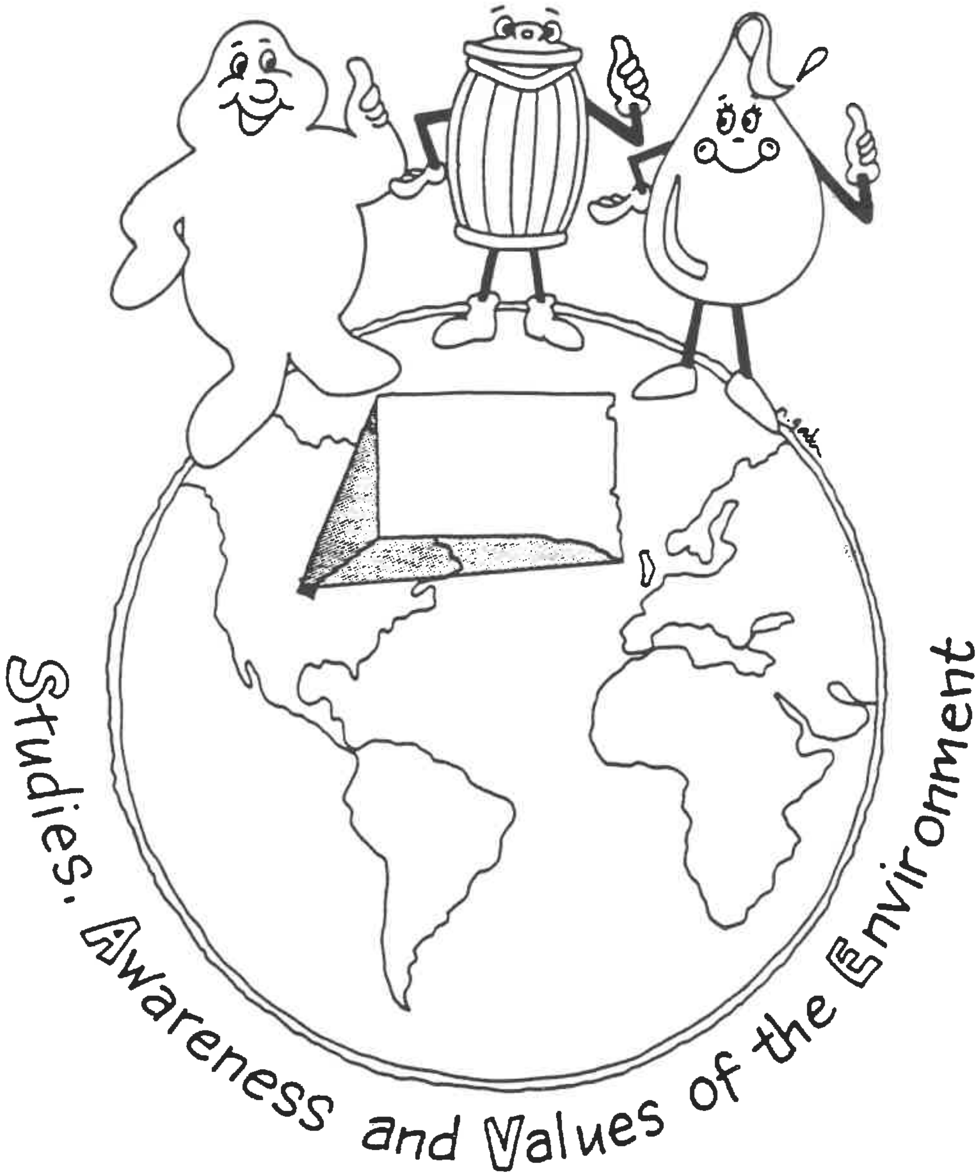
South Dakota

Department of

Environment and Natural Resources

Project SAVE



Environmental Activities for the Classroom

ENVIRONMENTAL PROTECTION EDUCATION MODULES

prepared by

Department of Environment and Natural Resources

DIVISION OF TECHNICAL AND SUPPORT SERVICES

Environmental Education and Training Section

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Solid Waste	SW-19	Keep on Trucking	Calculate, give examples, list, outline waste transportation costs
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Solid Waste	SW-33	Au Naturale or Un-Natural	Examine decomposition of various materials
Solid Waste	SW-35	What's Poppin'?	Evaluate different packaging
Solid Waste	SW-37	Solid Waste Volume Reduction	Calculate the volume of cube and cylinder
Solid Waste	SW-44	Bug-A-Boo	Recognize and Act on litter
Solid Waste	SW-46	An Apple A Day	Locate & describe products and waste
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Water Quality	WQ-8	Gunk in my Glass	Treat water with alum to observe adsorption & sedimentation
Water Quality	WQ-10	Everyone Need a Sandpile	Experiment with water filtration and equate to drinking water
Water Quality	WQ-12	What is in That, Thar Glass?	Observe Microscopic life; describe disinfection
Water Quality	WQ-30	Raindrops Keep Fallin' on my Head	Calculate vegetation cover and relate to water quality
Water Quality	WQ-35	Nitrates Below	Study, analyze, hypothesize, design and experiment about ground water nitrate pollution
Water Quality	WQ-39	Just Bob-Bob-Bobbing Along	Construct, calculate, predict water flow with a simple device
Water Quality	WQ-41	How's Your BOD	Collect and observe water stability
Water Quality	WQ-44	Know Your Shapes	Construct and use materials to map a water body
Solid Waste	SW-21	Let's Pull Together	Develop a recycling program
Solid Waste	SW-30	Home Is Where The Trash Begins	Examine Home Waste Develop home recycling center
Solid Waste	SW-37	Solid Waste Volume Reduction	Calculate the volume of cube and cylinder
Solid Waste	SW-59	What's in the Sack	Develop observation and written skills
Composting	CM-4	Construction of a Compost Bin	Construct a bin at school

ACKNOWLEDGEMENTS

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Clark G.Haberman 6/92
Project Coordinator

As Project SAVE has grown there are numerous teachers who need to be thanked for all their help and assistance in making the program a reality for the students. Thanks to all of the teachers in the middle schools at Stanley County and Sully Buttes and the elementary and Chapter teachers at Sully Buttes schools who worked with us during the NSF-SSI program which began in 1993. One teacher in particular who took the first Project SAVE workshop deserves a great deal of credit for all her help and enthusiasm. Ms. Bea Stough, 2nd Grade Instructor at Sully Buttes, was always willing to take the time for us and involve her students in the Project SAVE program tests. To you Bea, goes a huge THANK YOU!

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Clark Haberman 6/94
Project Coordinator

INTRODUCTION

The first Earth Day celebrated in 1970 caused a concerted effort to pass laws and educate young and old alike on the problems facing our planet Earth. There was a rush to develop many types of environmental education material in the early 1970s. Many excellent hands on activities were published then. The second national celebration of Earth Day occurred in the spring of 1990. Numerous organizations and publishers have developed environmental education materials since the 1990 Earth Day.

Until now, educators have been forced to wade through numerous and scattered materials to form a sound classroom lesson. With already demanding curriculum requirements, the feasibility of this task has prevented many otherwise interested educators from getting the "planet stewardship word" out.

The South Dakota Department of Environment and Natural Resources education and training staff created Project SAVE: **S**tudies, **A**wareness and **V**alues of the **E**nvironment. Staff synthesized an array of resources currently available. Some of the activities included were modified from existing material. Other material was developed by personnel in the Department to ensure pertinent concepts about our environment are addressed.

Project SAVE is divided into three (3) major sections: Air Quality, Water Quality and Solid Waste. Each section contains an introduction and a background. These provide the instructor with brief information about South Dakota's particular environmental concerns, basic environmental facts and related learning activities. Each activity contains a short background, a list of materials needed to conduct the activity, procedures to conduct the activity and follow-up questions. The questions are to engage the students in the learning process.

Appendices are included to further assist the teacher: word find puzzles, clip art of mascots for each of the environmental media, recycling facts about various solid wastes. The appendix material is to be used with the activities in any manner the instructor chooses. The Framework in Appendix A provides information from which we developed most of these activities and will continue to develop more. We have also introduced board games to make learning or pre- and post-testing fun and stimulating. The game(s) are to be used for reinforcing environmental concepts. The game can help the teacher introduce the next environmental education unit of hands-on activities. It can act as a transition to other activities related to environmental science.

As with any material, it is not expected all activities will be used by the instructor. We have compiled a variety of activities, allowing a range of choices appropriate to different classroom situations. We have purposely selected activities that do not require fancy equipment or have costly materials. All materials can be purchased locally or made in a shop at the school. Furthermore, hands on activities should not be the only environmental learning tool used. There are many activities such as reading, watching interactive videos and playing games that will help students understand their environment. We suggest the use of other activities to supplement Project SAVE. Other materials are Project WILD, Project Learning Tree, or the U.S. Department of Agriculture's Soil Conservation Topics Education Kit.

After conducting a Project **SAVE** activity, we want to hear from you! Please return the evaluation cards provided at the end of the manual so we can continue to improve the document.

SKY GUY

I CARE ABOUT CLEAN AIR!

AIR QUALITY INTRODUCTION

This part of Project **SAVE** contains a background to inform you of air quality problems and solutions. The modules are structured to develop student awareness and understanding of various concepts and meteorological phenomena as they relate to air quality.

South Dakota is blessed with excellent air quality. The main reasons South Dakota does not have major air quality problems are the prevailing winds and few industries. The only area of concern in the state is to the west and north of Rapid City. This area is used for quarrying operations. The quarrying activities cause dust to become suspended in the air. At one time meeting the National Clean Air Standards in Rapid City was a problem. The air quality in Rapid City is not an immediate threat to human health. The department continues monitoring to assure air quality stands are met.

Another air quality concern in the Black Hills and Rapid City vicinity is smoke from fireplaces and wood/coal stoves. To prevent future deterioration this concern should be addressed. The problem arises from stoves that are not equipped to burn wood or coal efficiently. Another cause is the burning of unseasoned wood.

Wood smoke, street dust that occurs from the quarrying operations and winter sanding are part of the air quality problem. The most noticeable time for this pollution is during a thermal inversion. A thermal inversion occurs when the cold air becomes the layer closest to the earth's surface, rather than the usual warm air. Inversions occur mostly in the winter months.

The Department of Environment and Natural Resources maintains air quality monitoring sites in Rapid City, Sioux Falls and Brookings. The Department monitors for the very small-sized particles that will not be filtered out by the nose or mouth. These small particles eventually lodge in the human lungs.

Industry in the state monitors the air quality at their sites. They sample by a method called a "stack test." This test involves measuring the amount of particles and gases coming from the smoke stack(s). This test information tells the Department if the industries are meeting the clean air standards.

Teachers and students should be aware of air quality throughout South Dakota. The state can take pride in the clean air and as instructors you can continue to help in maintaining this excellent quality. It is critical to understand air quality as it is a major concern to all of us who live on this planet. Global warming, acid rain, ozone depletion, and other pollutants affect our whole planet. We need to understand and think globally as well as act locally. It is with this premise in mind that this section of the curriculum is dedicated to air quality. The modules are designed you can fit them into a class or curriculum wherever it is convenient.

AIR QUALITY BACKGROUND

As mentioned in the introduction, South Dakota's air quality is excellent except the particulates in the Rapid City area. Air pollutants of most concern over the past several decades have been particulates, sulfur dioxide, nitrogen dioxide, lead, ozone, carbon monoxide and acid precipitation. A discussion of each of these air quality pollutants follows.

PARTICULATE MATTER

Particulate matter in the atmosphere consists of very small pieces of liquid, solids, and liquids-solids in combination. Particles found suspended in the atmosphere are usually less than 100 micrometers (microns) in diameter. One micron is 1/25,000 of an inch. A human hair is typically 100 microns thick. Particles larger than 100 microns quickly settle out of the air under the influence of gravity.

Particles less than 1.0 micron in size cause the most health and visibility difficulties. These particles are the hardest to reduce in numbers once they are generated. Rainfall washout accounts for the major decrease of the smaller particles from the air. Particles between one (1.0) micron and one-tenth (0.1) micron are the most efficient in scattering visible light. This scattering results in reduced visibility. Combined with high humidity these particles can result in the formation of haze.

Particulate pollutants enter the body via the respiratory system where they have the most immediate effects. The size of the particle determines the depth of penetration into the respiratory system. Particles greater than 5 microns are usually deposited in the nose and throat. Particles ranging in size from 0.5-5.0 microns in diameter can be deposited in the bronchi. These are tubes extending from the lungs to the trachea or "windpipe." Most particles deposited in the bronchi are removed by cilia (minute hair-like structures) within a few hours. Particles smaller than 0.5 microns in diameter reach the alveoli (air sacs) and remain there for some time. When these small particles become lodged in the walls of the alveoli they must be broken down into small particles. These small particles migrate through the lung wall where the material is carried away by the bloodstream. Eventually, they are eliminated by other organs of the body.

Particulate composition, concentration and length of time in the respiratory system can contribute to health effects. Particulates have been associated with increased respiratory diseases, cardiopulmonary disease and cancer.

Plant surfaces and growth rates may be adversely affected by particulate matter intercepting light needed by the plant for photosynthesis (food production). Particulate matter can cause a wide range of damage to materials. This damage is caused by accelerating corrosion of iron and steel; disfiguring and damaging building materials; and soiling painted and textile surfaces. High concentrations of particulate matter promote cloud formation and reduce solar radiation, thus causing possible climate changes.

SULFUR DIOXIDE

Sulfur dioxide (SO_2) is a gaseous pollutant. It results from combustion processes, refining of petroleum, manufacturing of sulfuric acid, and smelting of sulfur containing ores. Combustion of fossil fuels is the main source of sulfur dioxides in South Dakota. In South Dakota the concentrations of SO_2 are low.

Sulfur dioxide health effects include irritation and inflammation of tissue that it directly contacts. Inhalation of SO_2 causes bronchial constriction resulting in an increased resistance to air flow, reduction of air volume, and an increase of respiratory and heart rates. Sulfur dioxide also can aggravate pre-exisiting respiratory diseases, such as asthma, bronchitis, and emphysema.

NITROGEN DIOXIDE

Nitrogen dioxide is formed primarily by combustion of fossil fuels. The nitrogen found in the fuels will eventually form the nitrogen dioxide. The earth's atmosphere is made up of 80 percent nitrogen and 20 percent oxygen. Under combustion conditions this will cause the nitrogen and oxygen to join, eventually forming the nitrogen dioxide.

Nitrogen dioxide (NO_2) is a reddish-brown gas with a pungent odor. It is very corrosive, irritating and toxic.

Nitrogen dioxide can cause an increase in airway resistance, an increase in sensitivity to bronchoconstrictors, and an enhanced susceptibility to respiratory infections. Nitrogen dioxide is a deep lung irritant and, if inhaled with other pollutants the results are additive causing increased complications. Nitrogen dioxide has also been shown to cause injury to vegetation by destroying plant cells. This effect increases growth alterations, reduces yields and changes the quality of plant products.

LEAD

Lead is a soft, naturally occurring element. In it's airborne state, it is primarily emitted by motor vehicles. The use of unleaded gasoline has drastically reduced nationwide lead concentrations in the air. Lead enters the body through ingestion and inhalation and can accumulate in the blood, bone and soft tissue. It affects the nervous system and blood forming organs and is especially harmful to children.

OZONE

Ozone (O_3) is a colorless, pungent gas that is the principal part of "smog." It is not emitted directly into the air by specific sources. Smog is formed by photochemical reactions involving oxides of nitrogen and volatile organic compounds (VOCs). A major source of ozone is vehicle emissions. Ozone sources other than automobiles are: dry cleaners, paint manufacturers, and gas stations that use chemical solvents. These sources also contribute to the ozone problem. The ozone levels are highest during the day, usually after heavy emission levels and when sunlight is abundant. Since reactions are stimulated by sunlight, ozone reaches peak levels in most parts of the country during the summer. Ozone has long been a major air pollution problem in most major metropolitan areas of the United States.

Ozone can cause health problems for many individuals. Scientific research links ozone to reduced lung functions, difficulties in breathing, asthma and coughing. Also, ozone has been linked to eye irritation, sore throat, nasal congestion, headaches and reduced resistance to infection.

CARBON MONOXIDE

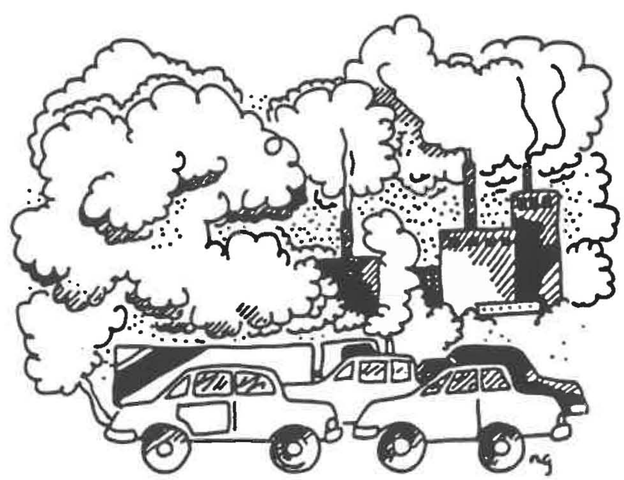
Carbon monoxide (CO) is a colorless, odorless, and very poisonous gas. It is produced by the incomplete combustion of organic fuels such as coal, oil or gasoline. It consists of one atom of carbon and one of oxygen. Scientific estimates are that two-thirds of the carbon monoxide released into the air comes from motor vehicle exhaust. This is especially true when automobile engines are starting, idling or when automobiles are moving slowly through traffic. Other sources of carbon monoxide include fuel burned in homes, incinerators, and industrial processes. The formation of carbon monoxide can be prevented if steps are taken to assure the fuels are completely burned. The techniques for controlling CO emissions include increasing the amount of oxygen, temperature, burning time, and turbulence during the burning process.

Carbon monoxide attaches itself to those blood cells that normally carry oxygen throughout the body. This prevents the oxygen from being delivered to the body cells. It also will weaken the contractions of the heart and reduce the amount of blood delivered to the body. Symptoms of carbon monoxide poisoning include nausea, headaches, and drowsiness. Exposure to very high concentrations of carbon monoxide, in an enclosed or confined area, is usually fatal. Concentrations in the ambient air do not get as high as in an enclosed area. They can get sufficiently high to reduce the ability of a healthy person to perform physical exercise. This can be life threatening for persons with heart disease because they are unable to compensate for the decrease in oxygen.

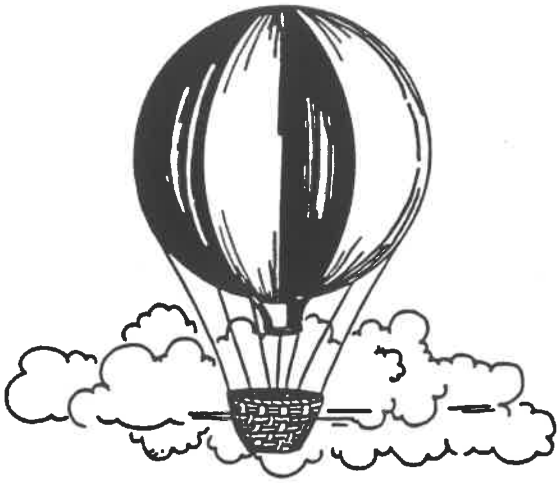
ACID PRECIPITATION

Acid precipitation is believed to be produced when atmospheric sulfur or nitrogen oxides chemically react with moisture in the air. Acid precipitation may fall out of the atmosphere as rain, snow, sleet, fog or even dry particulate. Sources of the sulfur and nitrogen are fossil fuel (coal, oil, gas) combustion, other industrial sources, and automobiles.

Acid precipitation has been blamed for a variety of environmental problems including damage to aquatic life, forests, crops and buildings. It has its greatest effects on the natural environment in regions where the soil has the least capability to provide neutralizing materials.



NOT EVERYTHING ALWAYS GOES WAY-Y-Y UP



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GRADES: 3 to 6

CLASS: Art, Science, Geography

TIME: 30 minutes

EMPHASIS: Air Inversion

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Objective(s)

The students will:

1. examine air or thermal inversions and the trapping of pollutants in the atmosphere.
2. Graphically illustrate inversions for science and art classes.

Background

Air quality can be deteriorated, especially when an air or thermal inversion occurs. A thermal inversion occurs when the cold air and warm air layers are inverted; i.e., when the cold air becomes the layer closest to the earth's surface. When a thermal inversion does occur the cold air cannot rise. Since it is heavier all the air pollutants are trapped near the surface of the earth. The air pollutants can be harmful to humans and animals. The small air pollutant particles suspended in the air can be inhaled and the material becomes lodged in the lungs.

Materials

- Four (4) 250 ml or 8 oz clear bottles made of pyrex or heavy canning glass. The best bottles are the small fruit juice bottles that are slightly tapered toward the top.
- Drawing paper
- Cardboard for burning (You will need a piece about the size of a dime.)
- Matches
- Forceps or tongs to hold the small piece of cardboard.

Procedure

Conduct the following as a demonstration unless you are confident the students can handle this exercise safely where hot and cold glass are involved.

1. Cool two (2) bottles in a refrigerator or in an ice bath.
2. Use a forceps or tongs to hold the cardboard, light with a match, and drop into a warm or room temperature bottle immediately after blowing out the flame.
3. Invert a cold bottle over the warm bottle and observe what happens to the smoke.

4. Reverse the procedure and this time light the cardboard and place it in the other cold bottle. Invert the other warm bottle over the cold bottle and observe the smoke.

CAUTION: Make sure the containers are made of pyrex. Pyrex is not needed if the flame is blown out before dropping the smoldering cardboard into the cold bottle.

Questions
1. What did you observe?
2. Explain what happened?
3. How might this affect air quality in your area or where this might occur most frequently in South Dakota?
4. How might the smoke be cleared out of the cold or bottom bottle?

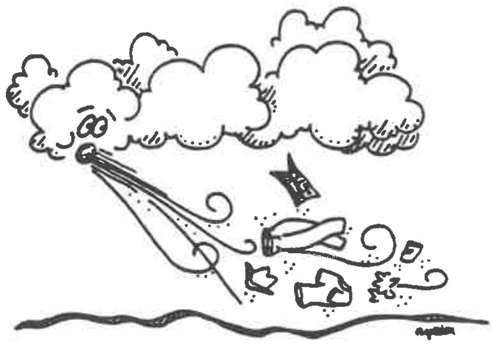
Bibliography

Blough, G.O. and J. Schwartz. 1984. *Elementary School Science and How to Teach It.* Holt, Rinehart and Winston. 620 p. 7th Ed.

Additional Ideas

☞ Show a film on cities such as Los Angeles, New York, or other foreign cities where urban air pollution is currently causing problems.
☞ Discuss Denver and the "brown cloud" concept.
☞ Ask the question why Rapid City would be more susceptible to thermal inversions than would be Sioux Falls, Watertown, Pierre, etc.

WHAT IS IN THE AIR??



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GRADES: 3-6

CLASS: Science

TIME: 4 Periods approximately 20 minutes each.

EMPHASIS: Air Quality
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Objective(s)

The student will:

1. examine particles found in the air and are various sizes and shapes,
2. interpret that under normal circumstances lengthening sampling periods will increase the particle numbers, and
3. use a control in an experiment.

Background
Many particles are suspended in the air for short or long periods. The larger particle in the air can be seen, especially in a beam of sunlight such as found coming through a window. Other particles are very small and must be collected by special instruments on filters to determine the amount. The most harmful air particles are the very small ones. These will not be filtered by the nose and will be inhaled into the lungs where they can cause respiratory problems. These particles are usually viewed under microscopes or very special viewing instruments.

Materials

- Scotch tape or a greased piece of paper
- Microscope, magnifying glass or a microprojector

Procedure

1. Place the scotch tape, sticky side up, or the greased paper, moist side up, in various places. This can be done at home or in the school. (The greased paper may be made by rubbing a spot on the paper with oil or butter. The excess is removed when the oil/butter has penetrated.)
2. Place one piece of the collecting material, scotch tape or greased paper, in an envelope. This is the control for the experiment.
3. Examine the tape/paper under a microscope, with a magnifying glass or a microprojector.

Have the students keep records in a table such as the one below.

Table 1.

Date	Place	Kind of Particle	Came from Where?

Questions

1. Did you observe any differences in the particles?
2. Where did the particles come from that were in the air?
3. How might we make our air cleaner?

Bibliography

"What kind of Dust is in the Air?" *The Newsletter* (New York: Elementary School Science Association, 1970).

Additional Ideas

☞ Obtain a used furnace or air conditioning filter and use as a demonstration on the removal of materials from the air.

☞ Hope Armstrong of the Pierre Public School system uses the following collection system. The students use clean, recycled jars covered with a thin layer of petroleum jelly. Particles in the air will stick to the petroleum jelly. The students in her class determine where to set the jars in the school and around the community. They select sites based on their own assumptions where the cleanest and most polluted air might occur. Permission is obtained from the manager before the students place the jars at the business site. The jars are left at the site for several weeks with the students checking on them once per week. The jars are then picked up and viewed with a hand lens. Observations are recorded and a discussion of their findings takes place.

SLOW BURN

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GRADES: 6 to 9

CLASS: Science

TIME: One 45 minute period

EMPHASIS: Air Pollution

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Objective(s)

The student will:

1. recognize combustion causes the formation of soot or particulate matter formation and
2. observe hotter part of the flame will not produce as much particulate matter.

Background

When something burns without enough oxygen (O_2) it does not burn completely. This is called "incomplete combustion." This incomplete burning releases soot or particles into the atmosphere. To gain complete combustion enough air must be provided to the fire or flame so the material will burn "hotter." Thus, soot or particulate matter formation is reduced.

Materials

- Candle
- Pyrex glass of some type (cookware or labware).
- match
- facial tissue or paper towel

Procedure

1. Make sure all the students have their hair pulled back and any loose clothing protected so they do not catch on fire.
2. Light the candle. Hold the pane of glass or bottom of the glass jar in the yellow portion of the flame. Hold the burning wick so it nearly touches the glass. Do this for approximately 10-20 seconds. Blow out the candle.
3. Allow the glass to cool for about a minute and then wipe with the facial tissue or the paper towel.
4. This time hold the pane of glass or jar above the flame for only a second or two. Quickly remove the glass. Blow out the candle.

Questions

1. What did you notice about the facial tissue?
2. How do you suppose this occurred?
3. What did you notice about the second part of the experiment?
4. What would cause this to be different from the first part of the experiment?

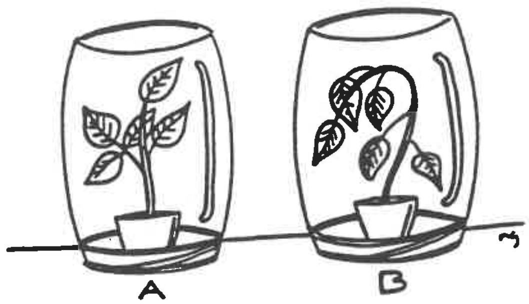
Bibliography

Gutnik, Martin J. 1973. *Ecology and Pollution/Air.* Childrens Press, Chicago. 48p.

Additional Ideas

☛ Have the students look up information about a flame. They should note different colors depict different temperatures. The need for oxygen in the burning process should be noted.

FOR WHOM THE BELL TOLLED



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GRADES: 4 to 8

CLASS: Science, Art

TIME: One 20 minute period and 5 minutes each day for two weeks

EMPHASIS: Air Pollution

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Objective(s)
The student will observe the effect of combustion on a plant.

Background
Plants require carbon dioxide (CO_2) to make their food. They also need oxygen to assist in breaking down food they have produced. The burning match will consume the oxygen under the jar. Since plants need oxygen this experiment will show how lack of oxygen can harm a plant. Sulfur oxides are gases produced by a burning match. The sulfur from the burning match also is harmful to the plant.
Caution should be exercised in this experiment because of the use of the flame. Air will enter the jars each time they are lifted. The burning match will not have any affect on the plant in Jar B if too much air enters.

Materials
- Two (2) healthy potted plants of approximately the same size
- Two (2) bell jars or jars large enough to fit over the plants
- matches, preferably the large wooden type
- water
- Two (2) aluminum plates

Procedure
Conduct this exercise as a demonstration unless you feel the students can conduct this exercise safely.

1. Place each plant in an aluminum plate.
2. Water each plant, but do not over water.
3. Cover each plant with a bell jar or the jar you have obtained.
4. Label the jars A and B.
5. On the second day, lift jar A for 10 seconds. Lift jar B only high enough to place the burning match under the jar.
6. Allow the match to burn out. Do not remove the burned out match until the next day.
7. Repeat steps 5 and 6 for two weeks using caution with the matches and not leaving the B jar exposed to the outside air any longer than jar A.

Questions
1. What did you observe?
2. What could have caused this?
3. Does this occur in your environment?
4. How would this work assuming the atmosphere in the jar was the earth's atmosphere?

Bibliography

Gutnik, Martin J. 1973. *Ecology and Pollution/Air.* Childrens Press, Chicago. 48p.

Additional Ideas

☛ This experiment can lead to other types of air pollution research or reading. Students might study about acid rain, smoke stack pollution by industry or automobile exhaust pollution. Have students report on automobile exhaust pollution and air quality in South Dakota and in other states.

I'LL HUFF AND I'LL PUFF

++++++++++++++++++++++++

GRADES: 4 to 6

CLASS: Science

TIME: Approximately 50 minutes

EMPHASIS: Air Pollution

++++++++++++++++++++++

Objective(s)
The student will make and observe:

1. particles rising through the stack of a pollutant source and
2. particles settling out in the environment.

Background
Burning of materials produces ash and soot. Wood or coal burned improperly, in a wood burning stove or fireplace, releases particles (soot) from the smokestack. The particles produced by industrial smokestacks are collected in special filters. Particles are released to the atmosphere if the filters fail. The larger particles will settle out, as in this demonstration. These larger particles will not get into the lungs of humans. Large particles can cause environmental problems such as reduced visibility and plant damage.

Materials
- Adult shoe box
- Hollow tube obtained from a paper towel or toilet tissue roll
- Plastic wrap for top of box
- Coal dust or charcoal dust made from artist charcoal or a ground up briquette
- Flexible straw
- Awl or ice pick
- Masking or cellophane tape
- Scissors

Procedure
Refer to the diagram at the end of this module.

1. Remove the shoe box top and set aside.
2. Place the toilet tissue or paper towel roll in the box. Place the top of the tube is <u>at least one inch</u> from the top of the box. Cut the tube and tape it to one corner of the shoe box.
3. With the awl, punch a hole through the shoe box into the tube. This hole should be about 1/2 inch above the bottom. Insert the straw through the side of the box and into the tube.
4. Pour the coal or charcoal dust into the tube to a depth of about one inch.
5. Seal the top of the box with plastic wrap.
6. Bend the flexible straw up and have the student blow gently for two or three seconds on the straw. If the straw is long enough the student should be able to observe what happens.
7. The straw should be long enough for the student top see into the box. Students should cut away one side of the shoe box if the straw is not long enough. Seal the opening with plastic

wrap. This cut away enables the student to observe what happens.

Questions

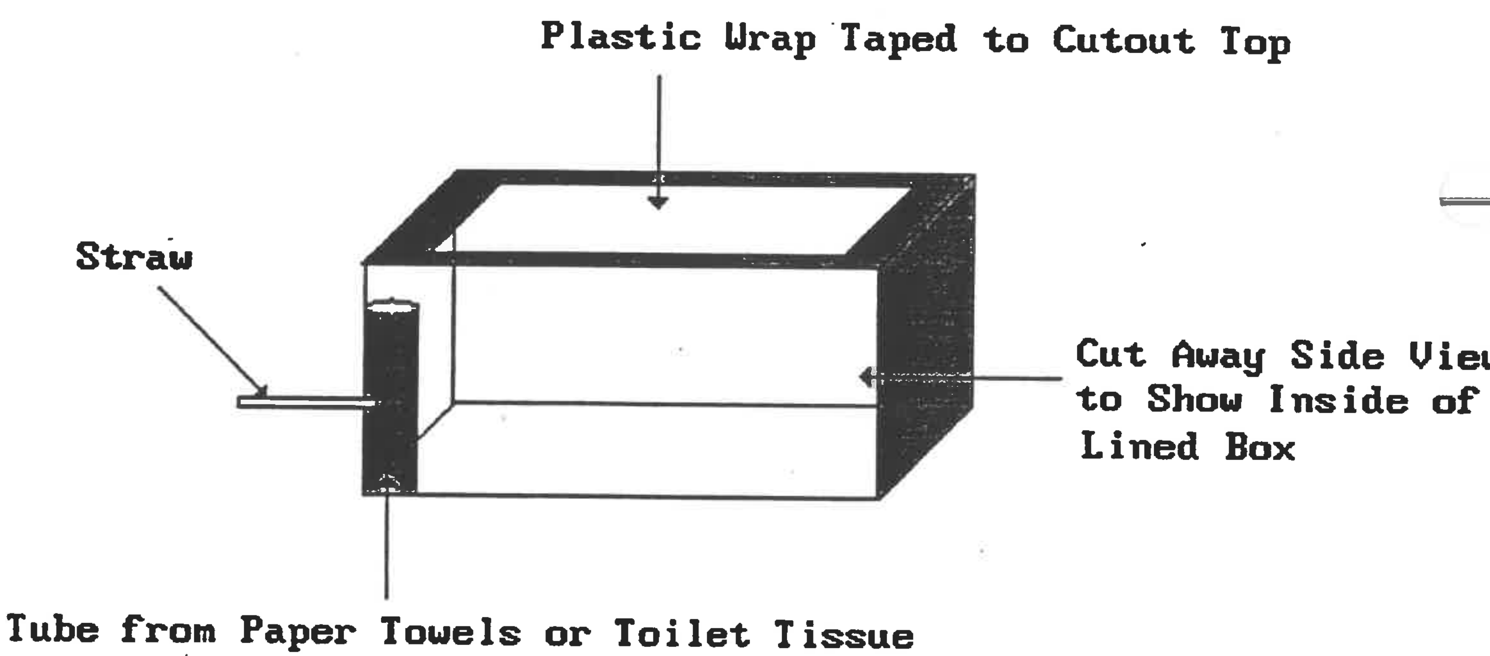
1. What did you observe?
2. How might this occur in industry or in a home with a wood stove or a fireplace?
3. What might be done to prevent this?
4. How might this be harmful to your environment?

Bibliography

Gutnik, Martin J. 1973. *Ecology and Pollution/Air.* Childrens Press, Chicago. 48p.

Additional Ideas

☞ In place of charcoal or coal dust you may want to use talcum powder or fine dust from the school yard. Line the shoe box with dark construction paper if you use light colored dust. (Caution should be exercised so the students do not suck in on the straw and inhale dust into their lungs!)



ADOPT A CLEAN AIR DAY

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GRADES: K - 8

CLASS: Any class

TIME: 20 minutes for a week

EMPHASIS: Air Quality Enhancement

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Objective(s)
The students will:

1. use activities to maintain clean air in their community and in the U.S. and
2. practice having a positive impact on their community.

Background
The Adopt A Clean Air Day is being introduced by the Department to increase the awareness of South Dakota's clean air. The department mission is to meet and maintain the clean air standards set for the state and the nation. South Dakota is meeting all air quality standards. The only place that remains a concern is the area around Rapid City. The concern is about particles suspended in the air.

This exercise encourages students to work together as a group. The group work is for betterment of their community, state, nation and the earth.

The students need to understand the simplest of actions such as walking can assist in maintaining clean air. Walking will save gasoline. There will be less pollution from fuel production if we use less oil. Air currents carry pollution and this affects the entire planet. Reinforce to the students that what they do in their community can affect the world. Have them think about cumulative impacts from many communities.

You should work closely with your administration before starting this activity. Let them know you desire to participate in the Adopt A Clean Air Day for your school and community.

Materials

- Poster materials
- map or poster of the earth
- calendar
- notepads and pencils

Procedure

Day 1

1. Divide the class into teams of two or four students.
2. Students select a day in the spring or fall for their Clean Air Day.
3. Allow 15 minutes for thinking of clean air activities that can be conducted throughout the school and community. Encourage use of their imagination.
4. Have each team put the ideas on the board or other appropriate visual media.

5. Ask each of the students to come with two new ideas from home for use in the next day's class.

Day 2

1. Have the students add any new ideas to the list of activities.

2. Have each team re-assemble for 15 minutes to design how they will promote, as a class, Adopt A Clean Air Day.

3. Have the students list the ideas on the appropriate visual medium so the entire class can participate.

Day 3

1. Re-assemble the teams so they can outline their approach to encouraging the school and community to participate in the Adopt A Clean Air Day. Use Sky Guy as the theme wherever appropriate within the school and in the community. Encourage the students to come up with a mascot or theme in addition to Sky Guy.

2. The teams should list their activities. An action plan should be developed. You may want to guide the students if they are having difficulties developing the plan.

Day 4

1. Allow the students time to work on the final activities. Encourage them to make posters and contact the media by letter. You may want to seek final input from your administration now.

2. Send a note home seeking assistance of the parents. Their can assist with taking children around to post signs, talking to businesses and delivering articles to the newspaper(s).

Day 5

1. Go over the time and arrangements from Day 4 planning activities. Check the names of the parents who will be assisting.

2. Set up times for the students to continue developing their materials. Allow time each week until the Adopt A Clean Air Day is completed.

Final Note

Have the students record their success after the Adopt A Clean Air Day is complete. In addition, they should write other information that will be helpful to next year's class.

Questions

Use questions to assist the students in getting started. Help them through the rough spots in planning the activities by using questions.

You should discuss the success of the program. Ask how this effort helped the environment at the local, state and national level.

The final question you may want to pose is "What if everyone adopted the same day worldwide?" This question may lead to working with another school in the district or even a neighboring town for next year!

Additional Ideas

☞Stress a clean environment by conducting the WQ8MOD "Adopt-A-Stream" as a follow up to this activity.

SMOKE GETS IN YOUR EYES

+ +

GRADES: 5 - 7

CLASS: Math and Science

TIME: 50 minutes

EMPHASIS: Air quality measurements

+ +

Objective(s)

The students will:

1. use a protractor to measure angles and
2. describe how scientists determine air quality violations.

Background

Air quality personnel are trained to read smoke emissions. Each spring and fall the department holds a school for smoke readers (environmental scientists, engineers, and industry personnel) to calibrate his or her eyes! This is called a visual emissions evaluation (VEE).

Smoke readers must pass a visual test. The test is conducted by using a machine that produces white and black smoke plumes. The smoke readers must determine how much light is blocked by the smoke. Light blockage is called opacity.

A person running the smoke machine varies the smoke opacity emitted. The values of 25%, 50% and 75% opacity are used during practice runs for the individuals "reading" the smoke.

Actual reading begins by varying opacity percentages at 5% increments ranging from 0% to 100 % opacity. Readers are tested for 25 different values each of white and black smoke. The smoke readers must be able to determine the opacity within 15% (or three, 5% increments) on any reading or they fail the test. If they have not missed more than three 5% increments on any one reading the readers must add up the total amount of increments they missed. (For example, if a smoke reader read the opacity at 25 % and the actual values was 30% this would be incorrect by one increment. If the reader read the smoke at 30% and the value was 45% the increment would be three, and so on.) The readers cannot exceed 37 total increments or they cannot be certified. When the smoke readers have successfully calibrated their eyes they are certified to read smoke.

In most cases smoke opacity greater than 20% is a violation of air quality rules. If the stack's smoke plume is more than 20% opacity the smoke reader must figure out what occurred to cause the "violation." The business operating or owning the stack is subject to a fine!

Two points must be observed by a reader. First, the smoke reader must have the sun at his or her back. The sun behind her/him must be within a 140° angle. Second, the reader must be back from the smoke plume at least three stack heights. The opacity reading will not be accurate if the sun is outside the 140° angle or the reader is closer than three stack heights. Smoke opacity appears greater if the reader is too close to the stack or if the sun is outside the 140° angle. (See diagrams in Appendix F.)

A certified reader must take four (4) readings (one every 15 seconds) per minute for at least six (6) minutes. Any number less than 24 readings will not be accurate. The usual length of reading time is ten minutes. The numbers are averaged together for each minute. The highest reading over a 6-minute set is used to determine if the air emissions opacity. (See example of readers sheet in Appendix F.)

The reader also must make sure they read at the correct point in the plume. Some plumes have steam in them and can be misleading. Steam plumes are usually white, billowy and wispy at the point of dissipation. They are not a pollution problem as they consist only of water. The diagram at the end of this activity shows three steam plumes. The points where opacity readings should be taken are shown.

Materials

- pencil
- protractor
- paper
- calculator
- copy of scientists visual emissions sheet
- copies of the Source Layout sheet, Stack Height sheet and Visible Emissions Form.

Procedure

1. Divide the students into teams of two or four.
2. Explain to them about calibrating the eye.
3. Hand out a copy of the source layout sketch from Appendix F.
4. Give them time to use the protractor to measure the angle.
5. Hand out the stack height sheet from Appendix F.
6. Each student should measure the different angles with the protractor.
7. Provide each student with a completed Visible Emissions form from Appendix F.
8. Explain to the students about reading smoke from the explanation in the background section above.
9. Have the students determine which set of six was used by the smoke reader.
10. As an alternative, use a blank observation form from Appendix F to fill in your own figures. Have the students calculate the average opacity for the highest period. Remember that a consecutive 6-minute set must be used to determine the highest period.

Questions

1. How did you determine the 140° angle in the Source Layout sheet?
2. What would happen if the sun were outside this angle?
3. What were the different angles on the stack height sheet?
4. What happens to the numbers if you get too close?

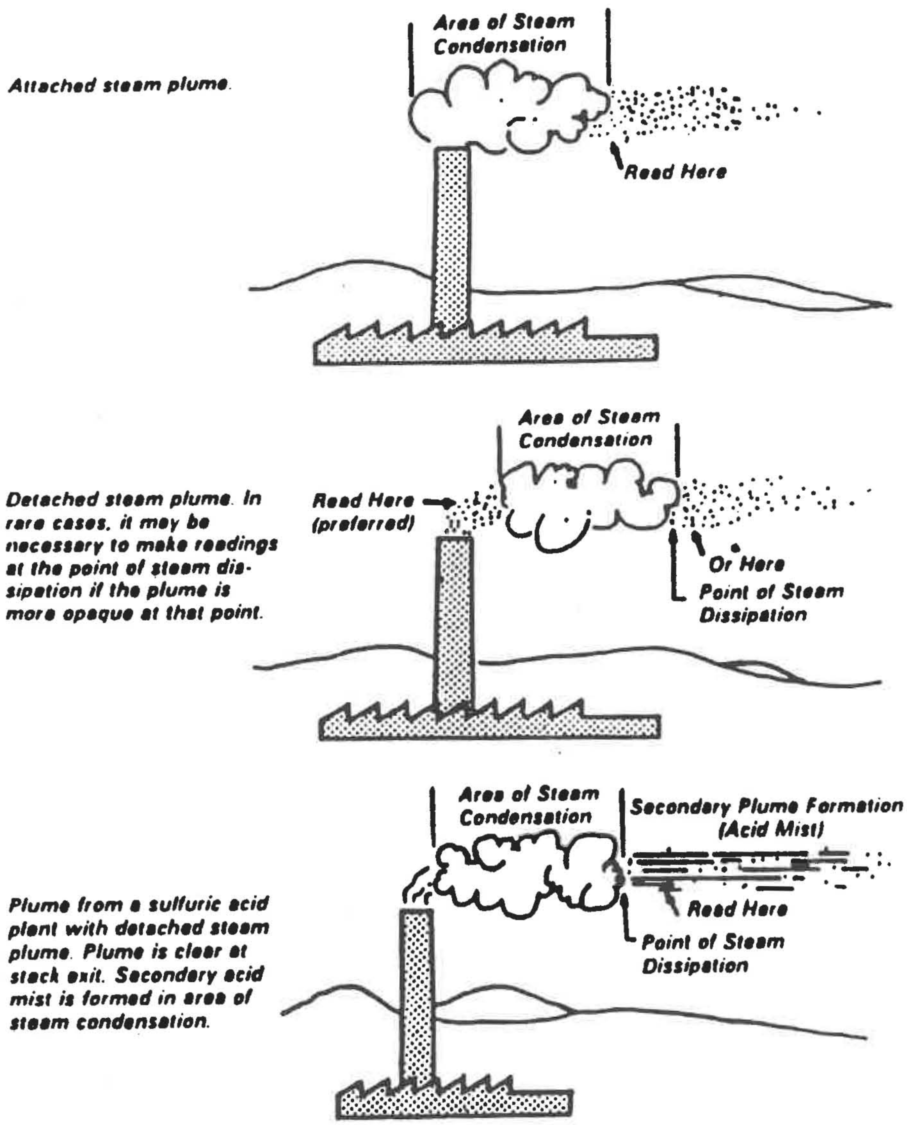
5. Which set of numbers did the smoke reader use to determine the 40% average opacity for the highest period?

6. Optional: What was the average opacity for the highest period on the South Dakota Form?

Bibliography

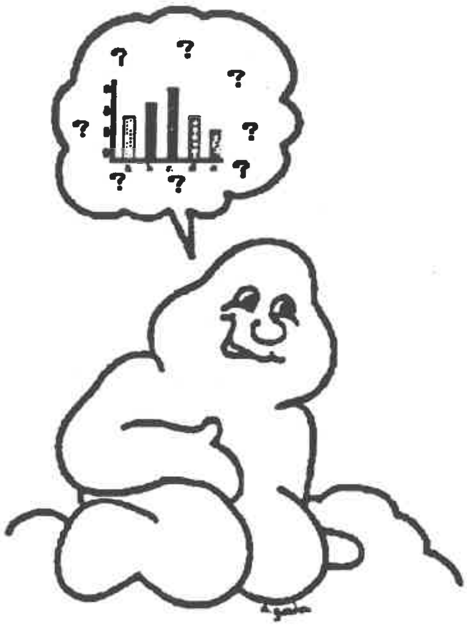
U.S. Environmental Protection Agency. 1984. *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III. Stationary Source Methods.* Environmental Monitoring Systems Laboratory, Research Triangle Park, NC 27711.

Additional Ideas



Location for reading opacity under various conditions.

LET'S GET GRAPHIC



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GRADES: 3 - 5

CLASS: Math and Science

TIME: 20 minutes

EMPHASIS: Amounts of Air Quality Pollutants

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Objective(s)

The students will:

1. interpret a line graph,
2. graph air quality data and
3. convert pounds to kilograms.

Background

Air quality is measured by weight. Figure one (Appendix F) is a hypothetical air quality graph depicting pollutants as average pounds per month.

Air quality measurements are normally recorded in pounds per day. Industry calculates the amount of air coming out of the stack as well as the energy used to produce the product. Industries record the pollutants coming from the stacks in pounds per hour or tons per day.

The tables in Appendix F are all hypothetical. They reflect the type of data that come from industry or from department sampling.

Air quality depends on the number of industries and automobiles in the area. Wind velocity and patterns will affect the pollutants. Winter weather conditions affect pollutant levels. These conditions many times coincide with air inversions (see AQ1MOD). More cars left idling in the winter add more pollutants to the air. Dry, windy conditions in late summer and early fall add dust particles to the air.

Materials

- Copies of tables and graphs from Appendix F
- Pencil
- Paper
- Calculator

Procedure

1. Hand out the generic graph depicting average pounds of pollutants recorded by month (Figure 1, Appendix F). Use the questions below to assist the students with the exercise.
2. Change the average pounds to average kilograms. (Remember 2.2 pounds equals 1 kilogram. To convert pounds to kilograms divide the pounds by 2.2)

3. Hand out the second graph (Figure 2). Have the students interpret the graph. Use the questions below to stimulate their thoughts.
4. Hand out the tables in Appendix F. Divide the students into teams. Instruct them to graph the data.
5. Ask for volunteers to explain their graphs.

Questions

1. What information is shown on the a) vertical axis and b) horizontal axis?
2. What does the information on the axes tell you about the purpose of the graph?
3. What would be the reason for using rounded numbers?
4. What were the months where there was no change?
5. One kilogram equals 2.2 pounds. What will be the average kilogram numbers per month?
6. What was the approximate pollution from plant number one?
7. What was the exact pollution load from plant number 3?
8. Which plant pollutes the most?
9. Which plant causes the greatest air problems?
10. Was there information asked for from graph number two for which you could not provide an answer?

Bibliography

Additional Ideas

A CANDLE IN THE WIND

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GRADES: 6 -8

CLASS: Science

TIME: 15 minutes

EMPHASIS: Air Pressure

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Objective(s)

Students will:

1. predict what will happen to a candle flame,
2. observe what happens to a candle flame and
3. conclude and state the results of the experiment.

Background

When teaching weather patterns the concept of low pressure areas may be discussed. What are the implications of the low pressure zones on a microscale? A simple experiment using a candle and two pieces of paper will help the students grasp the concept of low pressure and how it relates to air quality concerns. The experiment is simple because all the students need are a candle and a square piece of card file such as a 3 X 5 card trimmed to a 3 X 3 shape. Paper shape will determine the air flow dynamics. With a square card the candle flame will bend toward the card when air flows by it. The resulting air pressure behind the card is lower than the surrounding sides. Changing the shape of the card to a teardrop or triangular shape will yield different results. In this case, the air is directed toward the flame and it will bend away from the card or be extinguished.

This simple exercise can be used to demonstrate how air pollutants can be deposited or siphoned into an air of low pressure. An example might be an area of low particulate matter on the down wind side of a hill which becomes polluted due to siphoning into the low pressure area. The second example of what might happen is un-seen chemicals from a factory may be drawn into an adjacent building's fresh air vent system if a low pressure area is created by the building design and improper air emissions stack height.

Materials

- One candle for every two students
- Candle holder or something on which to stand the candle
- 2 - 3 X 5 cards
- Matches
- Journal or piece of paper to record observations
- Pencil
- Scissors

Procedure

1. Stress lab safety about using candles and flames.

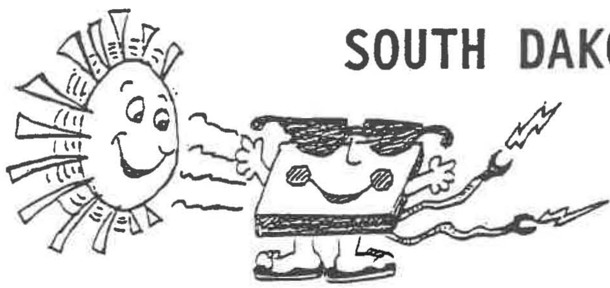
2. Demonstrate how to melt a small amount of candle wax to position the candle, if you do not have a candle holder.
3. Pass out two 3 X 5 cards for the 2-student teams.
4. Have the students trim one of the 3 X 5 cards to a 3 X 3 size.
5. Demonstrate how the students should hold the card between themselves and the lighted candle.
6. Demonstrate how the remaining 3 X 5 card should be shaped into the teardrop or triangular form.
7. Direct the students to blow toward the candle. Let them experiment with blowing soft to hard.
8. Ask them to record a hypothesis about this simple experiment.
9. Encourage the students to write down their observations.

Questions
1. What did you observe?
2. Did anything happen to the flame?
3. Explain what you think caused the flame to bend toward the card with the square.
4. Do we have pressure zones on a large scale? What happens when we do have these low pressure zones cross the U.S. or our state?
5. How might this apply to natural or man-made features in our environment as it relates to air quality from particles in the air or to gasses that are vented from factories?

