollution. 2) recognize that some types of air pollution are invisible or visible only under certain circumstances.	1. A, C, N, R 3. A, F, G	
Leggo My Ozone (pages 35-42)	Students first develop a model of the Earth's atmosphere and then participate in a simulation which illustrates the difference between "good" and "bad" ozone.	Students will: 1) understand the different layers of the atmosphere and the importance of each. 2) understand the difference between good and bad ozone and where each is located. 3) understand how choices made on Earth affect the atmosphere.	1. A, C, F, J 2. B, F 3. C, D, E, G	
What's Blowin' in the Air (pages 58-62)	Students collect particulate matter from the air at different locations around the school and analyze particles collected.	Students will: 1) analyze collected particles and draw conclusions about them. 2) identify areas of the school where air pollution might be a problem.	1. C, J, L, R 2. I 3. A, F	
It's Warm in Here, or Is It? (pages 63-68)	Students read two differing articles on the concept of global climate change and determine how or if air pollutants may be affecting our climate.	Students will: 1) judge the strengths and weaknesses of information. 2) discuss the causes and possible effects of global climate change.	1. C, F, J 2. C, F, E, G 3. A, E 4. B	

Pollution Effects on Land

Playing with Food...Waste (pages 43-46)	Students analyze a pollution issue dealing with the trash generated by a school caferteria, and will consider the obstacles to reducing the amount of trash and food waste.	Students will: 1) recognize there are costs associated with pollution remedies. 2) analyze and compaire their values regarding pollution issues.	1. G 2. F, G 3. H 4. L, M	
Hasting to Waste (pages 80-86)	In this activity students will design models of leakproof landfills and will observe how each functions.	Students will: 1) design a landfill and observe what happens to materials when placed in it. 2) recognize that materials and design can affect the integrity of a landfill.	1. D, P, R 3. H, J, L	
Common Household Hazardous Waste (pages 87-91)	Students identify and discuss various types of household hazardous waste (HHW) and disposal methods. They then complete a home inventory with the help of their parents or guardians.	Students will: 1) be able to identify common household products that contain hazardous waste properties. 2) identify proper storage and disposal methods for household hazardous waste.	1. E, P 2. B 3. K, L	

	Skills	Time	Location	Subject	Illinois Learning Standards
	• Predicting • Interpreting	One class period	Indoor and outdoor	Science	Science: 11.A.2 b, c, d 13.B.2 b
	• Measuring • Creating models • Critical thinking • Classifying • Role playing	Two class periods	Indoor and outdoor	Art Physical Education Science Social Studies	Science: 11.A.2 c, 12.E.2 b, 13.B.2 b, e, f Social Science: 17.B.2.c, 17.C.2 c Physical Dev. & Health: 22.C.2
	• Analyzing • Comparing/ Contrasting • Drawing conclusions • Collecting • Hypothesizing	Two class periods one week apart	Indoor and outdoor	Mathematics Science	Mathematics: 10.B.2 c Science: 13.A.2 b, c
	• Analyzing • Comparing/ Contrasting • Drawing conclusions	One class period	Indoor	Language Arts Science Social Studies	Language Arts: 2.B.2 a 5.B.2 a Science: 13.B.2 b, c Social Studies: 17.C.2 b, c
	• Analyzing • Problem solving	One class period	Indoor	Language Arts Science Social Studies	English Language Arts: 2.B.2 a Science: 12.E.2 c, 13.B.2 d, f Social Science: 15.B.2 c
	• Observing • Hypothesizing • Measuring • Comparing/ Contrasting	One class period for set up, one period three weeks later and 10 minutes every other day	Indoor	Science	Science: 11.B.2 c, d, e 11.A.2 a, b, c, d, e
	• Researching • Classifying • Analyzing	Two class periods	Indoor and home	Science Social Studies	Language Arts: 1.A.2 a Science: 11.A.2 b 13.A.2 a 13.B.2 a, f Social Studies: 17.C.2 c