Bibliography

Additional Ideas

SOUTH DAKOTA SUNSHINE



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GRADES: 5 to 8

CLASS: Language arts, science, social studies

TIME: One 50 minute period each for the modeling and solar cell experiments. Three to four periods for library research and writing letters and reports.

EMPHASIS: Alternative Energy and Clean Air

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Objective(s)

Students will:

1. write for information on solar energy,
2. model a solar cell to demonstrating electron flow based on the description at the end of this module,
3. experiment with sunlight, solar cells and solar devices and
4. compare different sources of energy production and the types of pollutants produced.

Background

This activity was developed with educators and students at Sully Buttes and Stanley County Middle Schools. It was part of a National Science Foundation Systemic Change grant. The modeling and experimentation were conducted in language arts classes in an attempt to integrate the sciences into the language art classes' daily activities. Students used the library to research the names and addresses of solar industries or solar energy. They wrote to the companies for information about solar energy, cells and the various uses of the sun's energy. (Hint: Have the students start writing to the resource at least 6 weeks ahead of time!) Writing exercises were done by hand or on computer. We encourage use of computers whenever possible.

Students were asked to model electron flow and to experiment with solar cells. using the background material included with this module. Journals may be used rather than the sheets supplied at the end of this exercise. Oral reports on each team's model were presented in class.

Finally students were asked to research where they or their community got their source of energy. The students finished the activity by writing a paper explaining their findings regarding pollutants associated with their community's energy production and/or usage.

Solar cells and diodes along with other simple solar gadgets can be obtained at places like Radio Shack, hobby stores, or ordered from various science supply companies.

Materials

- Marbles
- Expanded Polystyrene (EPS) sheets (the best known trade name is Styrofoam™)
- String
- Solar cells
- Diodes (tiny lights), transistor radios or

other small gadgets that can be wired to the solar energy cells.

- Journals or handout sheets at the end of this exercise
- Pencils
- Cutting utensils for the EPS

Procedure

1. At least 8 weeks before conducting this exercise have the student teams (2-4) use the library to research solar energy companies or resources.

2. Students should write to the companies or resource for information at least six weeks prior to your planned modelling and solar cell experiments.

3. After the students have received their information provide them with the description sheet at the end of this activity on how solar cells work. On the sheet are directions for them to accomplish their work.

4. Provide them with the string, marbles and the EPS sheets and ask them to model what they have read from the materials supplied.

5. After 15-20 minutes ask the student to report to the class demonstrating their model and the reason for their construction.

6. Hand out the What's Your Opinion sheet with this activity and assign it as a written activity to be completed by each student.

7. Discuss student results by using some of the question below.

Questions

1. What energy source(s) is/are found in the community?

2. What pollutants are associated with this energy?

3. What pollutants are associated with solar energy?

4. Are we using solar energy in the community?

5. Where is most of the solar energy produced in the U.S.?

6. What is the potential to use solar energy in South Dakota?

7. Why are we not using more solar energy?

8. What are other "clean" energy sources?

Bibliography

Additional Ideas

HOW DO SOLAR CELLS WORK?

Most of the solar cells produced today are made with silicon. This plentiful natural resource makes up more than one-fourth of the earth's crust and is the main component of ordinary sand. The silicon used in the production of solar cells must be highly purified. The greatest cost of producing solar cells is the difficult task of removing all but the slightest traces of impurities.

To make the solar cell that will power your solar model, producers start with a thin disc of almost pure silicon crystal. When the silicon crystal is being formed, a small amount of a substance called boron is added. The boron gives the crystal structure a unique characteristic. It actually has a positive electrical charge. Since this part of the solar cell has a positive charge it is referred to as "P" type silicon and it forms the base of the cell. Next, a very thin layer of silicon crystal is formed over the disc of "P" type silicon. However, instead of adding boron, this time a small amount of phosphorous is added to the mixture. The phosphorous provides a negative charge and thus is referred to as "N" type silicon.

The two halves of the solar cell, one "P" type silicon and the other "N" type silicon. cancel each other out to produce a neutral cell.

NEUTRAL SOLAR CELL

SILICON LAYER WITH PHOSPHOROUS (Negative "N" -)
SILICON LAYER WITH BORON (Positive "P" +)

When sunshine penetrates to the junction of the "N" type and "P" type silicon cell layers it creates a flow of electrons throughout the crystal structure. The crystal structure of silicon contains empty areas that will accept electrons. As one electron moves to fill a hole, it creates another hole. It is the flow of electrons which produces electricity.

Your first task is to devise a model to demonstrate the flow of electrons and the change of light energy to electrical energy.

MODEL DESIGNS

1) Using the marbles and the pieces of expanded polystyrene design a model that might show how electrons move.

Work as a group to come up with your ideas. When you have designed AND TESTED your model describe the construction and your results in writing on your ELECTRON MODEL SHEET. A diagram of your model should be sketched on the sheet.

2) You have a solar motor, a solar panel, wires, etc. Design a model that now converts solar energy to electrical energy.

Use the DATA COLLECTION SHEET to record what you observe and what it means. A sketch of your model should be drawn on this sheet. Please answer the questions found on the back side of the data collection sheet.

WHAT'S YOUR OPINION?

YOU HAVE NOW DESIGNED TWO NEW MODELS TO DEMONSTRATE THE USE OF "CLEAN ENERGY." IN YOUR GROUP, DECIDE WHY SOLAR ENERGY IS CALLED CLEAN ENERGY. WRITE YOUR IDEAS THE SPACE BELOW.

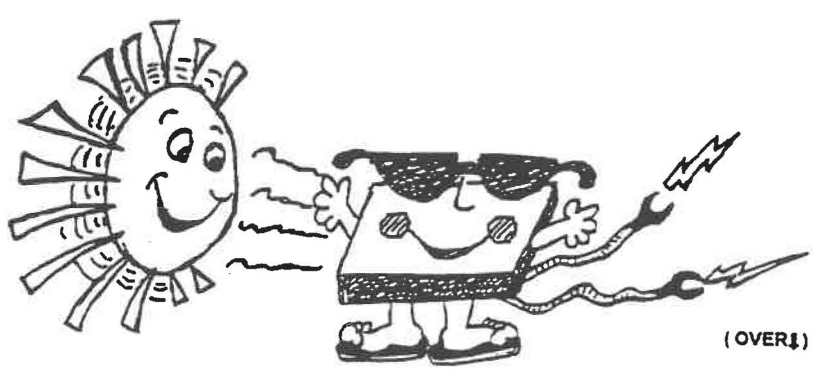
WHAT IS THE SOURCE OF ENERGY FOR YOUR TOWN? DECIDE IF THE SOURCE IS "CLEAN ENERGY" AND IF YOU THINK IT IS WHY? ARE ALL SOURCES OF ENERGY CONSIDERED TO BE "CLEAN?" IF NOT, WHY? WRITE YOUR EXPLANATIONS IN THE SPACE BELOW.

NAME ____________________

DATE ____________________

DATA COLLECTION SHEET

WHAT I OBSERVE	WHAT IT MEANS
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.



(OVER)

1. How can solar panels be used to help save the environment?

2. What are some problems with using solar panels to produce electricity?

NAME________________________

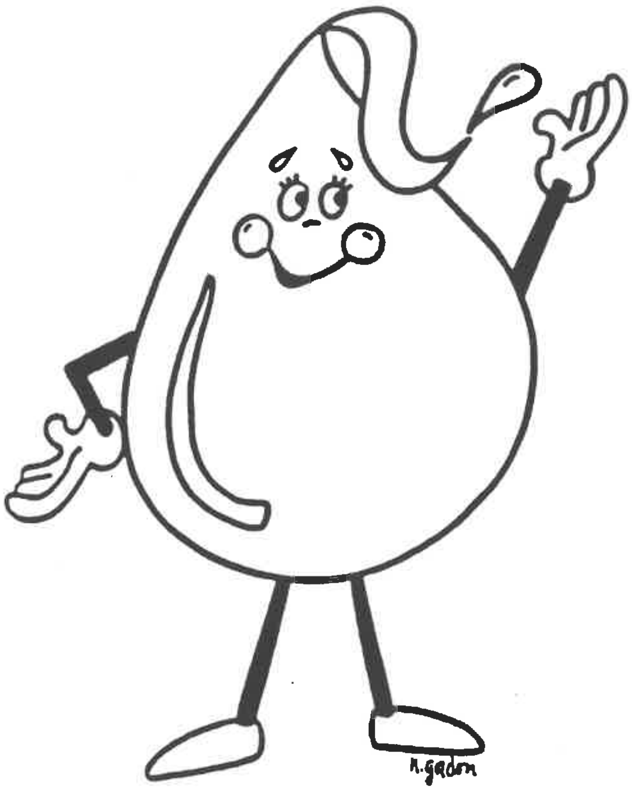
DATE________________________

ELECTRON MODEL SHEET

DESIGN SKETCH

DESIGN DESCRIPTION

Wendy Water



WATER QUALITY INTRODUCTION

South Dakota has a total of 9,937 miles of rivers and streams. The quality of these rivers and streams may be impacted by the runoff from agricultural land and inadequate wastewater treatment. Natural causes such as low flow conditions also can affect the streams.

The Department of Environment and Natural Resources has designated a total of 3,965 miles as fishable/swimmable waters. Eighty percent (80%) of the streams meet the fishable criteria and nearly fifty percent (50%) the swimmable criteria.

In addition to rivers and streams there are 799 lakes and reservoirs (including the Missouri River mainstem reservoirs) totalling 1,598,285 acres. The lakes are affected by runoff carrying sediment and nutrients from agricultural land. In many of the lakes this speeds up the aging and threatens their well being. The term for this accelerated aging is "cultural eutrophication." Man is responsible for much of this problem.

The most impaired stream in the state is Whitewood Creek. This impairment is due to the use of mercury and arsenic during past Black Hills mining practices. Most of this pollution is now controlled. Cleanup along the creek is being contemplated soon.

Another water body impacted is the White River. The problem is due to natural soil erosion in the Badlands. This erosion causes the river to carry a heavy silt load, thus the name White River from the soil color.

Ninety-three percent (93%) of the 875 public drinking water systems are drawn from ground-water sources. Ground-water quality is highly variable, but is mostly suitable for domestic, industrial and agricultural use.

Ground water is found in aquifers or natural underground layers of porous material such as sand or gravel. One quarter of the water that irrigates, powers and bathes America is taken from an ancient network of underground aquifers. In 1950, the United States took some 12 trillion gallons of water out of the ground; by 1980 the figure had more than doubled.

In South Dakota the aquifers that lie deep below the surface contain high amounts of salts. These deep aquifers are not prime sources for raw water supply.

The shallow aquifers in the state are easily contaminated. Improper disposal of materials on the ground can destroy this precious resource. Percolation through the soil is a main cause of ground water contamination.

The main concern in South Dakota has been with the petroleum products that have leaked from underground storage tanks. Petroleum contains some chemicals that can make ground water useless if the concentrations go above a certain level. Three teaspoons of a chemical, such as dry cleaning solvent, can contaminate 1,000,000 gallons of water. These one million gallons must be treated or otherwise they are useless! The treatment of ground water is not cheap! The best method of having clean ground water is to prevent the pollution.

In South Dakota, public water supplies must be treated before home use. Many of the constituents in the drinking water that must be removed are naturally occurring. These do not pose a health threat. The water must be treated for taste and appearance.

Another concern in South Dakota is the increase in nitrates and bacteria in the ground water along the Big Sioux River. This increase in nitrates may reach levels where it can be harmful to human infants and small pigs. The bacteria can cause intestinal problems and is an indicator there may be more disease organisms in the aquifer. Most of this contamination comes from feedlots and septic tanks.

The Water Quality Background Section provides more detail on surface and ground water. The background also can be used for a better understanding of water as it relates to you and your students. It also provides the necessary information for conducting the modules on water quality.

WATER QUALITY BACKGROUND

Importance of Water

Water is regarded as commonplace because it is the most plentiful liquid on earth and because of our familiarity with it. All the tissues of our bodies are bathed in it. Our foods must be suspended or dissolved in water solution to be carried to the different parts of the body. Also, most wastes are eliminated from the body as water-soluble substances.

All life on earth requires a water environment. A plant receives nutrients from the soil that are dissolved in water. The food manufactured by the plant leaves requires water.

Water is present in most natural objects and most places on earth. There is water vapor in the air and liquid water in rocks and soil. Clay and certain kinds of rocks contain water in chemical combination with other substances.

Water may be commonplace, but useful water is not always readily available. Even before the discovery of America, one of the common causes of war between Indian tribes was water rights. Among the first considerations of any new land development is water. Useful water is rarely free, and it is not very abundant in many parts of the United States. There are few places left where a person can feel safe drinking water from a spring, stream or pond.

Even the ground water produced by wells must be tested regularly. In some cases, human activity has made it difficult to locate a safe water supply of any sort. In certain costal areas, for example, over-pumping from the ground has depleted the ground water basins. As a result, the intrusion of sea water is ruining the basin for most useful purposes. Some of man's activities clearly pose a threat to life on this planet.

For decades, Americans have used water as though their water supply would never fail. In recent years, drought conditions have forcibly brought the need to conserve and properly budget our water resources. Even in the driest years, rain across the nation exceeds water use. Underground basins of water, deposited over many years, have been seriously depleted in a matter of decades.

The trouble is the nation's water resources are poorly distributed. The Pacific Northwest has a large surplus, while the Southwest agricultural states fight for the last salty drop Colorado River water. The federal government has spent billions of dollars building and operating facilities to divert water for use in arid and water-short areas.

Contamination is a problem, too. Mineral residues from irrigation have damaged once fertile soil. Acid rain, as mentioned in the air quality background section, is killing fish in mountain lakes. America's shrinking water supply has been tainted with substances as exotic as trichloroethylene(TCE) and as commonplace as highway salt. Other sources of ground water contamination include septic tank seepage and the improper disposal of hazardous wastes.

Sources of Water

The Hydrologic Cycle

Water comes in the form of precipitation. Ninety-two percent of water either evaporates immediately or eventually flows into the oceans. Energy from the sun evaporates ocean water at an overall rate of about six feet of water annually. The water that is evaporated is salt-free water, since the heavier mineral salts are left behind. This water vapor rises, is carried along by the winds, and eventually condenses into clouds. When these clouds become chilled, the small particles of water collect into larger droplets that fall over land or water.

When water falls as rain, sleet, or hail, it clings to and carries with it all the dust and dirt in the air. The first water that falls picks up the greatest concentration of contamination. After a short period of fall, the precipitation is mostly free of pollutants.

A large part of the evaporated water is carried over land masses by the winds. The air cools and causes droplets to form. The droplets that fall make up our supply of fresh water. These droplets may soak into the ground, fall as snow on the mountain tops, or collect in lakes. In one way or another, all of the droplets seek to return to the ocean from where they came.

This, in brief, is the framework of the hydrologic cycle. The figure at the end of this section depicts the Hydrologic Cycle.

Ocean

At some time in its history, virtually all the water was found in the oceans. Moisture is transferred from the ocean surface to the atmosphere by evaporation. The winds carry the moisture-laden air over land masses. Under certain conditions, this water vapor condenses to form clouds, which release their moisture as precipitation. This precipitation can be in the form of rain, snow, hail or sleet.

When rain falls toward the earth, part of it may re-evaporate and return immediately to the atmosphere. Precipitation above the amount that wets a surface or evaporates immediately is available as a potential source of water supply.

Surface Water

Surface water collects as a result of direct runoff from precipitation (rain or snow). Precipitation not entering the ground through infiltration or not returning to the atmosphere by evaporation is classified as direct runoff. Direct runoff water flows off saturated or impermeable surfaces. into stream channels, and then into natural or artificial storage sites.

The amount of available surface water depends largely upon rainfall. When rainfall is limited, the supply of surface water will vary between wet and dry years. In areas of scant rainfall, people build individual cisterns. These are underground storage areas for rain that drains from the catchment areas of roofs. This type of water supply is used in the Bermuda Islands, where ground water is virtually non-existent and there are no streams.

Surface water may further be divided into rivers, lakes and reservoirs. The quality, in general, is characterized by turbidity, suspended solids, some color, and microbiological contamination. Ground water is characterized by higher concentrations of dissolved gases, lower levels of color, and freedom from microbiological contamination.

Rivers and streams

The importance of rivers and streams in South Dakota are two-fold. The water is used by aquatic organisms such as fish, insects and wildlife and by humans for drinking water purposes.

The natural state of our streams is upset if man dumps untreated waste or nature rapidly delivers too much silt to them. Improperly treated wastes dumped into streams and rivers kill or cause organisms to move. The problem is the build up materials that require oxygen for decomposition. The organisms in need of oxygen exhaust the oxygen supply near the waste. Any organism that cannot move out of the area perishes. Organisms that sense the lower oxygen will move away seeking better water in which to live.

Rivers and streams will recover below where man has dumped his waste materials. The problem is many rivers, after partial recovery, will flow past another area where humans dump waste. In some cases the waste sites are so close the river never recovers.

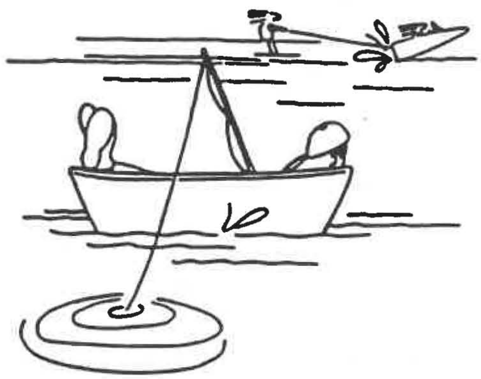
Other wastes, with an immediate impact, are chemicals from industrial discharges and from oil spills. Both have a disastrous effect on the organisms dependent on the rivers and streams. Usually, these spills and discharges can be prevented. It is much cheaper to **PREVENT** the pollution than to clean it up.

Man is also dependent on the rivers for his drinking water. Any pollutants, added upstream of a community using the water, will need to be removed before consumption. In this case the treatment costs become very high for supplying citizens with good quality water. The cost is borne by the user and not the polluter.

Lake and Reservoirs

There are many lakes and reservoirs in the eastern one-half of the state. Many of the lakes in eastern South Dakota were caused by the glaciers many years ago.

Most of the lakes in South Dakota are used for recreation and by fish and wildlife. Some of the lakes and reservoirs serve as drinking water supplies for South Dakota citizens. Thus, it is critical that human activity above reservoirs or lakes be conducted to prevent pollution. possible. When ponds, lakes, and open reservoirs are used as sources of water supply, the danger of contamination and of the consequent spread of diseases exists. Some diseases are: typhoid, hepatitis, and dysentery. Clear water is not always safe water.



The old saying that running water "purifies itself" to drinking water quality within a stated distance is false.

Lakes and reservoirs are subject to seasonal changes in water quality. Such changes are brought about by stratification. This is the formation of separate layers of varying temperatures. Lakes and reservoirs will be warmed by the sun in the spring and summer causing higher temperatures on the surface. In the fall, the air temperatures will cool the surface water until it reaches the same temperature as the subsurface waters. At this point, the water temperature is uniform throughout the depth of the lake or reservoir. A breeze will start the surface water circulating. This causes the lake to "turn over," thus bringing the poorer water quality on the bottom to the top.

Lakes and reservoirs are subject to algae blooms, especially after spring or fall turn overs. The rapid growth of algae (blooms) occurs when the temperature is right. Also, the bloom occurs when the water contains enough nutrients for rapid growth. Increased nutrients cause "cultural eutrophication" or accelerated aging of lakes. This will impair the water body use.

Ground Water

Part of the precipitation that falls infiltrates the soil. This water replenishes the soil moisture. It is used by the growing plants and returned to the atmosphere by transpiration. Transpiration is the process by which water vapor is released to the atmosphere by plants. Water not used by plants drains downward (percolates) below the root zone. The water reaches a level where all the openings or voids in the earth's materials are filled with water. This is known as the zone of saturation. Water in the zone of saturation is called ground water. The upper surface of the zone of saturation is called the water table. The water table occasionally intersects the surface of the ground. This is caused by irregularities in underground deposits or layers and in surface topography.

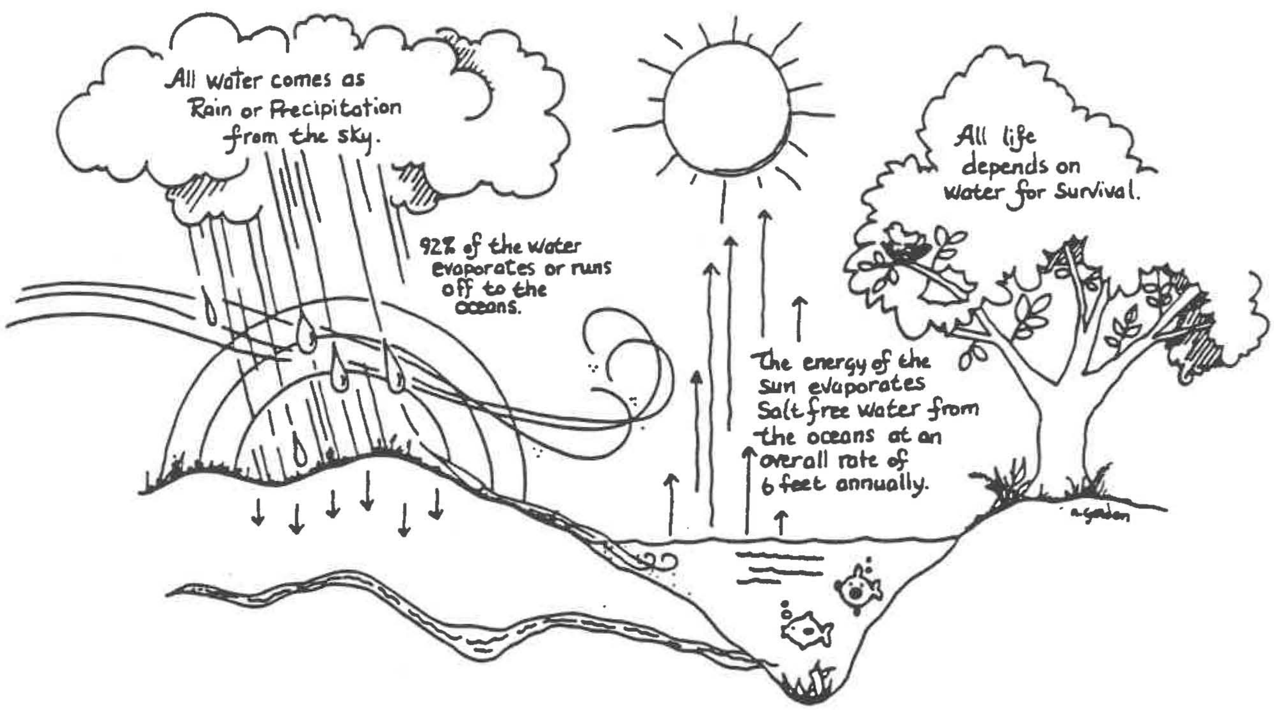
Ground water that flows naturally from the ground is called a spring. The flow from a spring may vary considerably due to the level of the water table. As a result, ground water moves to these locations as seepage out of the aquifer (ground water reservoir). Thus, ground water is continually moving within aquifers though the movement may be very slow.

A well that penetrates the water table can be used to extract water from the ground water basin. The removal of water by pumping will naturally cause a lowering of the water table near the well. Continuous pumping, that exceeds the rate of replacement by the water-bearing formations, may deplete the aquifer.

Quality of ground water is naturally

affected or can be contaminated by human activity. Indiscriminate dumping of chemicals on the ground can cause ground water to become contaminated by the chemical percolating into the aquifer. This activity can cause a water to become unusable though the amount dumped may be very minor.

Much of the deeper aquifers in South Dakota have high concentrations of mineral salts. Without treatment they cannot be used for a drinking water supply. Some of the deeper aquifers contain salt concentrations so high the water cannot be treated at a reasonable cost.



Hydrologic Cycle

GUNK IN MY GLASS?

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GRADES: 6 to 12

CLASS: Science

TIME: Three 20 minute blocks

EMPHASIS: Water Treatment for particle removal.

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Objective(s)

The student will:

1. observe gravitational action on large particles and
2. use a simple chemical applied in water treatment.

Background

Surface water taken from a stream or reservoir may be carrying particles that must be removed before use as drinking water. The water goes through a treatment process by use of settling basins and flocculation. The latter is the use of chemicals to cause fine particles to join. These larger particles will settle due to gravity. Most water treatment plants use alum or iron salts as the flocculent. The floc or settled materials are easily observed using this process. Alum may be found in the grocery stores in the canning section or with the salts.

Materials

- 1 quart jar of silty or muddy water
- several ounces of alum
- 1 empty quart jar to collect water from the treated quart

Procedure

1. Have each student collect a quart jar of silty or muddy water before class. If they cannot, then make several gallon jars of silty/muddy water before class. Silty water can be made by adding garden soil to tap water.
2. On the day of the module the silty or muddy water should be shaken to distribute the material. The jar should be allowed to stand for 15 minutes. Then add several pinches of alum and note the flocculation of the silty particles.
3. Allow the treated jar to sit overnight.
4. Observe the final effects of the alum on the water.
5. Carefully pour off or draw off the cleared water so as not to disturb the floc at the bottom of the jar.
6. Use the cleared liquid for the next module on filtration.

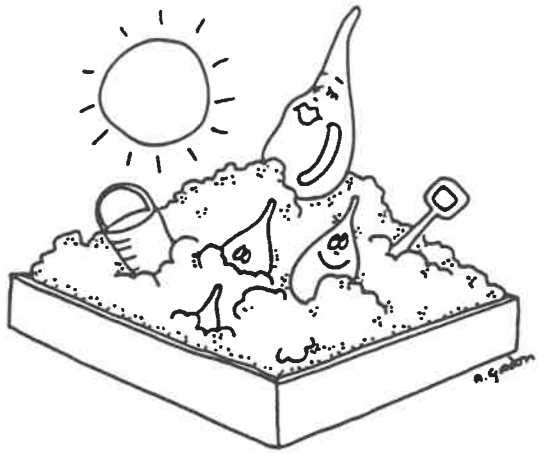
Questions

1. What happened 15 minutes after shaking?
2. How long did it take for any visible change?
3. What happened when you added the alum?
4. How would this apply to drinking water taken from a stream or lake?

Bibliography

Additional Ideas

EVERYONE NEEDS A SANDPILE!



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GRADES: 6 to 12

CLASS: Science

TIME: 45 minute block

EMPHASIS: Water filtration

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Objective(s)

The student will:

1. practice simple drinking water filtration and adsorption and
2. express the use in drinking water and waste water treatment.

Background

After water has been chemically treated for drinking water or biologically treated at a wastewater treatment plant, it is filtered. Sand filters are used to remove the remaining suspended particles. The previous module demonstrated the removal of particles chemically and by gravity. Sand or mixed media (sand, anthracite coal, and garnet) is used to adsorb particles before disinfection.

Sand filters are used on wastewater released back into the environment.

Materials

- Liquid from the previous module on chemical flocculation
- Cheesecloth
- Clean, washed sand
- Clean quart jar

Procedure

1. Place the cheesecloth over the mouth of the jar. Attach it with a rubber band. The cheesecloth should hang into the jar at least two inches.
2. Place sand in the cheesecloth to just below the rim of the jar.
3. Gently pour the water, in small amounts, over the sand. The filtering may take 30 minutes to complete.
4. Examine the unfiltered water, filtered water, and the sand. Students should record the observations in a chart.

Questions

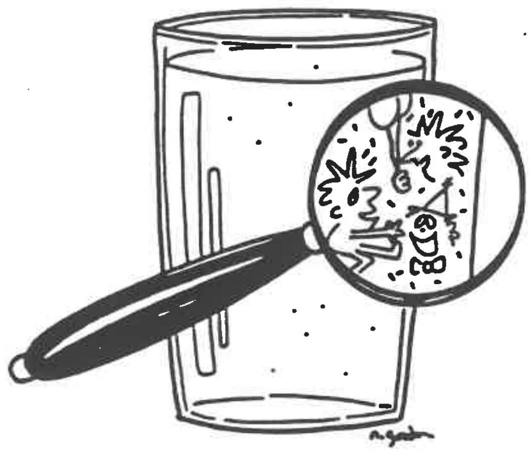
1. What is the purpose of the sand?
2. What happened to the water after passing through the sand?
3. How might this be applied to drinking water or waste water?
4. How might this work under natural conditions?
5. What might assist in nature?

Bibliography

Additional Ideas

☛ Use fine and very fine sand. Sand from the lumber yard will do for the fine sand. The very fine sand can be purchased at the art or craft stores. Layer with the very fine sand on top.

WHAT IS IN THAT THAR GLASS?



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GRADES: 6 to 12

CLASS: Science

TIME: Two 45 minute periods

EMPHASIS: Water disinfection

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Objective(s)

The student will:

1. use a microscope and prepare a slide for observation;

2. Observe the life in pond water;

3. examine the disinfection power of chlorine with bleach; and

4. describe how disinfection works in water and wastewater.

Background

South Dakota obtains the majority of its drinking water from ground water. Flocculation and filtration are not highly used for treating water. Some communities that use these methods are Vermillion, Yankton, and Sioux Falls. Most ground water treatment is disinfection. A few communities conduct water softening. The most commonly used chemical for disinfection is gaseous chlorine. Chlorine gas can be hazardous. We have substituted bleach for the chlorine gas in this activity. Bleach contains chlorine that is bound with other elements, but is released in the water soit can be used as a disinfectant. Disinfecting water destroys bacteria harmful to humans.

Special lenses are needed for viewing bacteria. This module uses microscopic organisms that can be readily observed. This accomplishes the objectives of observing disinfection effects.

Materials

- 2 one-quart jars, eye dropper, bleach
- Pond water containing viable microscopic organisms
- Slides and cover slips
- Microscopes (viewing lenses if organisms are large enough).

Procedure

First 45 minute period:

1. Have the students collect the pond water while the weather is still warm.

2. Label jar 1 and 2 and add several drops of bleach to the second jar.

3. The students should obtain a drop or two of water from jar 1. Place the drop(s) on the slide and gently lower the coverslip over the drop(s).

4. The students are to observe the life in the pond water noting in writing the size shape and movement of the organisms.

Second 45 minute period:

1. Prepare a slide using water from the jar 2 that contains the bleach.

2. The observations again are to be recorded on the size, shape and movement of any organisms.
3. Discuss the observations the last 15 minutes of the period.

Questions

1. What was observed on the first slide?
2. What was observed on the second slide?
3. What happened when the bleach was added?
4. What else might be used in a real treatment plant?

Bibliography

Additional Ideas

IS IT SAFE??!!

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GRADES: 4 to 8

CLASS: Science, Home Economics

TIME: 30 minutes

EMPHASIS: Unseen Water Contamination
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Objective(s)
The students will analyze that clean appearing water may not be drinkable.

Background
Ground water cannot be judged as fit to drink strictly by sight. Human activity has contaminated drinking water sources across the nation. This contamination has been caused by the many chemicals developed over the last 50 years. These chemicals, in minute amounts, can actually render a community's water supply useless. The contamination may not be noticeable by taste or smell.

Materials
- 2 gallons distilled water
- 1 empty and washed gallon milk jug
- 1 small jar of pickle juice
  (If pickle juice not used then use salt or sugar)
- grease pencil or washable marker pen

Procedure
1. Before class, flavor one of the distilled water jugs with pickle juice, sugar or salt. Add enough so the flavor is detectable.
2. Fill the empty jug with tap water from the drinking fountain or another tap.
3. Label each jug with a letter so the students do not know what is in each.
4. Before the experiment, ask the students to bring from home 3 reusable plastic cups. (If your budget allows, you may want to purchase reusable plastic cups that can be easily washed; we do not want to create more trash).
5. Instruct the students to work in groups or individually, dependant on class size.
6. Instruct the students to label their cups with the grease pencil or washable marker pen. These should be marked the same as the jugs you marked.
7. Instruct the students to pour a very small amount (a swallow or two) into each appropriately labelled cup. Have the students taste the water in each cup. Each student should record his or her observations.

Questions
1. Was there any taste in each jug?
2. How would this apply to noticing pollution in drinking water?
3. Will taste always reveal pollution?
4. What might happen to a person who consumes drinking water over a long time that contains contaminates?

Bibliography

Additional Ideas

SUDS IN MY TUB

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GRADES: K to 6

CLASS: Health, Science

TIME: 30 minutes

EMPHASIS: Soft water
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Objective(s)
The student will analyze soap requirements for hard and soft water and express why this is important to cleanliness.

Background
Hard water contains minerals are dissolved when water has percolates over rocks or through soil. Water percolating through soil and rocks deep below the soil surface contains high mineral content.

Hard water inhibits detergent cleansing action. Minerals tie up the soap so it does not work efficiently.

Several South Dakota communities have such hard water that home softeners are needed before any water use. Some U.S. cities have installed community water softening systems.

Materials
- 1 gallon of distilled water (water that has all minerals removed)
- 1 gallon of tap water that has not been softened
- 1 small bottle of liquid hand detergent
- 2 small containers with caps, one for the distilled water and one for the hard water
- hand towels or paper towels
- stirring tool for the water, if they are not going to shake the containers

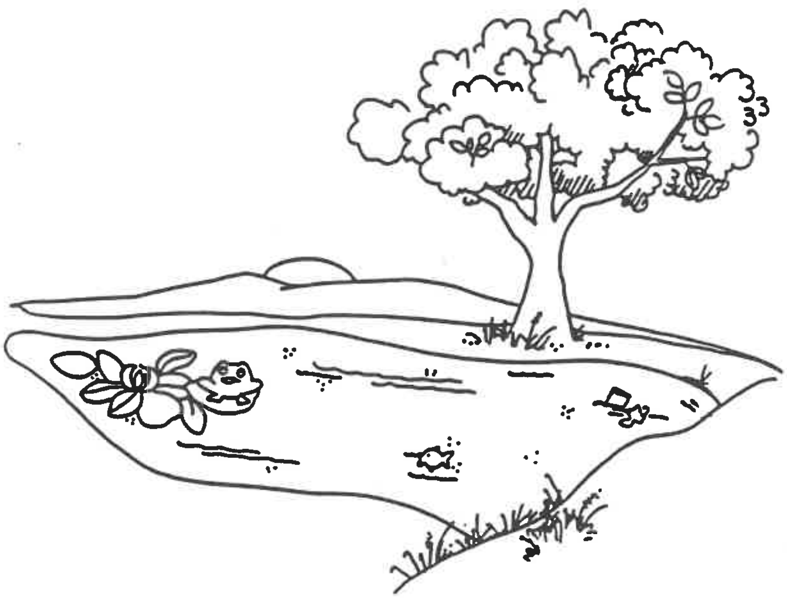
Procedure
1. Before class, label the distilled water bottle and the tap water bottle so the students are not aware of the contents.
2. Instruct the students to label their dishes the same as the jugs of water. The students should gently pour water into each small container and add 5 drops of detergent to each.
3. Instruct the students to stir or shake their containers an equal amount of times to create suds. The students are to observe and record any differences.

Questions
1. What was the difference in the amount of suds, if any?
2. How would you explain this?
3. Do your parents use distilled water and if so what for?
4. What is the advantage of soft water?

Bibliography

Additional Ideas

PLANT CHANCE



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GRADES: 3 to 8

CLASS: Science

TIME: Two 30 min periods and four 10 minute periods

EMPHASIS: Water pollution from chemical plants

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Objective(s)

The student will:

1. examine that chemicals coming from wastewater without treatment can be deleterious to aquatic plant life which in turn damages animal life and
2. recognize it is better to avoid use, or substitute a less toxic material for, the problem chemical.

Background

The past 20 years have shown we can control pollution. Pollutants such as suspended solids, oxygen demanding compounds, and bacteria are being reduced or controlled. Many chemicals are still placed into the waters of this state and across the United States. These chemicals need special treatment. The special treatment cost is very high. Many of the chemicals used in manufacturing products are now under review. Industries are seeking substitutes that are less toxic. Substitution with a less toxic chemical will make wastewater treatment much simpler. This will save energy and dollars and make for a better environment.

Materials

- 2 fish bowls or tanks or similar types of containers
- 2 healthy water plants - obtained at most pet stores, from the high school aquarium or from a stream in your area in warm weather
- water
- clean sand or gravel - obtained at most pet stores or lumber yard, remember that it must be washed if obtained at the lumber yard
- vinegar (5% acetic acid)
- Tablespoon
- Water pitcher or other container to pour water into the fishbowls

Procedure

1. Make sure the fish bowls or similar containers are washed and thoroughly rinsed before use.
2. Place sand or gravel into the bottom of each bowl. The sand should be deep

enough to cover the plant roots.

3. Make a hole in the sand or gravel with the index finger so the plant roots can be covered. Place the aquatic plant roots and a small amount of the base into the hole and push the sand or gravel around the plant to cover the roots.
4. Using the pitcher, carefully pour the water into each fish bowl. There should be enough water to cover the aquatic plant.
5. Label the bowls A and B.
6. Into bowl B place four (4) tablespoons of vinegar. Do this for the next five days and note what happens. (Vinegar should kill the plant within a week. If not, continue the experiment for one more week.)

Questions

1. Was there a difference in the plants at the start? If so what was the difference?
2. Was there a difference at the end of the experiment?
3. How would this apply to chemical factories?
4. What could the factory do to lessen the impact?

Bibliography

Gutnik, Martin J. 1973. *Ecology and Pollution/Water.* Childrens Press, Chicago.

Additional Ideas

PERC-O-LATE

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GRADES: 5 - 8

CLASS: Science

TIME: 45 minutes

EMPHASIS: Ground water recharge and pollution paths.

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Objective(s)

The students will:

1. analyze percolation rates to the groundwater through different types of soil,
2. recognize water can be contaminated by substances dumped onto the ground and
3. construct graphs using time and categories of percolation rates.

Background

Soils vary across the state from very tight or clay soils to very sandy soils. These varying types of soils change the recharge rate to the water table. The water table is the area below the surface of the ground that is saturated with water. In addition, the soil type may affect what percolates into the ground water. Some soil types will attract certain pollutants and hold them until the soil is saturated. When the soil particles can no longer adsorb the material the polluting substance percolates to the water table.

Water from streams will percolate into the sands or soils nearby. This creates what is called an alluvial aquifer. If the stream dries up, the alluvial aquifer will disappear. The alluvial aquifer also can be depleted by humans and plants.

This exercise demonstrates the varying rates of percolation. It also shows how a substance can be carried through the soils to the ground water. The exercise will not demonstrate the adsorption of substances to the soil(s).

Materials

- Three clear glass or plastic bottles (pint or quart size). The plastic containers can be constructed by cutting a clear plastic beverage container in half and using the bottom.
- Small plastic bottles for pouring water.
- Three different types of soil or sand or a combination of the two. You may want to have your soil conservation or county extension agent assist you with the various types of soils found in your area.
- A supply of water
- A supply of food coloring or another non-toxic colored fluid.
- A clock with a second hand.
- Graph paper.
- A box of soil, sand, gravel in case students forget theirs. Sand and gravel may be obtained from the local lumber supply store or greenhouse.

Procedure

1. Have the students work in pairs.
2. The students bring in some soil from their garden or similar place near their home (enough to half fill a pint or quart jar).
3. Instruct the students to label their pint or quart bottles. Eg.: Soil, Sand, Gravel.
4. One student should fill each labeled bottle half full with the appropriate material. The other student should obtain a supply of water and the food coloring.
5. Instruct the students to add a drop or two of the food coloring to the top of the soil, sand and gravel.
6. Slowly add a cup of water to each jar. Time how long it takes the water to percolate to the bottom of each jar.
7. The students are to construct a graph with the material on one axis and time on the other.

Questions

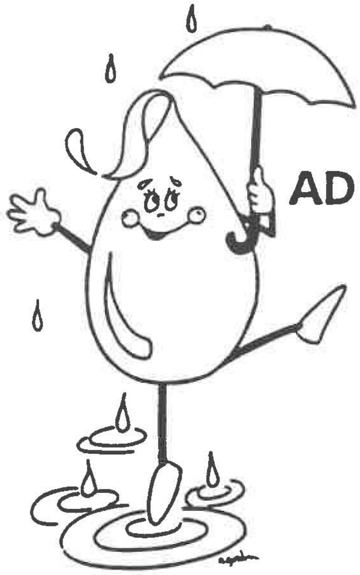
1. What happened in each different jar?. What was the time it took for each substance? (As a class exercise have the students construct a graph on the board. Ask them to compare the results of the classroom graph and their individual graphs.)
3. What might be the reasons for this?
4. Did the color of the water change?
5. If it did, what do you suppose would happen to our water when we dump substances on the ground?
6. What can we do to protect our ground water from pollution?
7. What would happen in the jar with the soil if we took out water faster than it percolates down?

Bibliography

Additional Ideas

☛ Students can expand on ground water recharge and ground water pollution by researching properties of substances. Suggest properties such as toxicity, solubility, and density. Each of these properties will have some type of effect on the ground water and may eventually render it useless. Students might research substances that are familiar to them. Such materials would be those used around the house or farm.

☛ Introduce the geologic time table to the students. Students might contact local water supply personnel to determine the geologic formations for an earth science activity. The students should ask which formation supplies the city ground water. Tie the ancient waters to history lessons where possible. Discuss ground water mining. The students can research what some states are doing to conserve ground water. Instructors who live in towns where water is obtained from streams or lakes may want to conduct the <u>Project Wild: Deadly Waters</u> exercise.



ADOPT A STREAM

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GRADES: 3 - 8

CLASS: Science, Social Studies, Math

TIME: Two 30 minute periods

EMPHASIS: Water protection

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Objective(s)

The students will:

1. collect stream bottom dwelling organisms and categorize them,
2. differentiate between good, fair and poor quality streams and,
3. calculate numbers per area and display their findings.

Background

Two methods are used to determine the quality of streams in South Dakota. First, the department does chemical monitoring of selected streams across the state. Second, chemical monitoring is done by communities and businesses discharging wastewater to streams. They sample the wastewater to assure federal and state water quality standards are met. The standards are set to protect the chemical, physical and biological integrity of a stream.

Biologists use a different method to determine the health and well being of a stream. They sample for living organisms found in streams. Certain organisms can only survive if a stream is of good quality. Others only live in a stressed or polluted stream. Small organisms can be used to determine the health of the stream; i.e., good, fair or poor quality water.

These organisms can be sampled by using a simple method. The method is collecting organisms within a given area. These samplers can be purchased, if you have the budget, or can be constructed at a low cost. (See construction diagram in Appendix E.)

Find a stream in your area that you would like improve or preserve as a natural resource. You are encouraged to Adopt A Stream either through a local organization or the Department of Environment and Natural Resources.

Personnel in the Department's Adopt A Stream program are available to aid the classroom instructor. Field help may be available from the Department to help the students collect and identify organisms. After the initial assistance program, the instructor or members of the community can continue the program. A minimum amount of time is needed to continue the program.

Recognition of your program will be made with a Charter Membership in the Adopt A Stream Program. Follow up visits will be conducted to recognize your progress and contributions to South Dakota's water quality. Recognition of each of the participating schools will be made annually at the South Dakota State Fair, at the Department's booth.

If you cannot participate on school time, you may consider forming an evening, weekend or summer Adopt A Stream Club. We encourage you to use an existing organization who wishes to involve youth.

Materials
- Stream bottom samplers
- Notebooks
- Pens or pencils
- Hand lenses or magnifying glasses
- 8" x 12" or similar size trays, preferably with a white bottom
- Forceps or tweezers
- Appropriate clothing for wading in the stream

Procedure

NOTE: We recommend a small stream for collecting the bottom dwelling organisms. You should provide safety instructions on the use of all the equipment and basic water safety.

This activity should include parents as sponsors. They can drive and help the students with sampling. The adults should be trained in sampling before helping the students.

FINAL NOTE: This activity is best conducted in the spring. This is when many of our streams have some water flow. Locate the origin of the stream. Is it spring fed or does it simply come from run off? Interesting exercises can be developed from your findings about the origin of the small stream.

1. Purchase or construct the Hester-Dendy sampler as found in Appendix E. This would be a good project for the students if they are old enough. If there is a shop class, ask if the samplers could be built as a class project.
2. Place the sampler in a small stream by inserting the protruding bolt portion of the sampler (see diagram in Appendix E) into the stream bed. In a rocky stream you may not be able to insert the rod into the bottom. Screw the bolt even with the 2 X 4. Weigh the 2 X 4 down with a brick or two, depending on the stream current velocity.
3. Leave the samplers in the stream for about two weeks, preferably three.
4. Collect the sampler(s) and return to the classroom.
5. Place the samplers in a pan, preferably with a white bottom. The sampler(s) should be carefully taken apart. The students count the numbers of different organisms inhabiting the 3" square boards.
6. Have the students record the numbers and kinds of organisms they find. Do not be concerned with learning the names of the organisms. They can use the key found in Appendix E to aid in determining the types of organisms, if they so desire. The key also will help them determine the water quality based on the type of organisms found.

Questions
1. What can you tell about the condition of the stream water quality?
2. How can you develop a visual about the types and numbers of organisms you found? (Hint: averages and graphs, teams and the class, sites and times)
3. What do the organisms tell about the water quality?

4. Where does the stream start?
5. How might you substantiate your findings?
6. What did you notice about numbers and kinds of organisms?
7. Will the organisms be the same in the fall?
8. Would you expect to find the same organisms in a pond or lake?
9. How many organisms are there per square foot?
10. How can you display the organism number and water quality?

Bibliography

Additional Ideas

☞ An excellent follow up on this is the next exercise for pond sampling "Pond Life and Panty Hose."

☞ Substitute, add, or change the Project Wild activity "Water Canaries" for this exercise. The Project WILD objectives include sampling for acidity/alkalinity, dissolved oxygen and temperature.

☞ Another Project WILD activity use with the Adopt a Stream activity is "Deadly Waters." This activity includes naming and describing different types of aquatic pollution.

POND LIFE AND PANTY HOSE

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GRADES: 2 - 8

CLASS: Science

TIME: One-half day

EMPHASIS: Water quality and ecosystems

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Objective(s)
The student will:

1. observe life from a drinking water source,
2. use a sampler to collect the pond life and
3. use magnifying instruments such as microscopes and hand lenses.

Background
South Dakota has six public water supply systems that get their water from lakes. Lake or pond water contains an assortment of life. Like the previous exercise the quality of the water is revealed by the life that is found there.

Life in a pond can be a very interesting and a stimulating learning experience for children of all ages. This exercise uses only the microscopic and some macroscopic organisms to stimulate the student's interest.

This exercise is similar to Water Quality 3 Module (WQ3MOD). It emphasizes the collection and observation of organisms within the pond rather than treatment. This activity makes a good first step in WQ3MOD.

Construction of the phytoplankton net can be fun. It shows reuse of a material. This activity can be combined with some of the solid waste activities in this manual, especially the reuse portion.

Materials

- Phytoplankton net (See materials and construction details in Appendix E)
- Notebooks
- Jars for collection of pond water
- Squeeze bottles or wash bottles (make them from clean reused soda bottles, see appendix E)
- Magnifying instruments: hand lenses, microscopes with slides and cover slips
- Reference materials or books such as *The Golden Guide to Pond Life*

Procedure
1. Find an open spot along the shore of the pond. Collect some water from the shore area.
2. Cast the phytoplankton net into the pond. (Do not let the tow rope leave your hands. A suggestion is to stand on the end of the rope.) Slowly pull the net back to shore.

3. Hold the net upright and rinse the lower portion of the net with the squeeze bottle. The rinse water should flow into the collection bottle.
4. Repeat step 3 several times casting from the same area each time.
5. Have the students record their observations about the area before returning to the classroom.
6. Have the students examine a small sample of the water placed in a shallow dish. (These shallow dishes can be made from the bottom of clear plastic bottles.)
7. Have the students examine a drop of the pond water under a microscope.

Questions

1. What did you find?
2. What do the organisms say about the water quality?
3. Will these organisms be found in the water you drink?
4. Where did the water come from that is in the pond?
5. What could make the water quality better (or worse) than it is?

Bibliography

Additional Ideas

☞ Combine this exercise with the Water Quality 1 through 4 Modules.
☞ Research where your community gets their drinking water. Find out how they treat the water for human consumption.

WATER RECTANGLES

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GRADES: 5 - 7

CLASS: Math and Science

TIME: 30 minutes

EMPHASIS: Wastewater treatment

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Objective(s)

The students will:

1. calculate lagoon surface area, volume, flow measurement, waste loading and
2. describe a common form of wastewater treatment in South Dakota.

Background

Have you ever noticed the rectangular water bodies at the edge of a town? Have you ever smelled the rectangular water bodies at the edge of town?! These ponds are homes to organisms that take care of our waste. Wastes that come from homes and businesses in a community are broken down in these water bodies. The rectangular water bodies are called **lagoons**.

Lagoons can be designed to discharge treated wastewater to a waterway or to retain the wastewater (**complete retention lagoons or ponds**). Engineers design wastewater ponds according to the number of people and businesses. They must determine the water and waste flow from the town. This information is used to size the ponds. The ponds will be designed for complete retention if enough land is available and if the evaporation rate is high .

About 30% of South Dakota communities have lagoons. Nearly 50 communities in South Dakota now discharge wastewater to lagoons designed as **wetlands.** Wetlands are highly diverse and productive water bodies. They serve as excellent means of wastewater treatment because of the diverse plants and microorganisms.

Complete retention systems (ponds or wetlands) are designed so the evaporation and transpiration (loss of water through plants) rates equal the inflow rate. The retention ponds are designed with a **freeboard** (distance from the top of the water to the top of the pond banks) of three (3) feet. This freeboard prevents overflow from excess water inflow or from wind caused wave action.

A lagoon contains bacteria and algae (microorganisms) that break down the wastes entering the ponds. The size and rates of outflow from discharging ponds must be calculated so the wastewater is adequately treated. The microorganisms cannot keep up with the waste load if too much waste enters the system. This extra loading causes discharge of polluted water.

Ponds will "turn over" in the spring and fall of the year. When this occurs the water at the bottom of the pond rises and the gasses trapped in the pond bottom are released. This "turn over" is good as it distributes oxygen throughout the pond. Organisms that break down the waste need the oxygen (**aerobic** condition). Lack of oxygen causes the ponds to become **anaerobic** (without air). Waste breakdown under anaerobic conditions is only partially complete. Gases produced by anaerobic conditions have an unpleasant smell.

Lagoon systems are an inexpensive and easy way to treat wastewater. The maintenance is minimal and they last a long time.

Wetlands created by the wastewater can be helpful to many organisms. Bacteria and algae use the energy and nutrients in the waste material. The broken down wastes provide nutrients for plants such as bulrushes and cattails. These aquatic plants provide food and a home for many aquatic and semi-aquatic birds and animals. This is an example of a **food web**. (See the additional ideas section at the end of this activity.)

The words influent and effluent are commonly used in wastewater treatment. Influent refers to the flow into a treatment pond or a mechanical plant. Effluent refers to the flow out of a treatment pond or a mechanical plant. Effluent quality is periodically tested to insure it is safe for discharge to a waterway.

Organic loading is the amount of waste the influent contains. A high organic loading requires a large amount of oxygen for decomposition to occur. BOD (Biochemical Oxygen Demand) is the amount of oxygen used by organisms for the breakdown of organic matter. Also, oxygen is used in reactions of iron, sulfur and nitrate compounds. BOD is commonly measured in wastewater effluent.

Too much untreated organic material in the effluent is harmful. It is harmful because it robs the oxygen in the stream needed by fish and other organisms. This is one reason untreated waste kills fish and other aquatic organisms.

Materials
- Paper
- Pencil
- Lagoon Drawing & Problems (Appendix F)
- Calculator

Procedure
1. Provide each student with the wastewater lagoon diagram located in Appendix F.
2. Discuss lagoon systems using the background material above and the poster Wetlands: Water, Wildlife, Plants and People.
3. Hand out the problem sheets (Appendix F) to each student.
4. Allow each student or group of students to calculate the answers. Encourage the use of calculators if they are available.
5. Review the problems and waste water treatment with the students.

Questions

1. What are the answers to the five handout problems?

2. What happens to fish if untreated waste is added to a stream?

3. What is a lagoon?

4. What is a wetland?

5. What happens to the waste materials when they enter a wetland?

6. How does a lagoon system work?

Bibliography

South Dakota Department of Environment and Natural Resources. 1990. *Lagoon Problems Workshop.* Environmental Education and Training Section

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Additional Ideas

☛ Aquatic Project WILD exercise *WETLAND METAPHORS* can be used to expand upon understanding of a natural wetland.

☛ Aquatic Project WILD exercise *MARSH MUNCHERS* background and activities helps to understand a food chain and food web.

☛ Many farm ponds are excellent examples of a wetland. Follow up this exercise with the Project **SAVE** WATER QUALITY 9 MODULE - POND LIFE AND PANTY HOSE.

♪RAINDROPS KEEP FALLIN' ON MY HEAD♪

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GRADES: 5 - 12

CLASS: Math, Science

TIME: Three 50 minute class periods

EMPHASIS: Water run off and quality relationships

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Objective(s)

The students will:

1. calculate vegetation density and cover and
2. apply this knowledge to water quality.

Background

Water quality is dependent on good wastewater treatment and best management practices applied to reduce or treat over land water run off. Top soil can easily be carried into waterways if the vegetative cover is not maintained. Good vegetative cover can be maintained in a variety of ways. Two examples are: preventing over-grazing or leaving highly erodible soils under good crop or grass cover. Another method is seeding construction areas with a rapidly growing annual grass.

Vegetative density and amount of cover are determined through several methods. Two methods easily used in the outdoor classroom are the quadrat and line intercept (transect) methods.

QUADRAT METHOD

The quadrat method for determining grass density and coverage is easily conducted by using random one (1) square meter plots. These plots are laid out using four (4) meter sticks or by constructing a wooden 1-square meter sampler. A square can be laid out using four stakes and some rope (durable string) with right angle corners. The 1-square meter plot may be reduced to quadrats of 10 centimeters X 10 centimeters. This method is commonly used on prairie or artificial grassland with a high abundance of plants.

Circular plots will give better results than the same number of square plots when sampling grasslands. Construct a 10 cm hoop from durable wire or a coat hanger. A 1-meter diameter circle can be constructed by driving a stake at a random point. Attach a 0.5 meter string to the stake via a ring. Attach a steel or wooden pin to the other string end. Stretch the string out and place a marker (wooden or metal stake) at that point.

Repeat this step so there are several points marked that will define a circle.

All quadrats should be done at random to reduce human bias. A simple way is to close your eyes, turn two or three circles, and then throw the hoop or quadrat.

Random sampling is made more accurate by laying out grid lines on a map or aerial photo. Number the grid lines on the both the horizontal and vertical axis. Record the line numbers from each axis on separate pieces of paper. Place the numbers from each axis in separate containers. Draw a number from each. Locate the first plot on the map or aerial photo where the two numbered lines intersect. Transfer this information to the actual site by converting the map scale to the proper field measurements.

A systematic sampling approach can be used rather than random sampling. Start by laying out evenly spaced lines (transects) through the study area either by use of a compass or by simply pacing off distances. Next, step off the plots along each line. The distances need not be exact between the plots. Resist the temptation to move a plot because of interest.

The number of quadrats or circles to be sampled for an area is usually 10% of the total area. This can be as few as 10 samples for a small area or more than 100 for a large area.

Several types of quadrats exist. These quadrats are:

1) List Quadrat. Identify and list by name, the plants within the frame or hoop. No number counts are made. *Frequency* of each species is determined using this method. Simply divide the number of plots in which species occur by the total number of plots and multiply this number by 100. For example, 5 pasque plants found in 50 plots, the frequency of occurrence would be $5 \div 50 \times 100 = 10\%$. The *relative frequency* of a specific plant species with that of another is calculated as follows: Frequency of a species ÷ total frequency of all species × 100.

2) Count Quadrat. Both the number as well as the species is noted. The density may be determined when conducting a count quadrat survey. This is accomplished as follows: number of plants of a certain species ÷ total area sampled. For example, if you sample 10, 1-square meter quadrats and there are a total of 50 dandelions the density of dandelions is $50 \div 10 = 5/m^2$. To determine *relative density* calculate as follows: density of a species ÷ total density of all species × 100.

3) Cover Quadrat. Use this quadrat to determine the percentage of land "covered" by a certain species. Cover is many times used to identify the dominant species. Thus cover is commonly called dominance. Cover is determined by the following methods. If the plant is low growing, simply measure the plant diameter and use arithmetic to determine the area it covers. Measure a tall herb or shrub by simply measuring the diameter of the crown or the downward projection of the crown on the ground. Convert the diameter to area. In a forested area the downward projection of the crown diameter is measured on the ground. Convert the diameter to area.

To determine cover simply do the following: total area covered by a species ÷ total area sampled = cover. For example, 25, 1-square meter quadrats contained a total of 20 square meters of buffalo grass. The cover of the buffalo grass would be 20 ÷ 25 or 4/5 of the area. Calculate *relative dominance or cover* as follows: cover for a species ÷ total cover for all species × 100.

The sum of relative frequency, relative density and relative dominance shows the value of the species. This sum is termed the **importance value** of a species.

LINE INTERCEPT (LINE TRANSECT) METHOD

The line transect method simply is lines laid out in the area to be studied. Plants that touch, overlie, underlie each line are identified, counted and measured. The data can be used to calculate most of that collected by a quadrat study. Density cannot be determined but relative density can be. This method is not as reliable for frequency and abundance. Transects are usually more rapid and objective than the quadrats. The method is commonly used in grasslands and shrub areas.

Information using line transect calculations is shown below.

Frequency = number of intervals containing the species ÷ total number of intervals × 100

relative frequency = frequency of a species ÷ total frequency of all species × 100

Relative density = total number of individuals of a species ÷ total number of individuals of all species × 100

Cover = total intercept length of a species ÷ total length of transect(s) × 100

relative cover = total intercept length of a species ÷ total intercept length of all species × 100

Importance value = relative frequency + relative density + relative cover

Materials

Quadrat Method

Items listed below are those necessary for most quadrat studies. The equipment used will depend on the place and purpose of your study.

- 1-square meter quadrat (pre-constructed) or 4 meter sticks
- Measuring tapes
- Strings and pegs
- Compass (optional)
- Hammer
- Plant identification guides
- Data sheets, clipboard, rubber band (or a journal)

Line Intercept Method

- Tape measures (at least 20 meters) or lengths of strong cord with marked intervals
- meter sticks or short tape measures
- plant identification guides
- Data sheets, clipboard, rubber band (or a journal)

Procedure

Select one or both of the procedures to be used by the students. The choice will depend on the time and area of study. You may wish to have half the class use quadrat sampling one day and then use the other method another day. The results can be compared to see if one is preferable over the other for the study area.

Quadrat Method

1. Explain the quadrat method of sampling and how vegetative cover relates to soil protection.
2. Decide the sampling area.
3. Divide the student into teams.
4. Instruct the students how to do systematic or random sampling using the intersecting lines. If an area map is not available, then instruct the students about closing their eyes, turning two or three times and tossing the quadrat sampler.
5. The students should decide, as a class, whether plants on the boundary of the sampler should be counted as part of the plot.
6. The plots should be located before class, if the area is large. If the area is not too large, the class can proceed to the site and locate their plots.
7. Identify the species in the quadrats and make any measurements and record their positions, if this is part of the study.
8. Record the results in the journals or on data sheets fastened to clipboard and held down with the rubber band. A table similar to Table 1 below can be used for this exercise.

Line Transect Method

1. Explain the line intercept (transect) method to the students.
2. Proceed to the study are. Lay out a transect line. The line can be a long measuring tape or strong cord marked at predetermined lengths. A length of 20-30 meters is usually enough. To determine random lines, simply close your eyes, turn two to three circles, toss a stick. Lay out the line in the direction in which the stick points. An adequate sample of an area is usually 20-30 lines. All lines should be the same length.
3. Imagine a strip one centimeter wide along the measuring device.
4. Record if a species occurs in each interval. Use a table similar to Table 2 for calculating the frequency.
5. Move along the line. Each species that touches, underlies or overlies the 1-centimeter strip should be recorded. Also, record the distance along the line. Record the data in a journal or on data sheets attached to a clipboard and held down with a rubber band.

Always sample the ground plants first if there are different strata in the study area. The species recorded are abbreviated to save time. Distances between the preselected species are measured along the line. For example, you may have chosen dandelions (Dl) and spurge (Sp) in a lawn. The measurements might be a dandelion at 2.5 centimeters from the beginning of the transect. The next study plant encountered may be another dandelion and this may be 24.7 centimeters from the first dandelion. The next plant may be spurge and it was 3.5 centimeters from the last dandelion. Table 3 represents one way the information may be recorded.

Questions

1. What is the reason for random sampling?
2. What is the reason for systematic sampling?
3. How does plant cover relate to water quality?
4. What relationship exists between vegetative patterns and soil conditions?
5. Is there a relationship between plant patterns and animal populations?
6. How would you design and experiment to determine the impact of vegetative cover on water quality?

7. What are some reasons for being concerned about addition of soil to surface water?

8. How is vegetative frequency calculated?

9. How is density calculated?

10. How is cover calculated?

11. How would you graph the data collected?

Table 1

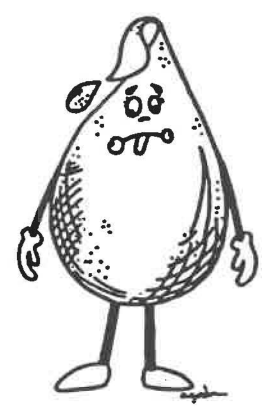
PLANT SPECIES	Quadrat Number									
	1	2	3	4	5	6	7	8	9	10

Table 2

SPECIES	Interval									
	1	2	3	4	5	6	7	8	9	10

Table 3

Stratum *Ground*	Transect line
Species	**Intercept length**
DI	2.5 cm
DI	24.7 cm
Sp	3.5 cm
DI	12.8 cm



Bibliography

Additional Ideas

NITRATES BELOW

+ +

GRADES: 8 - 12

CLASS: Science

TIME: 50 minutes plus up to six weeks for the student designed experiment

EMPHASIS: Groundwater Quality, specifically nitrates

+ +

Objective(s)

Students will:

1. study well construction,
2. analyze nitrate data from a contaminated ground water supply,
3. speculate about sources of contamination,
4. design a hypothetical long-range experiment to test their hypotheses.

Background

Nitrates combine with oxygen to form nitrate (NO_3^-) Nitrate is a specific chemical compound found in the ground water that is routinely measured to help evaluate the quality of a water supply. Nitrates found in ground water are of concern because in high concentrations it may cause methemoglobinemia ("blue baby" syndrome"). Nitrates are converted to nitrites by bacteria in the infant's digestive tract. These nitrites are toxic to the infant because they may inhibit the blood cells from carrying oxygen throughout the child's body. Eventually the child may turn blue due to oxygen starvation of body tissues. This syndrome is of particular concern for pregnant women and infants up to the age of 12 months. The U.S. Environmental Protection Agency's enforceable limit of NO_3-N in public drinking water supplies is 10 milligrams per liter (mg/L).

In agricultural areas, nitrates in ground water are commonly attributed to fertilizer and animal-waste products. Water seeping (leaching) through these sources may result in elevated nitrate concentrations in the ground water. In this manner shallow water supplies may become easily contaminated with excessive concentrations of nitrate.

Materials

- Diagram of nested well set, with nitrate data
- Student journal to record hypotheses
- Pencil
- Materials to set up experiments for student designed exercises to test their hypotheses such as soil(s), plant material (can be obtained from grocery store), manure, artificial fertilizer, water source, containers for simulating an aquifer, materials to design a hand pump for a well, etc.

Procedure

1. **a)** Review the basics of ground water and aquifers from previous earth science lessons, references or Appendix H.

b) Review the basics of water quality and specifically nitrates with the students, using information in Appendix H or from other references.

c) Discuss drinking water supplies in terms of ground water and its relationship to land-use activities. Background information is supplied in Appendix H.

Include a discussion of the responsibilities of well owners and operators. For their own health, an owner of a private well is responsible for having the water quality of their well checked. They should also keep all water quality records. For a community water supply system, the city or rural-water system has these responsibilities.

2. Hand out copies of diagram 1.
3. Have the students work in groups of two or three to interpret diagram 1. Ask them come up with any correlations or relationships they might notice and to record these in their journals.
4. DO NOT give the students the answers.
5. Ask the students to design ~~and~~ a method to test their interpretations. Emphasize the use of controls and the need to test only one variable.
6. Ask the students to document any difficulties they might encounter in trying to duplicate nature in the laboratory.

Questions

1. Are the nitrate concentrations the same throughout the aquifer?
2. Do the nitrate concentrations seem to correlate with anything?
3. What might explain the nitrate distribution?
4. What might be the cause of the nitrate contamination?
5. How could you test your ideas?
6. What might be the ramifications of ground water contamination events and the resulting investigations and clean-up procedures?

Bibliography

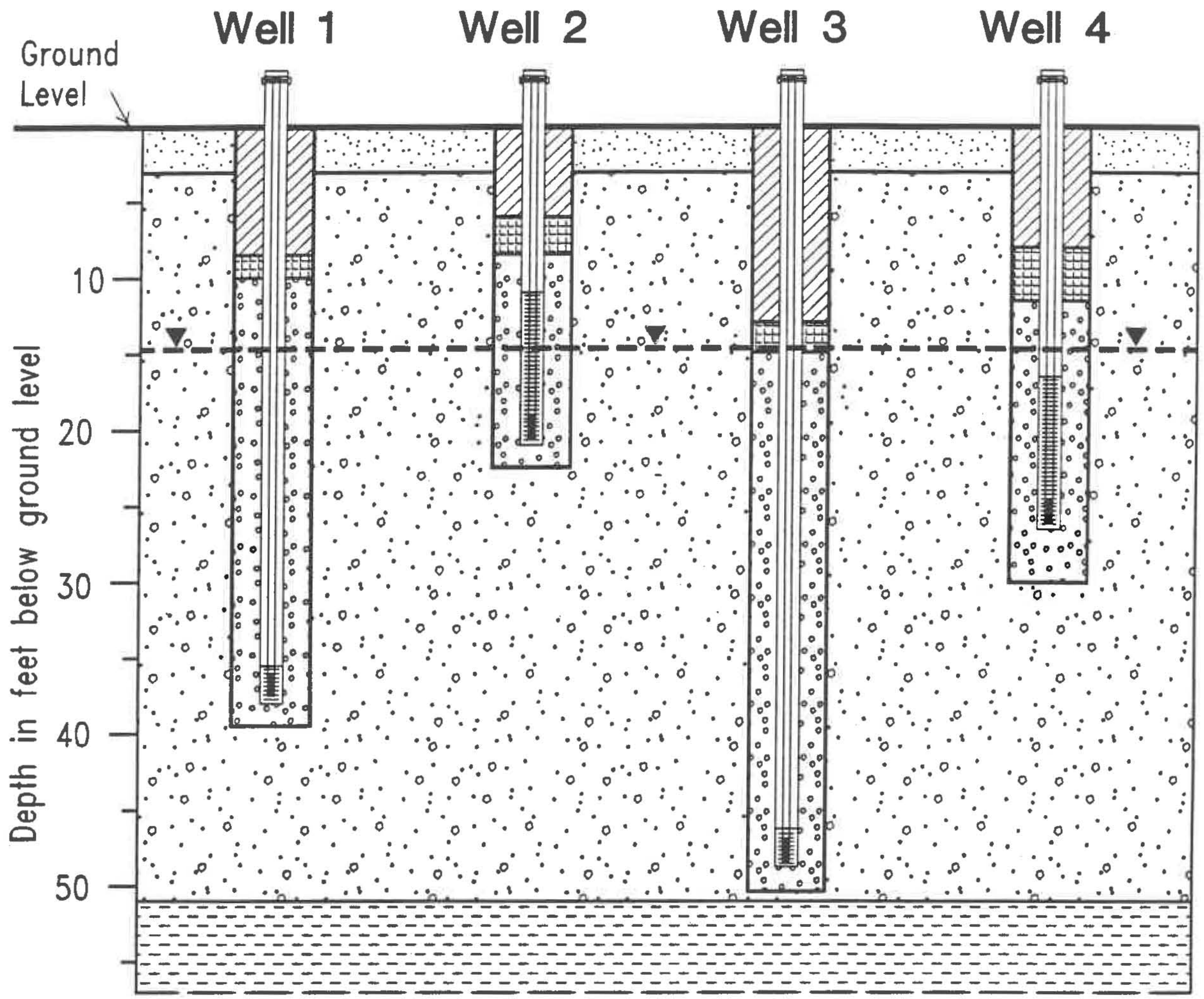
Chadima, Sarah and Pat Hammond. 1994. *Well Construction and Nested Well Diagrams*. Geologic Survey Division, SD Department of Environment & Natural Resources, Vermillion, SD

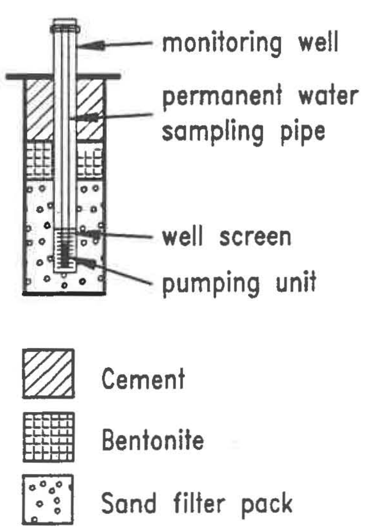
Additional Ideas

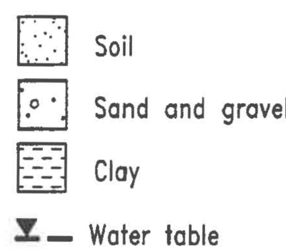
☛ The use of pumps to lift water can be used as an introduction to the physical sciences. Vacuum and pressures can be studied using the idea of lifting water to various heights.

☞ A good performance based assessment to follow this activity would be the lift used by plants as compared to the pumps that humans must use to raise water for their use. Ask the students to design an experiment demonstrating plant lift of H_2O. This experiment might be as simple as a celery stalk in colored water or as complex as covalent bonding of water molecules that is the basis of plant transpiration and water movement.

Diagram 1. Nested wells and nitrate concentrations



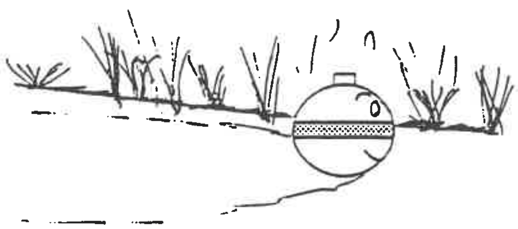




Nitrate concentrations in milligrams per liter (mg/L)

Well	Concentration
1	0.15 mg/L
2	19.6 mg/L
3	<0.04 mg/L
4	16.0 mg/L

JUST BOB-BOB-BOBBING ALONG



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GRADES: 7 - 12

CLASS: Science, Math

TIME: One 50 minute period

EMPHASIS: Water Quality

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Objective(s)

The students will:

1. construct a simple device to sample stream flow velocity,
2. use the device to obtain stream flow velocity,
3. calculate the volume of stream flow using average stream width and depth calculations and
4. hypothesize how velocity may affect types of organisms inhabiting the stream

Background

Environmental scientists and limnologists often need to know the estimated stream flow to understand the dynamics of the ecosystem they are studying. The stream flow can affect the channel, the organisms and the quality of the water. A fast-moving stream will contain more oxygen than a slow-moving stream.

A minimum oxygen content must be maintained in a stream to protect the various species inhabiting it. Most prairie streams should be protected at 5 mg/l of dissolved oxygen (DO) for fishable use. For trout streams it is usually 6 mg/l DO. The velocity and volume of stream flow can be very easily and cheaply estimated with a fish line, bobber and meter or yard stick. The velocity and temperature determinations should be correlated with DO.

Materials

- Bobber or similar floating object (weighted if wind conditions will affect results)
- Stop watch
- Yard or meter stick
- Journal to record data
- Permanent marking pen or pencil to record data
- Piece of wood (optional)
- Predetermined length of monofilament fishing line (Recommended length of 5-6 feet)
- Calculator
- Waders or old tennis shoes

Procedure

1. The first step is to select a stream for data collection. If possible find an area of the stream where there is a constriction that funnels most of the flow through a small area. This simplifies the measurement procedures and increases data reliability.
2. Construct a stream velocity device in the classroom from the bobber and monofilament fishing line. Remember, if it is windy use a float that is weighted so it is nearly submerged.
3. Instruct the students to work in pairs.

One student will control the float, holding it as close as possible to the surface of the water where it is to be released. The other student uses the stop watch to time the float. The float is dropped and timed until it reaches the end of the line. The velocity is recorded in distance over time, such as meters/second or feet/second.

4. The fastest part of the stream's main channel should be selected. At least six measurements should be taken.

5. To calculate volume the average stream width and depth must be determined. If the stream is very wide it should be divided into thirds and at least three separate measurements of depth taken for each section.

6. To ensure more accuracate measurements, multiply the surface current rate by 1.33 if the channel measured is not more than 2 ft. deep or multiply by 1.05 if 10 ft. or more in depth. For intermediate depths interpolate between these two values.

7. To calculate the volume of stream flow the following formula should be used:

$$r = \frac{wdal}{t}$$

where

r = rate of flow in cubic meters or feet per second

w = average width of channel section tested

d = average depth in feet or meters

a = constant (0.9 for smooth bottom streams with sand, silt, mud, bedrock or hardpan; 0.8 for streams with rocks or rubble for the stream bed)

l = length in feet of the line

t = average time (six tests) in seconds required for the float to travel the length of the line

8. If the velocity is known before the calculation you can use the formula:

$$r = wdav$$

where v = average velocity of stream section tested.

Questions

1. What is the average velocity of the stream?

2. What is the volume of the steam flow?

3. How might velocity have an effect on plant and animal life in the stream?

4. What would be your hypothesis regarding correlation between organism morphology and stream velocity?

5. Are the measurements highly accurate?

6. What might be the results of pollution release in a stream of high velocity versus one of low velocity?

7. What does topography have to do with velocity?

8. Can you tell an older stream from a younger one? How?

Bibliography

Welch, Paul S. 1948. *Limnological Methods*. McGraw-Hill Book Company, Inc.

Additional Ideas

☞ Follow this exercise with Adopt A Steam Activity (WQ8MOD).

HOW'S YOUR BOD?

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GRADES: 7 - 12

CLASS: Science

TIME: Two 20 minute periods Monday and Friday and 5 minutes on Tuesday, Wednesday and Thursday.

EMPHASIS: Water Quality

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Objective(s)

The students will

1. collect water samples from various sources and
2. observe and record the stability of the water.

Background

Water pollution control agencies such as the South Dakota Department of Environment and Natural Resources require a permit to discharge wastewater to streams. The permit usually requires the discharger to monitor several parameters such as pH, fecal coliform bacteria, suspended solids and biochemical oxygen demand (BOD). The BOD is a measure of the amount of oxygen that is being used by organisms to break down organic waste. When organic loading in the wastewater is high organisms require more oxygen from the stream to break down the waste. Under normal conditions aerobic bacteria can handle the waste entering a stream without upsetting the oxygen balance. When heavy doses of organic waste enter a water body the aerobic decomposers increase. They will use up the oxygen to break down the waste. The depletion of oxygen in the water body is called a DO (Dissolved Oxygen) sag or depletion. Anaerobic bacteria take over and produce the typical (hydrogen sulfide) sewage smell in the absence of oxygen.

Most states place a limit of 30 mg/l BOD (five day) on a discharger's permit. This usually protects the stream to which the wastewater is discharged. In some cases the BOD may have to be more stringent to provide greater protection.

The 5-day BOD is a measure of the amount of oxygen in a sample of water used over a five day period. The sample is incubated at 20°C.

A simple qualitative oxygen demand experiment is used to demonstrate the relative stability of a water sample. This experiment is conducted with an oxygen indicator, methylene blue, which in the presence of oxygen is a vivid blue. If oxygen is depleted in a sample the water will turn clear. The table at the end of this activity provides students with the relative stability of their sample. For example, if the organic loading is very high the water color will remain blue for only a day or two. Highly stable samples will maintain the blue color over the five-day incubation period.

Caution must be exercised in interpreting BOD values, whether qualitatively or quantitatively. Most samples will not deplete the oxygen supply over the five days because they break down slowly. Some organic materials such as wood wastes (bark, chips,sawdust) will register a low BOD because they have a slow decomposition rate.

Materials

- Methylene blue
- 300 ml water sample in air tight bottle (preferably one with ground glass stopper)
- 1 ml disposable or glass pipette
- Incubation chamber to maintain temperature of 20°C
- Journal
- Permanent marking pen or pencil
- Copy of table at the end of this module

Procedure

1. Introduce the students to wastewater issues by visiting a sewage treatment plant.
2. Discuss aerobic and anaerobic break down of materials by organisms .
3. The day before this exercise ask the students to collect a 300 ml sample of water from a stream, farm pond, lake, wetland or any other water body.
4. Demonstrate how to take a sample without introducing added oxygen to the water. This means tilting the bottle at approximately 45° under the water and letting the water slide down the side until it is nearly full. When nearly full, slowly tilt the bottle to an upright position to allowing all air to be replaced by water. Stopper or cap the bottle to prevent excess oxygen from entering the sample.
5. To delay bacterial action until returning to the laboratory place the sample in a cooler with ice.
6. With a disposable or glass pipette add 1 ml of 0.1% methylene blue solution (made by adding 0.10 g to 100 ml distilled or de-ionized water) to the sample. Place the pipette tip under the water in the sample bottle when adding the solution so oxygen is not taken up by the methylene blue. Inform the students that methylene blue is an indicator for the presence of oxygen.
7. Stopper the bottle and invert it to disperse the methylene blue solution.
8. Place the bottle in the dark in an incubator or another area where the temperature will remain at nearly 20°C.
9. Check the sample every 12-24 hours and record the color of the sample.
10. Use the table at the end of this exercise to determine the sample's relative stability.
11. As a control use a sample of distilled, aquarium, or tap water.

Questions

1. Based on your knowledge of decomposition what has happened?
2. What was the reason for a control?
3. Are there differences in the samples taken by different students?
4. What might some causes of the differences?
5. How might we test these differences?
6. Is there a smell from the unstable samples?

Bibliography

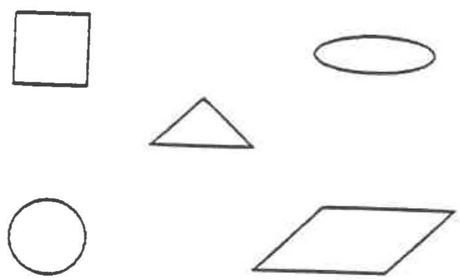
Andrews, William A, Ed. 1972. *A Guide to the Study of ENVIRONMENTAL POLLUTION*. Prentice-Hall, Inc.

Biochemical Oxygen Demand Stability Table

Approximate time in days for blue color to disappear	Stability of sample expressed as percent (approximate)
0.5 1.0 2.0	10 20 35
3.0 4.0	50 60
5.0 6.0	65 75
7.0 8.0	80 85
9.0 10.0	87 90
11.0 12.0	93 95

Methylene blue is an indicator for the presence of oxygen. When oxygen in the water is depleted the blue color disappears. Organic material entering surface waters increases the biochemical oxygen demand (BOD) because organisms require oxygen to assist in breaking down this material. The more organic loading the greater the demand for oxygen. The table above approximates values for stability of the water sample collected. For example, the more demand for oxygen the quicker the sample will lose the blue color. If a sample takes 7 days for the blue color to disappear this means the sample has enough oxygen to satisfy 80% of the total biochemical oxygen demand. In this case, the sample did not contain much organic or oxidizable material.

KNOW YOUR SHAPES



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GRADES: 7 - 12

CLASS: Science, Math

TIME: One-half day or full day field trip

EMPHASIS: Water Quality
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Objective(s)
The students will:

1. construct a rectangle with right angles around a water body,
2. read a compass,
3. use a measuring tape or marked rope to determine distances from sides of the rectangle to shore line,
4. record data in their journals and
5. construct a scale map from the measurement they collected.

Background
Physical knowledge of water bodies helps us understand aquatic ecosystem dynamics. Mapping of ponds, wetlands or other small bodies is an essential part of any water system study. The terrestrial surroundings of a pond, lake or wetland can make a difference in the types of organisms that may inhabit them.
Mapping of the shoreline is just one step toward understanding a body of water and the organisms that inhabit it.
Technology has taken the work out of mapping as compared to what was once required. Use of lasers and satellites are just two ways surveys are more accurate and quicker to plot. Cost of these methods are prohibitive to someone wanting to conduct field studies in most middle and secondary schools.
This activity provides the instructor with a simple and inexpensive method to map a small pond or wetland that cannot be traversed. The water body is simply enclosed in a rectangle. Mappers decide where to set stakes along the rectangle to best illustrate the shore line. Lines are set at right angles to the sides of the rectangle. These lines are extended to the shore line and measured. Students use these data to construct a scale map. The instructor should provide students the opportunity to construct their own map of the pond or wetland where they are collecting data. Along with this mapping they should also construct or consult topographic maps of the area.
Drainage into the pond or wetland must be stressed so students can define cause and effect relationships at their site and between other sites.

Materials
- Wooden stakes
- Sledge or ax
- Steel tape or graduated rope
- compass
- Journal (field notebook)
- pencil

Procedure

1. Surround the pond or wetland with four lines to form a rectangle with right angles. (See the diagram at the end of the activity.)

2. Set stakes at various intervals so the features of the water body are best depicted.

3. Set a stake behind and in contact with stake 1; set a second stake back from stake one as shown in the diagram so the two stakes (these are the line stakes) are at a right angle to the side of the rectangle.

4. The steel tape or the graduated rope is attached to stake 1 and, using the lines stakes, make sure the tape is extended to the shore line 1' (One prime). Drive the 1' stake and measure the distance.

5. Each team should record their observations of the terrestrial conditions at each shore line point being plotted. Have the students make predictions about cause and effect in their journals. Change each prediction into a hypothesis for the project.

6. Follow the same procedure for point 2; i.e., set up the line stakes. Ensure right angles of the line stakes and extend tape rope from point 2 at a right angle using the line stakes as guides, drive stake 2' (two prime) and measure.

7. Continue this procedure for 3/3' to 24/24'.

8. Use the compass to find the bearings of each side of the rectangle.

9. Return to the classroom and plot the data at a suitable scale in pencil.

10. Start with the rectangle AA'BB'. Use the proper bearings and accurate scale.

11. Locate, to scale, the distance of A1. Draw a line through 1 at a right angle to AA'. Scale draw line 1/1' (See diagram).

12. Continue plotting the data for 2/2' to 24/24'.

13. Connect all the shore line points and erase all others. Add the compass figure to the map.

14. Follow this activity with a sampling design for aquatic and terrestrial organisms. Use the hypotheses the students generated from their observations made during this mapping exercise.

Questions

1. Is there a more accurate way to construct the map?

2. If we added more rectangle to shore measurement lines would our map be more accurate?

3. What other features did you notice when mapping the water body shore line?

4. What could you add to your map to make it more useful for your project?

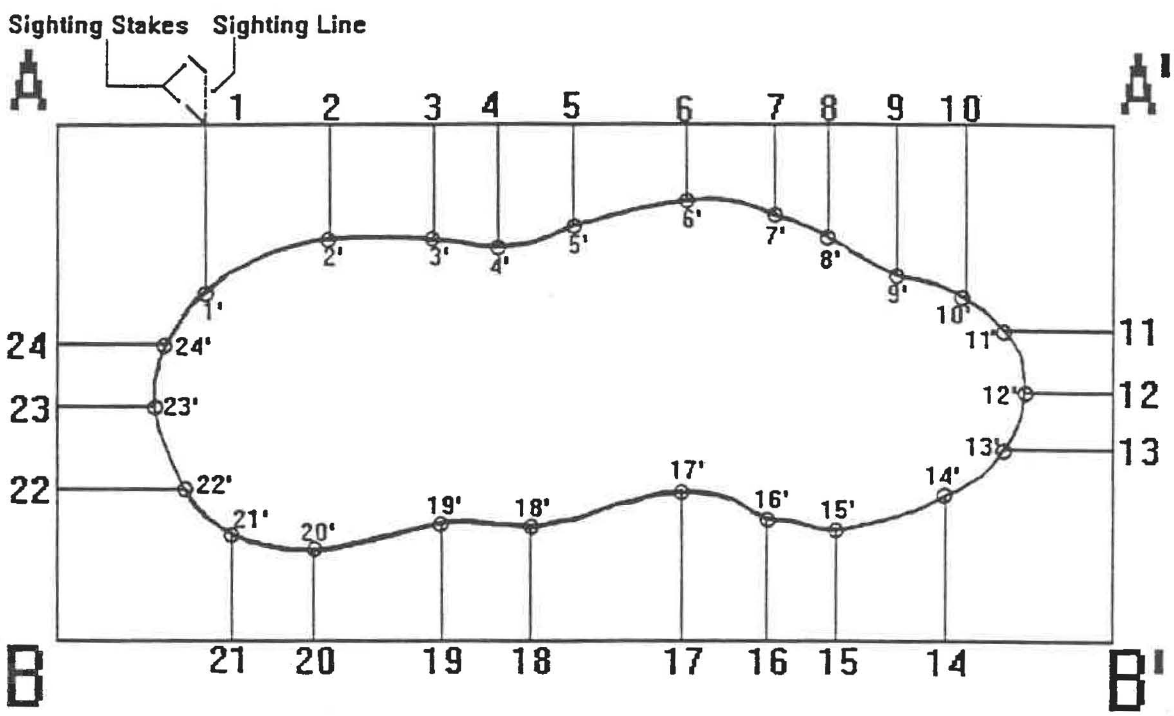
5. Hypothesize how the land forms around the water body

Bibliography

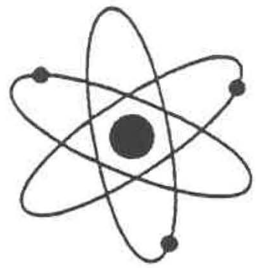
Welch, Paul S. 1948. *Limnological Methods.* McGraw-Hill, Inc.

Additional Ideas

Diagrammatic Scheme for Mapping a Small Water Body



TRACKING TRITIUM



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GRADES: 9 to 12

CLASS: History, Math, Science

TIME: 50 min

EMPHASIS: Ground Water

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Objective(s)

Students will apply knowledge of ground water tracers to solve hypothetical scenarios.

Background

Sometimes materials called tracers are added to water to find out where the water flows or how fast it moves underground. Tritium (an isotope) is a naturally occurring substance which may be used as a tracer in the hydrologic cycle. Unlike a dye, which can often be detected visually, tritium concentrations are detected using laboratory techniques.

What Is An Isotope?

An isotope is a variety of an element. Elements always have the same number of protons in their atomic nuclei, but the number of neutrons may vary.

Hydrogen Isotopes

The element hydrogen has three isotopes. By definition, all hydrogen atoms have one proton in their atomic nucleus. The most common hydrogen isotope makes up more than 99 percent of all hydrogen on earth. It contains only one proton and no neutrons. A second isotope of hydrogen contains one proton and one neutron in its nucleus. This isotope is called deuterium or heavy hydrogen. A third isotope of hydrogen called tritium also exists. Tritium contains one proton and two neutrons in its nucleus.

More About Tritium

Tritium is naturally radioactive and spontaneously disintegrates or decays to form helium. Tritium has a half-life of 12.3 years. The term half-life means that after 12.3 years, one half of the tritium is left; the remainder has changed into helium.

Tritium is produced naturally by the interaction of cosmic rays (neutrons) with nitrogen, the most abundant gas in the earth's atmosphere. Tritium can also be produced artificially in the atmosphere as a byproduct of aerial nuclear weapons testing. For example, when a hydrogen bomb explodes, tritium is formed and radiation (neutrons) is emitted. These neutrons may interact with the nitrogen in the atmosphere, also producing tritium.

What Is Tritiated Water?

Water is made of two hydrogen atoms combined with one oxygen atom. Tritium in the atmosphere combines with oxygen to make water just as the most common isotope of hydrogen does. If tritium is present in a water molecule, the water is called tritiated water.

Basics About Nuclear Bombs

There are two types of nuclear bombs - atomic bombs and hydrogen bombs. Atomic bombs (like the one dropped on Hiroshima during World War II) release huge amounts of energy through a process called fission. Fission is defined as the process whereby the nuclei of atoms (usually uranium or plutonium atoms) are split apart. In contrast, the energy in hydrogen bombs comes from the process of fusion. Fusion is the process whereby atoms of hydrogen are combined or fused together, releasing tremendous amounts of energy. Hydrogen bombs are much more destructive than atomic bombs. In general terms, hydrogen bombs produce tritium while atomic bombs do not.

Tritium in Rain Water

The first aerial hydrogen bomb test was conducted on October 31, 1952 (Fontes, 1985). Most of the world's aerial nuclear weapons testing occurred between 1952 and 1969. Prior to 1952 the natural (pre-bomb) level of tritium in rainwater was approximately 10 TU (tritium unit). One TU is equal to one tritium atom per 10^{18} hydrogen atoms. During the 1960's, the level of tritium in rainwater rose to above 1,000 TU and modern values in rainwater may be as high as 50 to 100 TU.

Tritium In Ground Water

In ground water, tritium is not affected by chemical processes. Thus, tritium concentrations can be used to identify water which has seeped into the ground, as ground-water recharge, since 1952. Most commonly, tritium concentrations are used in determining if ground water is older or younger than the year 1952.

Materials

Figures 1 and 2 with this activity.

Procedure

1. Hand out the Hypothetical Scenarios that follow this activity.

2. Ask the students to work in groups of two to four to analyze, state and defend their answers.

Bibliography

Fontes, J. Ch., 1985, Some Considerations on Ground Water Dating Using Environmental Isotopes, in, Hydrogeology in the Service of Man, Volume XVIII, Part 1, Keynote Papers, Memoirs of the 18th Congress of the International Association of Hydrogeologists, Cambridge, England.

Exercise

In both scenarios, assume the only tritium sources are natural tritium and tritium due to above-ground nuclear weapons testing.

Hypothetical Scenario 1:

The last pre-bomb rain or snow of 1952 in South Dakota had tritium values of 16 TU.

1. Approximate how many tritium half-lives have elapsed between 1952 and 1995?

2. What would the approximate TU value of the last pre-bomb water be in 1995 (remember - assume the water has not mixed with any other water)?

Hypothetical Scenario 2:

It is the year 1980. A landfill investigation is being conducted in Flint, South Dakota. The existing landfill was built in 1957. This community needs more space to expand their landfill (see Figure 1). A chemical manufacturing plant brought into the community in the early 1960's was so successful that the population of the town doubled between 1962 and 1972.

The city gets its water from a sandstone aquifer which crops out northwest of town. The town of Flint is built on sandstone and shale (clay). City officials are considering two options (see Figure 1). The first option (Option A) is to expand the existing landfill to the south. The second option (Option B) is to close the existing landfill and open a new one at a site southeast of town.

Monitoring wells with water-intake areas (well screens) about 40 feet deep are located around the perimeter of the old landfill site. New monitoring wells 40 feet deep were constructed around the perimeter of Option A as well as around Option B.

Water samples were collected from all the monitoring wells in October, 1980. Samples were also collected from the city wells which are 200 feet deep. The results of analyses for tritium in these samples are indicated on Figure 1.

A cross section through the area is given in Figure 2. It indicates what the subsurface looks like along the line X-X' in Figure 1.

Question

1. If you were the city manager, would you recommend purchasing the land in Option A or in Option B to the mayor and city council? Use the results of the tritium analyses in making your decision.

Additional Ideas

Lead the students in a discussion on the following question: What other kinds of geological, economic and political information do you need to consider to present a balanced assessment of the situation?

Answers

Hypothetical Scenario 1

You know that:

1. In 1952, the last pre-bomb precipitation was 16 TU.

2. The half-life of tritium is 12.3 years.

3. 43 years have passed (from 1952 until 1995).

Answer 1:

(approximately how many tritium half-lives have elapsed in 43 years)

1952 + 12.3 = 1964.3
1964.3 + 12.3 = 1976.6
1976.6 + 12.3 = 1989
1989 + 6 = 1995

= 3.5 half lives

Answer 2:

(calculate the TU value accordingly)

YEAR	# of half-lives	TU value
1952	0	16
1964.3	1	8
1976.6	2	4
1989	3	2
1995	3.5	1.5

Hypothetical Scenario 2

Answer 1:

Recommend the purchase of the land in Option B. Low tritium values indicate that ground water movement is very slow in this area.

Additional Discussion Ideas

Consider the rock types which are present; shale (clay) is much less permeable than sand (the aquifer). Option A extends into the sandstone layer. What is the predominant wind direction? What about odors, birds, or rodents? Consider the cost of the land; will the owners sell? Will the current road construction be adequate for garbage trucks? Are there any mandated time restraints; does the landfill have to be constructed within a certain time to meet federal and state requirements? Are there different legal requirements for a landfill expansion than for opening a new landfill? Does the city have enough money to do either one, or will taxes need to be raised? Will the disposal fees charged to landfill users remain the same? Does the city haul the trash or do private companies haul the trash? What about new legislation regarding recycling; is the city going to implement a community-wide recycling plan? Are the garbage haulers open to consideration of recycling issues that may change the way they must operate their business? What costs are associated with recycling? Are grants available to help purchase new vehicles?

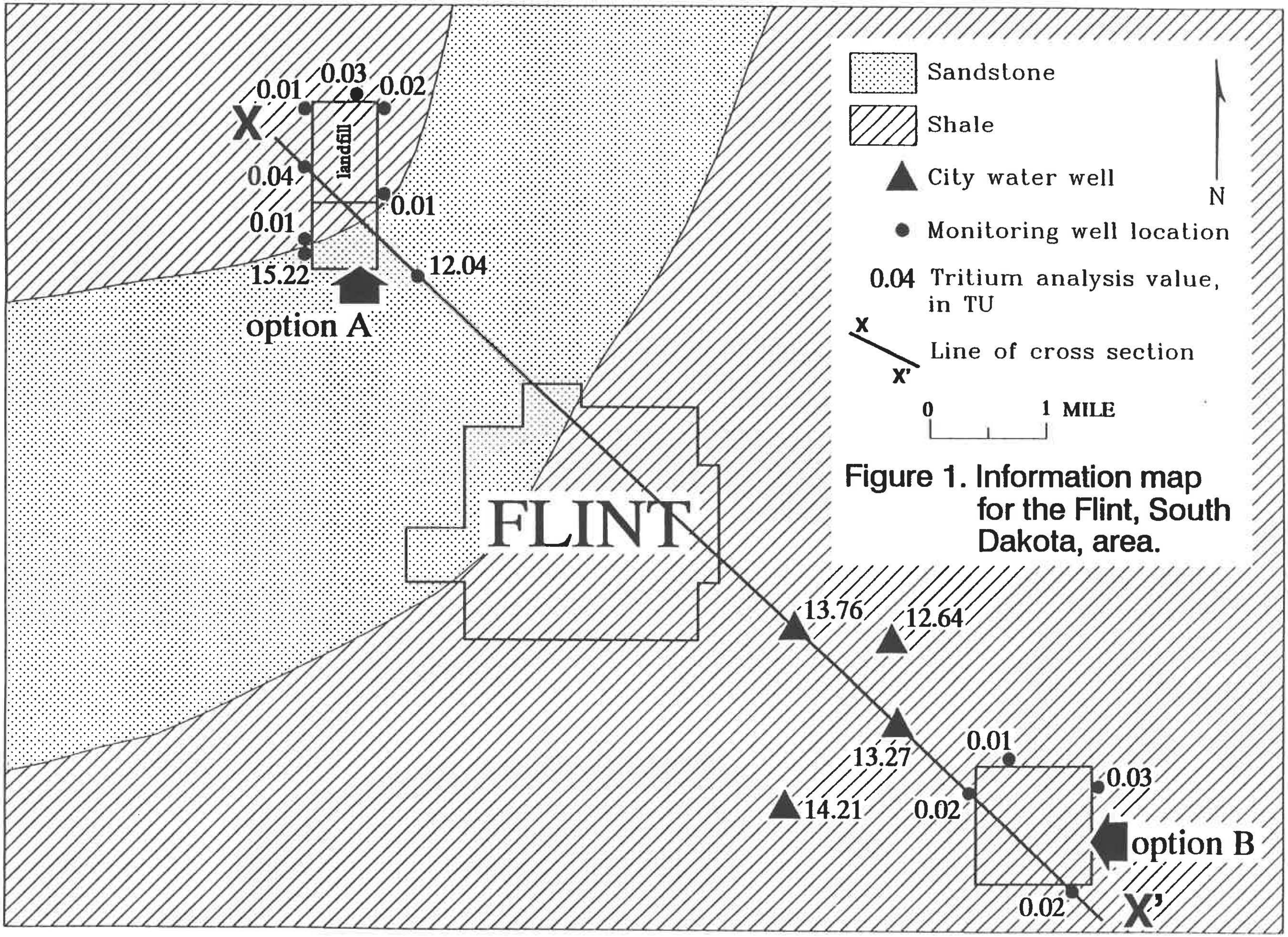


Figure 1. Information map for the Flint, South Dakota, area.

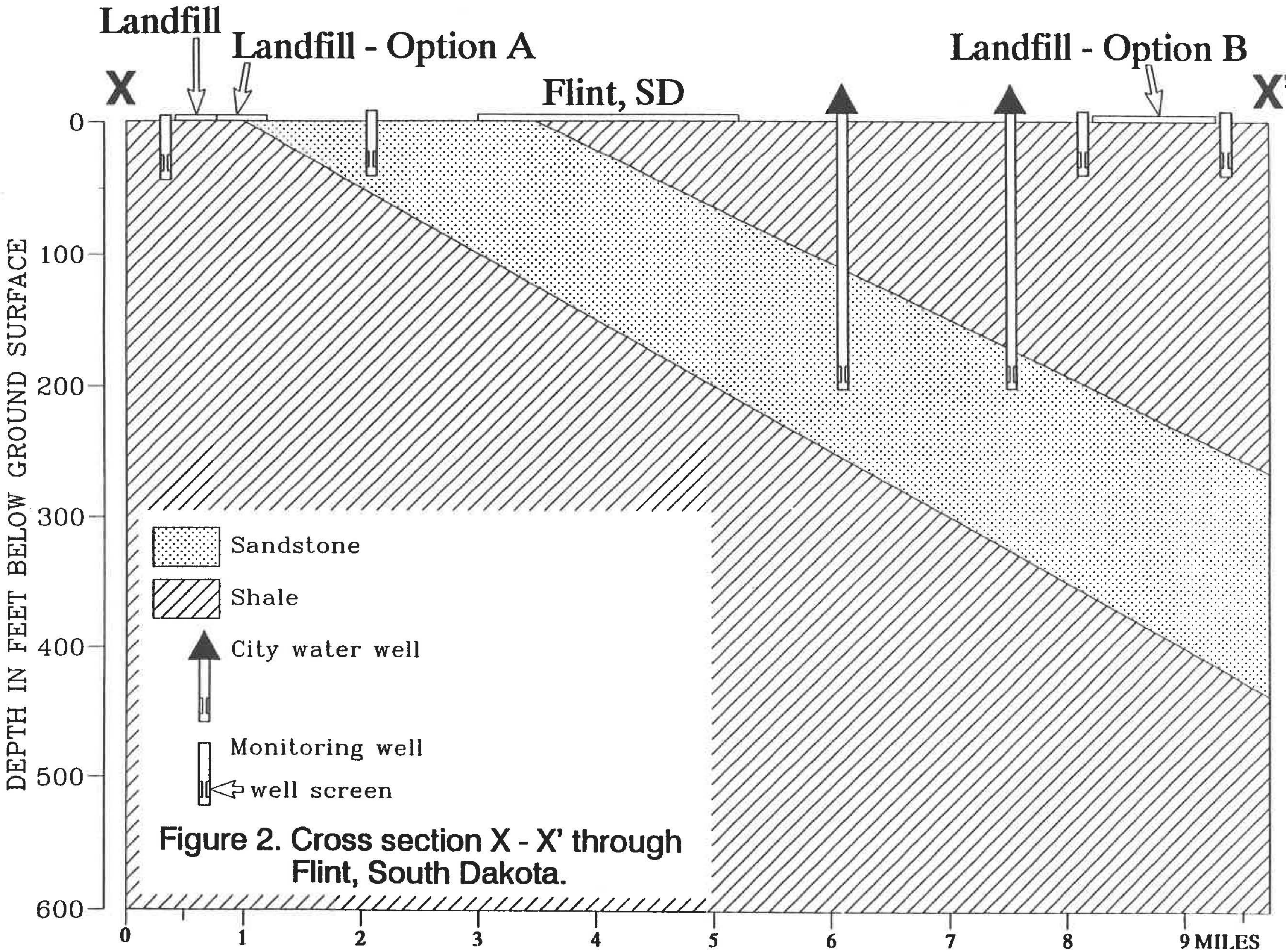


Figure 2. Cross section X - X' through Flint, South Dakota.


Together
we CAN
Make a
Better World
THE CAN MAN

SOLID WASTE INTRODUCTION

Solid waste is used to define the waste stream that is collected from homes, businesses and industry. Some waste generated from our homes and industries is toxic. Toxic waste volume from homes and small businesses is rather small in comparison to all solid waste generated. The improper disposal of home and small business waste can have an adverse effect on the environment. Many of the toxic wastes generated in homes and small businesses across the state reach our landfills every day.

Hazardous waste is a part of industrial solid waste that is highly regulated, if produced at more than 220 pounds per month. It is any material that is toxic, corrosive, ignitable, reactive or specifically listed.

Improper solid waste disposal adversely impacts ground water quality. This happens when water gets into a landfill. The water dissolves materials in the landfill and eventually leaches to ground water. This can make the ground water useless. Other threats to the environment are surface runoff that pollutes streams. Birds and other animals living on the garbage at the landfill can be harmed. Health problems from rodents may arise if the landfill is not properly managed.

State law has set a solid waste hierarchy. The waste management priorities are: 1) reduce the amount of waste generated, 2) recycle and reuse, 3)incinerate for energy, and 4) landfill.

South Dakota has prepared a 15 year plan to address the waste management for the entire state. Management of solid is left to the local governments. They are to follow the state laws and rules.

Solid waste in South Dakota can be soundly managed. Waste reduction and reuse should be the first consideration for managing waste. The public must realize that recycling may cost the same or less than landfilling waste. Waste disposal costs will rise as more regulations are placed on landfills. Communities should review cost **and environmental protection** when determining how to manage their waste.

The goal of waste management must be generating less amount of waste. This will reduce the costs for consumer goods production and disposal. It also will conserve energy. Because of the rural nature of our state, we need to be more ingenious in our ways to be less wasteful and more resourceful.