ACTIVITY BY TOPIC AREA Continued

Pollution Effects on Water

Activities	Overview	Objectives	Concepts	
Charting the Water (pages 29-32)	Students classify and graph the pollutants found in a hypothetical river and hypothesize what caused the pollution in the first place.	Students will: 1) identify forms of pollution and describe the effects that pollutants can have on people, wildlife and plants. 2) describe relationships between various forms of pollution and human actions.	1. A, D, F, J, N, P, R 2. B 3. R	
On Illinois Pond (pages47-51)	Students take part in a role playing exercise in order to understand the interests of different groups and different causes of pollution in a land development issue.	Students will: 1) understand that different land uses can affect the types of pollution in a given area. 2) recognize that people have different and sometimes conflicting interests in how land is used.	2. C, D, E, H, I 3. A 4. H, I, J	
Where Water Wanders (pages 69-72)	Students will research, create and develop a presentation in which they explain how water gets to them and where it goes after being used.	Students will: 1) understand where their domestic water originates, how it reaches them and where it goes after use. 2) be able to explain the movement and management of water in their own words.	3. M, P, R	
Pointing to Point and Nonpoint Pollution (pages 73-79)	Students will read a mystery story involving numerous types of water pollution and will use their know ledge and reasoning skills to solve the mystery.	Students will: 1) understand the difference between point and nonpoint source water pollution. 2) identify tpes of point and nonpoint source water pollution.	1. A, E 2. J, K 3. A, D, J, O, P	

	Skills	Time	Location	Subject	Illinois State Standards
	• Clasifying • Comparing/ Contrasting • Computing • Matching	One class period	Indoor	Mathematics Science	Mathematics: 10.A.2 a, c Science: 11.A.2 c, d 13.B.2 e, f Social Science: 17.C.2 c Physical Dev. & Health: 22.C.3 a
	• Public speaking • Problem solving • Planning • Comparing/ Contrasting	One class period	Indoor	Language Arts Science Social Studies	English Language Arts: 4.B.2 b 5.C.2 b Science: 13.B.2 f Social Science: 14.D.2 15.B.2 c, 17.C.2 b, c
	• Creative thinking • Reporting/ Presenting • Researching • Collaborating • Evaluating	One week or more	Indoor and outdoor	Language Arts Science	Language Arts: 4.B.2 b 5.C.2 b Science: 11.A.2 c,d,e
	• Analysis • Reading • Deductive reasoning • Problem solving	One class period	Indoor	Language Arts Science	Language Arts: 1.B.2 b, d 1.C.2 d Science: 13.B.2 b, f Social Studies: 17.B.2 f

Illinois Learning Standards

Activities	English Language Arts	Mathematics	Science	
"Drawing Out" Pollution (pages 18-24)		10.A.2 a, c	11.A.2 b, c, d, e	
"Sock It" to Air Pollution (pages 25-28)			11.A.2 b, c, d 13.B.2 b	
Charting the Water (pages 29-32)		10.A.2 a, c	11.A.2 c, d 13.B.2 e, f	
Leggo My Ozone (pages 35-42)			11.A.2 c 12.E.2 b 13.B.2 b, e, f	
Playing with Food...Waste (pages 43-46)	2.B.2 a		12.E.2 c 13.B.2 d, f	
On Illinois Pond (pages 47-51)	4.B.2 b 5.C.2 b		13.B.2 f	
What's Blowin' in the Air (pages 58-62)		10.B.2 c	13.A.2 b, c	
It's Warm in Here, or Is It? (pages 63-68)	2.B.2 a 5.B.2 a		13.B.2 b, c	
Where Water Wanders (pages 69-72)	4.B.2 b 5.C.2 b		11.A.2 c, d, e	
Pointing to Point and Nonpoint Pollution (pages 73-79)	1.B.2 b, d 1.C.2 d		13.B.2 b, f	
Hasting to Waste (pages 80-86)			11.B.2 c, d, e 11.A.2 a, b, c, d, e	
Common Household Hazard-ous Waste (pages 87-91)	1.A.2 a		11.A.2 b 13.A.2 a 13.B.2 a, f	
Illinois Pollution Jeopardy (pages 92-97)	4.A.2 b 4.B.2 b 5.A.2 a, b		12.E.2 a 13.B.2 f	
Piecing Together the Future (pages 107-109)	1.C.2 a, b 4.A.2 a,b 4.B.2 b		13.B.2 b, d, f	
Living with Wants & Needs (pages 110-113)	4.A.2 b,c	6.C.2 a 7.A.2 b	11.A.2 c 13.B.2 f	
Looking Locally (pages 114-116)	1.C.2 a, 3.B.2 a, b, 4.B.2 a, 5.A.2 a, b & 5.C.2 a, b		11.A.2 a, b, c, d, e	
Be Your Own Action Figure (pages 117-119)	1.C.2 a, 3.B.2 a 4.A.2 b & 5.A.2 a, b		11.B.2 b 13.B.2 f	