The solid waste modules were developed to reinforce various concepts of waste management. Many activities deal with recycling and waste reduction. Incineration and landfills can be viable methods of disposal if done properly.

The modules used in the classroom should arouse the curiosity of the students. They should search for answers and come up with ideas for waste management. After conducting these modules, you and your students can assist the community with environmentally sound method(s) of waste management.

SOLID WASTE BACKGROUND

Solid waste defined

Solid waste is any garbage, refuse or any other discarded material that can be hazardous or non-hazardous in nature. Solid wastes are divided into non-hazardous and hazardous categories. This distinction is based on affect on the environment.

As mentioned in the introduction, solid waste can be toxic. For example, chemicals disposed from homes and small businesses are not regulated under the hazardous waste laws and rules. These toxic materials can be disposed in the landfills without any special precautions being taken. Leachate is formed if liquids are allowed to get into the landfill. This material percolates to the ground water if not controlled. Ground water may be contaminated by landfills to the point it is useless as drinking water.

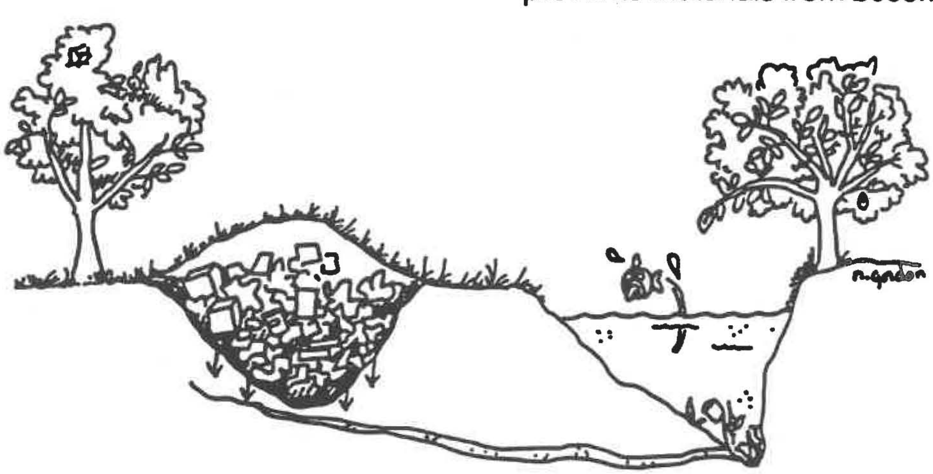
Sometimes soils under the fill cause the water to move horizontally rather than down. This can cause surface water contamination. The figure below provides a schematic of potential contamination pathways from an improperly lined landfill.

The United Sates Environmental Protection Agency has published rules to ensure the landfills across the country are properly constructed. These rules will make construction cost rise. In turn, solid waste disposal costs will go up.

Waste might be considered a resource out of place. It makes sense for us, as a society, to look for other avenues of managing our solid wastes, rather than landfilling. Current South Dakota law mandates a priority for managing solid waste. The first priority is to reduce the amount of waste. The second priority is to recycle and reuse our wastes. The third priority is to incinerate waste for energy production. The last management priority is to landfill waste. Each of these priorities is discussed below in more detail.

Waste reduction

Waste reduction at the source is a management technique that attempts to reduce the amount of waste disposal. The difference between waste reduction and resource recovery is reduction prevents materials from becoming waste.



Resource recovery techniques, such as mechanical separation and energy conversion, occur after the waste has been discarded and collected.

Volume reduction means producing less garbage by changing purchasing habits or by reusing items that would normally end up in a landfill. Consumers can demand products that contain waste materials.

Items produced and eventually discarded should contain fewer materials or last longer. This will reduce the volume of usable sources lost to landfilling. Thus, volume reduction reduces the quantity of material in manufactured items that become solid waste. The consumer can help by purchasing fewer disposable single use and convenience items. Another way to reduce waste is to purchase reusable products and returnable containers. Recycling can work, but there must be a market for the material. There are a variety of benefits resulting from a comprehensive reduction policy. These benefits include lower costs for consumer goods.

The price of every product includes the item itself, the container, any outside packaging, and the bag used to carry it home. By eliminating the excess wastes accumulated in packaging, the cost of the product is lowered. There also is a reduction in the amount of garbage created. Products in returnable containers are often less expensive than those in throw-away containers. The reason for the lower cost is the reduction in packaging cost.

Another benefit is conservation of resources. The raw materials and energy used to produce the consumer goods purchased everyday are lost when the items are discarded. Reusable and returnable containers use helps conserve valuable raw materials and the energy required to produce them.

On the local level, the major responsibility of waste reduction rests with the consumer. The state, county, and local governments can have impact on volume reduction by passing legislation requiring government agencies to use recycled products. Consumer-level for waste reduction can have a large impact.

Recycling and Reuse

Recycling is the separation, processing, and reuse of certain parts of the solid waste stream. The most commonly recycled items are metals, glass, paper, cardboard, and plastics. The separation and reuse of yard wastes and other organic wastes, a form of recycling, is discussed later. Separation of recyclable materials can be done at home, in offices, at restaurants, or in schools. Source separation and recycling reduce the quantity of waste disposed at landfills by recovering those items that are reusable.

Most recycling is called low technology recovery. Low technology recovery is labor intensive. A person does not need sophisticated mechanical devices to separate recyclable materials. It simply requires time of individual citizens and industry for separating the materials. A strong nucleus of public support and a commitment to public education is necessary to make recycling work.

Source separation can provide communities with a cost effective means of handling recyclable waste, while saving energy and conserving landfill space. Recycling programs can range from elaborate to simple curbside collection of separated materials (either voluntary or mandatory). Drop-off donation boxes or buy back redemption centers are considered simple recycling methods. Each type of program has its individual costs, level of risk and potential waste-abatement benefits.

Materials that should be considered for recycling programs include: newspaper and mixed paper, corrugated cardboard, and office paper (higher quality papers). Other recyclable materials are aluminum cans and steel cans. Glass bottles, of mixed or separated colors, and plastic bottles are also recyclable.

The importance of finding markets for recovered materials cannot be over emphasized. Recycled material markets are historically unstable. The markets themselves change rapidly as do the prices and methods of collection and delivery. It is frequently difficult to secure contracts for the purchase of most materials. Recyclers must identify the types of markets available. They must be ready to store commodities if the markets are not available.

Recycling and reuse can be accomplished. Reiterating, public education is the most effective tool in implementing a good recycling and reuse program.

Composting

Compost is a stable humus-like substance formed when organic material is allowed to decompose. Composting can be thought of as a recycling of the non-hazardous, biodegradable portion of the municipal waste stream. Compostable materials make up 40 to 65 percent of the solid waste stream. Compostable material includes yard waste, kitchen waste, paper, and cardboard. When organic wastes are buried as garbage they take up increasingly scarce landfill space. Their decay can speed the seepage of chemical wastes into ground water.

Composting is not a new technology. Placing wastes such as animal manures, food, and crop waste, in big piles or pits for decomposition has been practiced for years. Composting speeds up the natural process of decay, and organic wastes that are usually thrown away are turned into valuable soil conditioner. Natural organisms, such as bacteria and earthworms, break down kitchen, yard, and garden wastes into a rich, earthy substance. The heat from this rapid decomposition is enough to kill most weeds and disease-causing organisms. When mixed with high-nitrogen organic wastes or a small amount of garden fertilizer, compost is superior to conventional fertilizers.

One area where solid waste composting has achieved some success has been in the composting of yard wastes. Yard wastes include leaves, grass clippings, garden waste, trees and brush, but does not include stumps. About 20 percent of residential waste consists of yard wastes that could be composted. Composting is the ideal method of managing yard waste.

Problems can be caused by yard waste. Yard waste is not desirable for incineration. When burned it is a significant contributor to formation of nitrogen oxides that causes air quality problems. Yard wastes take up valuable landfill space. This waste is high in moisture content and water accumulation in landfills will eventually become a leachate.

Yard waste composting is performed in individual's backyards or at centralized collection/composting sites. Yard waste composting has gained in practice because of the low cost of the processing involved. The final compost product is especially valuable as a soil conditioner as it improves soil texture, increases water holding capacity. It also improves soil aeration, decreases erosion, and regulates soil temperature.

Composting can be easily accomplished on the school grounds or at the student's home. Modules are included to aid in your educational efforts to develop composting programs throughout the state.

Incineration

The aim of incineration is to reduce the quantity of waste disposed in a landfill. Incineration will not replace landfills as the ash from the incineration must be properly disposed. Many times the disposal will be in special landfills.

Two methods of energy recovery from waste have emerged in the United States. The first method is designed to produce a refuse-derived fuel (RDF) for firing as a supplemental fuel. The bulk of the material is paper and other light weight material. The second method is a mass-burn system. This system uses the total waste stream including glass and metals.

The RDF method provides mechanical processing of the solid waste. This allows for recovery of recyclable materials and eliminates the abrasive, non-burnable materials. The mechanical processing consists of size reduction, screening, magnetic separation, air separation, and hand picking of the material. The RDF from the processing system is burned in specially designed furnaces or co-fired with coal in existing furnaces.

The mass-burn systems, as the name implies, involve the feeding of solid waste into a furnace without any mechanical preparation. In the mass-burn facility the solid waste is placed on a tipping floor or in a storage pit. Three days of solid waste can be held. Large tree branches, stumps, refrigerators, stoves, water heaters and other bulky items are separated from the garbage. These items are taken to a landfill or recycling center. The solid waste is then pushed into the furnaces to be burned. The material is burned under particular types of conditions to keep the pollution levels low. The aim is to have a complete burn of the garbage. The air emissions are scrubbed and the ash has the ferrous metal separated before it is disposed.

Both methods can include equipment to recover energy from the combustion process. The energy can be recovered in the form of steam, electricity, hot water, or chilled water. The major concerns with both types of incineration is the formation of air pollutants. Also, the mass-burn ash may contain materials that can be toxic. This will require safe disposal, possibly in specially built landfills.

Landfill

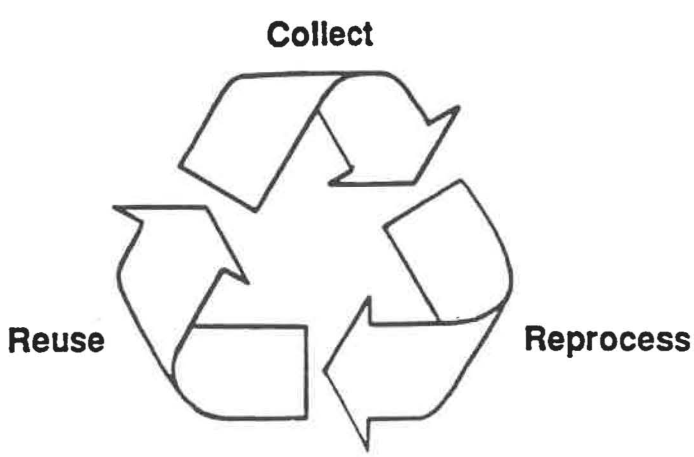
The waste abatement alternatives, discussed above, do not account for the total solid waste stream being removed from the system. The need for a landfill to dispose of bypass wastes, rejects, ash and unprocessed waste is still present.

There are two types of landfills, uncontrolled and controlled. Uncontrolled landfills are those that do not have leachate and air emissions control systems. Controlled landfills have modern gas control equipment for collecting and burning fugitive gas emissions. They have leachate collection systems.

A controlled landfill is designed to spread layers of waste in a confined area, or cell. The waste is compacted into the smallest practical volume and covered daily with soil. Such a landfill has leachate control and collection, ground water monitoring, gas monitoring and venting. There are also strict controls on the types of wastes acceptable for landfilling.
Solid waste deposited in a landfill will decompose and form primarily the gases of methane and carbon dioxide. Smaller amounts of nitrogen, oxygen, sulfides, hydrocarbons and trace volatile organics are generated. Environmental impacts may occur from gas migrating beyond the fill area. This migration, however, can be controlled by installing venting systems or and active collection system.

A principal concern associated with landfills is the pollution of ground water and surface water. Leachate is formed as water from precipitation, ground water infiltration and moisture contained in the waste, passes through the landfill. If not properly contained and collected, leachate can contaminate ground or surface water.

Features such as impermeable liners, leachate collection systems and impermeable capping systems minimize the potential for leachate formation and percolation. Operational procedures can inhibit leachate production. An operator can minimize the active fill area and apply daily cover. Placing a final cover over the landfill will reduce long term environmental impacts.



COUNT TO SEVEN?

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GRADES: K to 3

CLASS: Reading, Science

TIME: 15 minutes

EMPHASIS: Solid Waste

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Objective(s)
The student will:

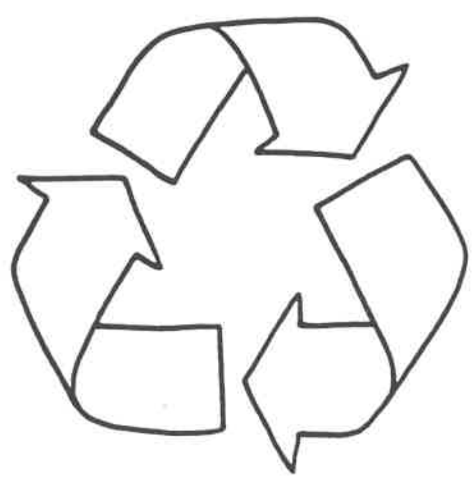
1. identify the recycle logo and
2. recognize numbers within the chasing arrows recycle logo.

Background
Most plastics contain a symbol or code to depict the type of material from which it is constructed. The codes and examples of containers made from these types of plastics are listed below.

Materials
You will need plastic containers with the various recycle codes. These can be obtained by checking your shelves at home or purchasing some of the goods at your local grocery or drug store.

Procedure
1. Draw the recycle logo or use an overlay made from the drawing below.
2. Have the students try to find the symbol on the container.
3. Let them observe the number.
4. Have them draw the logo and the number and then discuss what they notice about the different containers.

Questions
1. How many different numbers are there?
2. What do the arrows mean?
3. Is there a difference between the containers? What do you notice about the difference of the container?



Additional Ideas

☞ Students might use this exercise to brush up on their colors. Many of the plastic containers are clear to translucent and will allow the colors to show through. To develop observation skills start the exercise by asking the students to find the triangle. Have them note any difference on the plastic bottles compared to other types of containers. Other containers may have the recycling logo without any number.

Bibliography ______________________________

Additional Ideas ______________________________

CODE	Plastic Type
1 PETE	Polyethylene Terephthalate Example: Beverage Containers
2 HDPE	High Density Polyethylene Example: Milk Jugs
3 V	Vinyl/Polyethylene Example: Corn Oil, Shampoo Bottles
4 LDPE	Low Density Polyethylene Example: Cosmetics Packaging
5 PP	Poly Propylene Example: Syrup Containers
6 PS	Polystyrene Example: Cups for Hot Drinks
7 Other	

GARBAGE!!

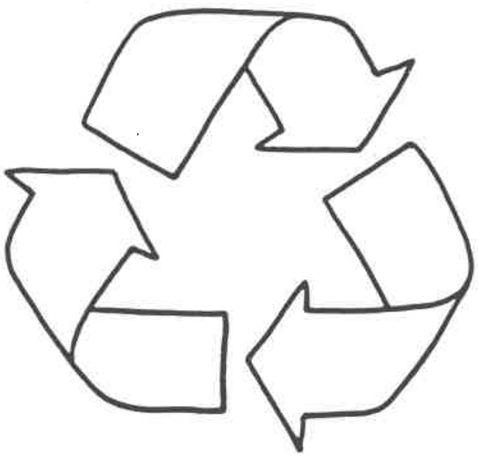
GRADES: K to 3

CLASS: Art, Social Awareness

EMPHASIS: Symbol recognition for Recycle and Clean Environment for all

Objective

This activity makes the student aware of the recycling logo found on most plastic packages and on many paper documents.



Background

The chasing arrows are a common symbol for recycling. This is a voluntary symbol for various manufacturers to use if they so desire. Many of the plastics and some paper has the recycle logo printed on the product. A good practice is to check the material you are purchasing to note if it is recyclable. The plastics symbols are included in the previous module.

Materials

- Copy the graphics from this activity.
- Crayons or colored pencils.
- Various plastic products with the recycle logo printed on them.

Procedure

1. Copy the three graphics on a sheet of paper for each student.
2. Have each student draw or write what this means to them.
3. Ask each student to show what they drew or read what they wrote.
4. After each student has had a chance to discuss his or her drawings, spend a few minutes talking about the plastics and where to look for the symbol.

Questions

1. What does the garbage can signify to you?

2. What do the arrows mean to you?

3. Where can you find the recycling logo?

4. What did the goose mean to you?

5. Could garbage hurt the animals if we throw away without any care?

Bibliography

Additional Ideas

☛ Use the plastic match game located in Appendix C. The students should bring empty plastic containers from home and match the number to the CAN MAN. The plastics in the drawing can be used to match the CAN MAN numbers.

CLASSROOM WASTE

++++++++++++++++++++++
GRADES: 5 to 8

CLASS: Math, Science, Geography

TIME: One 30 minute period and 20 minute blocks for one week.

EMPHASIS: Reduce, Recycle, Reuse
++++++++++++++++++++++

Objective(s)

The student will:

1. calculate the amount of waste generated in one classroom for one week.
2. design ways they and their classmates can reduce waste and recycle within their own classroom.
3. identify the geographic areas where the material is produced.
4. describe how products are shipped to market.

Background
Every day all of us dispose of many materials of which we are not even aware. In 1986 Americans threw away approximately 2.8 million tons of appliances, 1.8 million tons of tires and 12.6 million tons of newspapers. We trashed 5.5 million tons of glass beverage containers and 1.3 million tons of aluminum beverage containers. On top of all this, we disposed of 19.4 million tons of corrugated (cardboard) containers and 5.7 million tons of plastics.

The United States Environmental Protection Agency's Agenda for Action in 1989 stated that approximately 80% of our solid waste was landfilled, 9% incinerated and only 11% recycled.

Materials
- scale, sensitive enough to record weight of the trash in the can each day
- pencils
- graph paper or plain paper for recording weight of trash

Procedure
1. First have the students weigh the empty trash can. Have them design a graph to show the types and amount of trash discarded each day for five days.
2. Place the results on a large graph placed near the trash can. Each student should record the results in his or her graphs.
3. The students should calculate the total amount and types of trash discarded in their room. These figures should be extrapolated to each classroom in the school and for each school in the district.

The types and amounts of trash should be posted in an obvious place for all students to see.

Questions

1. What was the most common material discarded?

2. Where is this material produced?

3. How is this material transported?

4. Can our wasteful ways cause other forms of pollution? What are they?

Bibliography

U.S. Environmental Protection Agency. 1989. *THE SOLID WASTE DILEMMA: An Agenda for Action.* 70p.

Additional Ideas

HOME DISCARDS

+++++++++++++++++++++++

GRADES: 5 to 8

CLASS: Math, Science, Geography

TIME: Two 20 minute periods

EMPHASIS: Reduce, Recycle, Reuse

+++++++++++++++++++++++

Objective(s)
The student will calculate the percent of different wastes being discarded at home. This information should be compared to what is being discarded in their room at school (SEE CLASSROOM WASTE ACTIVITY - SW3MOD).

Background
In rural South Dakota communities each person discards an average of three (3) pounds of trash per day. In urban South Dakota communities each person discards an average of four (4) pounds of trash per day.

Nationwide waste generation was estimated to be 2.65 pounds per person in 1965. That figure jumped to an estimated 3.58 pounds per person per day in 1986.

The types of materials discarded nationwide by percentage in 1988 were:

Paper and paperboard -	41%
Yard Wastes -	17.9%
Metals -	8.7%
Glass -	8.2%
Rubber, leather, textiles -	8.1%
Food Wastes -	7.9%
Plastics -	6.5%
Other -	1.6%

Materials
- Paper
- Pencil

Procedure
1. Students should be instructed to check their waste baskets at home for one week to determine the material being thrown away. The material should be categorized as above. Do not give the students the percentages of each category until the end of the survey.
2. At the end of the home survey each student should calculate the percentage of discarded home waste by each category. Some students may wish to alter the survey by determining volume and weight of the materials with the type.
3. Each student should fill in a large chart that is provided in the classroom for all to see.
NOTE: Each student should be cautioned about hazard. Discards might be broken glass, razor blades, insect spray cans, and toxic materials.

4. Instruct each student to let his or her parents know they are doing a home waste survey for one week. Habits should not be altered by the household.

Questions

1. Ask each student to verbally characterize what they found in his or her home.
2. What were the most common categories of waste in the home?
3. What was the volume of each waste category?
4. What was the weight of each waste category?
5. What could be done to reduce the amount of waste?

Bibliography

Franklin Associates Ltd. 1988 (Update). *Characterization of Municipal Solid Waste in the United States.*

Additional Ideas

VOLUME REDUCER

+++++++++++++++++++++++
GRADES: 4 to 6

CLASS: Math, Science

TIME: 30 minutes

EMPHASIS: Solid Waste Volume Reduction and Recycling
+++++++++++++++++++++++

Objective(s)
The student will:

1. calculate volume and weight of un-flattened versus flattened cans and
2. identify the simple step to reducing volume can be accomplished at home with just a can opener.

Background
There is a need to reduce volume to preserve existing landfill space. Overcoming transportation problems in South Dakota is a major factor in conducting a successful recycling program. When transporting material to be recycled we must place the most amount of material placed in the least amount of space. This assures shipping and processing of large volumes.

Materials
- Any type of vegetable or fruit juice can
- A scale or several scales that can weigh to the nearest ounce.

Procedure
1. Have the students calculate the volume of the can they have brought to class. The can should have the label removed and it should have been rinsed clean.
2. Each student should calculate how many cans will fit into a box 6 feet long x 3 feet wide x 3 ft high.
3. Instruct the students to flatten the can by steeping on it. Determine how many flattened cans occupy the same space or volume.
4. Weigh the can to the nearest ounce. Have the students determine the difference between the weight of a box filled with the un-flattened and one with flattened cans.

Questions
1. What is the difference in the number of cans that can be placed in the box?
2. What is the difference in the weight of the cans?
3. How might you handle the can lids so they may be shipped with ease? HINT: Use a can opener on the closed end of the can. Leave a small portion of the lid attached to the can. Fold the end into the can and flatten by stepping on the can. Emphasize rinsing and label removal when you do this demonstration.

Bibliography

Additional Ideas

If you have a recycling center, check with the personnel to assure cans with folded ends are acceptable. If not acceptable, ask how the lids should handled so they are recycled.

LETS GO SHOPPING

+++++++++++++++++++++++

GRADES: 4 to 6

CLASS: Social Science, Science, Consumerism, Awareness

TIME: 30 minute discussion period

EMPHASIS: Waste reduction

+++++++++++++++++++++++

Objective(s)
The student will:

1. recognize different packaging methods and
2. assess the increased cost associated with extra packaging.

Background
Much of the material we currently purchase has extra amounts of packaging strictly for marketing. The question now being asked is all the extra packaging necessary since recycling is still not a daily routine in most people's lives. Side effects are extra energy used to produce and transport the product.

Materials
- None, other than pencil and paper

Procedure
1. Ask the students to attend a grocery store shopping with their mother or father.
2. They should be assigned specific areas such as canned vegetables and fruit, fresh vegetables and fruit, meats, cheeses, baked goods, frozen foods, health care, and toiletries.
3. The students should be asked to note the way the product is packaged and the cost per pound or item. The student should compare between companies and note any differences.
4. The parents should be asked to assist the students with this exercise. The parents can help identify where the product was produced. Use this information to evaluate shipping costs from the point of origin to the market.
5. The students should design a table depicting their information. The table should include the name of the product and where it was produced. The table also should include how the product is packaged and the cost per pound. Include a column for bulk price if it is available.
6. The final step in this exercise is determining what happens to the extra packaging. The students should be aware of waste that may be produced using bulk items.

Questions
1. What item did you study at the grocery store?

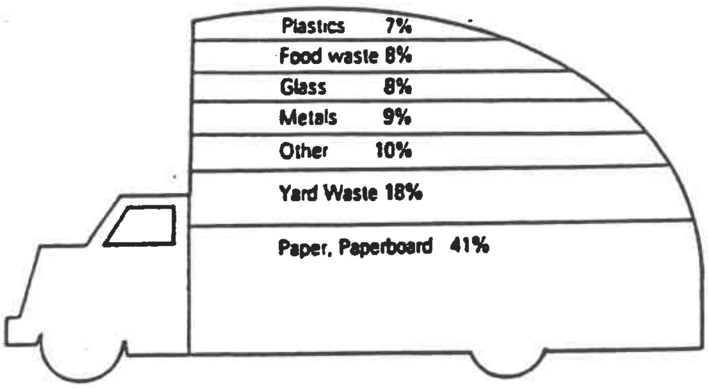
2. Did you find any differences in price between companies?
3. If so, what is the reason?
4. Was the item sold in bulk?
5. If so, what was the cost per pound or item?
6. Where was the item produced or packaged?
7. How might we determine the cost of shipping?
8. Is there any waste from the bulk items?
9. What could you do with the waste?
10. Were there any items where the extra packaging was needed?
11. What could we do with the extra packaging?

Bibliography

Additional Ideas

KEEP ON TRUCKING!

Paper and yard wastes
are more than half of our trash



+++++++++++++++++++++++

GRADES: 4 to 8

CLASS: Math, Science, Consumerism, Social Science, Geography

TIME: One 30 minute period for instructions and five 30 minute periods for writing and assessing information.

EMPHASIS: Product and Waste Transportation

+++++++++++++++++++++++

Objective(s)
The student will:

1. calculate differences in cost to produce and transport an item they consume,
2. give examples of costs equated to extra packaging,
3. list the costs for waste transportation and
4. outline the costs for waste disposal after product consumption.

Background
The cost to ship a product or products is one part of the price we pay. The packaging cost has been built in to each of the product(s) we purchase. Also, there is a cost to dispose of any solid waste caused from the product consumption. There is a pick up fee for waste produced at your home. This fee may be direct payment or a tax assessment.

A South Dakota recycler's major expense is shipping. The recyclable materials must be shipped in large quantities to reduce the cost for the shipping. The citizens of small communities may have to work together with a regional recycler so he or she can maintain a profitable business.
South Dakota communities may want to consider shifting landfill costs to reduction and recycling activities.

Materials
None other than paper and pencil.

Procedure
1. The students should be asked to pick a product of their choice to research.
2. Develop another table such as the one designed for the grocery shopping exercise. In the table list the product, where it is produced and the shipping method such as truck or rail. The table also should include the cost per mile to ship the product to the point of destination. Another table should be designed to show what waste is produced, recycle center, waste market and shipping costs to the market.
3. The students should be asked to contact the transportation company, by letter, for their average shipping costs for the product. Ask the retailer who ships them the material. The student should

contact the shipper with their questions about costs.

4. Determine the waste produced from the item they picked. If it is recyclable, determine the shipping costs to the waste processor. The student should contact the local or regional recycling facility or a transportation firm for shipping costs.

5. Write the local finance officers in your city or county to determine local waste disposal costs.

6. Compare differences in the two costs. Explore ways recycling and reuse can be accomplished with reasonable costs.

7. The students should take note of all extra packaging material used on the item of their choice.

Questions

1. What is the cost of shipping your item?

2. What was the mode of transportation?

3. What is the percent of the shipping costs in the total price?

4. Is there a product comparable to the one you consumed that may be more environmentally sound?

5. Is the product or the packaging disposable?

6. If disposable, is it recyclable?

7. Could you have found a product with less packaging and at a lesser cost?

8. What were the shipping cost for the recyclable material?

9. How much needed to be shipped for the recycler to break even or make a profit?

10. Where was the product produced and where was the disposed material shipped for reprocessing?

11. How much does it cost to dispose of waste in your community?

12. How are the costs assessed?

13. Is there a better way to handle or take care of your waste?

14. What can we do to ensure we start and continue with the total reduce, recycle, reuse mentality?

Bibliography

Additional Ideas

LETS PULL TOGETHER

++++++++++++++++++++++

GRADES: K to 12

CLASS: All

TIME: Dependent on school size and participation.

EMPHASIS: Reduce and Recycle

++++++++++++++++++++++

Objective(s)

The students will:

1. develop a recycling program for elementary, middle or senior high school,
2. increase waste reduction through recycling and
3. express recycling must be combined with reuse so markets are available for recycled materials.

Background

Recycling alone may not be successful. The process of solid waste management must include the use of the 3Rs; i.e., reduction/recycling/reuse. Waste reduction means less waste produced. Consequently, there will be less need for raw material. Recycled material may be used in product manufacture. As consumers, we need to make a conscious effort to purchase those goods that are made from recycled materials. Aluminum is the big success story so far. The amount of aluminum beverage cans that is now recycled is 63.3%[1]. The same needs to occur for plastics, paper, tin/bimetal cans (now about 25%[1]) and glass.

Materials

- A notebook for each student.
- Pencil.
- Graph paper.
- Form for 3R determination.

Procedure

1. Use the previous activity on classroom throw away. They should decide:
   a. how to reduce the waste.
   b. what can be recycled?
   c. what recycled (reuse) material can be purchased or put into school use.

Place this in an easy to read tabular form.

2. The students should develop a survey form. Survey other students to obtain their ideas for waste reduction and recycling in the school.
3. Distribute the form to each student in the school, if possible. A sample from the student body can be substituted for an entire school survey. This is appropriate if you are using statistics for this exercise.
4. The survey results should be displayed in a tabular form for the school to see.
5. Determine the guidelines for overall waste reduction in the school. This will mean working with the administration,

secretarial and janitorial staff for ideas and permission to reduce the waste. Interviews will need to be held with the appropriate school administrators and support staff.

6. Ask the students to find recycling businesses in or near their communities. Letters should be written to determine the availability of recycling service. Make sure markets are available for each material to be collected for recycling.

7. All information should be placed in the student's notebooks. From this information the students can establish a reduction and recycling strategy. They should consider source separation, collection points, consolidation of materials, and costs to finance the program.

8. Consider reusing recycled materials after the recycling strategy is determined. Recycled merchandise that can be purchased for school use should be evaluated. Such merchandise may be paper products, school food supply companies, desks and other equipment.

9. When all the pieces to the school 3R program are in place the students will need to have the program procedures in simple outline form. This will assist all students on how to conduct the 3Rs.

Questions

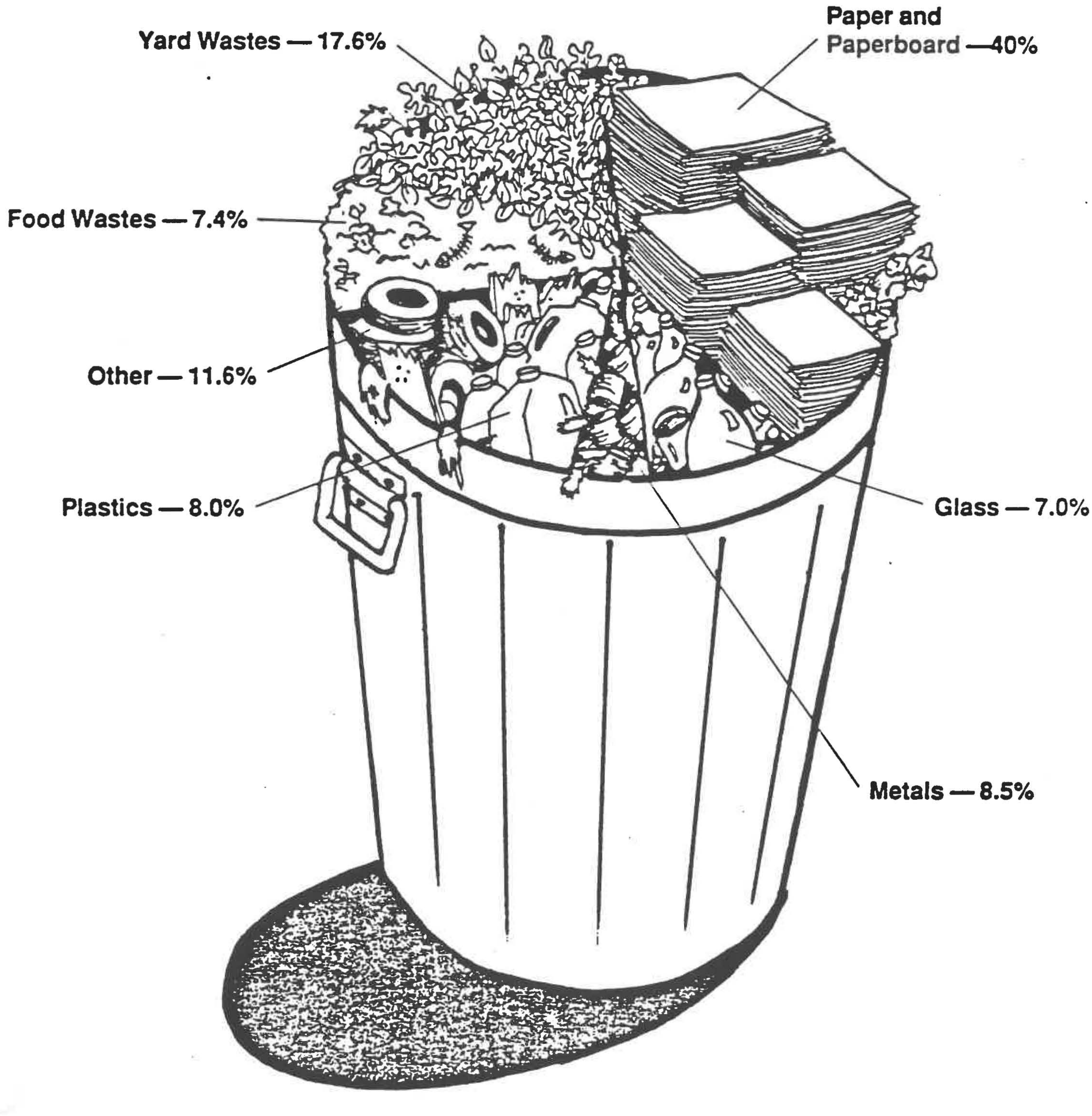
1. How can we find the recyclers are in our area?
2. What about fire codes for the recycling project?
3. What are the budget needs to conduct the program?
4. Where are the logical deposit locations?
5. What types of containers are used for collecting the recyclables and how are they to be labeled?
6. Who will collect the recyclables?
7. When will collection occur?
8. Is there ample storage space?
9. What is the truck access?
10. What are the markets for the recyclables?
11. Have all the staff at the school been notified of intent of the program?
12. Have the maintenance staff been included in the plans?
13. Have you scheduled an explanatory session?
14. Are the procedures clear?
15. What are some examples?
16. Are posters made for each stage of the 3R program?
17. Are there notices for the parents of the program?
18. Have you scheduled a special events day?
19. Are there any ordinances in the town that need to be addressed?
20. How will you keep records of what is being collected, reduced, reused?
21. What cost savings or extra costs are occurring because of the program?
22. How does this compare to your home program?
23. Are there other ways we could run the program?
24. How can we promote what we are doing at other schools?
25. Who is the coordinator for the program once we leave?

Bibliography

[1] Recycling News. 1991. *SOLID WASTE & Power The Magazine of Waste Management Solutions*. Vol V/No 4/August, pp 72 & 74.

Additional Ideas

Materials Discarded into the Municipal Waste Stream*



* Numbers do not add up to 100% due to rounding.

!!!!ZAP!!!!

+++++++++++++++++++++++

GRADES: 4 to 8

CLASS: Social Studies, Science, Math

TIME: One 20 minute introduction and one 30 minute wrap up.

EMPHASIS: Waste reduction

+++++++++++++++++++++++

Objective(s)

The student will:

1. evaluate the small amount of time many home products exist and
2. describe alternatives to reduce wastefulness and use longer lasting or recyclable items.

Background

The United States has become a throw away society. This has occurred because of consumer demand for convenience items. We demand <u>disposable</u> razors, cameras, underclothing, diapers, and flashlights. This exercise will heighten the student's awareness of the short life of some of our home items. I will challenge the students to look at alternatives for longer lived materials. This longer life also will translate into the idea of recycling and reuse of items. We need to be more conscious about purchasing items that can be detrimental to the environment. The convenience items are sometimes less costly, but the production or use can damage the environment.

Materials

- Watch with a second hand.
- Paper and pencil.
- Design a table for keeping track of discarded items, life of the item, and alternative(s) to the item.

Procedure

1. The students should be given a background on landfills, waste reduction, recycling, and reuse. The exercises on Home Discards and Let's Go Shopping may be run concurrently or previous to this exercise.
2. Ask the students to record the items in their household that are disposable. They should record the cost of the item, when it was purchased and put into use. Determine how long the item was used before disposal. Write down a substitute item and the new item life span.
3. After two weeks ask the students to discuss their findings and provide a classroom listing of the items, the life span, and the alternatives.

Questions

1. What were the most prevalent items?
2. What items had the shortest life spans?
3. What were the costs of the items?
4. What were the alternatives?

5. Could any of the throw away items been reused?
6. Could any of the items been recycled?

Bibliography

!! Thanks to Shirley Frederick of the Rapid City School District for this exercise idea!!

Additional Ideas

☞ You may wish to have the students work with their parents on this exercise to ensure family involvement.

☞ Results of the class may be recorded on a poster. Placed the poster in a conspicuous place to alert other students in the school about product life spans.

☞ Conduct this exercise when doing the Let's Go Shopping activity.

☞ The items such as old clothes may be turned into cloth napkins. Use them in place of paper napkins. Replace disposable diapers with cloth diapers, disposable razors with regular razors, and paper plates and cups with reusable plates and cups.

FROM RAGS TO RICHES

Lets Do It Together
REDUCE
RECYCLE
REUSE

++++++++++++++++++++++

GRADES: 4 to 8

CLASS: Organization activity

TIME: A 30 minute organizational meeting for decision making.

EMPHASIS: Recycling and reuse of cloth material

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Objective(s)

The student will:

1. discuss clothing collections and
2. develop a clothing drive.

Background

Many times old clothing or old cloth material is discarded without thought for use by the needy or homeless. The material may be used in the manufacture of rag rugs by persons doing home weaving.

Materials

- Bags and vehicles for transporting the clothing/cloth material drive.
- A storage facility will be needed for the clothing/cloth material.
- Contact with an outlet or a weaver for the recycling of the material.
- Volunteers to assist the students in their clothing/cloth drive.

Procedure

This will be determined through interaction of the students and the advisor for the organization.

Questions

1. How can this activity help the environment?
2. What materials made up the cloth?
3. How will this recycling or reuse benefit the environment?
4. What other types of drives could be conducted to benefit the environment?

Bibliography

Additional Ideas

☞ Students may wish to work with the weaver or clothing outlet to have a continuous clothing/cloth drive.

☞ Clothing outlet or weavers who make a profit might be enticed into donating a percentage of their profits to the organization. These funds can help the organization for other recycling/reuse activities.

☞ Students, or members of an organization, should try to fine funds for a loom. With the loom the organization can continue to make and sell rag rugs for additional funds. The idea is not to make a profit, but to ensure materials are being recycled.

CAN-CAN MAN

++++++++++++++++++++++

GRADES: 4 to 8

CLASS: Science

TIME: One 45 minute class

EMPHASIS: Recyclable recognition

++++++++++++++++++++++

Objective(s)
The student will identify aluminum, tinned and bimetal cans.

Background
The most recognizable recyclable item is the aluminum can. Other types of cans commonly called tinned and bimetal cans are mistaken for aluminum. Tinned cans are those made up of 99% steel with a thin coating of tin such as soup cans. Bimetal cans are those that have an aluminum top and a steel body. Examples are tuna fish cans, small juice cans, and tennis ball cans. "Bimetal" cans do not refer to a can that has two metals combined to form an alloy.

All cans are very similar in appearance. The main reason for recognizing the difference is the bimetals are hard to recycle. The need to recognize the different types of cans is to enable the separation to take place for recycling purposes.

Materials
- Various types of cans (empty and rinsed if food cans) collected from home.
- Magnets

Procedure
1. Group students into teams of 3 or 4.
2. The students should record the difference in appearance of the cans such as weight, seams, color, shininess. (Bimetal cans appear almost like aluminum cans.)
3. With the magnets have the students test each can and record what happens.

Questions
1. What were some of the differences in the cans in your group?
2. Were there any particular food group cans that had both aluminum and bimetal in the same can?
3. What was the results with the magnets?
4. Was there any difference by placing the magnet at the top of the can or on the side?
5. Were there some companies that packaged with more easily recyclable material such as aluminum?
6. What could you do to encourage a change in the packing habit of less recyclable material?
7. Is there a recycling center that will take these different cans?
8. What could the can packaging industry do to make identification easier?

Bibliography

New Jersey Department of Environmental Protection. Pilot Project. *Here Today, Here Tomorrow -- Revisited, A Teacher's Guide to Solid Waste Management.* 78p.

Additional Ideas

☛ Have students compare types of cans when shopping with their parents.

☛ Have students design a recycle logo such as the plastics industry. Send it to an organization such as the National Recycling Coalition, National Solid Waste Management Association, or the Steel Can Recycling Institute. Addresses listed in the Appendix.

HOME IS WHERE THE (HEART IS) TRASH BEGINS

+++++++++++++++++++++++

GRADES: K to 12

CLASS: Social studies, Science, Consumer Science, or any class/organization

TIME: 30 minute preparation discussion and 30 minute wrap up discussion.

EMPHASIS: Recycling

+++++++++++++++++++++++

Objective(s)

The student will:

1. examine home source separation of recyclable materials and
2. develop a home recycling center.

Background

Each of us produces approximately 3.5 pounds of trash per day. Much of this can be reduced by developing good purchasing habits. There will always be materials that might become waste such as left over portions of food. (Leftover vegetables can be composted.) Packaging material such as glass, cans, plastic and paper are the commonly generated wastes in the home.

Materials

Paper, pencil and vision of the students home layout.

Procedure

1. The students should be requested to lay out a sketch of their home. It does not have to be pretty!
2. Ask them to design a home recycling center for their family. The additional ideas section of this activity lists the highlights of a home recycling center.
3. Encourage the students to have mom and dad help set up the home recycling center. Students are tp report back in two weeks on the success or failure of their project.

Questions

1. How is your recycling center set up in your home?
2. How will you handle each item that is recyclable?
3. Where is the nearest recycling center?
4. Could our community develop a curbside program using this home separation?
5. What can we do to encourage home curbside collection?
6. What can we do to make sure the material taken to the recycling center picked up at the curb is suitable for recycling?
7. Can you think of anything else that could be recycled besides paper, glass, tin/bimetal cans, and plastic? (Hint: Old clothing, vegetable food scraps, string, Christmas bows, wrapping paper, etc.)

Bibliography

New Jersey Department of Environmental Protection. Pilot Project. *Here Today, Here Tomorrow, Revisited. A Teacher's Guide to Solid Waste Management.* 78p.

Additional Ideas

☞ The following home recycling center was adapted from the above cited literature.

ESTABLISHING A HOME RECYCLING CENTER

Setting up and maintaining a home recycling center can be easy. The time per household varies, but it can take as little time as two minutes. The above exercise emphasized simplicity and ease to encourage continuation. Parents should eb involved where possible. Students can maintain the home center on their own. You can establish a home room or classroom center and seek day to day student participation.

The basic steps in establishing a home recycling center are:

1. Locating a convenient place in the home or apartment (it does not take much room for your recyclables; places might be the garage, a closet under the sink, or in a corner of the kitchen),
2. Storing the materials in a sturdy container (plastic buckets or boxes that are reusable).

RECYCLING TIN/BIMETAL CANS

These cans are typically 99% steel and 1% tin.
1. Remove all the labels and rinse them clean.
2. Remove both ends and flatten.
(If you are unsure about the type of can this one will be attracted to a magnet and will have a seam)

RECYCLING ALUMINUM

1. If in doubt about the can being aluminum, check with a magnet. There will be no seams in the can if it is aluminum.
2. Rinse the can and flatten to save storage space.
3. Other aluminum products, such as T.V. dinner trays and foil, should be separated from the cans.

RECYCLING GLASS

Buy returnable bottles as much as possible. Prepare the glass for recycling by:

1. washing. There is no need to remove the labels.
2. removing all metal caps and rings (discard appropriately).
3. separating the glass by color, if necessary.

RECYCLING PAPER

Newsprint

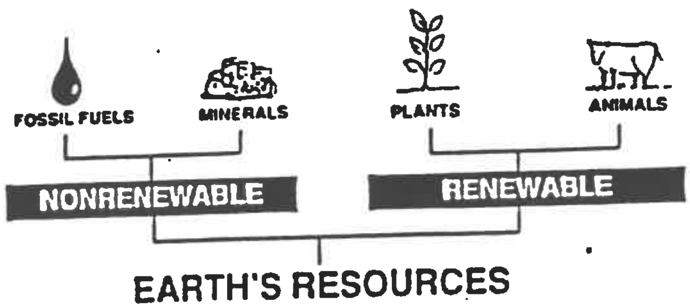
1. In a fire-safe area stack the newspapers.
2. Check with the collection service or drop off center on how the papers need to be prepared. Thye may have to be tied in stacks or bundled in brown grocery sacks.

Other Papers

Corrugated cardboard is heavy cardboard with two layers and a ribbed section in between and should be flattened for easy storage and transportation.

High-Grade paper is computer paper, tab cards, ledger paper and copier paper.

AU NATURALE OR UN-NATURAL



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GRADES: K to 6

CLASS: Science, Social Studies

TIME: Two thirty minute periods - the second two months after the first.

EMPHASIS: Landfills - decomposition

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Objective(s)

The students will examine the decomposition of nature's materials and man-made materials.

Background

Materials produced by nature such as leaves, grass, shrubs, trees, and other living plant and animal organisms will be broken down by nature's activity. Decomposition occurs by action from bacteria and fungi with the addition of water and oxygen. This is the same principle used in establishing compost piles. Some of nature's materials decompose readily while others take longer. Some of man's materials take hundreds of years to decompose. (See Clip Art Appendix C.) This ties up materials and alter nature's cycles.

Materials

- Two (2) jars or clear plastic bottles
- Some materials such as grass clippings, leaves, small twigs, pieces of fruit, soil, and other material. The student should determine what is naturally produced. (The students should be directed to bring in only what is needed to fill their jar 2/3 full.)
- Some man made materials such as plastic pieces, gum wrappers, gum, aluminum foil, styrofoam and other material. The student determines what is not nature's product.
- Mold, weed inhibitor.

Procedure

1. Ask the students to label their jars one with natural and one man-made.
2. In the natural jar place the nature's materials and lightly moisten.
3. In the man-made jar place some soil and the items the students have determined to be man-made.
4. Set the jars aside in an area where they will not be disturbed for two months.
5. Do not let the material dry out. The material should be moistened periodically. When the students are adding the water they should note their observations about the material in each jar without disturbing the contents.
6. After two months, the students should dump the contents onto a large piece of heavy paper or card board.
7. They should record their observations. Discuss the class observations.

Questions

1. What are some of nature's materials you have added?
2. What are some of the man-made materials you added?
3. How long will it take to break down materials that nature produces? that man produces?
4. What was the reason for adding water?
5. What was the reason we did not place a cap on the jars?
6. What do you suppose would happen if we put a cap on each of the jars?
7. What causes the material to break down?

Bibliography

Additional Ideas

☞ Some students may wish to cap the material and note what happens. If this is done, the contents will undergo anaerobic decomposition. This will cause a bad odor so open the jars outside!
☞ You may want to use the chart supplied in the appendix to show how long some items take to decompose. Have the students to do some individual research on decomposition times.
☞ This exercise may be followed with the Cycle exercise or the Composting exercise.

WHAT'S POPPIN?

+++++++++++++++++++++++
GRADES: K to 4

CLASS: Social Studies, Conservation, Science

TIME: 20 minutes

EMPHASIS: Conservation, solid waste reduction, recycling.
+++++++++++++++++++++++

Objective(s)
The student will examine various alternatives for packing materials that are biodegradable or recyclable.

Background
Polystyrene peanuts for packing have been in use for many years. There are alternatives for this packing that can be used and reused. Such packing material can be old newspapers, wood shavings or chips, sawdust, or other materials that might be reused by carefully looking around the house. Many of these materials can be recycled or reused. Other materials that can be used for packing are old newspapers. Popcorn can be used as packing and then feed for the birds. Reused or recycled wood chips, shavings, saw dust might be used and then added to the compost pile. The polystyrene peanuts can be reused/recycled rather than throwing them in the trash.

Materials
- Polystyrene peanuts

Procedure
1. Hold up the polystyrene peanut and ask the questions below.

* An exercise to run concurrently would be weight determination of the materials as suggested in the additional ideas listed below. The students should be encouraged to come up with this idea by using the right choice of questions?

Questions
1. What is this object?
2. What is the use?
3. What are some other packing materials that we might use?
4. How might we reuse some of the materials that you have suggested?
5. What is polystyrene?
6. What is the life of polystyrene?
7. What might we do with the polystyrene peanuts when we are done with them?
8. Should we continue to use the polystyrene peanuts?
9. Are there any recyclers nearby who will take the polystyrene?
10. What is the advantage of the polystyrene over the other substitutes you have suggested?

11. How might popcorn be a good substitute?

12. What might be the problems with popcorn?

13. Can you think of other packing materials that might be used?

Bibliography

Additional Ideas

☛ Compost the packing material if it is popcorn or wood material.

☛ If you have not already conducted the **From Rags to Riches** exercise, you may want to follow up with it now.

☛ Design an exercise to determine weights of the different materials. The students should understand costs of shipping. This would affect their decision on what to use as a packing material.

SOLID WASTE VOLUME REDUCTION

+++++++++++++++++++++++

GRADES: 8 to 10

CLASS: Math

TIME: One class period or about one hour

EMPHASIS: Solid Waste Volume Reduction

+++++++++++++++++++++++

Objective(s)

The student will:

1. calculate the volume of a cylinder,
2. the volume of a cube and
3. identify the benefits gained by waste volume reduction.

Background

A major problem facing recycling in South Dakota today is transporting the recyclables from local recycling centers (points of collection) to the reprocessing facilities. Most reprocessing facilities utilized by recycling centers in South Dakota are located in larger cities in other states (ie. Minneapolis, MN; Denver, CO). This connotes recyclables be transported distances and the cost of this transportation is very high.

To transport the recyclables more efficiently their volume must be reduced, enabling a much greater number of cans, plastic jugs, etc.(this module will deal with tin cans) to be hauled in every truck or rail car. Economics does not allow the small recycling centers in South Dakota to purchase the can crushers or balers necessary to perform this volume reduction. With a nominal time investment volume reduction can be achieved in the home. Not only does this help your local recycling center but it also means fewer trips to the recycling center for you.

Materials

- Paper, pencil and calculator (optional).
- Tin cans (assorted sizes).

Procedure

1. Calculate the volume in cubic inches and then cubic feet of the tin cans using the formula for volume of a cylinder:
   $V = \pi r^2 h$
2. Calculate the volume of various sized garbage cans.
3. Calculate the maximum number of various sized tin cans that would fit into the different sized garbage cans.
4. Flatten the tin cans. If the cans are already empty, then cut around the bottom of the can with a can opener. Leave the bottom attached to the can. Fold the bottom of the can in and flatten the can by stepping on it's side. This is one way to ship tin cans to the recycler. When opening a can leave the top attached. Fold both ends inside the can and step on it to flatten.

5. Calculate the volume of the can. Use the formula for the volume of a cube:
$V = a \times b \times c$
6. Calculate the maximum number of various sized flattened cans that would fit into the different garbage cans.
7. Calculate the maximum number of un-flattened and flattened cans that would fit into a semi-trailer. Use the dimensions of 8 ft x 40 ft. for the trailer. Pile the cans 5 ft high in the semi-trailer.
8. Do the same for a rail car with dimensions 16 ft x 60 ft x 12 ft.

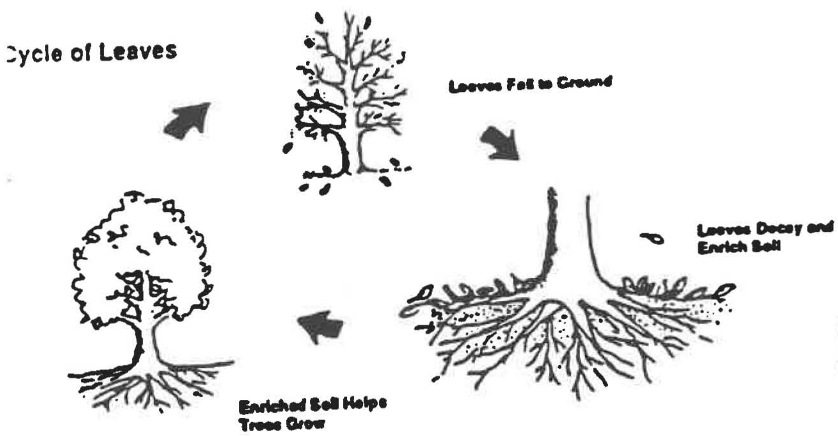
Questions

1. What is the formula for the volume of a cube?
2. What is the formula for the volume of a cylinder?
3. Why should you practice this form of volume reduction at home? Why not rely on the recycling center to do this for you?
4. Calculate the savings of diesel fuel for a shipment from Pierre. The shipment is 500,000 cans (you choose the size) to Minneapolis, MN. Assume it is 400 miles to Minneapolis and the trucks get 8 miles to the gallon.

Bibliography

Additional Ideas

WHAT'S A CYCLE



+++++++++++++++++++++++

GRADES: K to 5

CLASS: Social Studies, Science

TIME: 15 minutes, plus game

EMPHASIS: Cycles, Resources, Recycling

+++++++++++++++++++++++

Objective(s)
The student will:
1. recognize the importance of a cycle and
2. identify, compare and evaluate cycles.

Background
For students to understand the importance of recycling, they must understand a cycle. A cycle may go through many phases, yet it always arrives back at the point of origin. This is important to living organisms because it allows them to be subjected to changes and still maintain stability. Cycles are also important because they enable us to build upon the past. (What would life be like if each day were completely different?) It is through this repetition that we are able to learn and accomplish as much as we do.

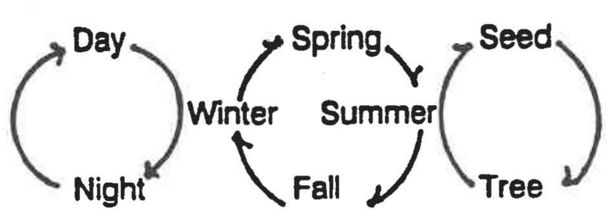
Some cycles are endless while other cycles are limited by one or more of their components.

Materials
- Approximately twenty-five 3" x 5" note cards for the game.

Procedure
1. Write out on the board the following life cycle:

   (birth) -- Baby
   Adult

Explain to the students how life is able to go through these changes yet remain stable. New life is stable because it is patterned after the old.
2. Have the students draw a cycle of a typical day at school, then a typical week.
3. Write out on the board some endless cycles and ask them to add to the list.



4. Write the following cycle on the board and ask the students whether or not this cycle is endless.

Drill For Oil

Consume Oil

(Oil is a nonrenewable resource therefore this cycle cannot go on forever.)

5. Ask the students to define a nonrenewable resource. A nonrenewable resource is one in which the length of time necessary for formation is very long, such as petroleum. Have the students list nonrenewable resources as you write them on the board.

6. Which of the two examples below is a cycle?

Mine Aluminum	Mine Aluminum
Make Cans	Make Cans
Consume	Consume
Wastebasket	Return Cans to Manufacturer
(Non-cycle)	(Cycle)

Have the students draw in the arrows. Ask them where the cans in "A" end up. (In the landfill) Ask them where the cans in "B" end up. (Making new cans) Explain to the students that taking cans back forms a cycle. This is why it is called recycling. Ask the students to list some reasons for recycling. (Saves nonrenewable resources, saves energy, saves landfill space, curtails littering)

7. The Cycle Game: The Cycle Game is designed to help the student to better understand cycles, with emphasis on recycling. Write the following items (and any others you can think of) on the 3" x 5" cards, one per card and stack them face down.

tin can	aluminum
car	food
metals	minerals
book	glass
paper	rubber
wool sweater	building
rain	petroleum (oil)
pets	bus route
newspaper	crop
plastic	tree
flower	mountain
seasons	milk carton

Write CREATIVE CARD on one card and put it in the stack. Use of the CREATIVE CARD is explained later.

Break the students up into groups of four. Either the teacher or one of the students can keep score.

To begin, one student selects a card. After the card is read, the student has 30 seconds to write down as many steps of the cycle as he or she can. The steps must be in the proper order. They can either work alone or as a group.

The group scores one point for every step of a cycle. To score, the cycle must contain a minimum of 3 steps.

One point is granted if the student or group can tell whether the cycle is for a nonrenewable or a renewable resource.

The student or group that selects the CREATIVE CARD will be able to select any resource he or she desires to develop the cycle. These will be worth 2 points per step. The game can continue until all the cards are gone or until a pre-set time has been reached.

The team with the most points WINS!

Questions

1. What is a cycle?

2. What is a nonrenewable natural resource? List three nonrenewable resources.

3. How does recycling help to conserve nonrenewable natural resources? List two nonrenewable resources.

4. Ask the students what would happen if there were no cycles in school. Ask the students what would happen if each day or week were completely different? (If you could not build on the past, would very much be accomplished?).

Bibliography

Additional Ideas

SAVE! SORT! RECYCLE!

+++++++++++++++++++++++
GRADES:K-3

CLASS: Science, Art, Citizenship

TIME: 30 minutes

EMPHASIS: Recycling
+++++++++++++++++++++++

Objective(s)
The student will recognize the different types of materials that CAN be recycled.

Background
The following categories CAN be used to separate material for recycling.

Compost
Paper
Plastic
Metals
Glass
Old Clothes

You may not have a recycling center in your town that accepts these various materials. In this case the children should be made familiar with what CAN be recycled and the reasons for recycling. If there is a center, you may want to start recycling in your class. Consider starting a school recycling program if the classroom project is successful. Students can start recycling in the community by involving their parents. **Remember, be sure you have suitable markets and you know how they want to receive the recyclables before you start any recycling program.**

Materials
- Clip art from Appendix C
- Scissors
- Glue
- Poster paper

Procedure
1. Copy the clip art of the various types of recyclables found in Appendix C.
2. Reproduce the CAN MAN and the empty word cloud. There should be six on a sheet.
3. Write the six types of recyclables on the chalkboard or on a large poster board. The six types are listed in the background section above.
4. Ask the students to write these words into each of the six CAN MAN drawings. Cut out the drawings and place them on the piece of poster board.
5. Ask the students to cut out each of the six materials and match them to his or her CAN MAN.
6. Display the posters around the room when they are complete.

Questions

1. How many different types of recyclable materials did you cut out?
2. Where CAN we take them?
3. What if we do not have a place to take them for recycling, where do they wind up?
4. What is the CAN MAN saying to you?
5. What is recycling?
6. Do you through recyclable material away in this schools?

Bibliography

Adapted from: U.S. Environmental Protection Agency. 1990. *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness.* Revised Edition EPA/530-SW-90-005.

Additional Ideas

☞ Expand on this activity by putting on a play in the class room. Use the CAN MAN as your theme. After the students write the play on recycling, perform it for the parents at an appropriate time. An appropriate time may be EARTH DAY (April 22). This would be especially helpful in a community where there is no recycling program.

☞ Plan a visit to the local landfill. If this is not possible ask the students to have their parents take them to the landfill when they go.

BUG-A-BOO!

+ +

GRADES: K-6

CLASS: Science, Citizenship, Health

TIME: 20 minutes

EMPHASIS: Litter problems

+ +

Objective(s)
The student will recognize any litter problems in school and around their neighborhood, community, and South Dakota.

Background
Many students are unaware of the litter that can be created because of the lack of concern for their environment. Litter made up of plastic and glass last a long time. This litter can be harmful to the environment. Broken glass can injure animals. Plastic rings can catch on an animal's causing them strangle. Bottles can act as a trap for small animals causing them to die inside the bottle.

Litter is a resource out of place and should be recycled rather than be strewn along our streets, in our schools or neighborhoods.

Materials
None

Procedure
1. Take the children on a litter hunt in the school, around the school grounds and in the neighborhood.
2. Have the children look for signs of litter on their way to and from school.
3. Have the children look for litter while taking a trip with their parents. Trips can be to the grocery store, the movie, the shopping center or a vacation break.

Questions
1. What was the most common type of litter?
2. Where did you find most of the litter?
3. Do you know what a litterbug is?
4. Is the CAN MAN a litterbug?
5. What are the different ways we can be litterbugs?
6. What can we do about stopping litterbugs?
7. What are some of the reasons we should not litter?

Bibliography

Adapted from: U.S. Environmental Protection Agency. 1990. *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness.* Revised Edition EPA/530-SW-90-005.

Additional Ideas

You may want the students to think of some songs to sing in music to encourage proper disposal of wastes. The music instructor may have some ideas of tunes for a starter such as "Make haste, Reduce Waste - Being a Litterbug is not in good taste."

AN APPLE A DAY!!

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GRADES: 4 to 8

CLASS: Math, Science, Geography

TIME: 30 minutes

EMPHASIS: Production and Disposal

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Objective(s)

The student will:

1. locate where the majority of apples sold in South Dakota grocery are obtained,
2. describe how apples are produced; i.e. irrigation is needed,
3. list methods of transporting produce,
4. recognize use of the apple core for compost,
5. recognize composting reduces waste going to a wastewater plant and
6. make the students aware of his or her actions and that waste disposal should be thought of in terms of the total picture.

Background

The majority of apples found in the grocery stores of South Dakota come from the state of Washington. These apples are produced in the Yakima River Valley. This river originate on the east side of the Cascade mountains. It drains into the Columbia River. The apple production is successful due to the climate of the area. The climate consists of warm days and cool nights. The limiting growth factor is rainfall. The valley receives only 10-12 inches of precipitation during the year. The apple orchards are intensively irrigated with Yakima River water. The water in the Yakima River comes from snow melt that is stored in reservoirs and released throughout the year. The Yakima is known as a glacial stream as it originates from the glaciers in the Cascade mountains.

Consumption of apples occurs throughout the year. The apples are stored in buildings that have fresh air flushed through them. Sometimes carbon dioxide gas is used in place of air. The fresh air and carbon dioxide gas reduce the apples ripening until they are ready to be shipped.

Most people discard their apple cores in the garbage or down the garbage disposal. This is an example of a resource out of place. The apple core can be composted. Use of the garbage disposal is an example of creating a solid waste that must be treated by the wastewater system. Garbage disposals cause extra treatment that would not be necessary if the cores were composted. Wastewater plants could smaller if fewer garbage disposals were used. There also would be less water and energy used.

Materials

- Map of the U.S. & state of Washington
- 1 small scale
- 1 apple per student
- paper
- pencil

Procedure

1. Pass out one apple per student.
2. Have the students eat the apples.
3. The students should weigh the cores.
4. The students should record the weight of the core in grams.
5. Next have the students list the weight of the cores in the class on the chalkboard.
6. The students should then calculate the average weight of the cores.
7. Use the actual weight of the apple cores in the class. Determine how much waste will go to the wastewater treatment plant.
8. Use the average weight of the classroom apple cores to determine the waste generated by the persons in the community. To work with percentages have the students calculate the number of persons more than five years of age consuming the apples. For your community you may want to assume under the age of five population to be 7%. The students should calculate the total amount of grams or kilograms that will be going to the treatment plant for the entire community.

Questions

1. What is the weight of your apple core?
2. What is the average weight of an apple core for this class?
3. How many persons are in the community?
4. What is the total amount of waste that is generated by the community just from apple cores?
5. Assume the community has 7% of the population under 5 years old. Assume most children do not consume apples under the age of 5 years. What is the total waste generated by the community?
6. What is the weight of the apple cores in pounds?
7. Where do most of our apples come from that our grocery stores sell?
8. What can you tell me about the climate in that state and specifically where the apples are produced.
9. How can we have apples year around to eat?
10. What is the alternative to throwing away the cores?
11. What is the problem with sending the material to the waste treatment plant?

Bibliography

Additional Ideas

☞ This exercise can lead to a special study on the needs for treatment of our wastewater. The extra suspended solid can be deleterious to aquatic organisms if not treated and held within certain limits. The Water Quality Module 7 is a possible experiment the students can run to test the outcome of increased wastes in the water.

INTRODUCING THE CAN MAN

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GRADES: K-3

CLASS: Science, Art

TIME: 20 minutes

EMPHASIS: Positive waste handling

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Objective(s)

The student will recognize the CAN MAN and that he stands for a positive approach to waste management.

Background

The Department of Environment and Natural Resources is concerned with the proper handling of waste and portraying a positive attitude about handling waste. The CAN MAN is the character and theme developed by Nancy Gordon of Pierre, SD. Nancy is an artist working with the Department on portraying positive approaches for children to use in their daily lives. The CAN MAN is to portray the concept that children CAN do something about waste in their schools, homes and communities. Use a positive attitude about waste reduction, recycling and reuse when using the CAN MAN. Encourage the children to take at least one step at home or in school to reduce their waste. Challenge them to stop and think about what they are buying or discarding.

Materials

- Clip art of the CAN MAN from Appendix C.

Procedure

1. Photocopy one of the CAN MAN Clip Art illustrations from Appendix C and distribute to the class. Have the children react to the picture.
2. After you have distributed the picture, go over the questions listed below. Help the children understand the CAN MAN is a fictional character. The CAN MAN is very positive (CAN rather than CANNOT) about reducing, recycling and reusing waste. Tell the children they will see the CAN MAN throughout their solid waste activities. They should pay close attention to his positive activities.

Questions

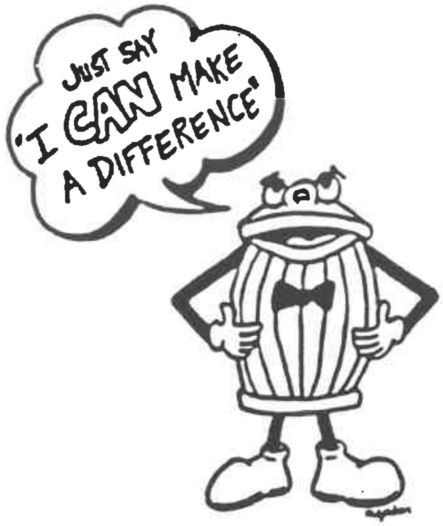
1. What do you see in the picture?
2. What do you notice about the character?
3. The character is called the CAN MAN - why do you suppose he is named this?
4. What can you do?

Bibliography

Adapted from: U.S. Environmental Protection Agency. 1990. *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness*. Revised Edition EPA/530-SW-90-005.

Additional Ideas

☛ Have the children color the picture. Then encourage them to draw their own garbage character. You may want to construct a bulletin board display from their drawings and of their CAN MAN they colored.



WHAT? A DUMP?

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GRADES: 5 - 8

CLASS: Science

TIME: One period to construct the landfill and dump. Five minutes every other day to observe the two.

EMPHASIS: Landfills vs. Dumps

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Objective(s)

The student will:

1. examine the difference between a properly constructed landfill and a dump,
2. predict that both surface and ground water can be polluted by improper waste disposal and
3. observe that garbage does not decompose in a landfill.

Background

South Dakota still has open dumps that may not protect the environment from the trash deposited in them. Open dump is a term used for a poorly constructed facility that is usually an un-lined pit dug in the ground and not covered daily. This means rainwater can run through the garbage and pollute both surface and ground water. Garbage decomposes in an open dump and produces a liquid called leachate.

Modern sanitary landfills prevent waste from polluting or contaminating the land around them. Waste is covered with soil daily. The soil cover prevents water from entering the landfill. Covering also prevents rodents from inhabiting the area and to keeps litter from blowing to adjacent land.

Modern landfills control liquid, or leachate. The leachate accumulates at the bottom of the fill and eventually leaks into the environment. To prevent leaching out the bottom of the landfill a liner is placed at the bottom of the fill. A collection system is installed to collect any leachate that forms.

Many environmental problems associated with dumps have been eliminated with the newly designed and constructed landfills. Landfills will continue to be the major form of disposal for many years to come. Little decomposition occurs in a covered and well operated landfill, thus producing little leachate.

In the mini-dump, over time, you can expect the food to rot and smell slightly. The newspaper will start to break down. Paper wrappers will decompose as well, but plastic will not. The metal barrette or paper clip will gradually rust and nothing will happen to the plastic or aluminum foil. Very little decomposition should take place in the mini-landfill and it should not smell.

Materials

- 1-gallon plastic milk or water jug
- soil

- Organic and inorganic items:
  - metal barrette or paper clip
  - piece of plastic
  - piece of aluminum
  - piece of newspaper
  - a candy or gum wrapper
  - a piece of food (apple, orange skin)

Procedure

1. In partners, have the children construct a mini-landfill and a mini-dump and compare the two over several weeks. You may wish to have the partners construct the mini-landfill and one partnership build a mini-dump for the class because of the decomposition and resulting smell.

2. To construct the landfill have the children cut three-quarters of the way around the top of a 1-gallon jug.

3. Place a layer of soil on the bottom of the container. Alternate layers of materials and soil. The final or top layer should be soil.

4. Sprinkle with water, then with masking tape replace the top and put on the lid for the jug. Open the lid and sprinkle water on the landfill approximately every other day.

5. To construct the dump, fill a second plastic jug wit soil and place the variety of inorganic and organic material on top. Sprinkle with water periodically and leave uncovered.

6. Have the children list all the materials they placed into their dumps and landfills and keep separate charts monitoring the changes in both.

7. Discuss the differences between what happened in the dump and in the landfill at the end of the experiment.

Questions

1. Can you think of any problems that might result from disposing of garbage in an open dump?

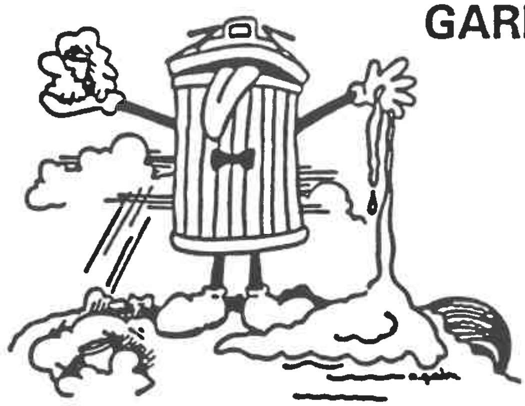
Bibliography

Adapted from: U.S. Environmental Protection Agency. 1990. *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness*. Revised Edition EPA/530-SW-90-005.

Additional Ideas

The water quality activity PERC-O-LATE may work well, especially for a data charting exercise.

GARBAGE SOUP!



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GRADES: 4 - 8

CLASS: Science

TIME: 30 minutes

EMPHASIS: Ground Water Pollution

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Objective(s)

The student will observe the pollution of water from discarded material (garbage).

Background

Rain water can get into a landfill that is not covered with soil at the end of each day. This water will percolate through the garbage. The resulting liquid is a mixture of many different materials. These soluble materials can produce odors and taste. Some are toxic and render ground water useless. Most liquid formed by this percolation is usually a dark and smelly substance that is visually very displeasing.

The liquid may accumulate in the bottom of the landfill. This accumulated liquid may percolate out of the bottom of the landfill. The liquid that percolates is called leachate. The leachate may reach the ground or surface water many years later.

A build up of methane may occur in a landfill or dump that is not properly operated. This methane can migrate and get into homes. Methane is highly explosive and may cause damage if a spark ignites this gas!

Materials

- 1 large clear bowl per pair of students
- various types of garbage such as:
    - shredded paper
    - food scraps
    - small tin can
    - cold coffee or another dark liquid

Procedure

1. The students should place the materials in the bowl one at a time and add a little water with it.
2. Observe what happens after each addition.

Questions

1. What happened in your bowl?
2. What would happen if this were your landfill or town dump?
3. Where could the water go if the bottom of the bowl (dump) were sand or porous soil?
4. Where do we get our water supply?
5. Do you suppose this could get to our streams?
6. Is there a way to prevent this garbage soup?
7. Is there an alternative to disposal for the material you placed in the bowl?

Bibliography
Adapted from: U.S. Environmental Protection Agency. 1990. *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness*. Revised Edition EPA/530-SW-90-005.

Additional Ideas
☛ Use the Water Quality activity, PERC-O-LATE, to enhance the student's understanding of water percolation.

THROW AWAY! WHO, ME?

+++++++++++++++++++++++

GRADES: 6 - 8

CLASS: Science, Social Studies, Math

TIME: 30 minutes

EMPHASIS: Population and solid waste

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Objective(s)
The student will:

1. recognize the enormous amount of resources Americans throw away,
2. demonstrate exponential growth of populations and
3. practice the use of statistics.

Background
Every two (2) weeks we throw away enough bottles and jars to fill the 1,350-foot twin towers of New York's World Trade Center. We throw away 31.6 million tons of yard waste each year.
With the aluminum we throw away in three (3) months, the United States could rebuild its entire commercial airfleet. We throw away 2.5 million plastic bottles every hour (22 billion plastic bottles a year). We could build a 12-foot high wall from Los Angeles to New York City with the office paper we throw away every year. We throw away more than 200 million tires every year (one for every person in the United States).

This exercise illustrates that an ever increasing population creates more waste. It also illustrates crowded cities have limited space and the amount of waste pollution increases each year.

Materials
- Chalk
- A waste item from each student
- Graph paper

Procedure
1. Draw a square on the floor with chalk, approximately five (5) feet by five (5) feet. This square also might be delineated by grouping chairs to form the perimeters.
2. Ask one student to step inside the square. They should be holding one piece of solid waste, scrap paper or any other discard for the day.
3. Tell the student that she/he cannot leave the square.
4. Ask another student of the opposite sex to step in (with their discard item), representing a couple.
5. Ask two additional students (male and female) to step into the square and tell the class. Again have then hold their discard item.
6. Have four additional students (with their discard items) step into the square with the others. Tell the class these are the offspring of the first two couples.
7. Now ask four more students to step into the square with their discard items.

Tell the students this will be the mates to the four offspring who previously entered the square.

NOTE: The number of the children will go up very quickly (exponential growth), yet the square remains constant. As the square grows more crowded, obvious reactions will be observed, especially pushing, restlessness, and aggressive behavior.

Questions

1. How will they be able to get anyone out of the square?

2. Ask the children to leave the square one at a time and to drop their waste. What has happened?

Bibliography

Adapted from: U.S. Environmental Protection Agency. 1990 *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness.* Revised Edition EPA/530-SW-90-005.

Additional Ideas

☞ The exercise above lends itself well to demonstrating the facts statistics (note the background discussion) can bring out. Expanded this activity by encouraging the students to contact their local utilities to find out how much water is used. They can find out how much waste is produced. They can equate how many births or deaths there have been in the last year to waste production.

☞ The math portion of this exercise is most useful for graphing the population growth. Have the students record the community, state, U.S. and the world population census for the past one hundred years. Graph the population figures they have compiled. In social studies point out the shifting populations in the U.S. Relate this to social problems faced in areas of our country.

MAKING YOUR OWN RECYCLED PAPER

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GRADES: 3 - 6

CLASS: Art, Social Studies, Science

TIME: Two 40-minute periods

EMPHASIS: Learning a manufacturing process, Recycling

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Objective(s)
The student will:

1. examine a common manufacturing process and
2. make old paper into new, usable paper.

Background
Paper cannot be recycled indefinitely, because the fibers break down eventually. However, many grades of paper can be de-inked, cleaned and bleached. Paper processed as such can then be reused as gameboards, tissue papers, ticket stubs, packaging, covers for hardcover books, insulation and bedding.

The most discarded items in our solid waste stream are paper and paperboard. Franklin and Associates (1988) estimated that in 1970 we discarded approximately 43 million tons of paper and paperboard. This increased to nearly 65 million tons in 1988 and is projected for more than 80 million tons by the year 2000. These figures are before any material or energy recovery.
The recycling of paper is increasing as the paper industry is constructing more pulp and de-inking plants.

Materials
- Blender or egg beater and wide-mouthed container
- Pans
- Large mixing spoons
- Screens, preferably framed so it will fit over 1/2 of the pan
- Cups to scoop pulp onto screens
- Blotters
- Dishwashing detergent
- Sponges or towels for soaking up water
- Scrap paper to recycle
- Warm water
- A place to dry the paper
- Iron (to help dry the paper)
- Optional: spices, dried flowers, herbs, vanilla

Procedure
Also refer to diagrams.

1. Tear used paper into small strips, about one-inch square. Loosely pack into blender until 1/3 to 1/2 full. Add warm water until the blender is 2/3 full. (If you do not have a blender, use a bowl and an eggbeater. This will take more time and patience.)

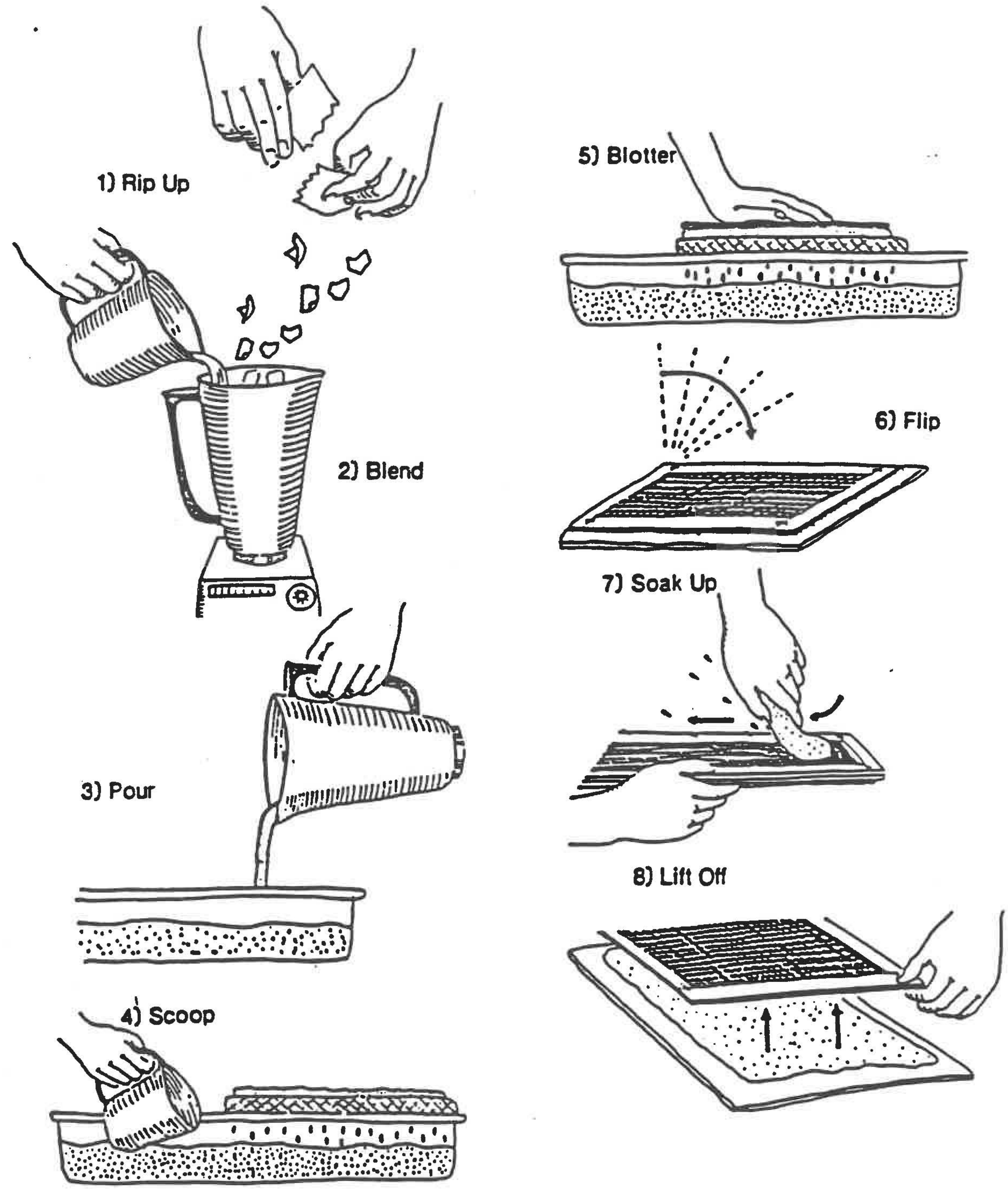
2.Blend until the paper looks like oatmeal mush. To make colored paper add construction paper scraps.
3. Pour the pulp into the pan. When pulp is mush consistency, add about 1/2 inch of water for every blender (bowl) full of pulp. Add water depending on the thickness of paper desired.
4. Scoop the pulp mixture onto the screen with a cup (place the screen over 1/2 of the pan). Students may want to add colors, paper bits, spices, or glitter to the pulp. They can add it to their cupful. Let the pulp drain.
4A. An alternative to this step is to have a screen that will fit into the pan. Slide the screen into the bottom of the pan and move it around until it is evenly covered with pulp. Then lift the screen out carefully, hold it over the pan for a minute or so to drain.
5. Place a piece of blotter over the wet recycled paper on the screen. Flip the screen over onto a piece of newspaper so the recycled paper is now between the blotter and the screen. The screen is on top. (See drawings)
6. Soak up the extra water with a sponge. This water may be reused in the pulp mixture for your next batch.
7. Lift off the screen and place the new paper in a place where it can safely dry. Exchange blotter and dry paper towels every few hours if you want the new paper to dry more quickly. The paper should not be touched or unnecessarily disturbed while drying. You may iron the paper to speed up the drying process. (Place a sheet of paper between the new paper and the iron.)
8. After the paper is completely dry, use it for art or writing lessons.

Questions
1. What natural resources are conserved when paper is recycled?
2. What kinds of paper can be recycled?
3. How should you separate paper to take to a recycling center?
4. How is this paper different from normal drawing or writing paper?

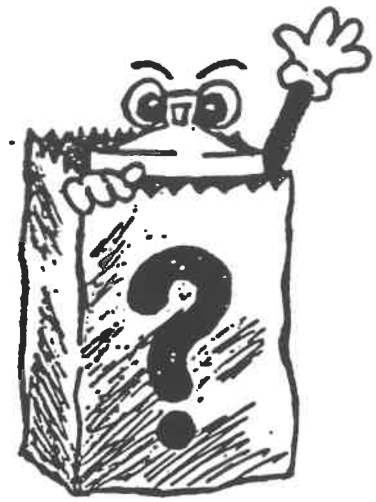
Bibliography
Adapted from: Washington State Department of Ecology. 1990. *A-Way With Waste.* Pages 189-191.
Adapted from: U.S. Environmental Protection Agency. 1990. *Let's Reduce and Recycle: Curriculum for Solid Waste Awareness.* Revised Edition EPA/530-SW-90-005.

Additional Ideas
☞ Invite a paper recycling vendor in to visit with the class. Check the South Dakota Recycling Directory for the resource person nearest you.
☞ Have the students contact the American Paper Institute listed in the Trade Association section of the South Dakota Recycling Directory.

PAPER MAKING ILLUSTRATIONS (From *A-Way With Waste.*)



WHAT'S IN THE SACK



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GRADES: K to 12

CLASS: Social Science, Science, Consumer Awareness

TIME: 20 Minutes

EMPHASIS: Waste Reduction

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Objective(s)

The student will:

1. use observation skills.
2. use written skills.
3. recognize different packaging methods and discuss the affect on the environment.

Background

In science, both observation and written skills are important. This lesson provides a short introduction to practice these skills.

Materials

- Paper bag containing 2 items:
  1) bottle with scent
  2) any packaged item
- Paper and pencil

Procedure

1. The students will break into groups of two, designate a recorder and be given a paper and pencil.
2. The students will be given a bag which is to remain closed.
3. The students will record what they observe through touching the bag.
4. The students will open their bags and record visually what they observe.
5. The students will be asked to compare first and second observations. Students will note differences, similarities and if observations are more detailed.
6. The students will be asked to open their bottles for further observation. What's something you didn't notice earlier? (scent)
7. Discuss packaging.

Questions

1. Is packaging necessary? Why?
2. Does the package have the chasing arrow symbol anywhere?
3. What do the chasing arrows mean?
4. Do you think the packaging of the item increased the cost of it?
5. Is there any other way of selling the product?

Bibliography

Additional Ideas

GARBAGE PIE?

Paper & Paperboard	40%
Yard Waste	17.6%
Food Wastes	7.3%
Plastics	8.0%
Metals	8.5%
Glass	7.0%
Other	11.6%

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GRADES: 6 - 8

CLASS: Math, Science

TIME: 50 minute period

EMPHASIS: Waste Volumes

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Objective(s)

Students will graph the percentages of solid waste generated in the form of pie and bar graphs.

Background

Pie (circle) and bar graphs are many times used to display data in a visual form to simplify findings from a study. The making of a pie graph is relatively simple. To make the pie chart take the degrees in a circle, 360°, and multiply it times each of the percentages from the data collection. The product from each multiplication will determine the degrees for each piece of the pie. Use a protractor to draw in each of the degrees until the pie chart is completed.

Materials

- Protractor
- Pencil
- Computer
- Spreadsheet software
- Paper for data records (tabular form)
- Graph paper

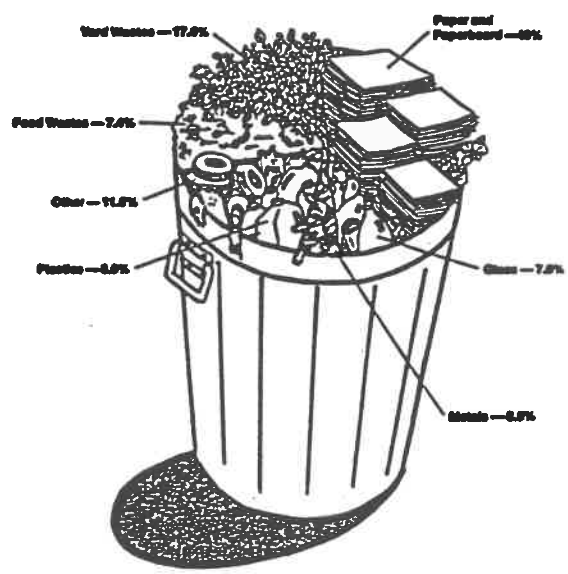
Procedure

1. Supply the students with the data to the left depicting the amount of solid waste generated by category. Each category is depicted as a percentage.
2. Discuss the different percentages of solid waste. This will prepare the students for a school and community survey.
3. Ask the students to graph the percentages neatly in the form of a pie (circle) graph and a bar graph.
4. The class should subsequently determine what types of trash are generated by their a) class and b) the school. These data can be stored in a computer and then graphed using the pie chart or the bar graph from the spreadsheet software available at the school.

Questions

1. Which graph best depicts the results of the data?
2. Which graph best depicts the finding from the classroom? school?
3. Do you suppose the same amount and types of waste are generated by different schools? communities?

Materials Discarded into the Municipal Waste Stream*



*Numbers do not add up to 100% due to rounding.

Bibliography

Additional Ideas

Composting

COMPOSTING BACKGROUND

Composting is nature recycling at its most basic level. Do you remember what the law of conservation of mass-energy states? It says the total amount of matter and energy in the world remains constant. It is neither created nor destroyed. It is only changed to another form. Composting is nature's way of changing form. Leaves, grass clippings, banana peels, egg shells, and other organic wastes, changing from complex structures into their essential elements. Let's look at the life cycle of a tree to see how this works.

It starts with a seed lying in the soil. As moisture swells the seed coat, the seed sprouts and begins to grow utilizing the energy reserves stored in the seed itself. As the seed grows it sends roots into the soil to absorb nutrients and water and sends leaves up and out to absorb carbon dioxide and sunlight. The roots of the plant take up nitrogen, phosphorus, potassium, and other elements from the soil. These elements are the building blocks that follow the plant's blue prints, DNA. DNA controls the synthesis. As the elements combine and the cells divide, the tree grows. As the tree becomes larger, more water and nutrients are taken up by the roots. These nutrients are stored in the plant's cells.

Envision how the tree looks after several years. It is very tall and sturdy. What is it in finer analysis? It is a structure made out of carbon, hydrogen, oxygen, nitrogen, and phosphorus. Before being part of the tree, these elements were in the ground and in the air. The genetic material, DNA, in the tree arranged them to make a tree. Now let's look at how this applies to composting.

A leaf falls. Several thousand leaves fall to the ground. The ground is now covered with a thick mat of leaves. A handful of this healthy soil has millions and millions of bacteria living in it. Many of these bacteria leave the soil and migrate to the leaves.

If the conditions are favorable; i.e. moderate temperatures, plenty of free oxygen, and proper moisture, the bacteria will secrete enzymes. The enzymes break down the leaves. The bacteria will take up the nitrogen, phosphorus, potassium, and other nutrients. They will use the nutrients to grow rapidly and multiply, while releasing other nutrients to the soil. The more bacteria, the more enzymes they secrete and the more the leaves are broken down.

When the leaves are fully decomposed and there are no more nutrients to be taken up, these natural composters die. When they die, additional nutrients are released to the soil. They are in a form that is available to plants. The cycle starts over.

Composting bacteria grow and replicate when their environment is suitable. As you will soon see, not all composting bacteria are the same, nor are their needs the same. Therefore, we can alter the environment to facilitate the growth of the desirable bacteria. Composting bacteria are influenced by such environmental factors as temperature, moisture, pH, nutrients, and the amount of available oxygen.

Composting can be accomplished with either aerobic or anaerobic bacteria. Both have their advantages, but the aerobic bacteria are more desirable. The temperatures involved in aerobic composting are high. It is the high temperatures that will destroy weed seeds, insect larvae, and problem microorganisms. Aerobic bacteria also work quickly and do not give off any unpleasant odors. Make sure your compost heap has enough oxygen to keep it aerobic. Turning your compost heap occasionally will keep the oxygen level up.

To keep the aerobic bacteria in your compost pile alive, you must make certain they have an ample supply of oxygen. Build the pile loosely to ensure enough space between materials to get a flow of air through the heap. This must be followed by regular turnings. As the organic matter is broken down, some settling will occur and it will compact the heap. If there are strong odors of rotten eggs, it is time to turn the heap. The bad smell is caused by anaerobic activity. Regular turnings keep the aerobes thriving and you will have compost much more quickly. The smell is earthy.

Moisture is another important factor in keeping the compost healthy. Keep the moisture like a damp sponge or towel. If it is too dry, the compost organisms cannot work. If it is too wet, anaerobic conditions will prevail and some nutrients will be leached from the pile.

The way to achieve the proper moisture content is lightly sprinkling the pile as you build the layers. Certain layers such as dry leaves or sawdust will require water to be added. Other layers such as green grass clippings or kitchen scraps will not. If the pile gets too wet, turn it and add some sawdust or dry leaves.

A healthy compost heap will be neither too acidic nor too alkaline. The pH should be between 6 and 7.5. At this pH the bacteria and fungi in the pile will do quite well. Most common plants will do well in soil that is slightly acidic to neutral (pH of 6.5 to 7). This is not too difficult to achieve. Kitchen scraps, sawdust and oak leaves are all slightly acidic. A light sprinkling of limestone or wood ash will help to neutralize the pile and is recommended.

Another critical factor of your compost pile is its temperature. As the microorganisms live and work in the heap they release energy in the form of heat. In a good size pile (3' x 3' x 3' or larger), the temperatures of the interior of the pile will rise quite high. This is caused by of the insulating qualities of the pile itself. This heating is essential for the destruction of weed seeds, and harmful organisms. All the material should be subjected to the intense heat of the center at some time.

Upon turning the pile you will notice a drop in temperature, due to the renewed circulation. This will be temporary, as the activity of the bacteria will increase due to the increase in oxygen. When activity increases the temperature is soon to follow. Turning the pile will keep the temperature high. When the temperature drops, and other conditions are favorable, all material has stabilized. The compost is ready to be used.

We as human beings need a balanced diet, as do the bacteria that inhabit a compost heap. Therefore, the inherent chemical makeup of the compost pile must be considered when it is being prepared. If you supply the compost organisms with the proper nutrients, the compost will eventually supply your plants with the proper nutrients.

Carbon and nitrogen are two very important nutrients in the compost pile.

Composting organisms use carbon as an energy source and nitrogen, essential in protein synthesis, is needed for growth. If there is too little nitrogen in a compost pile, the bacteria will not grow and reproduce in the numbers necessary for rapid decomposition. With a limited supply of nitrogen, all of it will soon be incorporated into the bacteria themselves. Nitrogen will not become available to new bacteria without the death and release of the nitrogen by the existing ones.

This leaves us with the question, "How much of what material do I add to the compost heap?". The answer is not as complicated as it first seems. This will be discussed in more detail in the module concerning the design of a compost heap. The pile should be constructed in layers. The layers should be alternated between wet and dry materials. Add manure and a little topsoil between the layers. For instance, add a 5-6" layer of dry leaves, then a 4" layer of green grass clippings, then a 1-2" layer of manure, then a 1/8" layer of topsoil. Start over and use the same ingredients or add others as kitchen scraps, straw, or sawdust. It is not essential to have such a diverse makeup of the compost, but it does help to ensure the balance of nutrients.

Composting can be a very fulfilling task. Many of the components that go into a compost pile are resources that would normally be sent to a landfill. In a landfill these organics would degrade anaerobically producing methane and hydrogen sulfide gases causing health risks. It will increase the speed with which we fill our landfills. This is not necessary. Composting our organics alleviates these problems. In the end we are left with compost, a fine soil conditioner for all types of soil.

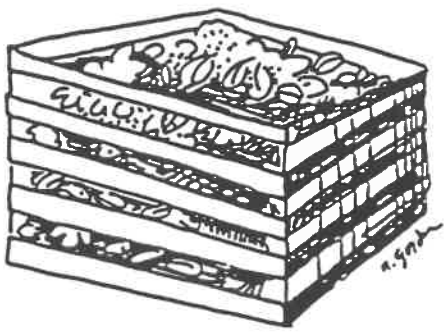
When compost is added to a heavy clay soil it helps loosen the soil. This creates more pore spaces that facilitates the circulation of water and air. Added to sandy soil, compost aids in water retention. Compost retains 900% of its weight in water; sand, only 2% and clay, only 20%.

And as we saw throughout this background, compost also enriches the soil with the nutrients it provides; the recycling of organics. It is more beneficial than commercial fertilizers because it releases a constant supply of nutrients. When a large amount of commercial fertilizer is added to soil it is either leached out of the soil or provides the plants with too much nitrogen. A plant provided with an excess of nitrogen will grow rapidly. The plant will have thin cell walls and an excess of water. Plants such as these are prone to insect infestation. Compost provides a gradual release of nutrients to the soil and in so doing makes for healthier plants.

By aiding in water and air penetration and availability, water retention, and nutrient availability, soil enriched with compost will grow healthier plants with better root systems. Hence, erosion of the soil by water and wind will be decreased.

The benefits of composting, as we have just seen, are many. As a society, we have adopted a short term, disposable mentality. The ramifications of this are long term. We have come to fear bacteria, though we could not live without them. With the modules provided in this section we hope to impress upon the students the importance of organic recycling. We want to show "all that looks like garbage, is not all garbage."

CONSTRUCTION OF A COMPOST BIN



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GRADES: 9 to 12

CLASS: Woodworking, Shop

TIME: Two 45 minute periods

EMPHASIS: Construction of a Compost Bin

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Objective(s)

The student will:

1. illustrate and use a design plan,
2. practice general woodworking and
3. discuss composting and why it is done.

Background

This should be a group project with the woodworking class working with the Biology or Natural Science class. It is a project in which the woodworking class will construct a bin or a series of three bins. The science class will add the compostables and monitor their progress. Compost is the resulting humus of organic decomposition. The aerobic bacteria needed for this type of composting require plenty of oxygen. This is why the slats are an inch apart on the sides; to provide for better air circulation. Compost is also a valuable soil-conditioner. Use compost on the school grounds in flower beds, around the flagpole, on the football field, anywhere there is a need. Composting is an ecologically sound practice. Any organics that are composted represent that much less space required at a landfill.

Materials

WOOD
- Frame
  - two 2" × 2" × 36"
  - two 2" × 2" × 38"
- Sides
  - thirty-two 1" × 4" × 36"
- Furring strips
  - two 1" × 3" × 36"
- Roof
  - one 40" square plywood

HARDWARE
- #3 galvanized nails (1¼")
- #6 galvanized nails (2")
- four hasps (2½")

These are only guidelines. If possible, build it with scrap lumber, keeping the size a **minimum** of 3' × 3' × 3'.

Procedure

1. Treat the lumber with linseed oil.
2. The 38" frame posts are to used for the front of the bin. The 36" posts are to be used for the back.

3. Nail the side slats to the frame posts. Leave a 1" space between slats. Remember to leave ¾" of the slats extending beyond the front (38") frame posts to allow room for the furring strips that hold the front gate together.
4. Nail the rear slats to the 36" frame posts to complete the third side of the bin.
5. Nail the front slats to the furring strips.
6. Attach the hasps to hold the front gate to the frame.
7. The roof should not be nailed to the frame, to allow it to be easily put on or taken off depending on the piles' need for rainfall.

Questions
1. Were there any problems understanding the design plans?
2. What would you change to improve them?
3. What do you put into a compost bin?
4. Why leave 1" spaces between the slats on the sides of the bin?
5. What comes out of a compost bin?
6. Why is this important?

Bibliography
Bem, Robyn. 1978. *Everyone's Guide to Home Composting*.

Additional Ideas

ENRICH YOUR LIFE WITH COMPOST

We through away 31.6 tons of yard waste each year in the U.S.

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GRADES: 9 to 12

CLASS: Science

TIME: Two 45 min. periods, then 15 min. every other week.

EMPHASIS: Composting

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Objective(s)

Tne student will:

1. describe a compost pile,
2. state that bacteria are helpful and we couldn't live without them and
3. list the benefits and importance of composting.

Background

Municipal solid waste has become a serious problem due to the large amounts generated. Much of this (40 to 50%) is organics that could be composted. Composting is a process by which natural decomposition is enhanced and proceeds very rapidly. Bacteria in the soil will migrate into the compost pile and begin changing the complex structures into their essential elements. This is how organics are recycled. Another positive aspect of composting is the resulting compost. Compost is an excellent soil conditioner and fertilizer.

Materials

- Kitchen wastes, only vegetable matter, absolutely no oils or meat products
- Leaves, grass clippings, garden debris
- Top soil
- Manure (can be purchased at a garden center)
- Branches

Procedure

1. Have the woodworking class build a compost bin or series of bins. Construction plans are one of the modules.
2. Place compost bin(s) on level soil.
3. Break up the soil that will be underneath the compost heap.
4. Lay out a mat of branches on the soil. There should be at least 2" to insure proper circulation.
5. Cover the branches with a 5"-6" layer of dry material, such as leaves or hay.
6. Cover the dry material with a layer of wet material such as grass clippings or kitchen wastes.
7. Cover this with a 2" layer of manure to ensure an adequate supply of nitrogen.
8. Cover this with a light layer (⅛") of rich top soil to provide bacteria and fungus.

9. Moisten (not saturate) the layers as you go.
10. Continue layering and alternating materials until the pile is 3'-5' tall.
11. Cover the pile with a layer of topsoil and finally some straw or hay for insulation (insulation is optional).
12. Form a shallow basin on top to catch rainfall.
13. Turn heap once every 1 or 2 weeks for about 2 months. If after turning you do not notice a significant rise in temperature, and all conditions are favorable, the compost is finished. This will probably take from 2 to 3 months or it could be longer if the compost is not turned as often.

Questions
1. Why is the compost bin constructed the way it is?
2. What does the manure supply?
3. What does the top soil provide?
4. What do the leaves, kitchen wastes, and grass clippings supply?
5. What are the benefits of composting?
6. What would happen if you chopped up the materials into smaller particles?

Bibliography
Bem, Robyn. 1978. *Everyone's Guide to Home Composting.*

Additional Ideas
☞ The more diverse the materials in your compost pile, the greater the variety of nutrients in the finished product.

☞If the materials are chopped up before going into the pile, they will compost faster because of the increased surface area.

☞ Items that are readily compostable:

- ◇ kitchen scraps (banana peels, egg shells, citrus rinds, coffee grounds, etc.)
- ⊗ absolutely no oils or meat products
- ◇ ground up corn cobs
- ◇ weeds
- ◇ straw
- ◇ sawdust
- ◇ wood ash
- ◇ limestone
- ◇ phosphate rock
- ◇ hair

☞ A Carbon:Nitrogen ratio of 25:1 to 35:1 is best. Use the following table of C:N ratios, adapted from Robyn Bems' *Everyone's Guide to Home Composting*, to help build your compost heap.

▫ Food wastes (table scraps)	15:1
▫ Sawdust	500:1
▫ Paper	170:1
▫ Grass clippings	19:1
▫ Leaves	a range of 80:1 to 40:1
▫ Fruit wastes	35:1
▫ Rotted manure	20:1
▫ Corn stalks	60:1
▫ Straw	80:1
▫ Alfalfa hay	12:1

HAVE YOU CHECKED YOUR COMPOST LATELY?

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GRADES: 9 to 12

CLASS: Science

TIME: 20 minutes initially, 1 to 2 minutes daily thereafter.

EMPHASIS: Monitoring the temperature of a compost pile.
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Objective(s)
The student will:
1. measure the temperature of a compost pile,
2. graph data,
3. interpret the trends from the graphs and
4. explain how hypotheses are formulated from trends.

Background
The temperature within a compost pile fluctuates. Soon after a compost pile is constructed, microbial activity increases and with this increase comes an increase in temperature. Temperatures will become too high for some bacteria and they will become inactive, die or enter a spore stage. For other bacteria these high temperatures are necessary for metabolism. These high temperatures are necessary to destroy any weed seeds, insect larvae, or harmful organisms that may exist in the compost pile.

The pile should be turned after a maximum temperature has been maintained for a few days or if the temperature begins to fall. After turning, the temperature of the pile will drop because of the aeration. Within a couple of days the temperature will be on its way back up. This will occur each time the pile is turned. If there is no increase in temperature, and all other conditions are favorable, then the composting process is complete. The finished compost is ready to be used.

Materials

- A thermometer with a range of 15°C (59°F) to 75°C (167°F)
- A wooden dowel to which the thermometer can be mounted.
- Graph paper

Procedure

1. Tape the thermometer to the wooden dowel to protect it from breaking.
2. Insert the stick and thermometer into the compost pile, making sure it is near the center.
3. Take a temperature reading daily.
4. Graph the temperatures vs. days on graph paper.
5. Discuss the results.