	Social Science	Physical Development & Health	Fine Arts	Foreign Languages
	17.C.2 c	22.C.3 a		
	17.C.2 c	22.C.3 a		
	17.B.2 c 17.C.2 c	22.C.2		
	15.B.2 c			
	14.D.2 15.B.2 c 17.C.2 b,c			
	17.C.2 b, c			
	17.B.2 f			
	17.C.2 c			
	17.B.2 a 17.C.2 a	22.C.2		
	15.B.2 c 17.C.2 c 17.D.2 a			
	15.B.2 a, b, c 15.D.2 a, b 15.E.2 a			
	14.B.2 15.E.2 a, b 18.B.2 a, b			
	14.D.2 18.B.2 a			

Excellence in Environmental Education—

This chart notes the guidelines addressed by the Excellence in Environmental Education—Guidelines for Learning (K-12). This document

+ = addressed well

✓ = addressed minimally

Activities	Questioning	Designing Investigations	Collecting Information	Evaluating Accuracy & Reliability	Organizing Information	Working w/ Models & Simulations	Developing Explanations	Processes that Shape the Earth	Changes in Matter	Energy	Organisms, Pop. & Communities	Heredity & Evolution	Systems & Connections	Flow of Energy & Matter	Individuals & Groups	Culture
Guidelines	**Strand 1**							**Strand 2.1**			**Strand 2.2**					
"Drawing Out" Pollution (pp. 18-24)			+		+			✓								
"Sock It" to Air Pollution (pp. 25-28)			+		+	✓			+	✓						
Charting the Water (pp. 29-32)	✓				✓	✓								✓		
Leggo My Ozone (pp. 35-42)					+	+		✓	✓							
Playing with Food...Waste (pp. 43-46)				✓	+	✓	+						✓	✓		
On Illinois Pond (pp. 47-51)						+	✓						✓		+	
What's Blowin' in the Air (pp. 58-62)			+	✓	+		✓									
It's Warm in Here, or Is It? (pp. 63-68)					✓			+	✓							
Where Water Wanders (pp. 69-72)	+		+				+									
Pointing to Point & Nonpoint Pollution (pp. 73-79)						✓	+						✓	✓		
Hasting to Waste (pp. 80-86)		✓	+		✓	+	+		✓					✓		
Common Household Hazardous Waste (pp. 87-91)			+		✓											
Illinois Pollution Jeopardy (pp. 92-97)	✓		+		+		✓	✓					✓	✓		
Piecing Together the Future (pp. 107-109)	✓	✓			✓		✓									
Living with Wants & Needs (pp. 110-113)					✓		+							✓	+	
Looking Locally (pp. 114-116)	+	+	+													
Be Your Own Action Figure (pp. 117-119)	+		+	✓												

—Guidelines for Learning (K-12)

is available from the North American Association for Environmental Education (706) 764-2926 or www.naaee.org

Political & Economic Systems	Global Connections	Change & Conflict	Human/Environment Interactions	Places	Resources	Technology	Environmental Issues	Identifying & Investigating Issues	Sorting Consequences	Alternative Solutions	Flexibility, Creativity & Openness	Forming & Eval. Personal Views	Need for Citizen Action	Planning & Taking Action	Evaluating Actions	Societal Values & Principles	Citizen Rights & Responsibility	Recognizing Efficacy	Accepting Personal Responsibility
Strand 2.3			Strand 2.4					Strand 3.1				Strand 3.2				Strand 4			
			+	+															
		+	+						✓	✓	+								
			+	+															
	✓	+	+			✓	✓												
			+																
		✓	+																
			+				✓			✓		✓						✓	+
✓		✓						+		✓	✓					✓			
		✓	✓				✓	✓	+	+	✓	✓	+	+	+	✓	+	+	+

BIBLIOGRAPHY

Air, Land & Water. Illinois Environmental Protection Agency. Springfield, IL. 1999.

An Ounce of Prevention: A Middle Level Science Curriculum on Source Reduction. NSTA / Dow Chemical Company.1996.

Braus, J., ed. Windows on the Wild - *Biodiversity Basics: An Educator's Guide to Exploring the Web of Life.* World Wildlife Fund. Washington D.C. 1999.

Bredt, S. *Community Connections: An Interdisciplinary Urban Environmental Education Curriculum for Middle Grade Students*. The Oakland Museum. Oakland, CA. 1992.