Questions

1. What causes the temperature to rise in a compost pile?
2. Why does the temperature fall when the compost pile is turned?
3. How does the graph help us?
4. Does the graph help us to make predictions?
5. What form does a hypothesis have?

Bibliography

Additional Ideas

Integrated Studies

Integrated Studies Introduction

In the fall of 1993 the Department teamed with Capital University Center to initiate a Project SAVE integrated studies program at the middle school level with Sully Buttes and Stanley County Schools. The program was funded in part by a South Dakota National Science Foundation Systemic Initiative grant. Involved with the program were the language arts, social studies, math and science teachers from both schools.

The first integrated curricular study occurred in the language arts classes at both schools. Students were assigned a reading and writing exercise to obtain information on solar energy and "clean energy." After they had obtained the information the students were asked to model solar cell electron flow based upon reading a description sheet supplied by the Project SAVE staff in the language arts classroom. Each team of students was to come up with a model and orally report on what they had designed to other members of their class. After the oral report they were asked to explore the use of solar cells with simple devices such as solar fans. The exercise concluded with students writing a paper about energy use in their community.

Success of the solar unit in the language arts classroom is dependent upon getting information ahead of time and allowing the students the freedom to explore. The most difficult part of such an exercise is the unfamiliar grounds of bringing a hands on science experience into a non-science class.

Other activities were conducted in the science and math classrooms dealing with environmental issues. The activities conducted were community water testing, use of math in garbage graphing exercises and ground water flow modeling. Students were given the opportunity to use computers and other technology.

The major cross curricular program is the SAVE Our Community activity. This activity is designed to take place over a two to three week period leading up to Earth Day which is always on April 22nd.

Both schools planned and conducted some type of program around the major themes of the cross curricular approach to science and math. These themes were past, present and future environmental issues revolving around people, business and industry, transportation and studying or designing the plant Earth. The Sully Buttes teachers combined their students efforts into a culminating event called Earth Day Expo.

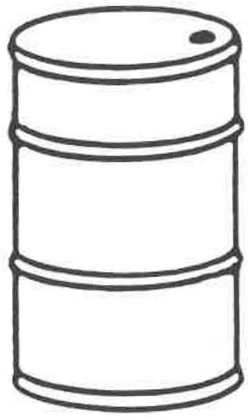
The activity conducted by the schools, especially Sully Buttes, was a smashing success. The activity outline in this section does not do justice to all the work and learning that took place leading up to Earth Day. If you chose to do this exercise then plan on high energy and involvement by the students.

We recommend you try this activity as it has many side benefits such as cooperative learning, using computers and calculators, developing oral and written communication skills, interacting with community businesses and individuals, taking pride in one's community, using journals and portfolios as assessment tools and most of all making students aware of their environment.

To all the Sully Buttes and Stanley county teachers and students involved in the SAVE Our Community exercise goes a huge THANK YOU!

The other integrated studies included in this section provide Project SAVE users with ideas and activities emphasizing various concepts of pollution prevention, control and abatement and environmental awareness. Case studies are a key component of this section and are meant to stimulate student thought and research. Some exercises have no answer(s) and any conclusions must be based upon arguments or research presented by the activity participants.

THE GREAT DEBATE



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GRADES: 6 - 12

CLASS: Social Studies, Language Arts, Science.

TIME: One week (five [5] class periods)

EMPHASIS: Science, Technology, Society, Decision-Making Processes
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Objective(s)
The students will:

1. examine a decision making process via role playing,
2. demonstrate that questions do not always have right or wrong answers,
3. analyze the pollution controls industry must undertake and
4. recognize the differing values of individuals/organizations.

Background
Have you ever experienced a situation where someone was going to locate a controversial project in your neighborhood? If you have, then you know all about this exercise. You can appreciate the complexity and the exasperation involved.

This exercise lets students experience the process of deciding or at least debating difficult public issues. You can use the scenario with this activity or change it to fit your community.

Many communities and counties in South Dakota do not have planning and zoning rules. The only approval a business needs for siting is a builder's permit. Even with a builder's permit, the local jurisdiction is sometimes in a dilemma.

The following exercise involves siting of a hazardous waste treatment, storage, disposal facility (TSDF). You may want to substitute another example such as a landfill, medical waste incinerator, large livestock operation or a chemical plant. Re-write the roles if you change the facility. Make sure homework is done with your community or county about siting or zoning. Students must thoroughly research each of her or his roles.

Materials
- Scenario and role descriptions
- Community and disposal facility diagrams
- Sample public hearing agenda
- Newspaper and magazine articles from your local area or from areas that have had problem/concerns
- Information packet in Appendix G

Procedure

The class will conduct a simulated public hearing on siting of a hazardous waste facility. The facility includes all phases of handling hazardous waste; that is, treatment, storage and disposal. Treatment can include incineration of the hazardous waste. Disposal includes building a landfill to bury treated and non-treated hazardous waste.

A sample hearing outline is at the end of this activity. It does not include options that could be part of the manufacturing plant operations. Some options for waste handling are:

- waste prevention and reduction in the plants,
- recycling on site or
- setting up a waste exchange program.

These issues face many citizens, communities or counties when recruiting industry.

1. Distribute the scenario and one role description to each member of the class. Different groups should not share the same roles. The purpose is to discuss business siting and waste disposal problems and arrive at solutions. Emphasis should be on possible alternative solutions and not just a single answer.

2. One student should serve as the County Commissioner or the Hearing Officer. Other students should fill the remaining roles. An example would be two journalists. One journalist comes from a community where one manufacturing industry hopes to locate. The other journalist lives in the community where the TSDF wishes to locate. Large classes may have two or three students assigned to one role. Students can work as a team to research the information necessary for the hearing. Not all the roles are necessary, but be sure to include the following roles.

- Spokesperson for the community recruiting the industry
- Spokesperson for the community where the TSDF wishes to locate
- Spokespersons for the Bixby Enterprises and Verona Chemicals
- A TSDF expert spokesperson
- Spokesperson for the concerned citizen group
- Toxicologist hired by the citizens group
- Environmental activist from outside the area
- County Commissioner
- A scientific expert

Other roles are to stimulate debate. Again, include those noted above for best results.

3. You might want to assign the more specific roles to a specific class or to students most interested in those areas. The science class might research the toxicologist and scientist roles.

4. Explain to the class this is not an actual case. Inform the students some communities and cities have rules industry must follow. A TSDF would need to first clear the local processes. The TSDF must meet all state and federal rules.

5. Each student should prepare to play the roles realistically. They should use the information packet in Appendix G. Additional information should come from the library, outside reading, and visitation with business and community leaders.

6. Students should prepare by using the following approach.

- state the problems
- determine a problem for solution
- research and gather expert information
- discuss possible solutions
- select most appropriate solutions
- set up a plan of action

7. Hand out the sample hearing agenda included with this activity. The student assigned as the hearing officer may research and prepare the agenda.

8. The hearing officer shall summarize the hearing. The commission or hearing board members vote on their decision after the summary.

9. Students not satisfied with the hearing ruling shall make arguments for appeal.

10. (Optional) Journalists report the meeting.

Bibliography

Adapted from A-Way With Waste. 1990. Washington State Department of Ecology.

Additional Ideas

☞ Invite speakers such as a lawyer, a hearing board member, business generating hazardous waste, county or city commissioners.

☞ Invite parents to listen to the hearing. If desired, parents can work with students, after the hearing, to appeal the decision.

THE SCENARIO

Two communities in the state have successfully recruited industry. Each industry will create about 150 jobs. Bixby Enterprises is located on the west coast and Verona Chemical on the east coast. The only hitch to the recruitment is both Bixby and Verona generate hazardous waste that is very expensive to transport, treat and dispose. Without a close facility to treat or dispose of their waste they will not move.

Jobs have been slipping away in the central part of the state. A company, Mike's Waste Disposal, Inc., approaches the county and community looking to locate a hazardous waste treatment, storage and disposal facility (TSDF). The facility will produce 50 new jobs and provide a large increase in the county tax base. The county commissioners see a way to help the county and the community through jobs and reducing personal property tax.

The TSDF personnel want to locate their facility along the rail line just outside of town. This location would enable Mike's to take the waste from both industries wanting to move into the state. The rail line will allow the TSDF to import additional waste to make their project possible.

Small industries must now ship their waste out of state. They are faced with increasing regulations and costs of getting rid of their hazardous waste.

The TSDF desired location is in the valley along the river. It is just upstream of a rural housing development and the community.

The people in the area have always been proud of their clean air and water. The area has been an attraction for tourists to hunt, fish and boat. Persons living in the area are concerned about environmental degradation and property devaluation that might result from the TSDF.

A decision must be made soon. Bixby Enterprises and Verona Chemicals are being courted by communities in other states. The TSDF wants a new site and feels this would be the place to locate, but needs to give investors and answer soon!

The County commissioners call a public hearing. They want to let the public be heard before a decision is made whether to approve or deny Mike's Waste Disposal building permit application.

ROLES

Spokesperson, Bixby Enterprises

You are a representative for this small industry that has just started on the west coast. The company manufactures hard discs for the booming microcomputer industry that is replacing lap top computers. Your industry now employs 50 people. The company wants to expand to 150 employees and within the next five years to 300 employees. The company is faced with increased costs for a variety of reasons. The only choice is to move to keep the costs within reason.

You mention the need for a TSDF nearby to help hold costs to a reasonable level. Mike's Disposal Company locating in the central part of the state would be the answer for your company. Time is short and you urge the hearing board for a quick and favorable reply.

Spokesperson, Verona Chemicals
You are Verona Chemicals' chemist and public relations person. Your company headquarters is located on the east coast with chemical manufacturing plants on all coasts. There is a need for your chemicals by industry moving to the northern Great Plains.

You testify before the board there is a need for a TSDF in the vicinity for your waste. You mention that about 150 jobs are contemplated for your company with expansion expected to reach nearly 250 persons. You praise the community recruiting you for all their support and interest in economic development. You ask the board for favorable action on Mike's building permit.

Spokesperson, Community Recruiting Bixby Enterprises
You are the economic development coordinator recruiting Bixby Enterprises. You have been working hard to bring this new and rapidly growing industry to your city and state. It will be a big plus if you can recruit this company . Other microcomputer industries associated with Bixby have stated they may move to your community should Bixby move. If you can pull this off, you will be in line for a position in state department of economic development.

You are aware that one of the reasons Bixby wants to move is the stringent environmental regulations the western state has passed regulating hazardous waste. Bixby has a toxic chemical only Mike's will accept.

You testify before the hearing board that Bixby Enterprises has potential to bring many jobs to the community and state. You urge the board to approve Mike's Waste Disposal Company so Bixby can make immediate plans to move.

Spokesperson, Community Recruiting Verona Chemicals
You represent a large real estate company. Real estate sales have been rather slow lately. Recruitment of Verona Chemicals would be just what is needed to revitalize the community and the county.

You have visited the headquarters of Verona Chemicals and several of their plants across the United States. You have noticed most plants are well run and are clean for a chemical industry. You have checked their environmental records and except two plants they have an excellent record. The only violations were incorrect listings of large quantities of chemicals sent to the TSDF the plants were using. The company had been heavily fined by the United States Environmental Protection Agency for these incorrect listings.

You urge the hearings board to approve Mike's Disposal TSDF building permit.

Spokesperson, Mike's Disposal Company
You represent Mike's Waste Disposal Company. Your TSDF knowledge is the best in the nation. You have been the main spokesperson for Mike's in dealing with the community where you want to locate.

Many hours have been spent going over all the construction details, land purchase, visits with the county commissioners and with the city council. Scientists have reviewed all the environmental data and health risks for the area. You have brought in soil, air, and water experts to do sampling for the past year. Tours to other facilities by Mike's Waste Disposal Company were given to county and city government officials.

Your testimony stresses safety, the construction money for the community and the 50 jobs that will be added. There is potential for future expansion of your business. You urge the board to approve the building permit. You explain to the board construction will not start immediately. The reason for the delay is the state must review the project before permitting the facility. The state will probably take at least a year to review the plans before granting a permit.

You thank the board for their time.

Spokesperson, Environmental Activist (HOPE: Helping Other People Environmentally)
You are an activist for the environment. The past 20 years you have become an expert on hazardous waste generation and disposal.

There have been many times various industries have wanted to locate in your state. Your organization has limited the number of larger industries wanting to locate in the state. The main argument for limiting the large industries has been the pollution potential.

You are aware of problems with industries and TSDFs, especially the time and costs to correct environmental problems. You urge the board to deny the building permit for Mike's Waste Disposal. You present to the board your reasons for denial. The reasons are: Verona and Bixby industries have not looked at options such as waste reduction, using less toxic chemicals and recycling.

You are very concerned about the incinerator proposal and what it will do to air quality in the area. The incinerator would be less than one mile from the rural housing development.

The land disposal option would include a landfill. This landfill would, in all likelihood, pollute the groundwater and surface water. You express concern for the downstream community water supply.

Once again you urge the board to deny the building permit.

Spokesperson, Rural Housing Development Concerned Citizen
You are a parent of two children. You work in the community and desire a quality life for you and your children. Much of your time is spent gardening and enjoying your rural living.

You are concerned about the air quality because of the proposed incinerator to treat the hazardous waste. Your children spend many hours outside and you have a genuine concern for their health.
The housing development has their own drinking water well. From what you have learned about the landfill and hazardous waste handling you express concern

about groundwater contamination.

You state concern with the safety for your area. Your concern stems from increased rail transportation of hazardous waste. The rail line spur to Mike's comes within 2,500 feet of the rural housing development. You pose the question to the county commissioners and the community leaders about being prepared to respond to chemical leaks or spills.

Based on your study you find that your property could be devalued by as much as 20%. Should you decide to move, the sale of your home would be very difficult.

You urge the board to deny the building permit.

County Commissioner/Council Members

As the county commissioner your job is to handle all types of waste problems, growth issues, water problems. You also must balance the environmental and business development interests. You are also interested in getting reelected to office. When weighing the issues you must understand all the technical information plus the frustrations, anxieties and concerns of the county residents.

Your role is to conduct the building permit hearing. You will need to seek input from other county commissioners or council members, businesses, experts and interested citizens. You are responsible for conducting a productive and orderly meeting. A fair hearing consists of treating all participants equally and allowing them to present their views on the proposed project.

County Citizen

You live across the county from the proposed site of Mike's Waste Disposal TSDF. You are concerned with escalating property taxes and dwindling population in the county.

You own a small auto repair shop and must dispose of hazardous waste every few months. The new facility would save you considerable money because you now ship your waste to an out of state facility.

You have worked around hazardous chemicals all your life and have not had any problems. You are more concerned about county roads, water drainage issues and reducing your property tax.

Toxicologist

You have been hired by concerned citizens in the county and state to testify on the hazards of the proposed facility. You have testified at many hearings on potential air pollution problems from incineration of hazardous waste.

The citizens are most concerned about dioxin production from the waste incineration. The dioxin known as TCDD is a potent cancer forming agents in rats and mice. The evidence for cancer production in humans is still not widely understood. The levels of exposure are still not established and scientists disagree on the what the safe levels should be.

You are to testify on the chance of toxic chemical getting into the drinking water. You have been involved with research on several chemicals that are commonly found in hazardous waste generated by Bixby Enterprises and Verona Chemicals.

Your research shows these chemicals have the potential to increase the stomach cancer risk if consumed in drinking water. Like the dioxin research, the information is only on rats and mice that have been given large doses over short periods.

Scientist-Expert
You are a groundwater expert for the state. You have been widely recognized as an authority on groundwater in the area of the proposed site of the TSDF.

The county commissioners have hired you, for a fee, to determine what impacts might occur to the groundwater. As a geohydrologist you know there are no certainties about geology and groundwater. You can only model the potential results from a spill or leak of the landfill. You know that it takes much site specific work to predict the behavior of groundwater. Even with profuse amounts of data there may not be a definitive answer.

The data collected by Mike's Waste Disposal Company scientists and from your own studies are not definitive. The impacts from the potential spills or leaks are sketchy. You are worried both "sides" will use the report for supporting its position. As you are the accepted and respected scientist in the state and region you will be looked upon as the gospel for their claims.

Journalist
You are a reporter from the county/community where Mike's Waste Disposal Company desires to locate. You have always been a believer in reporting the facts. You have been present at all the county and city meetings about location of the TSDF in the county. You were assured by the city and county officials there would be no significant health affects from air or water pollution.

In the past few days a rumor has surfaced that Mike's Waste Disposal is a subsidiary of Verona Chemical. The rumor mill says Verona Chemical is setting up Mike's to get rid of chemicals from the two plants that were fined by EPA.

You cannot go public with this information until you have the facts. This rumor will take considerable time to check. You would prefer to check the substantive issues rather than rumors.

State's Attorney
You are the county attorney elected where Mike's Waste Disposal Company wishes to locate. The county has certain regulations it must follow. You must assure the commissioners conduct the hearing and permit approval or denial according to the laws and regulations.

You know this proposal is going to be controversial and has the potential to be appealed all the way to the State Supreme Court. A successful defense of any court actions would be a first step to becoming a candidate for the State Attorney General position.

Private Consultant
You represent a company who was hired by the community nearest to Mike's Waste Disposal desired location. You have carried out extensive studies on

similar facilities across the United States. You have done stack testing for air emissions, groundwater monitoring and spill prevention and countermeasures plans. You have recommended landfill design, collections system liners and planned transportation and storage of hazardous wastes.

You are to provide an unbiased account of the facility. You know that one of the county commissioners is vehemently opposed to the project. The commissioner will attack you on all parts of the waste disposal project.

You are aware the city council members want the disposal facility for economic gains and jobs. If this facility is built, you may have several years of lucrative consulting business.

River Guide
You were born and raised just a few miles from where Mike's Waste Disposal Company wishes to locate. The area has always been very clean. It has brought you, and your clients, many hours of pleasure. This beautiful prairie and river are your life and your living.

You are to express the concerns you have about the proposed TSDF ant the impact on the river and surrounding prairie. You want to express your emotions and fears in as factual a manner as possible. You will need to do your homework on the real problems of TSDFs and the surrounding areas. Questions you are going to need to answer are why here and what will be the costs of an accident should one occur.

State Regulator
You are assigned to attend the hearing on Mike's Waste Disposal building permit. You have written the state regulations for hazardous waste facilities and are recognized as the authority on permitting of TSDFs.

You are acutely aware of the economic conditions of the county and nearby community. Many safeguards are built into the TSDF regulations so the potential for environmental damage is reduced. You also know that most rules are developed so a facility can be permitted.

The entire valley where this facility is located has a unique beauty. It is known for its good tourism and recreation. The permit review requires review of economic conditions and environmental safeguards. Any problems found in the permit application will need to be corrected before the facility receives a permit.

You will be expected to explain the current state and federal regulations. The explanation must relate to the county siting and applicable rules. You know that you will be questioned closely by both sides.

GREAT DEBATE HEARING AGENDA
(PLEASE MODIFY AS NECESSARY)

AGENDA

I. Opening Statement - Hearing Officer

II. Introduction of Proposed Project - County Commssioner

III. Industry Business Testimony

IV. Expert Reports

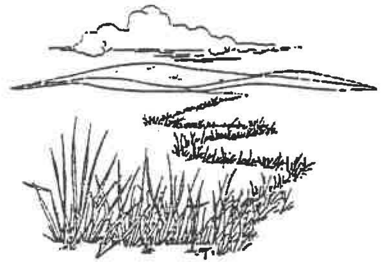
V. Citizen Testimony
- A. H.O.P.E.
- B. Other organizations

VI. Final Summaries and Questions

VII. Conclusion and VOTE

VIII. Optional - Report of Proceedings by Journalists

O WONDROUS RESOURCES



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GRADES: 7 - 8

CLASS: Language Arts, Art, Social Studies, Science, Math, Geography

TIME: One week to three weeks

EMPHASIS: Natural Resources Awareness, Appreciation and Understanding

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Objective(s)

The students will:

1. read two novels of prairie pioneer life,
2. draw or paint their visions from the books and actual observations
3. report (written or oral) about pioneer life from the late 1800s and early 1900s,
4. examine the prairie using several scientific methods, and
5. use math to assess plant cover.

Background

The goal of this activity is to integrate the environmental studies into all classes. Environmental study easily lends itself to core curricular class integration. Only imagination and time will limit how far the instructors want to take this activity.

This activity purposefully leaves out the high tech visuals, sophisticated instruments and fast paced presentations. It is designed to allow students to use their imaginations, to explore, to discover, to visualize and use all their individual senses and creativity.

The passages in Appendix I have been taken from Willa Cather's novels O Pioneers and My Antonia. These novels were chosen because they provide excellent verbal prairie paintings.

Ms. Cather displays the struggles and pleasures of prairie life in an easy to read format. It easy to identify with the characters in her novels. Because of these characteristics students can visualize, verbalize and hypothesize about the prairie---past and present.

Cather's novels were chosen because of the ease of introducing the prairie ecosystem. The procedures listed below take advantage of Cather's vivid prairie ecosystem descriptions to launch an integrated study program. Ecosystems involve both the living (biotic) and non-living (abiotic) world. Humans are an integral part of any ecosystem.

The abiotic component can be addressed by using some of the modules in the other sections of Project **SAVE** or using some of the procedures listed below. The biotic portions can be addressed using Project WILD or Project Learning Tree. The human element can be pursued through modifying the arts, social studies, geography or language arts classes to fit the novels.

Many fine novels, historical books, poetry and art works describe the prairie. Just a few references are listed at the end of this activity that may be more appropriate to the class you are teaching than the ones quoted in Appendix H. Please check with your librarian or the South Dakota State Library.

Materials

- Willa Cather novels My Antonia and O Pioneers
- Art supplies such as: charcoal, colored pencils, oil paints, easels, canvas, drawing paper
- Access to a park, grain field, pasture, vacant lot, and native prairie (if possible)
- History books or articles about the prairie in the school library
- Clipboards
- Pencils
- Paper
- Tape measure or nylon cord of a pre-measured distance
- Small stakes & hammer
- clothes hanger

Procedure

1. Explain to the students the procedure for meeting the learning objectives and what is expected of them.

2. Instruct the students on keeping a journal of their activities (journals should be designed by a team of teachers to reflect the interrelated subject matter).

3. Instruct the students in keeping a portfolio and the importance for classroom evaluation.

4. Read several passages from the Willa Cather paragraphs in Appendix H. Students should read from the library, the Cather books, or other references about early pioneer life on the prairie.

5. Schedule a trip to the park, open prairie, and a grain field for the students to learn to use all their senses.

6. Ask the students to draw or paint and describe, in their journals, what they see. They should record what they hear and any other observations.

7. Discuss what the students have read and share their drawings, paintings or writings in the appropriate class. Review each student's journal and portfolio to make sure they are progressing on their overall work. The environment and natural resources should be the theme running throughout each student's journal and portfolio.

8. Examples of themes for classes:

Social Studies - Pioneer settlement of the prairie; the Homestead Act.

Science - Prairie plants and densities of natural areas and disturbed areas. Compare the water quality and species diversity of both terrestrial and aquatic life.

Language Arts - Use the prairie as a basis for a fiction or historical novel about their town. Relate this to the quality of the environment at home and in another area of the U.S. or biosphere.

Questions

1. What are some of the visions you see when Willa Cather writes about the prairie?

2. How would you contrast what she wrote in the early 1900s to how she might write now?

3. Can you think of any similar writings from your area or the state that can rival how she described her environment?

4. What is meant by painting with words?

Bibliography

☞ See Appendix I

Additional Ideas

☞ Schedule a trip to Red Cloud, Nebraska to visit the home of Willa Cather and associated museum and countryside.

☞ Schedule a trip to a museum of art, a historical museum, a cultural heritage museum or another site to combine awareness of the environment with social conditions of an area.

Pollution Prevention

POLLUTION PREVENTION INTRODUCTION

Pollution prevention is simply defined as taking action so pollutants are not produced. For example, a company may change from using a toxic chemical in their manufacturing process to one that is non-toxic. Another example might be a company purchasing raw materials for their product line that has reduced packaging.

Over the past 30+ years industry and regulatory government agencies have approached pollution problems mostly by treatment, disposal and cleanup methods. Costs associated with treatment, disposal and cleanup has made industry and regulatory agencies look at avoiding production of waste materials, thus pollution prevention.

When you think of pollution prevention, think in terms of all environmental media; i.e., air, water and land. The way you, an industry or business conducts daily activities can have a tremendous effect on all areas of our environment.

Pollution prevention begins at home! Some of the activities in this section lend themselves to doing things at home. We encourage you to start your students thinking in terms of not polluting rather than the frame of mind of treating or cleaning up.

Check other parts of the program, especially the solid waste section for activities that can be modified for the purpose of teaching pollution prevention.

PICNICS AND PACKAGING

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GRADES: K - 6

CLASS: Science, Social Studies

TIME: 1 Hour

EMPHASIS: Waste Reduction

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Objective(s)
Students will each bring a picnic lunch and compare, record and discuss the types of packaging used.

Background
The best way to reduce pollution is not to create it. Solid waste created from every day living is something that we can control. We must think about what we are doing or purchasing before we act. This exercise alerts children to the idea of pollution prevention through a hands on learning experience dealing with the solid waste they generate from a meal.

Materials
- Picnic lunches
- Blankets
- Large paper
- Marker

Procedure
1. Set up a date for a picnic lunch. Remind the students the day before to bring in their lunch for the picnic.

2. Pick a sunny spot and have students sit with their lunches in a circle (on blankets).
3. One by one have students unpack their lunch and on large paper record the different types of packaging.
4. Have the students eat their lunches and to save all their packaging.
5. Return to the classroom and each student should record which of their packaging is reusable, recyclable and which is waste.
6. Weigh all the packaging together and record.
7. Discuss how some of the waste could have been prevented; that is, thermos instead of a juice box, reusable containers such as sandwich boxes, etc. Sample questions are listed below.

Questions
1. Who generated the most waste?
2. Was there more of one type of waste than another?
3. What is pollution prevention?
4. Where will your waste go?
5. What happens to the waste once it is in the landfill?
6. Is it better to prevent pollution or to recycle and reuse? Why?
7. Can you think of other pollution prevention things we might do to keep our environment clean?

Bibliography

Additional Ideas

☛ Have another picnic and this time tell the students a prize will be given to whomever creates the least amount of waste.

A SAFER SHINE

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GRADES: 4 TO 6

CLASS: Science

TIME: 1 hour

EMPHASIS: Natural Alternatives

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Objective(s)

Students will make a safer alternative to chemical furniture polish using vegetable oil and lemon juice.

Background

Many house cleaners contain toxic chemicals that are sometimes harmful to the environment and people. Often these cleaners can be substituted with a natural substance that works just as well.

The use of natural substances **prevents pollution** and there is less chance of harm to the environment or people. Encourage students to look at alternatives to harmful products and let them know it is cheaper in the long run to prevent than to clean up!

Materials

- Clean, empty pump bottles
- Lemon juice
- Vegetable oil
- Glass measuring cups
- Funnels

Procedure

1. Tell the students a few days before the activity to bring an empty pump spray bottle and any furniture polish they have from home.
2. In class, have students look at their furniture polish ingredients.
3. Write some of the ingredients on the board. Label which are natural and which are chemical.
4. Discuss what can be used instead of chemicals to polish furniture.
5. Break the students into groups and give them ingredients to make polish.
6. Students should mix 1 part lemon juice to 2 parts vegetable oil.
7. Using a funnel, pour the mixture into a clean pump bottle. Shake well.
8. Label the bottle with marker and tape.
9. Students can take the polish home and see how well it works.

Questions

1. What kind of vegetable oil did you use?
2. Is any of the oil produced in the U.S. or in South Dakota?
3. How much of your oil do you think you would need to use on the furniture?
4. What was the cost of your oil versus the furniture polish?
5. Where are the lemons grown?
6. Where was the polish manufactured?
7. What happens to the polish can after it is empty?
8. How are we preventing pollution?

Bibliography

Additional Ideas

PATTY & PETE'S PAINT PALACE

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GRADES: 8 to 12

CLASS: Science

TIME: Three 50 minute periods

EMPHASIS: Pollution Prevention

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Objective(s)

Students will:

1. research the toxics related to paints and allied products,
2. visit a paint store or similar store selling paints and solvents and
3. write a paper on methods for prevention pollution from paint production and usage.

Background

Pollution prevention is the name of the game. Many of the everyday products we use in our homes and businesses contain materials that can be harmful to the environment. When using materials around the home or at a business it is imperative we be familiar with the many compounds that are listed on the labels. If not listed on the labels then we need to be aware of what it takes to produce the product, the contents of the product and the waste products formed from the use of the products.

This exercise was developed for the purpose of alerting consumers to some of the chemicals we take for granted in our everyday lives. Not only should a person look at the product, but they must be concerned with the wastes produced during the manufacturing process. Manufacturers are continually seeking safe alternatives to use of toxics. They want to reduce toxics in their waste streams. This is due to concerns for the environment and the costs of hazardous waste disposal.

This exercise should be a challenge to the students because the paint or the manufacturing process may not be toxic but the materials used for cleanup and removal (stripping) may be. Students may need a few careful hints to guide them in this direction.

Materials

- Journal
- Pencil or Pen
- Library or Reference Materials

Procedure

1. Discuss with the students the concept of pollution prevention; i.e., using alternative materials which are non-toxic, not producing waste or reusing materials at the processing site.

2. Ask the students to record in their journals ideas of what might be toxic at Patty & Pete's Paint Palace.

3. Next, provide them with reference materials obtained from paint and paint solvent manufacturers or ask the students to spend time in the library researching paint production, use and contents of stripping materials. (If students are contacting manufacturers the exercise should start three to four weeks prior to any site visits.)

4. After the students have obtained their reference materials, arrange for a site visit to a paint store or a similar site that supplies paints and pain strippers.

5. Ask the students to go through their paint supplies at home or in an art class so they can determine if toxics or the potential for toxic wastes exist at either place.

6. Mention to the students they should develop a table(s) for recording their data depicting the product(s) and material(s) contained in the product that are harmful and the alternatives to the chemical, if any.

Questions

1. Are there a common ingredients used in the paint?

2. What material(s) proved to be the most dangerous to the environment? to humans?

3. How could you design Patty & Pete's Paint Palace to assist consumers with being more environmentally safe?

4. What environmental media (air, water, land) is most affected by the material(s)?

5. Are there alternatives to the products that are safer?

6. Are the alternatives more expensive?

7. What might be the costs to clean up the environment from the release of these chemicals?

8. What can we do as consumers to assist our environment and our pocketbook?

9. What is the difference between an oil based paint and a water based paint? Is one preferable over the other? If so, why?

Bibliography

Additional Ideas

☞ Develop a geography and/or history lesson by locating the paint manufacturing companies and locating their supplies of materials. Historically try to determine if the environment of the areas has changed.

☞ Develop a language arts lesson using computers to process inquiry letters to retailers and manufacturers.

HOUSEHOLD HAZARDS MEMORY GAME

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GRADES: K to 4

CLASS: Science, Health

TIME: 15 minutes

EMPHASIS: Pollution Awareness

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Objective(s)

Students will play a memory game to become aware of hazardous materials which exist in many households.

Background

Hazardous materials exist all around us. Many people are unaware of the dangerous products used at home. This game is to be used as a springboard for discussion of household hazards.

Materials

- Two copies of each sheet of cards per student
- Scissors
- Crayons
- Rubber bands

Procedure

1. Pass out two of each memory card sheets to each student.

2. Tell the students that all the pictures show something that could be harmful to them.

3. Go through the pictures identifying and discussing each item.

4. Have the students color each item.

5. Cut out each of the drawings and shuffle them together.

5. Explain the rules of the game:

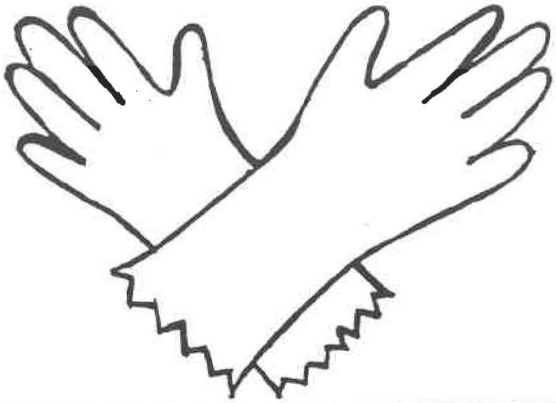
> **a.** two or more students get into a group,
>
> **b.** one student's deck of household hazard cards will be used for play,
>
> **c.** lay all cards face down on the floor in random order forming a square,
>
> **d.** taking turns, each student turns over two cards,
>
> **e.** if they match the student keeps the cards and turns over tow more cards,
>
> **f.** if the cards do not match, the student turns the cards face down again and the next student takes her/his turn,
>
> **g.** play continues until all the cards are gone,
>
> **h.** the student with the most pairs wins!

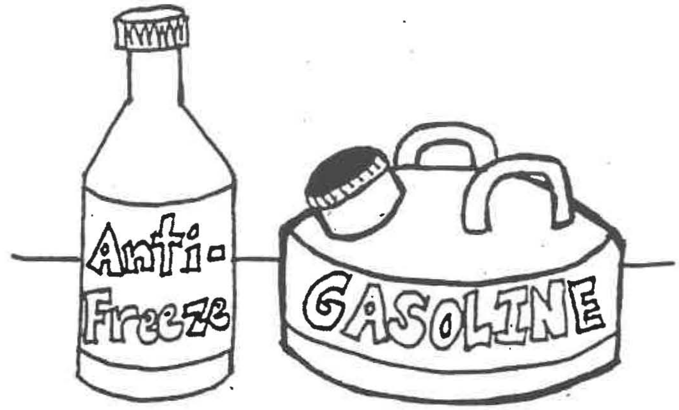
Bibliography

Additional Ideas

☞ Have students make a checklist of how many hazardous household items they have at home.

☞ Discuss alternatives to hazardous products.

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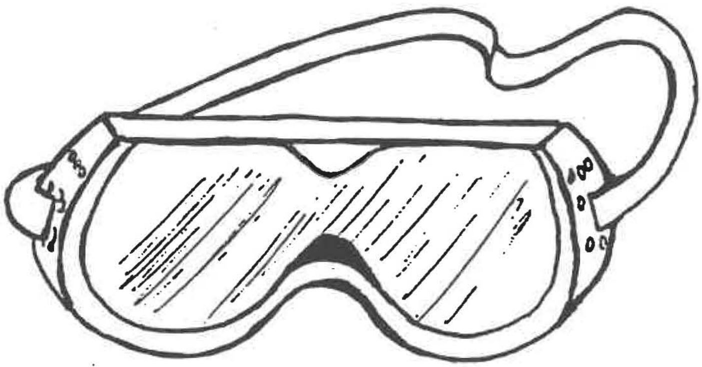
GASOLINE

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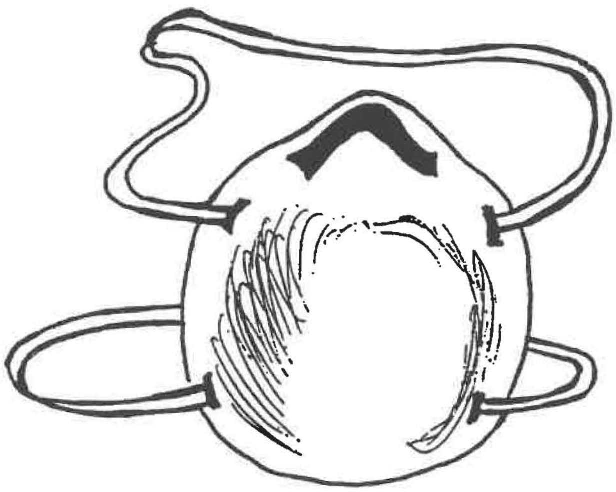
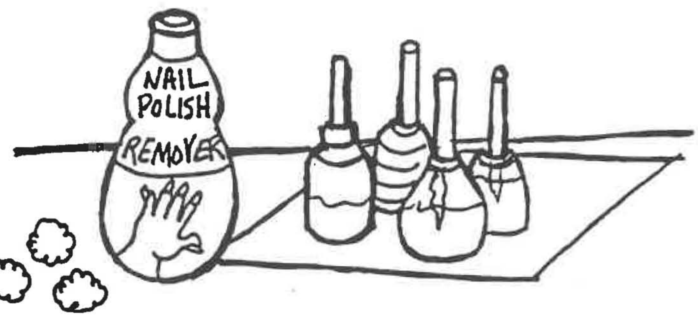
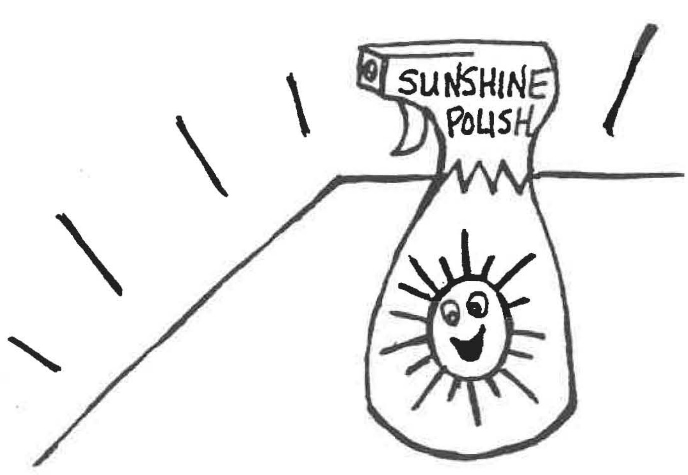
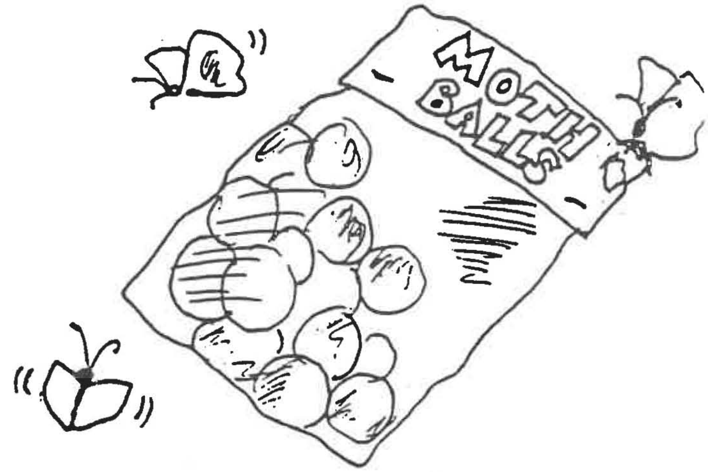


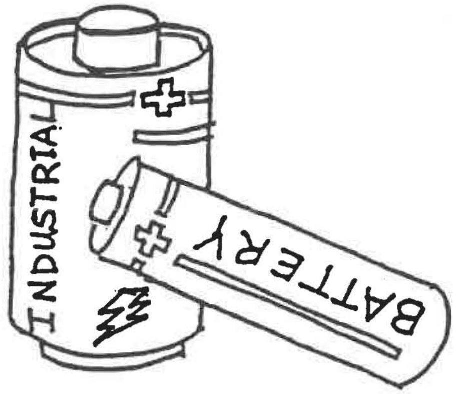

NAIL POLISH REMOVER


PETE'S
PAINT


SUNSHINE POLISH


WEED KILLER

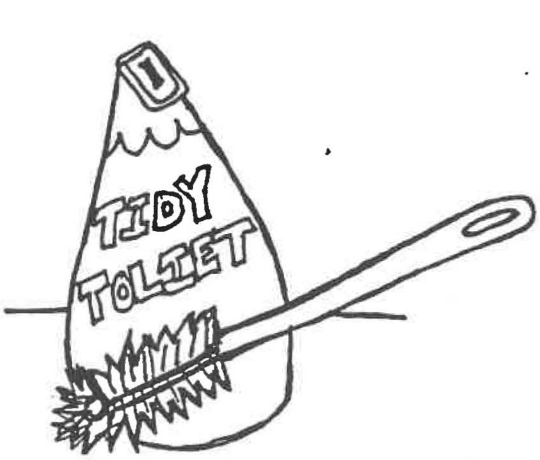

MOTH BALLS


INDUSTRIAL
BATTERY


LIQUID BLEACH


STAY
SPRAY


MOTOR OIL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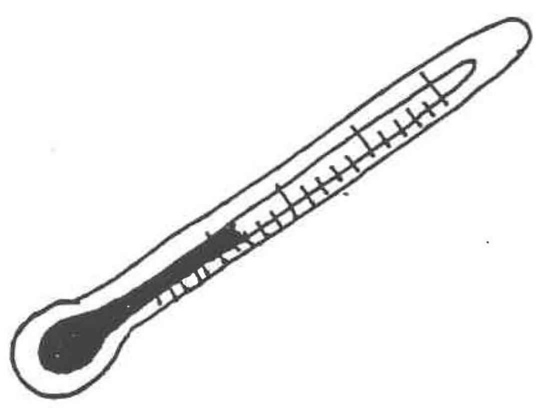


Art and Solid Waste

ART AND SOLID WASTE INTRODUCTION

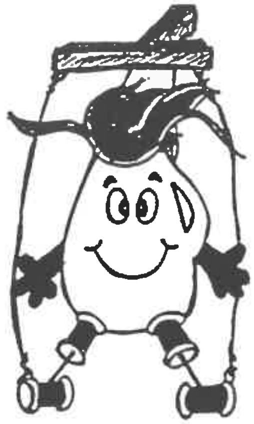
The following activities are to accompany the solid waste section of Project SAVE. These activities are just a few examples that can be conducted in art classes. All ages can use these exercises even though they were designed for the middle school. There are many more activities you, your students or class participants can do. Many excellent recycling and reuse books can be found at the library or your nearest book store.

The art work at the beginning of each activity was drawn by Jennifer Lawver. She was employed by Capital University Center at the time she developed the modules. Funding for her work was provided by a National Science Foundation Statewide Systemic Change grant and an Environmental Protection Agency Pollution Prevention grant.

Jennifer also designed and introduced the first CAN MAN puppet in 1993 in Ms Bea Stough's second grade class at Sully Buttes Schools. Use of puppets is an excellent way to make children aware of their environment, especially solid waste. A CAN MAN sack puppet is included with this section of Project SAVE. Please feel free to copy the any of the sack puppet designs for your use.

The use of fine arts to assist in environmental awareness is just one tool in the learning process. We encourage the use of all the materials in Project SAVE to assist your students or class participants in becoming more aware of their environment.

We would like to hear from you if you have designed other interesting art activities that go along with the Project SAVE program. If you have additions or suggestions for this section please write.



JUNK PUPPET

++++++++++++++++++++++

GRADES: 5 to 8

CLASS: Art/Craft

TIME: Three 50 minute periods

EMPHASIS: Recycling Junk

++++++++++++++++++++++

Objective(s)

The students will:

1. construct a puppet using 5 or more junk items and
2. work cooperatively in groups of three.

Background

People all over the world make puppets. Types of puppets include marionettes, hand puppets, shadow puppets and muppets. Puppets can be made out of anything. Kermit the Frog's eyes were made from ping pong balls cut in half!

Make sure the students know they will be making puppets from the "junk" they bring into class.

Think in terms of reusing or preventing the items from becoming "junk." Project SAVE stresses the prevention of "pollution."

Use with Solid Waste 4 Module-Home Discards.

Materials

- Junk items
- Wire
- Yarn
- Hot glue
- Markers
- Coat hangers

Procedure

1. Inform the students several days before making the puppets to find 4 "junk" items and to bring them to school on the assigned date. (Junk items can include such things as: plastic jugs, spools, old clothes, yarn, wire.)
2. Have students work in groups of three. The group will share the "junk" items they brought into class.
3. The students are to construct the puppets from the "junk" they have in front of them. The rules are:
   a. the puppet has to be moveable,
   b. all parts must be connected,
   c. at least 5 pieces of "junk" must be used and
   d. outside pieces can be brought in only to connect or decorate the puppet; that is, wire, markers, glue.
4. After constructing the puppet, students must write and perform an environmental skit. (Groups can pair together to do this.)

Questions

1. Where did you find most of the "junk?"
2. Could we have prevented the "junk?"
3. What is pollution?
4. Can you think of other ways you might "reuse" the "junk" items.

Bibliography

Additional Ideas

CRUSHED CAN STILL LIFE

+++++++++++++++++++++++

GRADES: 4 to 6

CLASS: Art/Craft

TIME: 40 Minutes

EMPHASIS: Developing Observation Skills

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Objective(s)
Students will draw from a still life composition of crushed and un-crushed cans.

Background
Scientists need to be close observers of details when conducting experiments. When artists draw, they also observe things closely for detail.
The students will be drawing a detailed picture of crushed and uncrushed cans to use and enhance their observation skills.
This activity can be used in combination with Solid Waste 5 Module-Volume reducer. This is found in the solid waste section on page SW-15.

Materials
- Pencils
- Large Paper
- Empty pop cans

Procedure
1) Create a still life using 5-10 different pop cans (crushed and uncrushed).
2) Pass out a sheet of paper and pencil to each student.
3) Tell students to draw the cans using all the space on the paper.
4) Students should shade the cans using their pencil to depict light and darkness.
5) Come up with a slogan for recycling cans.
6) Display the pictures and slogans somewhere in the school.

Questions
1. What did you notice about the difference in light contrasts?
2. Was there a difference between the crush and uncrushed can light contrasts?

Bibliography

Additional Ideas

MAGAZINE & GLUE BEADS

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GRADES: 5 TO 8

CLASS: Art/Craft

TIME: Two 60 minute blocks of time.

EMPHASIS: Recycling Magazines

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Objective(s)

Students will make jewelry using strips of magazines and white glue.

Background

Students should be made aware of the fact that magazines are not easy to recycle because of the material contained in the paper.

This activity accompanies Solid Waste 3 or 4 Modules.

Materials

- Old glossy magazines
- White glue
- Large needles
- Straws
- Pencils
- Yarn
- Fishing line

Procedure

1. Cut strips of various widths from colored magazines.
2. Select one or two items to roll beads on; that is, pencil, needle.
3. Place a puddle of white glue on a slip of paper.
4. Roll a strip of magazine around the needle or pencil (tight but not too tight to slip off the needle or pencil).
5. Put a dab of glue at the end of the magazine strip and press down.
6. Roll as many strips around the needle or pencil as desired, then carefully slip off the needle or pencil.
7. Allow the beads to dry.
8. String the beads using the fishing line or yarn.

Questions

1. How have you helped the environment by making these beads?
2. Can you think of other materials you might use to make the beads from other discarded items or materials?

Bibliography

Additional Ideas

PAINTED CANS

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GRADES: 4 TO 6

CLASS: Art/Crafts

TIME: Three 40 minute periods

EMPHASIS: Reusing "Tin" Cans

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Objective(s)

Students will make a decorative container using tempera paint, varnish, markers and a "tin" can.

Background

It takes a tin can in a landfill at least 100 years before it begins to decay or break down.

This exercise is for reusing materials instead of throwing away an item. It can, no pun intended, make someone a nice present.

This activity accompanies Solid Waste 11 Module-CAN-CAN CAN MAN.

Materials

- Clean, empty "tin" cans
- Tempera paints
- Glossy varnish
- Black permanent markers
- Brushes
- Newspaper

Procedure

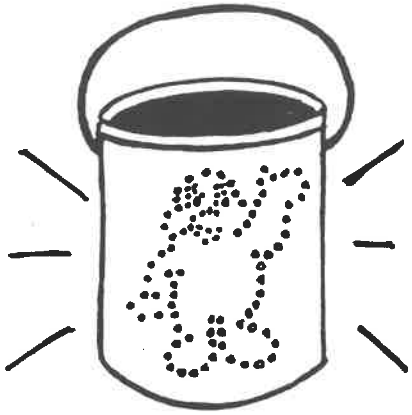
1. Remove any labels on the can and thoroughly clean it.
2. Draw a design on the entire outside of the can using the black marker.
3. Paint the outside of the can using tempera paint.
4. After the paint has dried, retrace the design outline with a black marker.
5. Spray or paint the can with a clear gloss finish.
6. Add a wire handle if desired.
7. Give it away as a present for various uses.

Questions

1. How are "tin" cans made?
2. Some cans are seamless and other are not. What might be the reason?
3. Which type of can is more easily recyclable: "tin" or aluminum?

Bibliography

Additional Ideas



LUMINARIES

++++++++++++++++++++++++

GRADES: 7 TO 8

CLASS: Art/Craft

TIME: Three 40 minute periods

EMPHASIS: Reusing Cans

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Objective(s)
Students will reuse empty cans, making them into candle luminaries.

Background
Before electricity and flash lights, people had to carry kerosene lanterns or candles to see at night or in dark places. Some lanterns were made of tin and had holes punched in them to let out light and heat. The holes made elaborate patterns to cast glowing designs.
Use in conjunction with Solid Waste 11 Module-CAN-CAN MAN.

Materials
- Empty cans (Coffee cans are best)
- Hammers
- Nails
- Crayons
- Heavy wire
- Candle
- Wire cutting tool(s)

Procedure
1. Remove wrappers or labels from the can and fill it with water. Place it in the freezer until the water is frozen.
2. After the water has frozen remove the can from the freezer and place it on a newspaper at a work station such as a table or the floor.
3. Carefully punch holes in the can using the nail and hammer.
4. Remove the water from the inside of the can when finished with the design.
5. Add a piece of wire for a handle.
6. Place a candle inside and light to view your finished product.

Questions
1. Why did you freeze water in the container?
2. Can we recycle the can in other ways?

Bibliography

Additional Ideas

SCRAP QUILT

+ +

GRADES: 4 TO 8

CLASS: Art/Craft

TIME: Four 30 minute periods

EMPHASIS: Reusing cloth materials

+ +

Objective(s)

Students will recycle leftover scraps of fabric and old clothing to make a classroom quilt.

Background

During pioneer days nothing went to waste. Worn out dresses and pants were made into patchwork quilts to keep the family warm.

This exercise accompanies Solid Waste 10 Module-From Rags to Riches.

Materials

- Scrap fabric
- Old clothing
- Large needles
- Heavy thread
- Scissors
- Seam ripper
- Batting
- Backing
- Paper
- Patterns
- Pencil

Procedure

1. Provide each student with a piece of paper the same size as the quilt block with which they will be working.
2. Instruct the students to draw on the block what their quilt square will look like.
3. The students should choose a large solid colored piece of fabric. Lay the paper square on the fabric and pin on or trace the outline.
4. Cut out the fabric square.
5. Students may cut out shapes from various fabrics to make their design. Glue or sew the pieces on their quilt block.
6. Ask the Home Economics class or parents to use a sewing machine to piece the finished blocks together.
7. Add backing and a low loft batting.
8. Tie the quilt with embroidery floss, yarn or hand quilt.
9. Display the quilt(s) somewhere in the school.

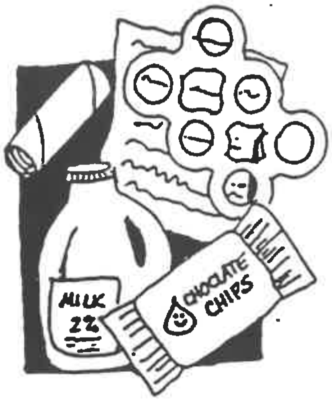
Questions

1. Reuse of fabrics may have helped the environment in the past. Can you hypothesize why?
2. Where was most of the material manufactured that was used for clothing on the prairies?
3. How was flour and various animal feeds transported in the 1930s, 1940s and early 1950s?
4. What does your grandfather and grandmother know about quilt making and flour/feed sacks?
5. Does anyone have a loom in the area? If so, how is it used?

Bibliography

Additional Ideas

PACKAGING COLLAGE



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GRADES: 4 to 6

CLASS: Art/Craft

TIME: One 40 minute period

EMPHASIS: Solid waste - Excess packaging

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Objective(s)

Students will assemble a collage depicting the harmful effects excess packaging has on the environment.

Background

Excess packaging of products is not needed. In South Dakota, and many other places, packaging cannot be recycled and often ends up as litter or take up landfill space. It also consumes more energy and thus adds more pollutants to our environment from energy production and byproducts from the manufacturing processes.

Waterfowl and other living animals can die from ingesting or getting entangle or trapped in the excess packaging that is purposely or accidently discarded.

This activity should accompany Solid Waste 6 Module-Let's Go Shopping.

Materials

- Assorted packaging
- Glue
- Stiff Pieces of paper (tagboard or cardboard)
- Markers

Procedure

1. Prior to the collage exercise ask the students to bring 5 empty packaging items from home.
2. In class, explain that using the items brought from home, they must show how packaging harms the environment.
3. Pass out the tagboard.
4. Instruct the students to first use a pencil to lay out the collage. Write any words or draw pictures on the tagboard before gluing on the packaging.
5. Display the art work around the school.
6. Copies of pictures depicting animals caught in packaging could also be used in the collage.

Questions

1. Why did you depict what you did?
2. Why is some packaging necessary?
3. Can you think of different ways to reduce the packaging?
4. How might you determine the cost of packaging versus the cost of the product?
5. What was the most frequent type of excess packaging you encountered?

Bibliography

Additional Ideas

☞ Ask the students to develop a collage depicting the necessity of excess packaging that has been caused by social problems or that is necessary for long distance transportation.

BLEACH JAR PIGGY BANK

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GRADES: K-3

CLASS: Art/Craft

TIME: 50 minutes

EMPHASIS: Recycling Plastic

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Objective(s)

Students will make a piggy bank from a bleach jug and other recyclable material

Background

Most all of the materials that we throw away have some type of thing for which they can be reused. Only the imagination is the limit to how we can reuse or recycle the materials that we classify as throw-aways.

Materials

- Thoroughly rinsed and cleaned bleach jugs
- Cardboard
- Tubes
- Glue
- Scissors
- Construction paper
- Crayons
- Hot glue gun
- Fabric scraps

Procedure

1. Before hand cut cardboard tubes for legs and hot glue to the bleach jugs.
2. Show students an empty bleach jug and ask what can be done with it besides throwing it away.
3. Inform students they will be making a bleach jug piggy bank. Show them the one you made.
4. Pass out a jug to each student.
5. Place construction paper and fabric scraps on a table for the students use.
6. Instruct the students to use scissors, crayons, glue and other things set on the table to decorate their bank.
7. Cut or assist the students in cutting a slit on top of each bank.

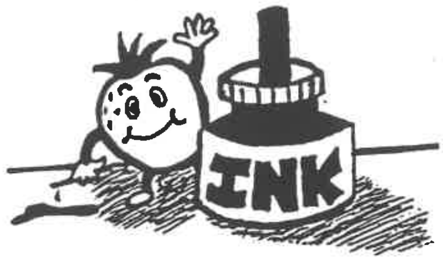
Questions

1. How can we get the money out when we need it?
2. Can you think of other ways to use the jug(s)?
3. Can we make money to fill our banks by recycling anything?
4. What was in the jug?
5. How was the material used?
6. Is the material that came from the jug at all harmful?

Bibliography

Additional Ideas

BERRY, BERRY BENEFICIAL



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GRADES: 3 to 12

CLASS: Art/Craft

TIME: One hour period

EMPHASIS: Alternative Ink

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Objective(s)

The students will:

1. make their own ink from berries and
2. research and list the benefits of using soy-ink versus petroleum-based ink.

Background

The use of petroleum-based ink once dominated the markets for printing most of our newspapers and magazines. With the passage of the Resource Conservation and Recovery Act the printing industry began switching to inks that contained no harmful materials.

The petroleum-inks are of concern because of the heavy metal concentration found in the sludge or bottoms from the ink processing. This waste is listed as hazardous and must be stored, treated and disposed of according to hazardous waste rules.

Papers that use petroleum-based inks still cannot be used for compost because of the metals.

In the old days students did not have ballpoint pens like we use today. Students use quill or stick pens and had to make their own ink.

Students can still do fun things with these low tech instruments and learn about some pollution prevention ideas.

Materials

- Strainers
- Spoons
- Bowls
- Baby food jars
- Berries
- Vinegar
- Salt

Procedure

1. Instruct students to bring 1/2 cup ripe berries to school prior to beginning the exercise.
2. Provide each student with a strainer, spoon and bowl.
3. Have the students put the berries in the strainer and use the spoon to press the juice into the bowl.
4. Discard the berry pulp after all juice has been squeezed from the fruit.
5. Add 1/2 teaspoon of vinegar and 1/2 teaspoon of salt to the juice. Stir. If the ink is too thick add a small amount of water.
6. Pour the berry ink into a tightly sealed baby food jar or similar container.
7. Use the ink when ready.

Questions

1. How does the berry ink compare to soy-based ink?

2. Can you think of natural plants in our area that might be used for ink?

Bibliography

Additional Ideas

☞ Students can make their own quill or wooden pen. To make the feather pen they should cut off the fat end of a feather at a slant. The inside of the feather should be hollow to hold the ink. To make a wooden pen, find a pencil size twig and whittle a tip at one end for writing.

☞ Students can make their own recycled paper and write environmental poems on it, using their berry ink and pen.

GLOSSARY

Aeration - exposing material such as compost to air

Aquifer - natural underground layers of porous material such as sand or gravel

Biodegradable - waste material such as food waste and paper which are capable of being broken down into simpler elements

Combustion - to burn in the presence of oxygen

Compost - organic material produced resulting from the controlled decomposition of organic solid waste such as yard waste and kitchen waste. Also referred to as humus.

Conserve - to protect our natural resources from waste and destruction

Contaminate - to make unfit for use - to pollute

Cultural eutrophication - accelerated aging of a body of water due to a deficiency of oxygen which is a result of increased nutrients from agricultural land and sediment from runoff

Decomposition - to decay, change form or break down into simpler materials.

Direct runoff - water that drains off saturated or impermeable surfaces.

Emission - discharge of gas into the air (as by a motor vehicle or smoke stack).

Flocculation - fine particles attracted together into clumps by the use of chemicals which then settle out by gravity.

Ground water - water found in natural underground layers(aquifers).

Hazardous waste - material that is intended to be or is discarded that is reactive, corrosive, ignitable or toxic or is specifically listed by the USEPA or a state

Humus - organic material resulting from decomposition of plant or animal matter. Also referred to as compost

Hydrologic cycle - a continuing cycle in which water evaporates, is carried by the wind, precipitates over land or water (in the form of rain, snow, etc.) and eventually returns to the ocean from where it originates. Includes ground water that returns to rivers, lakes and oceans

Incinerate - the process of burning solid waste in order to reduce volume

Landfill - site where solid wastes are received, spread in layers and covered with soil daily to minimize pest, disease, air and water pollution problems.

Leachate - liquid that has drained through solid waste and may contaminate ground or surface water

Mass burn - solid waste burned without prior sorting or preparation.

Natural resource - materials supplied by nature such as water, minerals, soil and living organisms

Organic - living or once living material.

Particulate matter - particles released during the combustion process which may be harmful to those who breathe them. These particles consist of small pieces of liquids, solids and liquid-solids combined.

Permeable - having pores or openings that allow liquids or gases to pass through.

Recycle - collection and reprocessing of wastes for reuse. May be used in the same form or part of a different product.

Refuse derived fuel(RDF) - a solid fuel produced by the mechanical processing of solid waste which allows for the recovery of recyclable material and eliminates the noncombustible items.

Resource recovery - the production of energy or other usable materials obtained by the burning of solid wastes.

Saturate - completely filled with moisture.

Solid waste - any garbage or discarded material. Can be hazardous or nonhazardous.

Source reduction - to minimize the quantity of waste produced by a change in manufacturing and reuse of materials.

Source separation - the sorting of recyclable from nonrecyclable items at home, school or business.

Stack test - a test measuring the amount of particles and gases released from smoke stacks.

Surface water - accumulates mainly from direct runoff into stream channels and then into man-made or natural sites (lakes, rivers, oceans)

Thermal inversion - cold air becomes the layer closest to the earth's surface rather than warm air causing pollutants to be trapped near the surface.

Toxic - poisonous.

Volume reduction - reducing the amount of garbage put in landfills by selective purchasing, recycling and reusing

Waste stream - the flow of solid waste from homes, businesses, etc., that must be recycled, burned or landfilled.

Water table - upper level below the earth's surface at which the ground becomes saturated with water.

Appendices

APPENDIX A

CONCEPTUAL FRAMEWORK

for the

ENVIRONMENTAL PROTECTION

EDUCATION MODULES

CONCEPTUAL FRAMEWORK OVERVIEW

The following material has been drafted to provide a conceptualized framework for development of educational packages. The emphasis has been placed on elementary education. The idea of an educational framework was developed by reviewing other areas of information delivery within the department. Also outlined is the current delivery of information from the department with some additions. The additions are in the area of more educational packages not only to elementary students but to the adult population.

The training portion of this framework has been expanded to include solid waste for better delivery of good landfill operation and closure/postclosure care. The operator training should include a component on recycling and collection. The addition of these actions can assist in meeting the department's statutory and regulatory mandates.

The framework is developed with the idea that information, training and education move in a coordinated fashion with an integrated approach to environmental action. This transcends the norm which is to use a programmatic approach such as water quality, solid waste, air quality, etc.

A great deal of environmental education material exists across the U.S., but little is tailored specifically to South Dakota and especially within the scope of the Department of Environment and Natural Resources.

Based on the conceptual framework the development of modules for elementary and adult education should start as soon as possible. This can be accomplished by compilation of existing materials, tailoring of those materials to suit South Dakota, and placing the modules in a loose-leaf booklet for development of teacher training and adult education.

Any curriculum materials developed must be approved by the Education and Cultural Affairs Department. This will allow educators to receive continuing education units for certification and will ensure a greater success for the department program.

CONCEPTUAL FRAMEWORK

This framework serves as a conceptual basis for activities by the Department of Environment and Natural Resources. Each activity should be designed to correspond to one or more of the points in the outline. The delivery mechanisms are outlined later. A major goal of education is the recognition by humans of their interdependence with the environment and with life everywhere, and the development of a culture that maintains that relationship through policies and practices necessary to secure the future of an environment fit for life and fit for living.

I. Environmental Awareness and Appreciation

A. In the long run, our welfare depends on the natural world. Our well-being depends on other living things, on air, on soil, on minerals, on energy resources.

B. Our planet is a closed system in which indefinite expansion or exploitation of its resources would be disastrous to all life, including that of humans.

C. Life is limited to a 13-mile-thick layer of our planet called the ecosphere or the biosphere.

D. In the biosphere humans enjoy the benefits of a self-renewing natural environment.

E. The understanding of interrelationships of living things with each other and with their physical environment is the key to sound environmental practice.

F. Food chains and food webs are pathways along which materials and energy are passed along in the world of living things.

G. The organisms that are part of a food chain or food web act as producers (usually green plants), consumers (usually animals), or decomposers (usually fungi and bacteria).

H. All living things are dependent on the interwoven cycles of water, carbon dioxide, oxygen, and nitrogen.

I. The consequences of disturbing the web of life are often unforeseen and often unfortunate.

J. Some resources--such as air, sunlight, and water--are inexhaustible. Air and water, however, can become unfit for living things.

K. Some resources--such as soil, vegetation, animal life, and fresh water--are renewable.

L. Some resources--such as coal, oil, natural gas, metals, land as open space, and certain kinds of wilderness--are nonrenewable. Their supply cannot be replenished.

M. All plants and animals, including humans, are dependent directly or indirectly on the soil.

N. One-third of the valuable topsoil in the United States has been lost since the coming of the colonists, largely because of unwise practices.

O. The erosion of soil can be checked by contour plowing, strip farming, terracing, and other farming methods such as conservation tillage.

P. It is necessary to maintain the proper nutrient composition of the soil.

Q. Forest conservation measures must be implemented to protect our watersheds.

R. The problem of water conservation is that of having the right amount of fresh water of good quality in the right place at the right time.

S. A matter of concern is the falling water table in many areas.

T. Water conservation involves the protection and extension of watershed areas, construction of dams and reservoirs, improved industrial practices in relation to water usage--including reuse of water--elimination of waste, and the use of water-conserving irrigation practices on farmland.

U. Automobile exhausts and smokestacks produce most of the dangerous air pollutants.

V. The dumping of toxic chemical wastes poses an awesome threat to our safety and health.

W. Wetlands prevent floods and droughts, serve as nurseries for many species of fish, provide a critical habitat for many forms of life, break down toxic chemicals, and serve as laboratories for learning.

X. The preservation of open areas in and near urban centers serves many vital purposes.

II. Environmental Values

A. We must achieve and maintain reasonable levels of air quality which will protect human health and safety, prevent injury to plant and animal life and property, foster the comfort and convenience of the state inhabitants, promote the economic and social development of the state and, to the greatest degree practicable, facilitate the enjoyment of natural attractions of the state.

B. We must conserve the waters of the state and protect, maintain and improve the quality thereof for water supplies, for the propagation of wildlife, fish and aquatic life, and for domestic , agricultural, industrial, recreational and other legitimate uses.

C. We must achieve and maintain safe drinking water for the public which will protect human health and safety.

D. We must control the generation, transportation, treatment, storage and disposal of hazardous waste to protect the public health, safety and welfare, protect the environment, prevent the pollution of air, water, soil and other natural resources of the state.

E. We must conserve resources as far as possible by recycling and by reducing our consumption.

F. We must establish markets for recycled products such as paper, aluminum, steel, glass and composted materials. This can be done by altering our purchasing practices.

G. We must improve our urban environment. This includes better housing, more neighborhood facilities, reduction of air and noise pollution, and better planning.

H. We must not try to master our environment but master our desires and judgement with respect to the uses of our environment.

III. Environmental Systems and Interactions

A. Domestic Activity

1. Household hazardous waste is generated in small amounts and disposed of by each and everyone of us. This action can affect land, air and water quality.
2. Garbage is currently generated at the rate of nearly 3.5 lbs/person/day and disposed of in landfills and through garbage disposals to our wastewater treatment plants. These actions can

affect the surface water, ground water, air quality and land use.

3. Natural waste is disposed through the sewer systems and septic tanks to surface water or the land.
4. Combustion waste from our automobiles, fireplaces and wood stoves affect air quality.

B. Industrial Activity

1. Waste is generated as a by product from manufacturing processes and can take many forms.
    a. Combustion which produces many by-products which can harm man directly or indirectly and cause problems for our aquatic and plant life.
    b. Wastewater which can directly affect the quality of the surface and ground water by being disposed of directly into streams or injected below the surface of the land. Also, wastewater which mixes with the domestic waste, if not properly treated can be toxic to the organisms in the domestic waste treatment process which in turn effects the surface water quality.
    c. Hazardous waste generated and exempt from environmental controls can affect landfills which in turn can affect the quality of ground water and may eventually affect surface water.
    d. Hazardous waste that is generated in sizeable quantities and improperly stored, treated or disposed of can cause problems with air and water quality.
    e. Non-hazardous or solid waste disposed of can cause problems by increasing the land needed

for disposal and may cause problems in the community landfills by interacting with domestic waste and causing other by-products.

2. Toxic materials are used in manufacturing and the home.
    a. Improperly stored chemicals can be dangerous and can affect the air, land or water quality and all life.
    b. Improper information on toxic chemicals used in manufacturing can cause problems via various pathways and under various conditions.

C. Agricultural Activity can generate harmful waste.
1. Improper farming methods can add sediment and attached chemicals to surface water.
2. Improper use of chemicals can affect surface water or ground water.
3. Improperly disposed of farm chemicals can cause ground and surface water quality problems.

IV. Environmental Practices and Alternatives

A. Air Quality
1. Smokestacks
    a. Removal Devices
        Electrostatic Precipitators
        Fabric Filters
        Wet Scrubbers
        Dry Scrubbers
    b. Alternatives
        Audit manufacturing process and reduce pollutant generation and change chemicals, where possible.
2. Vehicle Exhausts
    a. Control Devices
        Catalytic Converters
    b. Alternatives
        Walk
        Bicycle

- Car Pool
- Mass Transit

3. Teepee Burners
    - a. Control Devices
        - Dampers
        - Blowers
    - b. Alternatives
        - Automate to reduce woodwaste.
        - Use woodwaste in boiler.
        - Ship woodwaste to users of woodwaste such as particle board manufacturers.
4. Wood and Coal Stoves and Fireplaces
    - a. Control Devices
        - Dampers
        - Catalytic Burners
        - Burning Methods
    - b. Alternatives
        - Use seasoned and dry wood only.
        - Burn only when needed.
        - Change burning methods.
        - Add pollution control device.

B. Solid and Hazardous Waste

1. Disposal Methods
    - a. Landfills
        - Control Mechanisms
            - Liners
            - Caps
            - Leachate Collection
            - Operation during filling
                - Compaction
                - Daily Cover
    - b. Incinerators
        - Control Mechanisms
            - Wet Scrubbers
            - Dry Scrubbers
            - Fabric Filters
            - Burn Temperatures
    - c. Storage
        - Control Mechanisms
            - Lined sites
            - Permits
            - Safe Structures
            - Length of Time

Record Keeping

d. Treatment

Control Mechanisms

Lined sites

Permits

Operation

Air Quality Controls

2. Alternatives

a. Reduce Amount of Waste

Selective purchasing, such as buying only in bulk for certain goods, using more recyclable materials, checking products for toxic materials, etc.

Recycle at home, such as yard waste for composting.

b. Use less toxic chemicals at home and in business

c. Collection Days for Household Hazardous Waste

d. Establish Markets for Recyclables

e. Separation of Waste

Aluminum

Glass

Plastic

Paper

Yard Waste

f. Recycle/Reuse

g. Compost

C. Wastewater

1. Industrial

a. Control Mechanisms

Pretreatment

Send to Domestic Facility

Reduce Flow and Concentration

b. Alternatives

Process Alterations

Operations Alterations

2. Domestic

a. Control Mechanisms

Lagoons

Wetlands

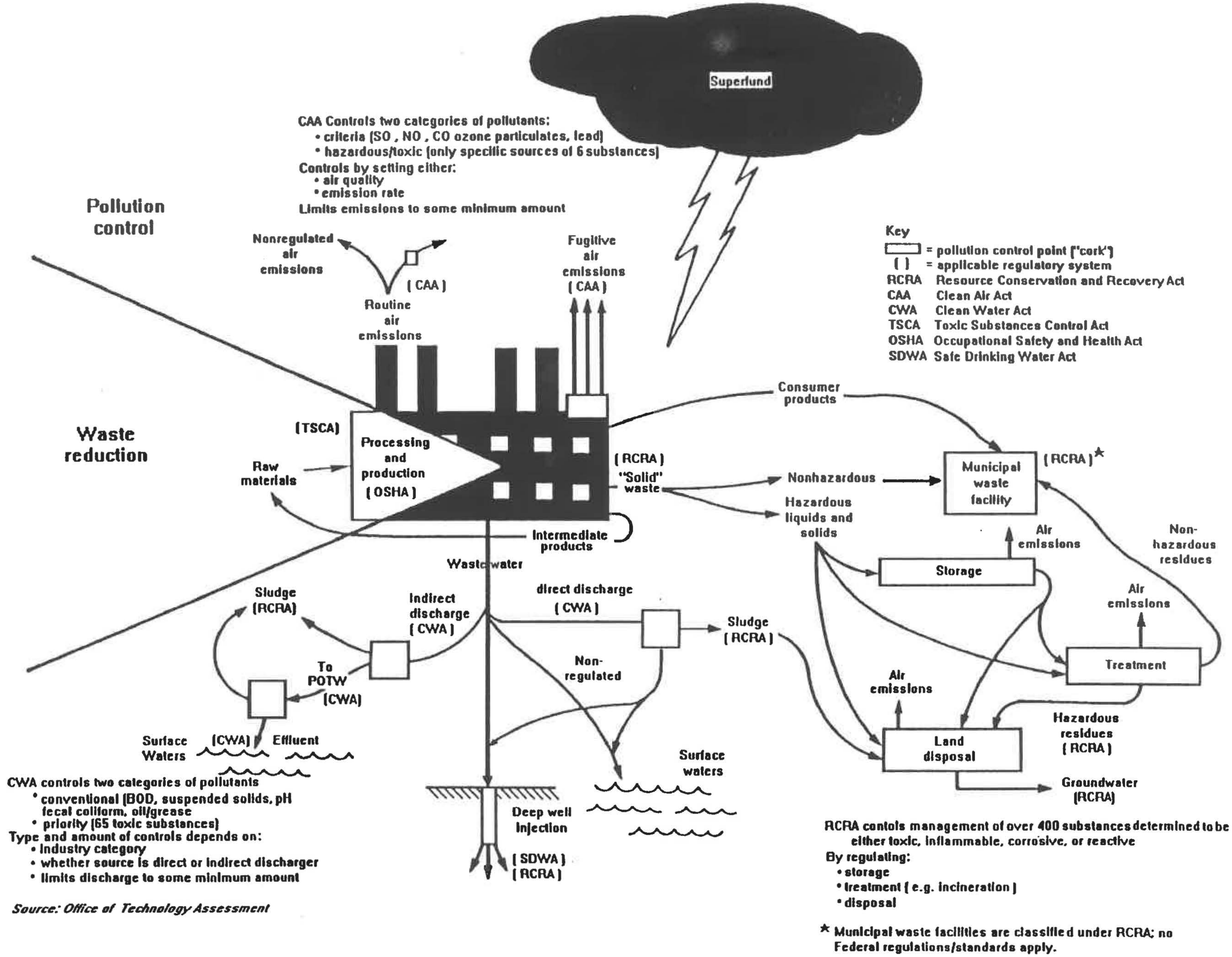
Mechanical Plants

b. Alternatives

Water Saving Devices
Compost Food Waste Rather than
Using a Garbage Disposal

3. Agricultural
   a. Control Mechanisms
      Feedlot Lagoons
      Fertilizer and Pesticide
      Application Methods
      Soil Conservation Practices
      Water Conservation Practices
   b. Alternatives
      Operation Changes
      Conservation Reserve Programs

Waste Reduction vs Pollution Control



Source: Office of Technology Assessment

EDUCATION AND INFORMATION DELIVERY FRAMEWORK

Public Information

- -Newsletter
- -Fliers
- -Brochures
- -Speakers
- -Videotapes/PSAs

Training

- -Department Staff
  - -Orientation
  - -Cross Program
  - -Inspector Training
    - -Safety (basic and program specific)
    - -Methods & Techniques
    - -Records
    - -Enforcement (Civil & Criminal)
    - -Air Quality Certification
- -City/County Operator Training
  - -Water
  - -Wastewater
  - -Solid Waste
    - -disposal
    - -recycle
  - -Air Quality Certification

Education

- -K through 12
  - -Speakers for Classroom
  - -Module Development
  - -Teacher In-service for module delivery
  - -Special A/V packets beyond modules
  - -Computer Games and Programs
  - -Board Games
- -Adult Education
  - -Speakers for Organizations
  - -Module Development for Organizations
  - -In-service Training for Organizations

APPENDIX B

WORD FIND
PUZZLES

AIR QUALITY WORD FIND

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

ACID RAIN
AIR
ATMOSPHERE
COMBUSTION
EMISSIONS

LEAD
OXYGEN
OZONE
PARTICULATE
POLLUTANT

AIR QUALITY WORD FIND

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

CARBON MONOXIDE
CLEAN AIR ACT
CONTAMINANT
FLY ASH
FOSSIL FUEL
GLOBAL WARMING
GREENHOUSE EFFECT
HYDROCARBONS
INHALATION
OZONE LAYER
PARTICLES
SMOG
SULFUR DIOXIDE
THERMAL INVERSION

WATER QUALITY WORD FIND

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

AQUIFER
CHEMICALS
CONSERVE
DROUGHT
EVAPORATE

LAKE
OCEAN
RAIN
RIVER
WATER

WATER QUALITY WORD FIND

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

ALGAE BLOOMS
CISTERN
CONTAMINATION
DIRECT RUNOFF
EROSION
FLOCCULATION
GROUND WATER
HYDROLOGIC CYCLE
MINERALS
NATURAL RESOURCE
PERCOLATE
PERMEABLE
PRECIPITATION
SATURATION

SOLID WASTE WORD FIND

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

COMPOST
HAZARDOUS
LANDFILL
RECYCLE
REDUCTION

REUSE
SOLID WASTE
TOXIC
TRASH
YARD WASTE

SOLID WASTE WORD FIND

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

AERATION
BIODEGRADABLE
DECOMPOSITION
EPA
GARBAGE
INCINERATE
INDUSTRIAL WASTE

LEACHATE
NON TOXIC
RECYCLE
RESOURCE RECOVERY
SANITARY LANDFILL
SOURCE REDUCTION
WASTE STREAM

SOLID WASTE WORD FIND

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

ALUMINUM
COLLECTION SITE
COMPOSTABLE
CONSUMER AWARENESS
DISPOSAL
FERTILIZER
HAZARDOUS WASTE
HOUSEHOLD WASTE
IRRITANT
MASS BURN
NON WASTE WATER
REFUSE
RENEWABLE RESOURCE
RESIDUE
SLUDGE
SOURCE SEPARATION

SOLID WASTE WORD FIND

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

BIOCONCENTRATION
CORROSIVE
DIOXIN
ENERGY RECOVERY
HUMUS
INORGANIC
LITTER
PACKAGING

PESTICIDE
PLASTICS
RECYCLING CENTER
REFUSE DERIVED FUEL
SOLIDIFICATION
WASTE REDUCTION
WASTE TO ENERGY
VOLUME

AIR QUALITY WORD FIND

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

ACID RAIN
AIR
ATMOSPHERE
COMBUSTION
EMISSIONS
LEAD
OXYGEN
OZONE
PARTICULATE
POLLUTANT

AIR QUALITY WORD FIND

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

CARBON MONOXIDE
CLEAN AIR ACT
CONTAMINANT
FLY ASH
FOSSIL FUEL
GLOBAL WARMING
GREENHOUSE EFFECT

HYDROCARBONS
INHALATION
OZONE LAYER
PARTICLES
SMOG
SULFUR DIOXIDE
THERMAL INVERSION

WATER QUALITY WORD FIND

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

AQUIFER
CHEMICALS
CONSERVE
DROUGHT
EVAPORATE

LAKE
OCEAN
RAIN
RIVER
WATER

WATER QUALITY WORD FIND

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

ALGAE BLOOMS
CISTERN
CONTAMINATION
DIRECT RUNOFF
EROSION
FLOCCULATION
GROUND WATER
HYDROLOGIC CYCLE
MINERALS
NATURAL RESOURCE
PERCOLATE
PERMEABLE
PRECIPITATION
SATURATION

SOLID WASTE WORD FIND

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

COMPOST
HAZARDOUS
LANDFILL
RECYCLE
REDUCTION

REUSE
SOLID WASTE
TOXIC
TRASH
YARD WASTE

SOLID-WASTE WORD FIND

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

AERATION
BIODEGRADABLE
DECOMPOSITION
EPA
GARBAGE
INCINERATE
INDUSTRIAL WASTE
LEACHATE
NON TOXIC
RECYCLE
RESOURCE RECOVERY
SANITARY LANDFILL
SOURCE REDUCTION
WASTE STREAM

SOLID WASTE WORD FIND

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

ALUMINUM
COLLECTION SITE
COMPOSTABLE
CONSUMER AWARENESS
DISPOSAL
FERTILIZER
HAZARDOUS WASTE
HOUSEHOLD WASTE

IRRITANT
MASS BURN
NON WASTE WATER
REFUSE
RENEWABLE RESOURCE
RESIDUE
SLUDGE
SOURCE SEPARATION

SOLID WASTE WORD FIND

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

BIOCONCENTRATION
CORROSIVE
DIOXIN
ENERGY RECOVERY
HUMUS
INORGANIC
LITTER
PACKAGING

PESTICIDE
PLASTICS
RECYCLING CENTER
REFUSE DERIVED FUEL
SOLIDIFICATION
WASTE REDUCTION
WASTE TO ENERGY
VOLUME

APPENDIX C

CLIP ART

Save! Sort! Recycle!

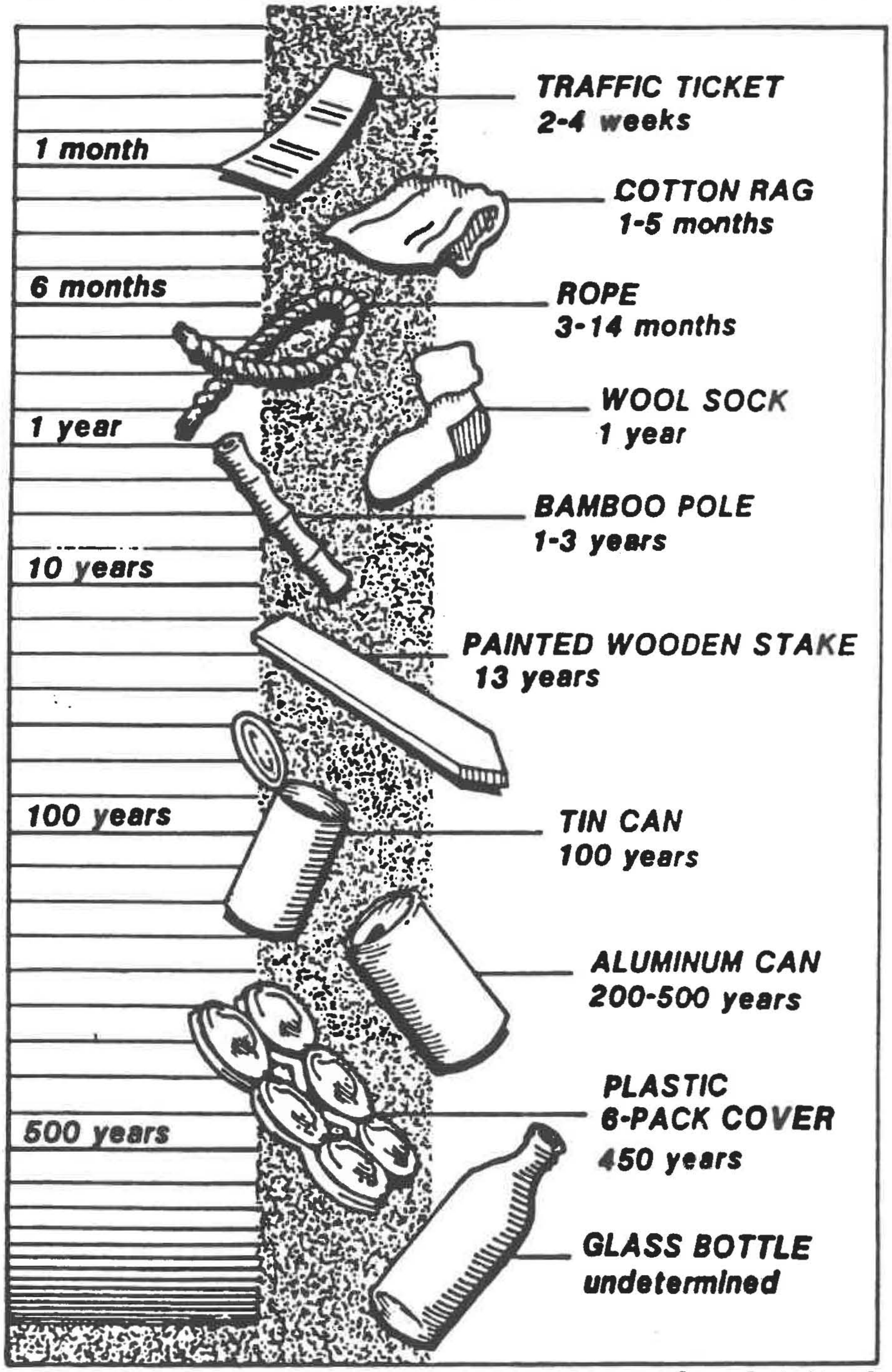
Color the recyclables in the boxes on this page. Then cut them out and paste them with the proper CAN MAN you made.

MATCH

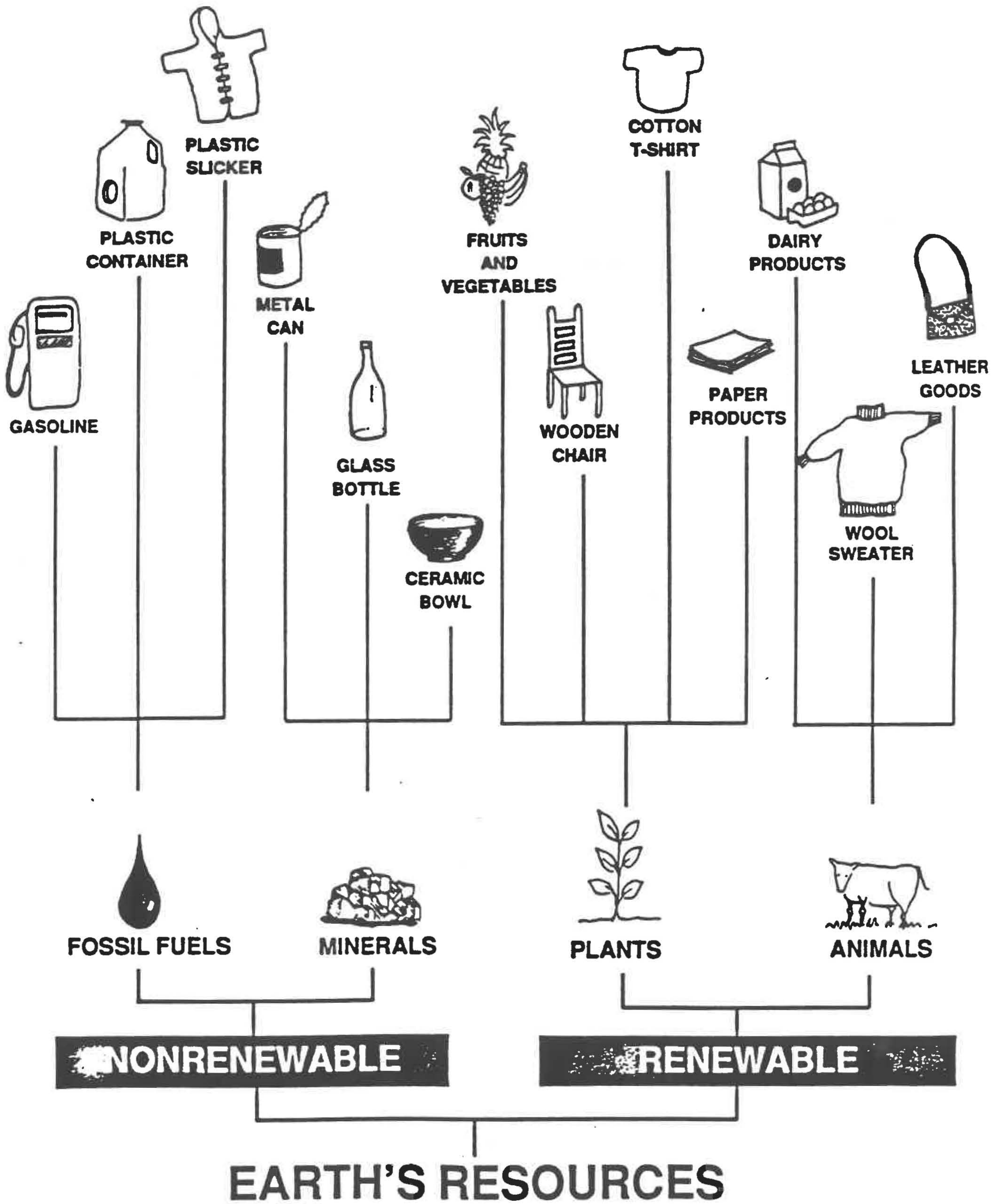
The plastic containers to the correct recycling can.

Enduring Litter

Litter at the roadside is ugly. How long it will stay before decaying may be an ugly surprise.



Source Book of Lists 2


PLASTIC SLICKER
PLASTIC CONTAINER
GASOLINE
METAL CAN
GLASS BOTTLE
CERAMIC BOWL
FRUITS AND VEGETABLES
COTTON T-SHIRT
WOODEN CHAIR
DAIRY PRODUCTS
PAPER PRODUCTS
LEATHER GOODS
WOOL SWEATER
FOSSIL FUELS
MINERALS
PLANTS
ANIMALS
NONRENEWABLE
RENEWABLE
EARTH'S RESOURCES


Together we CAN Make a Better World
THE CAN MAN


HEY KIDS LETS CAN THE TRASH
n.gordon


HOORAY FOR A CLEAN DAY!
n.gordon


n.gordon


Lets Care about our Land, Water, and Air!

WE CAN
REUSE • RECYCLE
REDUCE
FOR A BETTER WORLD

WE CAN BE PART OF THE CLEAN SCENE

JUST SAY "I CAN MAKE A DIFFERENCE"

WE CAN KEEP TRASH UNDER A LID!

YES WE CAN

MAKE A DIFFERENCE...

REDUCE • RECYCLE • REUSE

Lets Do It Together

REDUCE

RECYCLE

REUSE

I WEAR A TIE CUZ I'm A RESPECTABLE GUY!

I CAN HELP SO CAN YOU!

some say our world won't be a Good place to live...

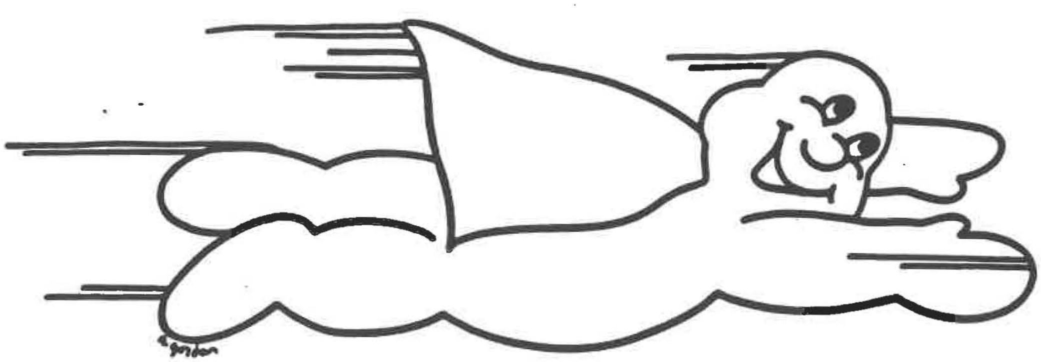
THATS GARBAGE

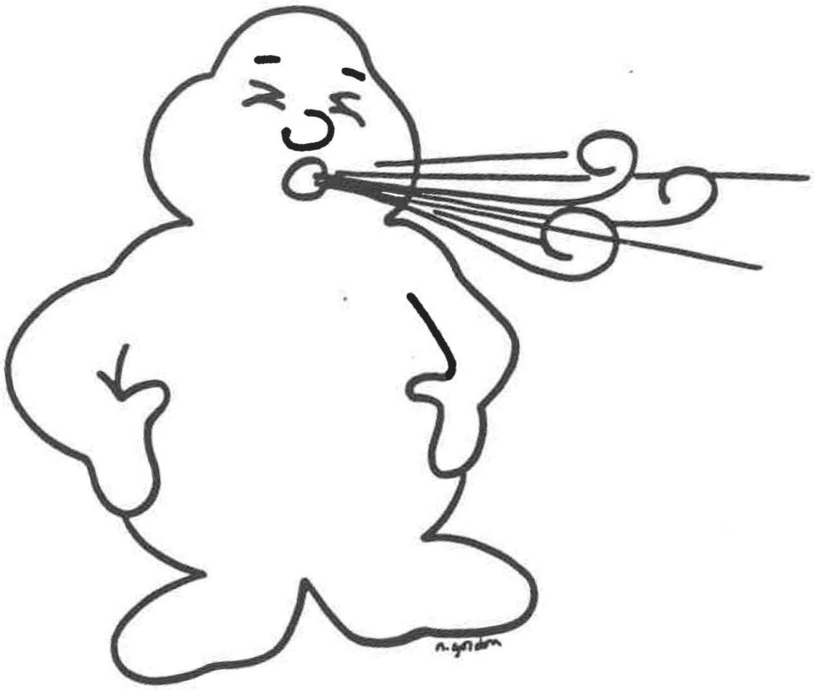
WE CAN CLEAN IT UP STARTING NOW!

REDUCE - RECYCLE

REUSE


SKY GUY
I CARE ABOUT CLEAN AIR!



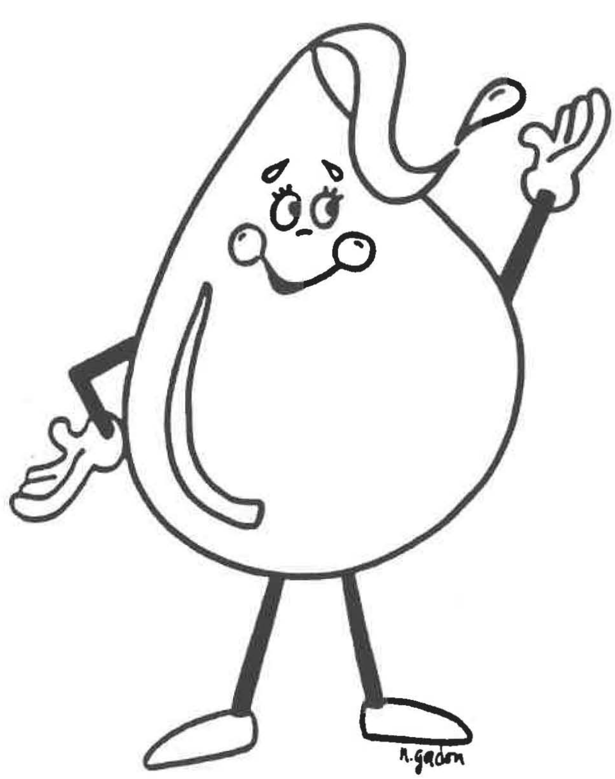


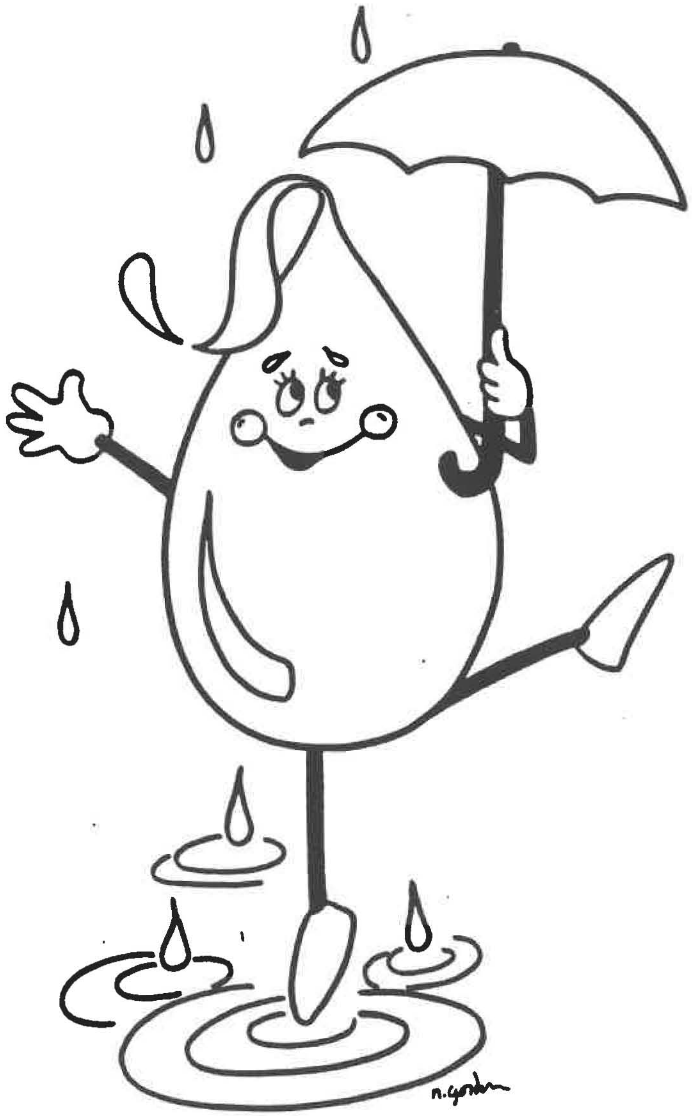

I'm a PROUD CLOUD
LUNG ALERT Someone's blow'n smoke
Don't Keep your head in a FOG help Keep our air clean!
Smoke makes me Choke

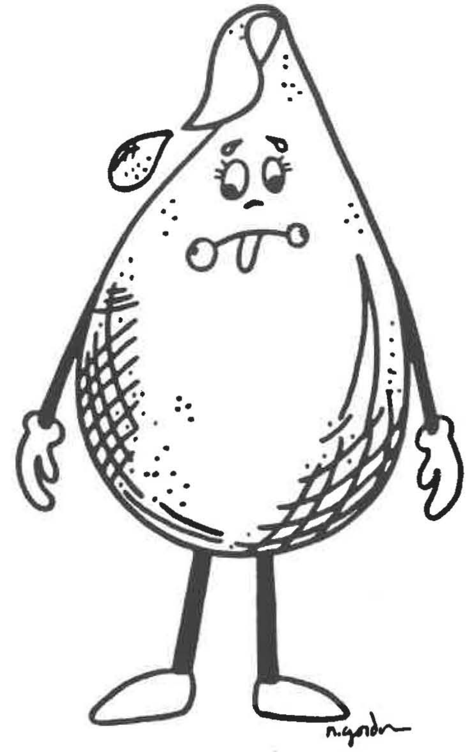

SKY
GUY


Breathe Deep in South Dakota!
When you look up look for me among the clouds is where I'll be.
Lets all CARE about clean AIR

Wendy Water

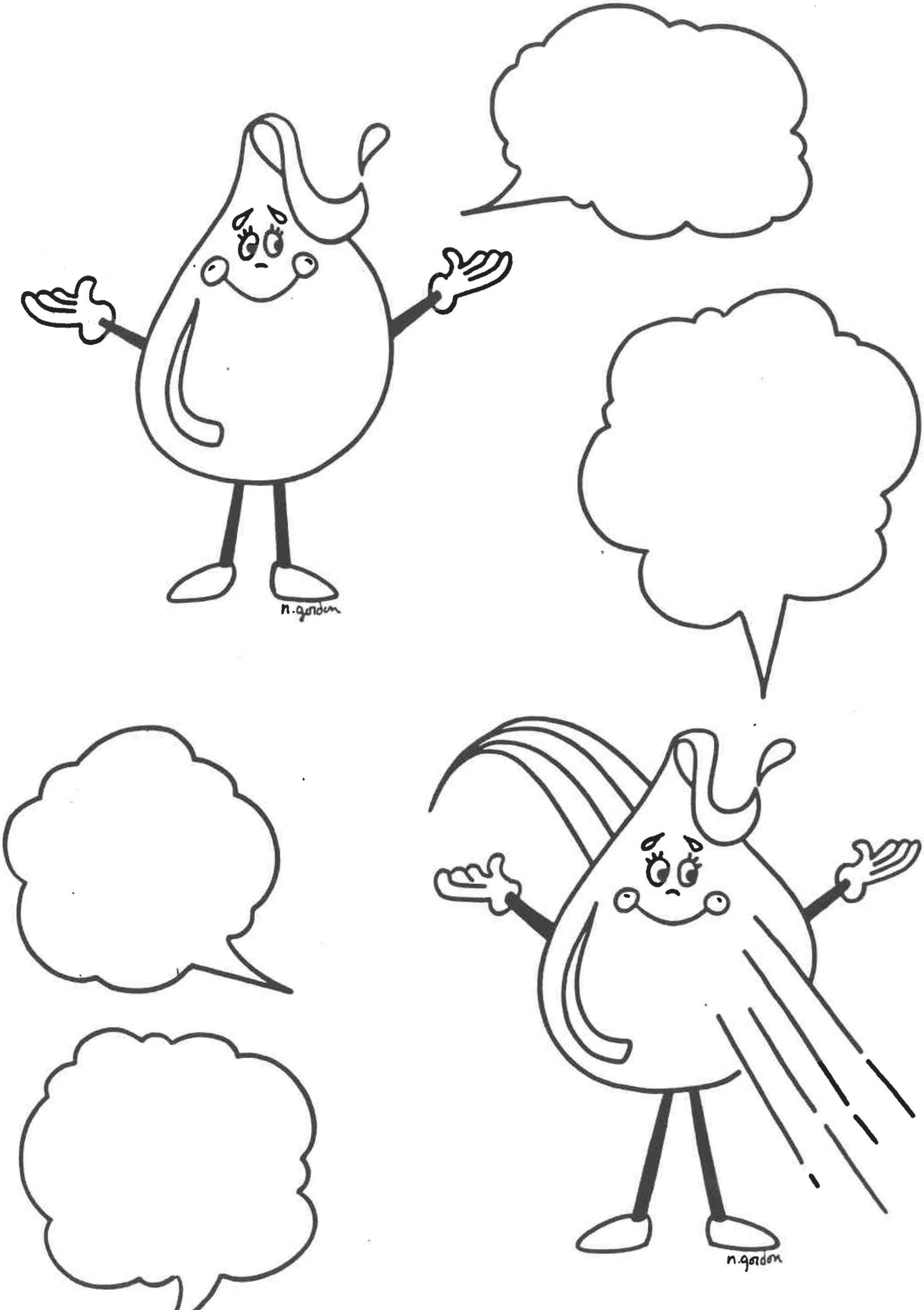



n.gordon


n.gordon

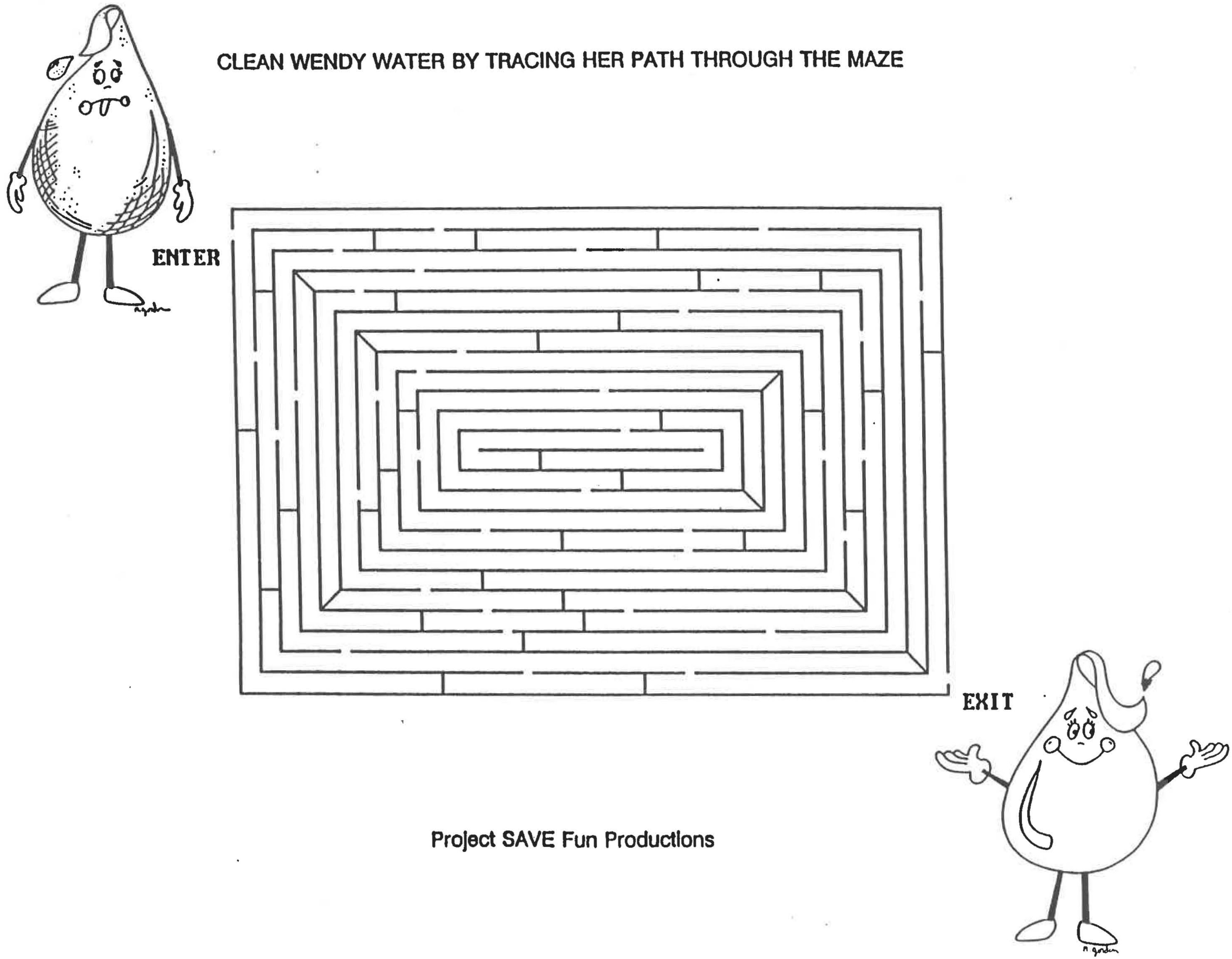

n.gordon


All Living Things need clean Water.


n.gordon
n.gordon

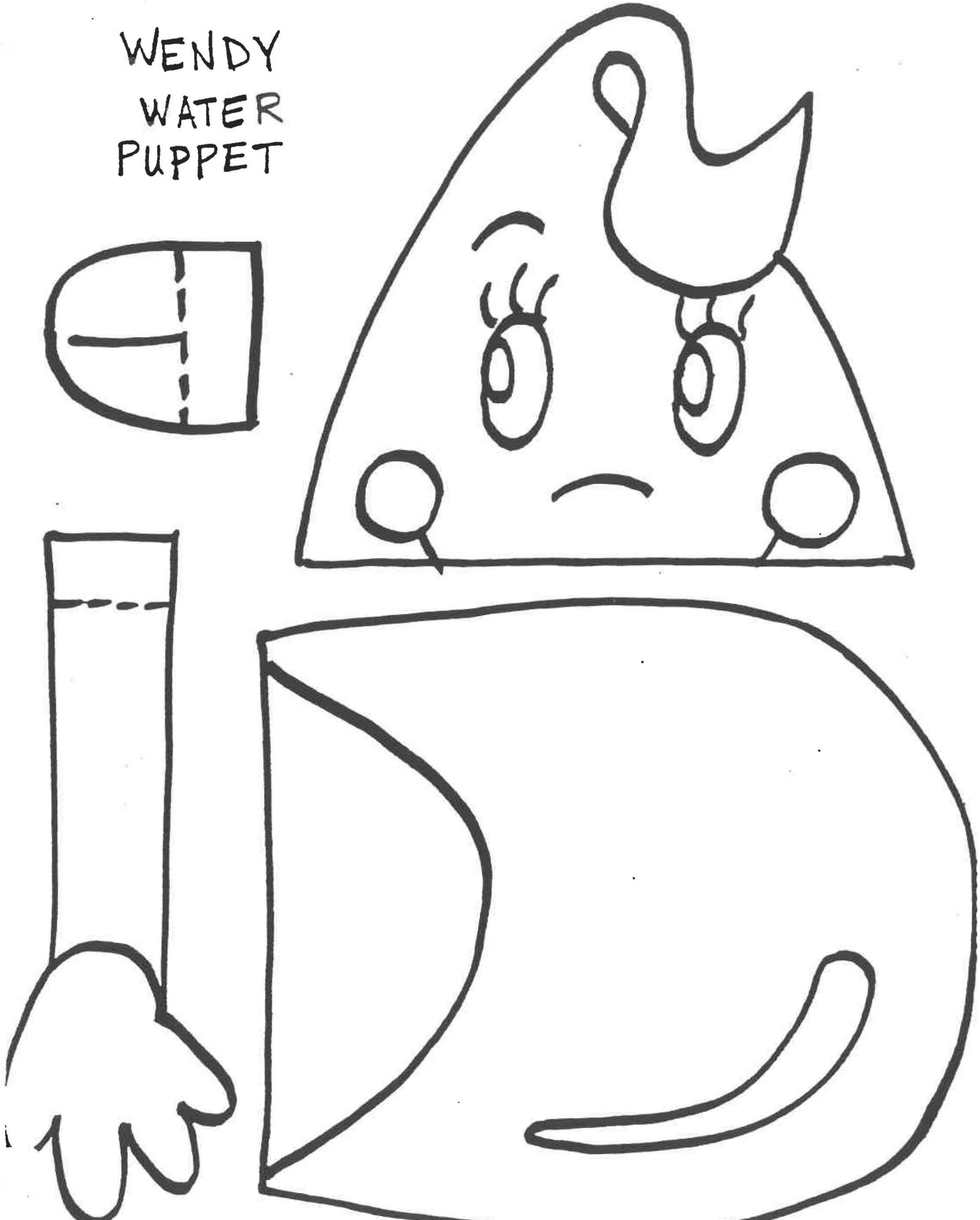

Clean Water is WONDERFUL.
Lets Keep our Water CLEAN!