Desdemona's Splash! (CD-ROM), 1997. University of Nebraska.

Environmental Education in the Schools. North American Association for Environmental Education / Peace Corps. Washington D.C. 1993.

Environmental Education Materials: Guidelines for Excellence. North American Association for Enviornmental Education. Rock Spring, GA. 1998.

Environmental Resource Guide - Air Quality Grades 6-8. Pittsburgh, PA. 1991.

Environmental Resource Guide - Nonpoint Source Pollution Prevention Grades 3-5. Air & Waste Management Association. Pittsburgh, PA. 1992.

Environmental Resource Guide - Nonpoint Source Pollution Prevention Grades 6-8. Air & Waste Management Association. Pittsburgh, PA. 1992.

Excellence in Environmental Education—Guidelines for Learning (K-12). North American Association for Environmental Education. Rock Spring, GA. 1999.

Miller, G. Tyler, Jr. *Environmental Science: Introduction*. Wadsworth. Belmont, CA. 1986.

Pollution Prevention (P2) Toolbox: Tools for Helping Teachers Integrate P2 Concepts in the Classroom. United States Environmental Protection Agency. 1997.

Project WET. The Watercourse / The Council for Environmental Education. 1995.

Project WILD Aquatic Education Activity Guide. Western Regional Environmental Education Council. Bethesda, MD. 1992.

2000-2001 Conservation Education Catalog. Conservation Education Advisory Board. Illinois Department of Natural Resources. 2000.

Turk, Johnathan, and Turk, Amos. *Environmental Science*, 3rd edition. Saunders College Publishing. Philadelphia, PA. 1984.

IEPA Document Order Form

IEPA Document Order Form

Send the completed form to:
Illinois Environmental Protection Agency
Environmental Education Coordinator, Mailcode #35
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Your Name:_____

Name of School / Organization:_____

Mailing Address:_____

_____

Telephone:_____ **E-mail:** _____

Check the box beside the material you would like sent to you. Please only order what you need.

- ☐ • *Air Facts - Air Quality Monitoring (pp. 61, 65)*
- ☐ • *Air Facts - Criteria Pollutants Fact Sheet (pp. 28, 61)*
- ☐ • *Air Facts - Nonattainment: Falling Short of Air Quality Standards (p. 61)*
- ☐ • *Lake Notes - Determining Your Lake's Watershed (p. 49)**
- ☐ • *Lake Notes - Fertilizers and Pesticides: Options for Lawn and Garden Use Fact Sheet (p.20)**
- ☐ • *Lake Notes - Home and Yard Fact Sheet (p.20)**
- ☐ • *Lake Notes - Septic Systems Fact Sheet (p.20)**

*Lake Notes are also available online at
http://www.epa.state.il.us/water/conservation-2000/lake-notes/index.html

Environmental Pathways Feedback Form

Please take a few minutes to give us feedback on *Environmental Pathways—Youth Investigating Pollution Issues in Illinois*. Your comments will be used when we reprint this document and as we develop new ones. Thank you for taking time to assist us!

Please answer the following (1 being strongly agree and 5 strongly disagree):

Did the material help your students to:

• gain an understanding of the complexity of pollution?	1	2	3	4	5
• strengthen their perception of their ability to influence the outcome of a situation?	1	2	3	4	5
• study outside of the classroom?	1	2	3	4	5

Do you find that the subject matter is pertinent to 5th and 6th graders? _____

_____

Was the material layout clear and logical? _____

If not, what would be helpful? _____

_____

_____

Did you use the supplied posters?

POSTER NAME	Used it (very helpful)		Did not Use it (not useful)
Water Quality: Sources of Pollution	**1**	**2**	**3**
Groundwater and Land Use in the Water Cycle	**1**	**2**	**3**
Good/Bad Ozone	1	2	3

What part(s) of the material did you find most useful? _____

_____

_____

What recommendations do you have to improve *Environmental Pathways*? Please be specific.

_____

_____

_____

_____

Send or fax the completed form to:

Illinois Environmental Protection Agency, Environmental Education Coordinator, Mailcode #35
1021 North Grand Avenue East, P.O. Box 19276, Springfield, IL 62794-9276
Fax: 217-785-8346

Your Name: _____

Name of School / Organization: _____

Mailing Address: _____

_____

Telephone: _____ **E-mail:** _____

PRINTED ON RECYCLED PAPER

Printed by authority of the State of Illinois, October 2006, 35274, 1000