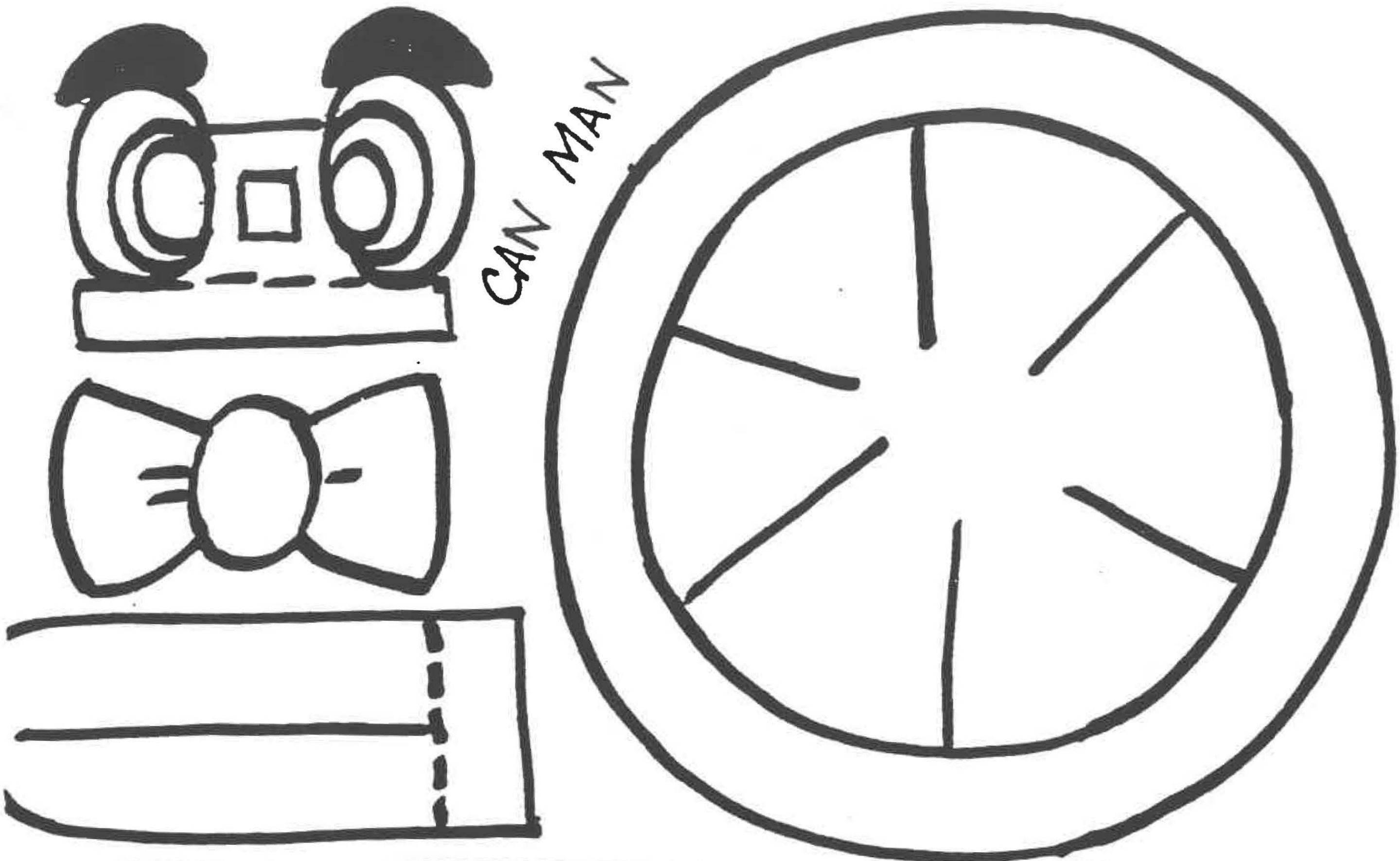
CLEAN WENDY WATER BY TRACING HER PATH THROUGH THE MAZE



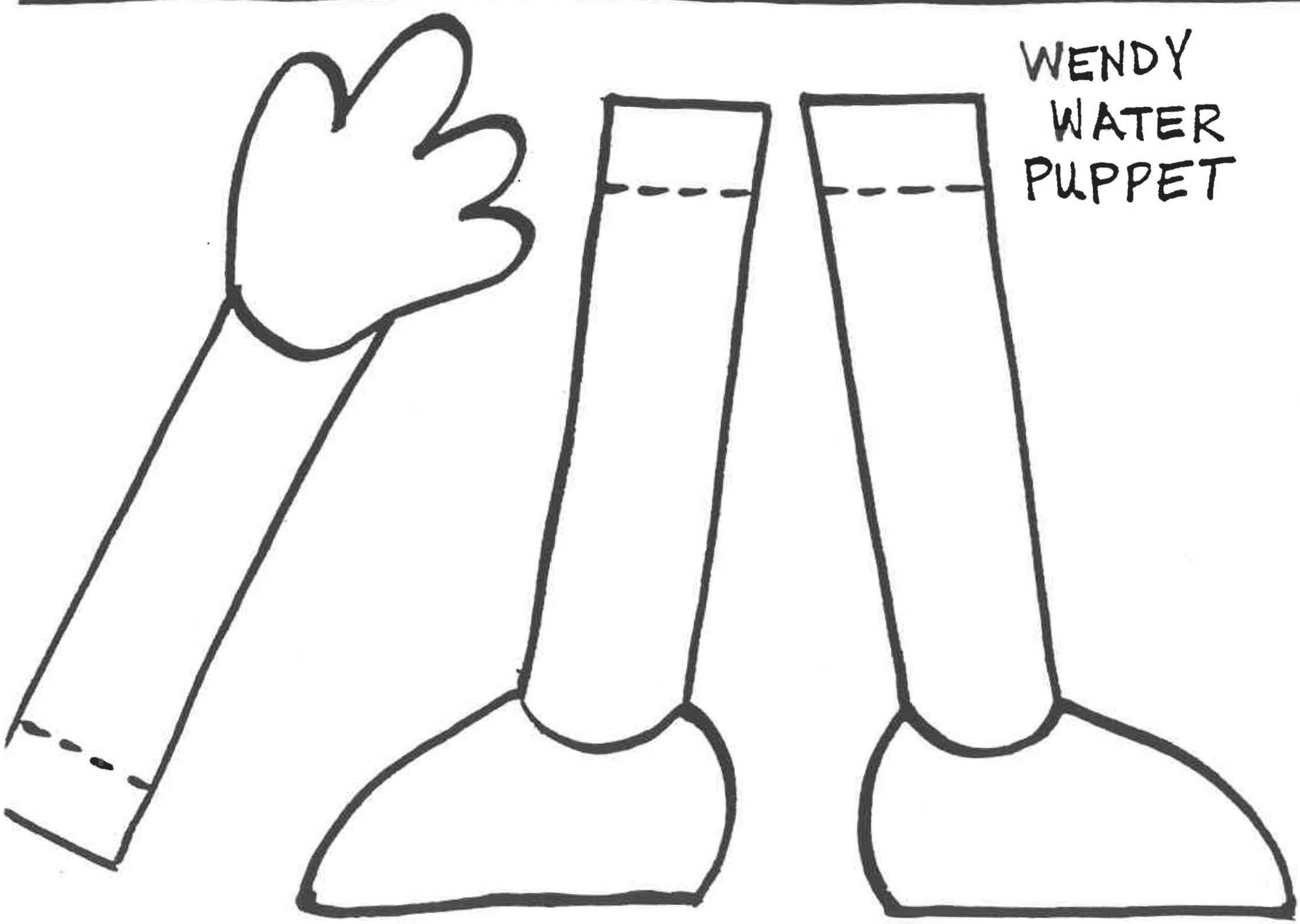
Project SAVE Fun Productions

WENDY WATER PUPPET



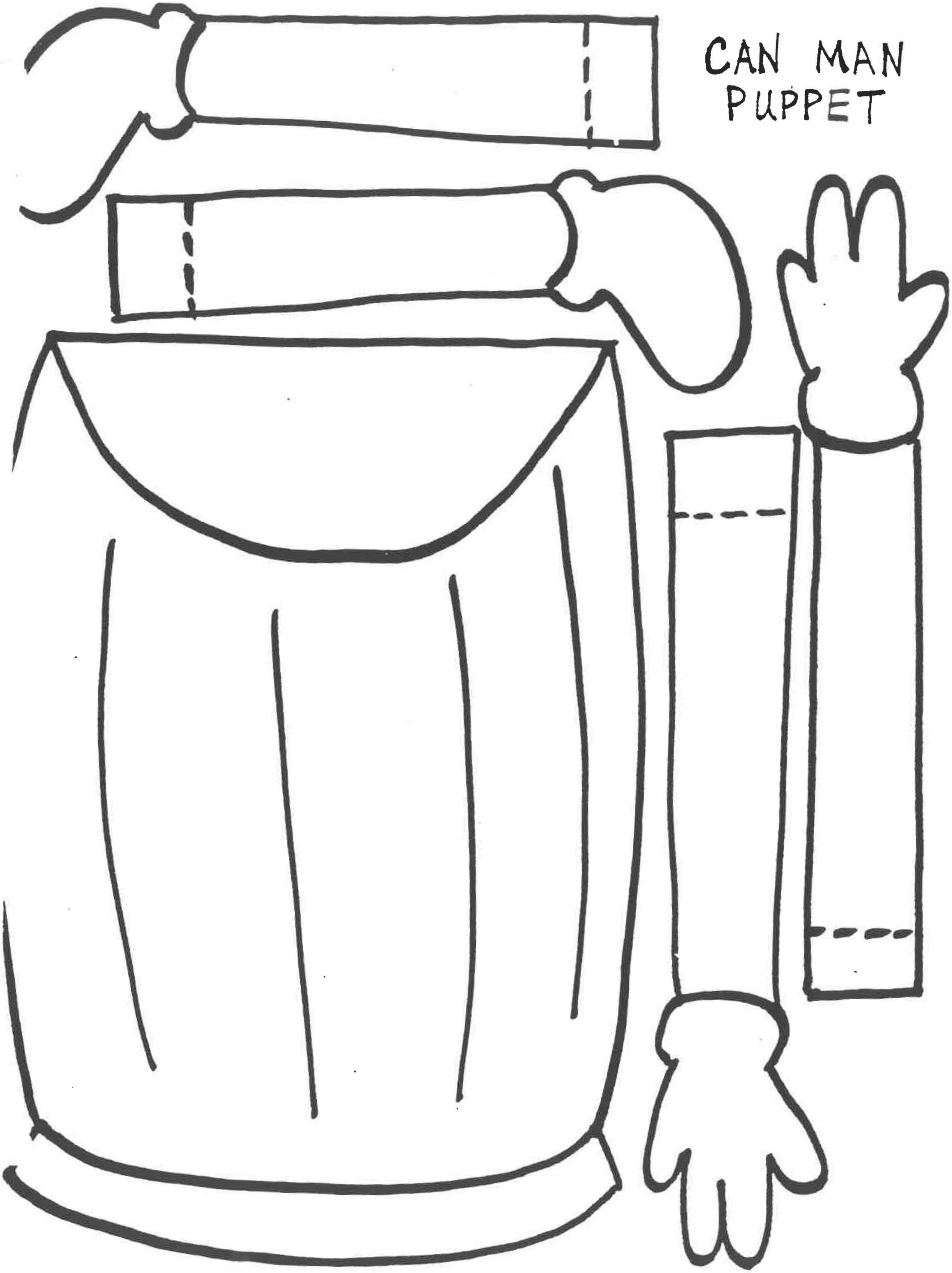


CAN MAN

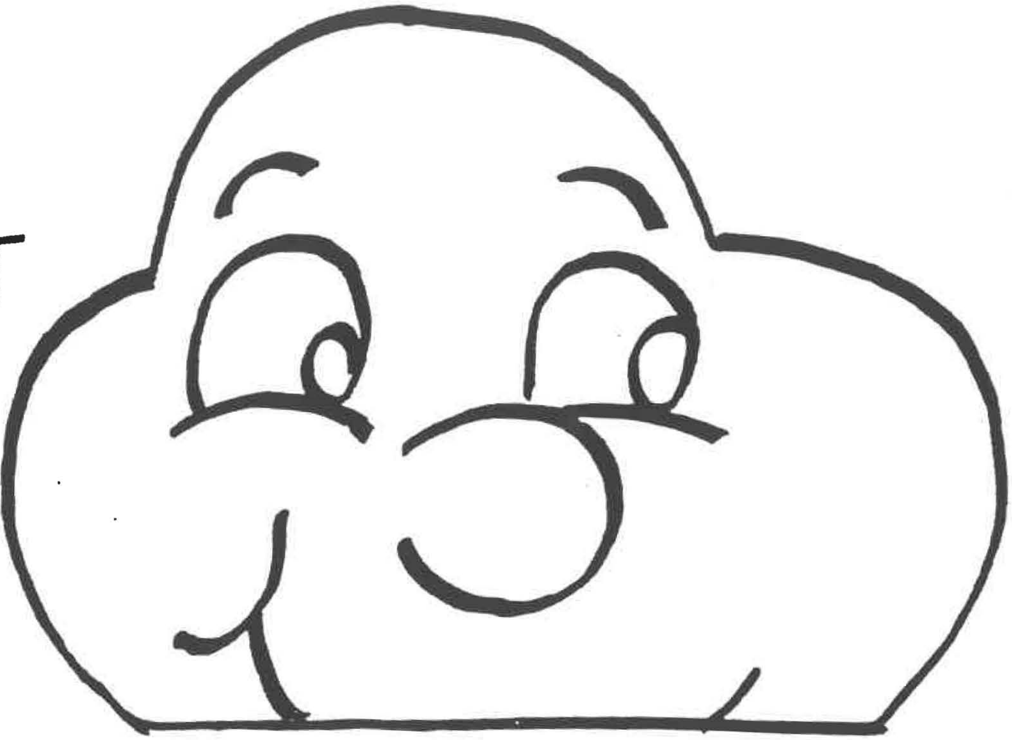


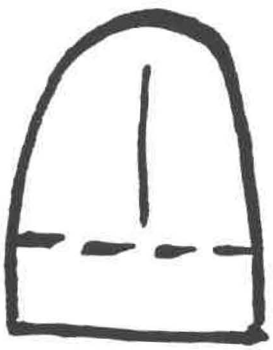
WENDY
WATER
PUPPET

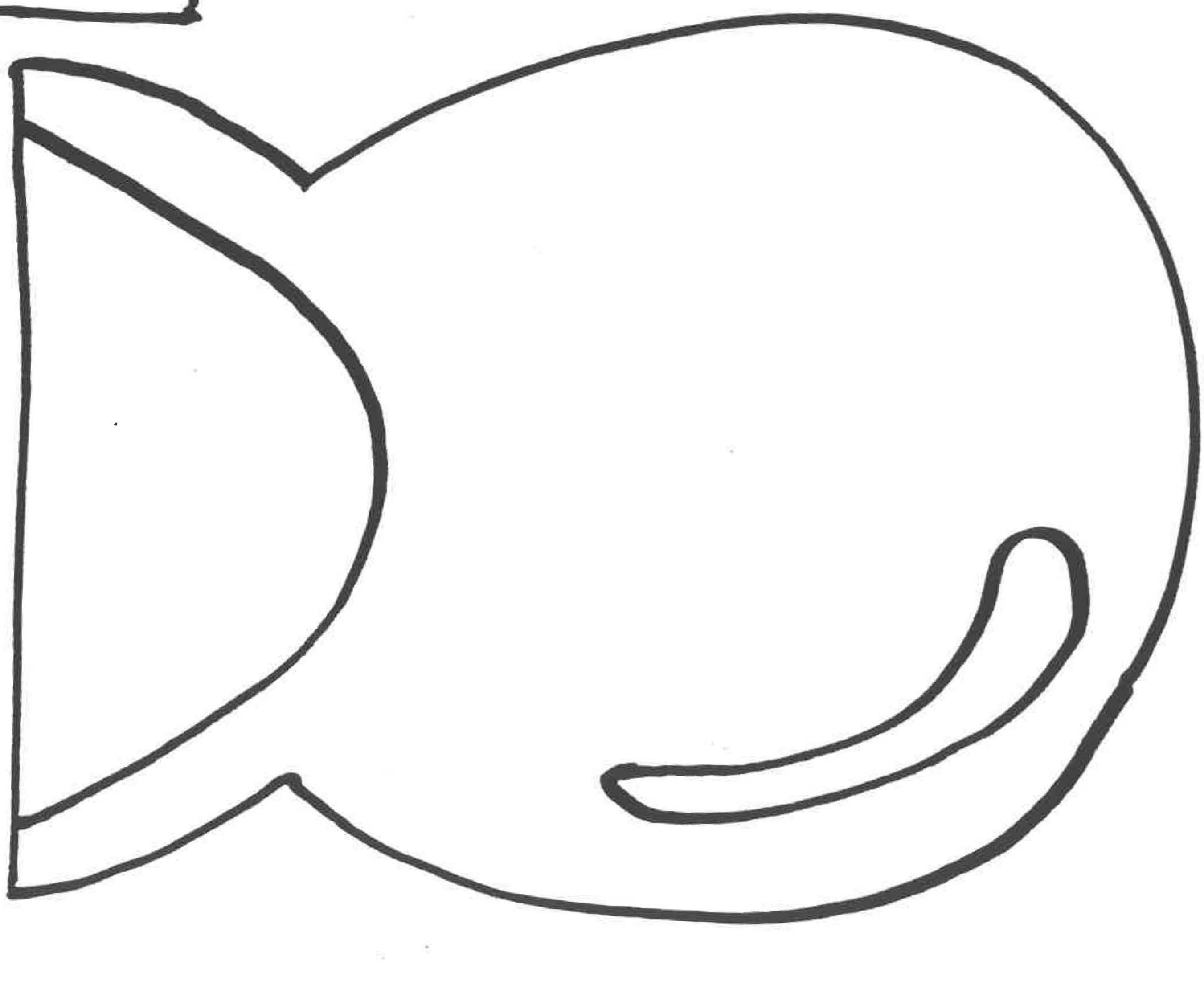
CAN MAN PUPPET

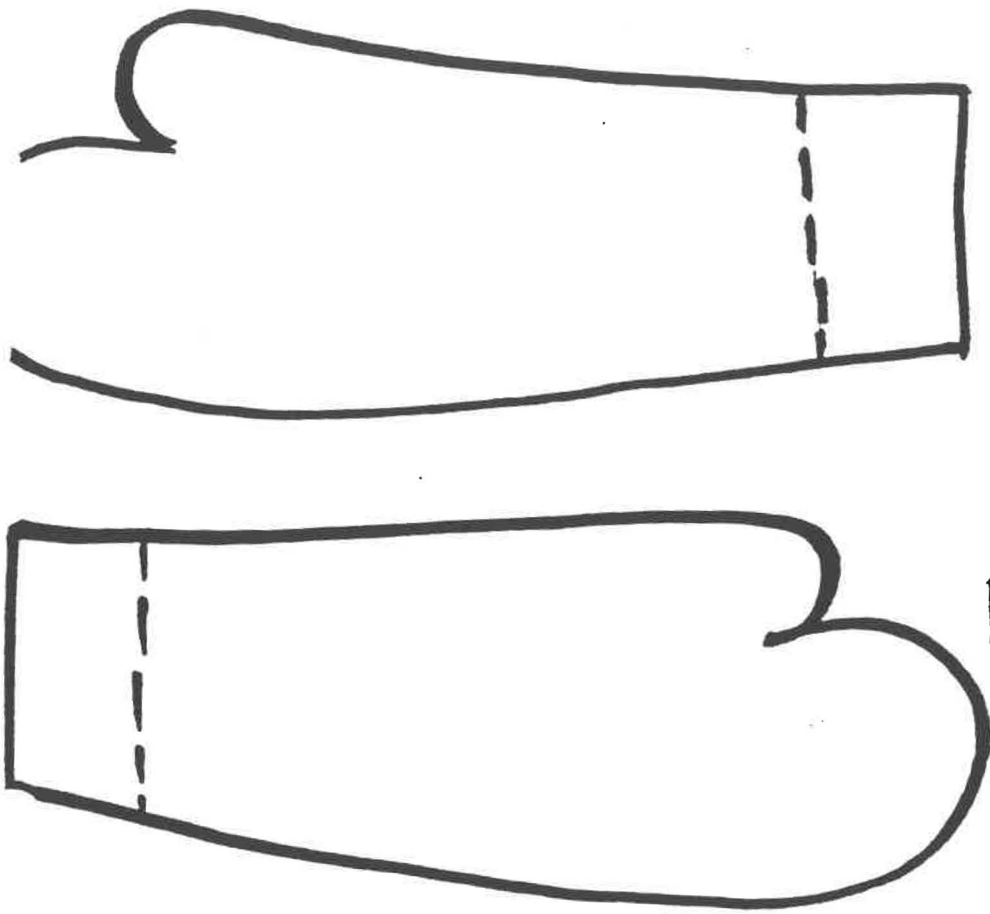


SKY GUY PUPPET

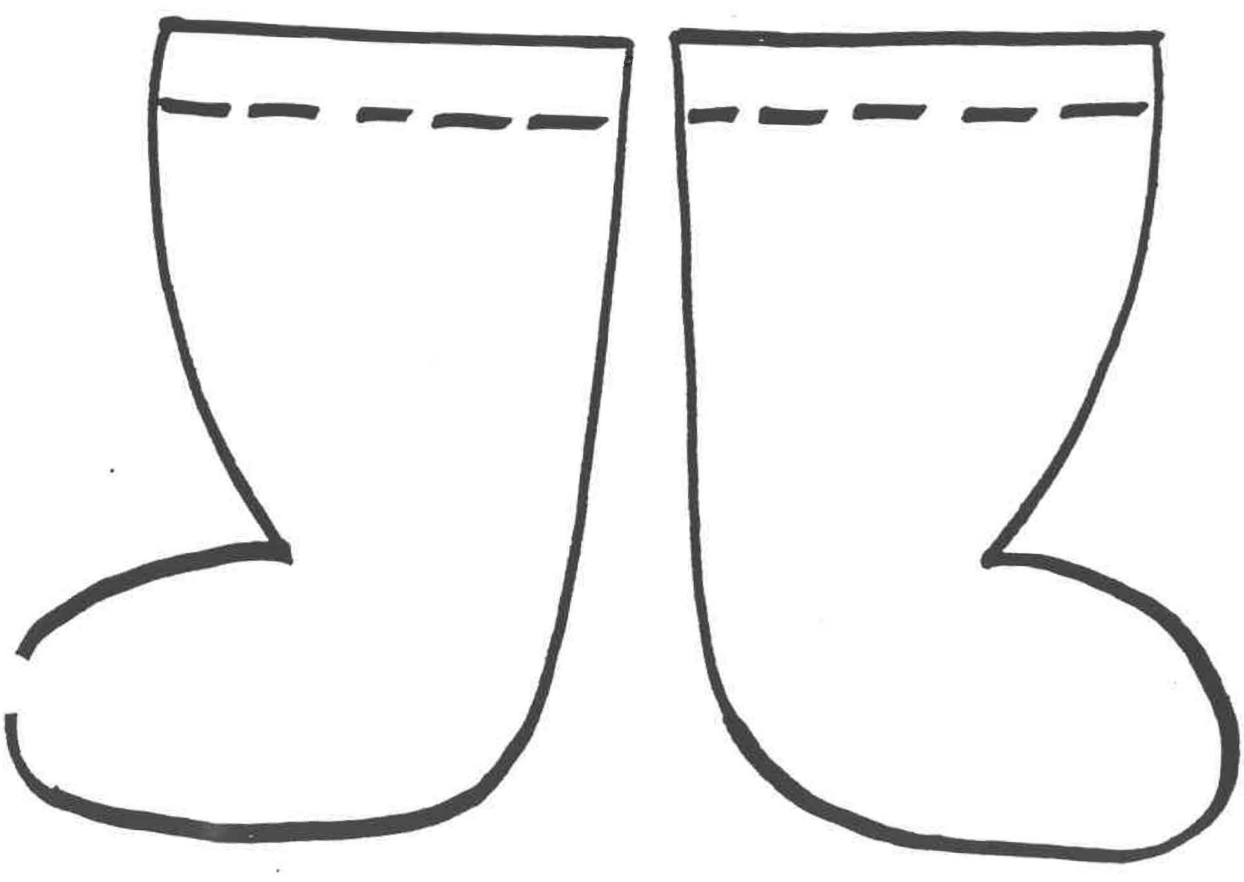








SKY
GUY
PUPPET



APPENDIX D

PAPER, PLASTIC, "TIN" CAN AND GLASS FACTS

PAPER FACTS

Grades of Recyclable Paper

If you are planning on establishing a paper recycling program in your school or community then the following information is important to know. This information is supplied by the American Paper Institute, 1250 Connecticut Avenue, Suite 210, Washington D.C. 20036.

Not all paper is the same. A grade system is used to facilitate buying and selling of recovered paper in markets. Individual grade definitions also specify quality standards for this "paper stock," a term used in the paper recycling business.

In most cases, sorted paper must be baled by recyclers. Bales may contain an average of one to ten percent "outthrows" (papers that are not appropriate for consumption as the grade specified) and "prohibitive materials" (foreign materials or contaminates that make the paper stock unusable). There are over 50 grades of paper that are generally divided into five categories as noted below.

☛ News: predominantly old newspapers (ONP), most contributed by private residences, along with the unprinted and over-issue news and other related grades

☛ Corrugated: includes old corrugated containers (OCC) that were used to ship merchandise to retail stores and homes, cuttings from the box factory, and kraft papers such as paper bags

☛ Mixed: a "catch-all" category for unsorted paper recovered from offices, homes and other establishments, such as colored papers envelopes, magazines, catalogs, food packaging, and other papers not classified elsewhere

☛ Pulp Substitutes: A combination of paper and paperboard trimmings from the paper mill and converting plants offering the highest quality fibber to recyclers

☛ High Grade De-inking: mostly bleached papers that have gone through a printing operation and discarded from a data processing center (e.g., computer printout paper), office recycling programs, and printing and converting operations; these grades generally require de-inking before used in new papermaking

Any recovered paper must be clean! Paper contaminated by foods, liquids, adhesives or other foreign substances are usually not acceptable.

PLASTIC FACTS

The following information is taken from the Facts about plastic bottles reference guide published by the Plastic Bottle Institute, The Society of the Plastics Industry, Inc., 1275 K Street, NW, Suite 400, Washington, DC 20005 and from Environmental Issues: Plastics Recycling, James River Corporation, P.O. Box 6000, RiverPark, Norwalk, Connecticut 06856-6000.

COMPOSITION/APPLICATIONS

Raw Material The principal raw materials used for plastic bottles come from the olefin chemicals ethylene and propylene which are derived almost entirely from natural gas and crude oil and the aromatic chemical benezene which is predominantly petroleum based.

Plastic products are 100% recyclable, providing there is the infrastructure to collect, sort and reuse the materials.

There are **seven** different categories of plastics. These are classified by the resin from which they are produced.

PET -- polyethylene terephthalate has clarity and the barrier properties to resist permeation of oxygen, water vapor and carbon dioxide, enabling the use of PET to package boil-in-bag foods, meat, cosmetics and carbonated soft drinks.

HDPE -- high-density polyethylene provides the necessary moisture barrier for milk bottles, the high chemical resistance necessary to contain liquid detergents, shampoos, pharmaceutical products, juices, bottled water, antifreeze and may other household and industrial products.

PVC -- polyvinyl chloride has the clarity, chemical resistance and oxygen barrier qualities required to package floor polishes, shampoos, edible oils, mouth washes and liquors.

LDPE -- low-density polyethylene is lightweight, tough and squeezable which are all desirable attributes in packaging toiletries and cosmetics.

PP – has a high heat resistance, stiffness and contact clarity and is thus used to bottle "hot-filled" foods, such as syrup.

PS – Has excellent clarity and rigidity for use in packaging tablets, salves, ointments and other products not sensitive to oxygen and moisture.

OTHER – Transparent and have outstanding oxygen and carbon dioxide barrier properties for packaging food, beverages, edible oils and meats.

Products Packaged In Plastic Bottles by Categories

51% Food/beverage
13% Household Chemicals
13% Medicinal
10% Toiletries/cosmetics
13% Miscellaneous
(U.S. Dept. of Commerce, 1986)

Plastic recycling Worksheet

Plastic Container Code	Kind of plastic	Recycle?	Products in my home that are packaged in this material.
1 PETE	polyethylene terephthalate example: beverage containers	easy to recycle	
2 HDPE	high-density polyethylene example: milk jugs	easy to recycle	
3 V	vinyl or polyvinyl chloride example: shampoo bottles	can be recycled	
4 LDPE	low-density polyethylene example: cosmetic packaging	can be recycled	
5 PP	polypropylene example: syrup containers	difficult to recycle	
6 PS	polystyrene or Styrofoam® example: cups for hot drinks.	difficult to recycle	
7 Other	other or mixed materials	difficult to recycle	

TIN (STEEL) CAN FACTS

Most "tin" food and beverage cans that you have at home are really 99% steel and 1% tin. The use of these types of cans occurred as long ago as 1839. Modern "tin" cans are constructed of steel for strength and then coated on both sides to resist corrosion.

Recycling of cans reduces the nations need for importing tin and means less ore needs to be mined, thus reducing the impact on the natural resources and the environment. Every ton of steel recycled saves *2500 pounds of iron ore, 1000 pounds of coal, and 40 pounds of limestone.*

As of late 1988 15% of all steel cans being produced in the U.S. were being recycled. The steel **beverage** cans recycled reached 30.1% by mid-1990. Before starting a steel can recycling program you should call the Steel Can Recycling Institute 800-876-SCRI. The Institute will be able to tell your the nearest location of a steel recycling facility or a detinning facility. The latter is a facility that removes the tin for reuse and sends the steel on to the mills.

If you can, no pun intended, find a market for your "tin" cans then you will need to educate the public as how to prepare the cans for recycling. Your buyer will be able to supply you with the information on how the cans are to be shipped. Labels may be left on, and cans do not have to be flattened or have the ends removed if your buyer has the proper equipment. If not, your local program may require you to flatten the cans for ease of collection and for shipping purposes. If the lid is removed remember that it is also recyclable. The lid and bottoms if not completely removed can be folded into the can and then when the can is flattened both ends are safely tucked into the can. If you do remove the ends of the cans be sure to check with the buyer how they will accept the ends.

The only preparation required for food and beverage cans is they should be rinsed. TO save water do this in the dishwasher if you have one or wash as the last item in the soapy water if you are doing the dishes by hand. Store up the cans until you have a curbside pick up or to take to the drop off center.

Paint and aerosol cans can be recycle if they are empty and dry. Proper education of the public is absolutely necessary before collecting these recyclable cans.

Paint cans **must be emptied**; there cannot be a liquid layer of paint on the bottom of the cans. A thin skin of paint on the sides and the bottom of the cans is alright; they do not have to be scrubbed clean. The skin **must be dry** before collection or drop off.

Empty aerosol cans that hold common household products such as whipping cream, hairspray, spray paint, deodorant, or shaving cream may also be recycled. Do not try to flatten or handle in large volumes!
Other steel products that can be recycled are caps and crowns, for non-steel containers,

such as bottles and jars, including the ends on paper frozen juice containers. To determine if they are steel simply use a refrigerator magnet. If the magnet sticks to the material it is steel.

One other fact is when considering all steel waste the recycling rate is 66%; if you are considering a can recycling program you may want to consider extending this to other steel products to provide the best benefit for the environment.

Source: Steel Can Recycling Institute

GLASS FACTS

Glass was invented over 3500 years ago, Egyptians and Mesopotamians glazed pots for use as containers. In 200 BC the Babylonians discovered the art of glass blowing.

The basic ingredient of glass is white sand, almost pure silica. Soda is added to help the sand melt and create an soft mixture. Lime is added to stabilize the mixture and keeps it from dissolving in water. This mixture is then heated to around 2800 degrees Fahrenheit, until it is completely dissolved and transparent. The mixture is cooled to around 1800 degrees Fahrenheit. At this temperature the mixture can be blown, cast, rolled or extruded.

Recycled glass has been used in the above mixture for centuries. Glass is broken before being shipped to the manufacturer. The broken glass is called **cullet**. At the glass factory the cullet is sent through a magnetic device which removes rings form the bottles and through a vacuum process to remove plastic coatings and paper labels. Collection programs should keep the glass as free from contaminants as possible. Contaminants are metal caps, lids, stones dirt and ceramics. Paper labels do not need to be removed as they burn off at high furnace temperatures. Quality control is very important! Once the contaminants are removed the cullet is ready to add to the mixture. Cullet lowers the melting temperature of the mixture and therefore less energy is required in the process. Only clear cullet is added to the mixture for clear glass products; primarily green cullet for green glass products; brown cullet for brown glass products.

In the manufacture of glass jars and bottles the red-hot glass is poured into molds and injected with air to shape the glass. The mold is removed and the glass is slowly cooled, inspected and then shipped to the customer for their bottling purposes.

Glass materials that are **acceptable**: *Soda and juice bottles, *Beer bottles, *Wine and liquor bottles, and *Food containers.

Glass materials that are **NOT acceptable**: *Mirrors, *Light bulbs, *Windows and windshields, *Crystal and drinking glasses, *Ceramics and clay pots and *Heat-resistant ovenware.

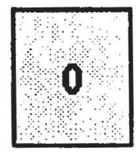
Source: Glass Packaging Institute

APPENDIX E

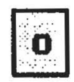
SAMPLER CONSTRUCTION
STREAM MACRO ORGANISMS

Hester-Dendy

COMPONENTS:



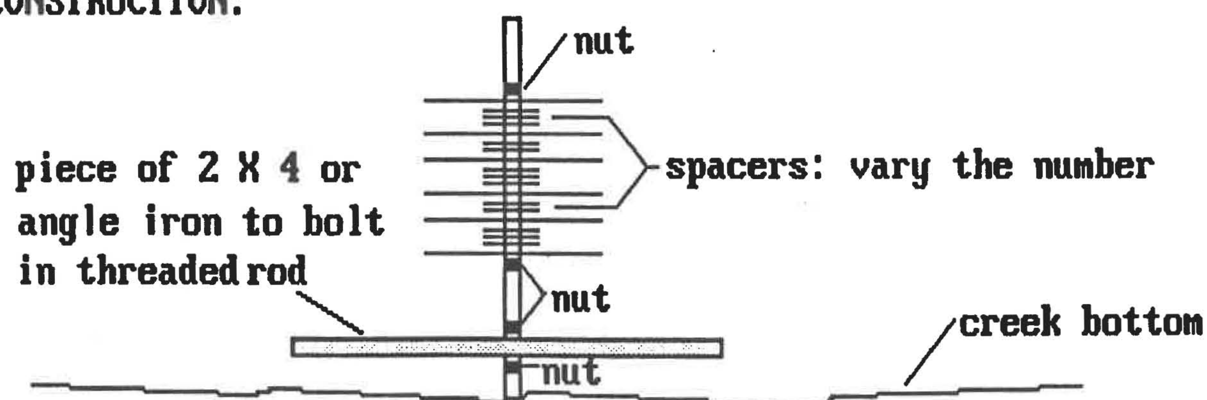
1. 3" square pieces of 1/8 " masonite, drill out 1/4" center hole



2. 1" square (spacers) of 1/8" masonite, drill out center hole

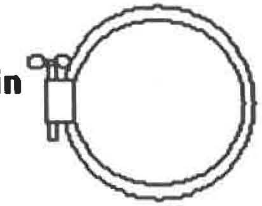
3. 1' long threaded rod - 1/4" diameter

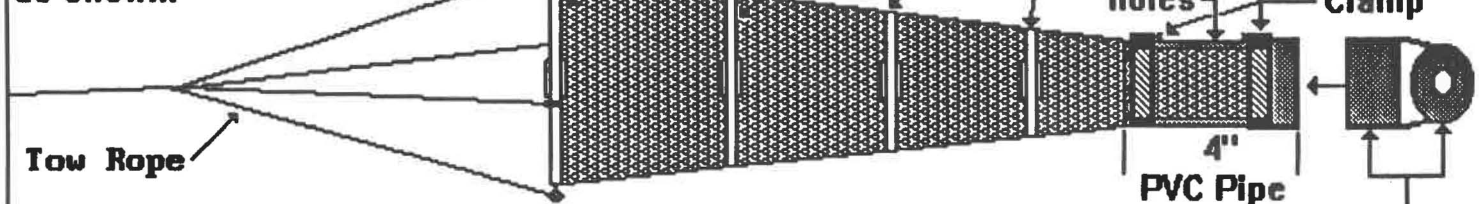
CONSTRUCTION:



Phytoplankton Net Construction

1. Obtain 3 to 4 plastic or metal embroidering hoops of decreasing size.
2. Cut a leg from a recycled panty hose.
3. Obtain or cut a 4" piece of 1 1/2" PVC pipe and a cap to fit one end of the tube. Cut 3 or 4 rectangular holes lengthwise in the tube. Cut the holes so there is a brace between each.
4. Cut the toe end out of the panty hose. Drill a small hole in the cap so a small cork or stopper will fit.
5. Insert the panty hose into the hoops as shown below.
6. Insert the PVC tube into the small end of the panty hose.
7. Clamp or glue the panty hose to the PVC tube as shown in the diagram.
8. Place a cork in the hole of the cap. Place the cap on the end of the tube so the cork is inside.
9. Attach a tow line to the hoop as shown.





10. Now for the use. Toss the net into a pond. Drag it slowly back to you. Carefully remove the cap from the tube. Remove the cork from the cap. Place the cap back on the tube. Hold the net and tube over a collection bottle. Flush the net and tube with water from a squeeze bottle.

Beck's Biotic Index Information and the Key to Major Invertebrate Species is taken from: **WATER QUALITY INDICATORS GUIDE: Surface Waters.** Reprinted 1991. USDA Soil Conservation Service. SCS-TP-161

Beck's Biotic Index

Beck's Biotic Index (see diagram on reverse side) was developed primarily for use in Florida and assumes taxonomic expertise, but can be used with generic level identification when less sensitivity is acceptable. This system can be used to indicate both the magnitude and probable cause of environmental stress. Beck developed the methodology to categorize stream macro-invertebrates (large animals without backbones).

Three categories are defined below:

Class I Organisms (Sensitive or Intolerant)

Organisms that exhibit a rapid response to aquatic environmental changes and are killed, driven out of the area, or as a group are substantially reduced in number when their environment is degraded.

Class II Organisms (Facultative)

Organisms that have the capability to live under varying conditions; i.e., a facultative anaerobe is an organism that although usually and normally lives in the presence of free oxygen, can live in the absence of free oxygen. Most survive in areas where organic pollution is producing eutrophication or "enrichment" of the aquatic ecosystem.

Class III Organisms (Tolerant)

Organisms capable of withstanding adverse conditions within the aquatic environment.

According to this approach, which assumes that there are not naturally occurring limiting factors, an undisturbed community will include representatives of the majority of the groups contained in Class I as well as some representatives of Classes II and III. By contrast, a sample which consists mainly of Class II organisms is being "limited" or impacted by either natural factors, such as low flow, homogeneous substrate, etc. or is impacted due to human activities. Waters dominated by Class III organisms are probably adversely affected by organic pollution.

The structure of the benthic (bottom) invertebrate community in waterways polluted by organic waste differs quantitatively from invertebrates communities in unpolluted waterways. That is, organic pollution results not just in a reduction in species richness (the total number of benthic groups), but also in a stimulation in density (the total number of organisms collected per sample).

By contrast, waterways impacted with toxic materials, such as pesticides or acid mine drainage, show decreases both in richness and density. Sediment causes a greater reduction in density than richness. Because of the above differences and because there are often dominant organisms characteristic of sediment pollution, it is possible to differentiate sediment stress from the stresses of toxic materials and organic wastes.

Use of Beck's Biotic Index Classes

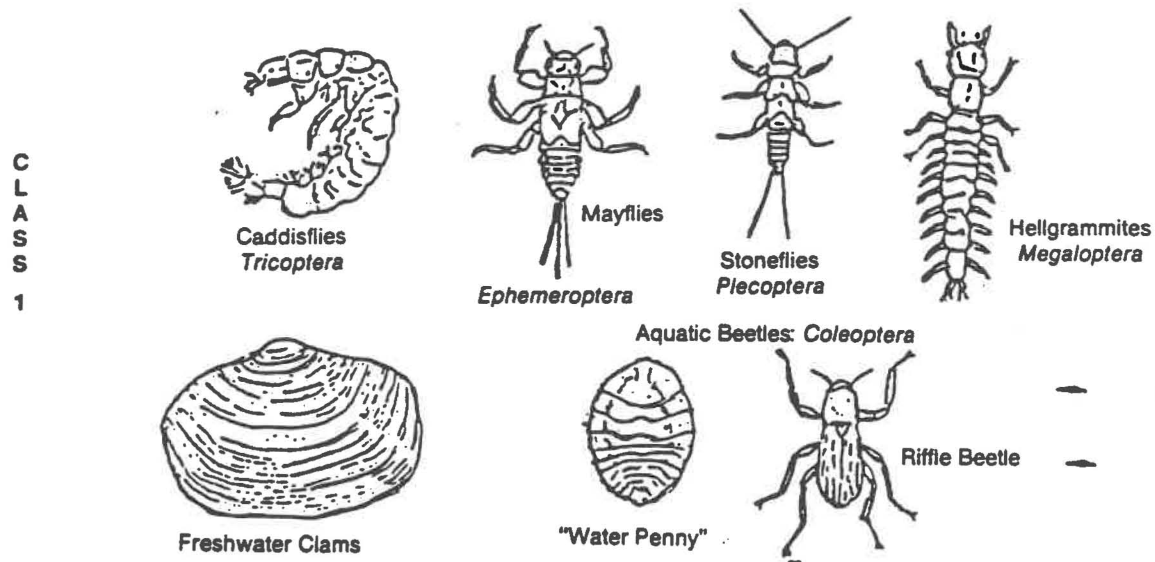
The information on the next page is very general in nature. Since this index has not been used outside of Florida the results you obtain from sampling a steam using this method should be construed as very generalized.

The key to the major invertebrates in a stream zone is included so the students might be able to generally identify organisms beyond what is supplied with Beck's Index.

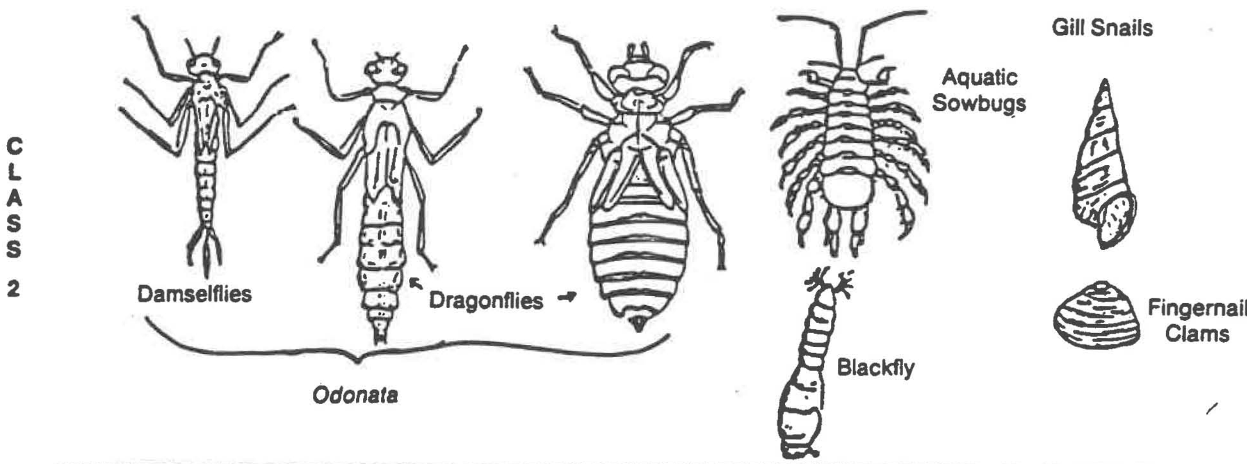
The guide referenced in the header is available from the Superintendent of Documents.

Macroinvertebrates According to Beck's Biotic Index Classes

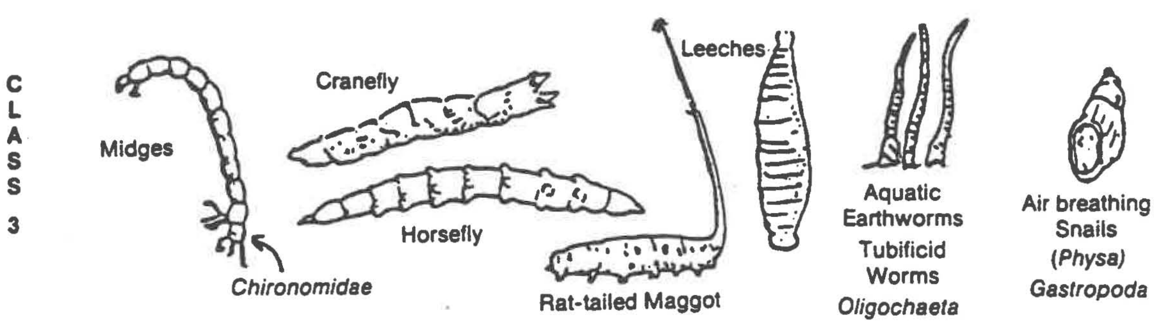
1. Intolerant (sensitive) to pollution:



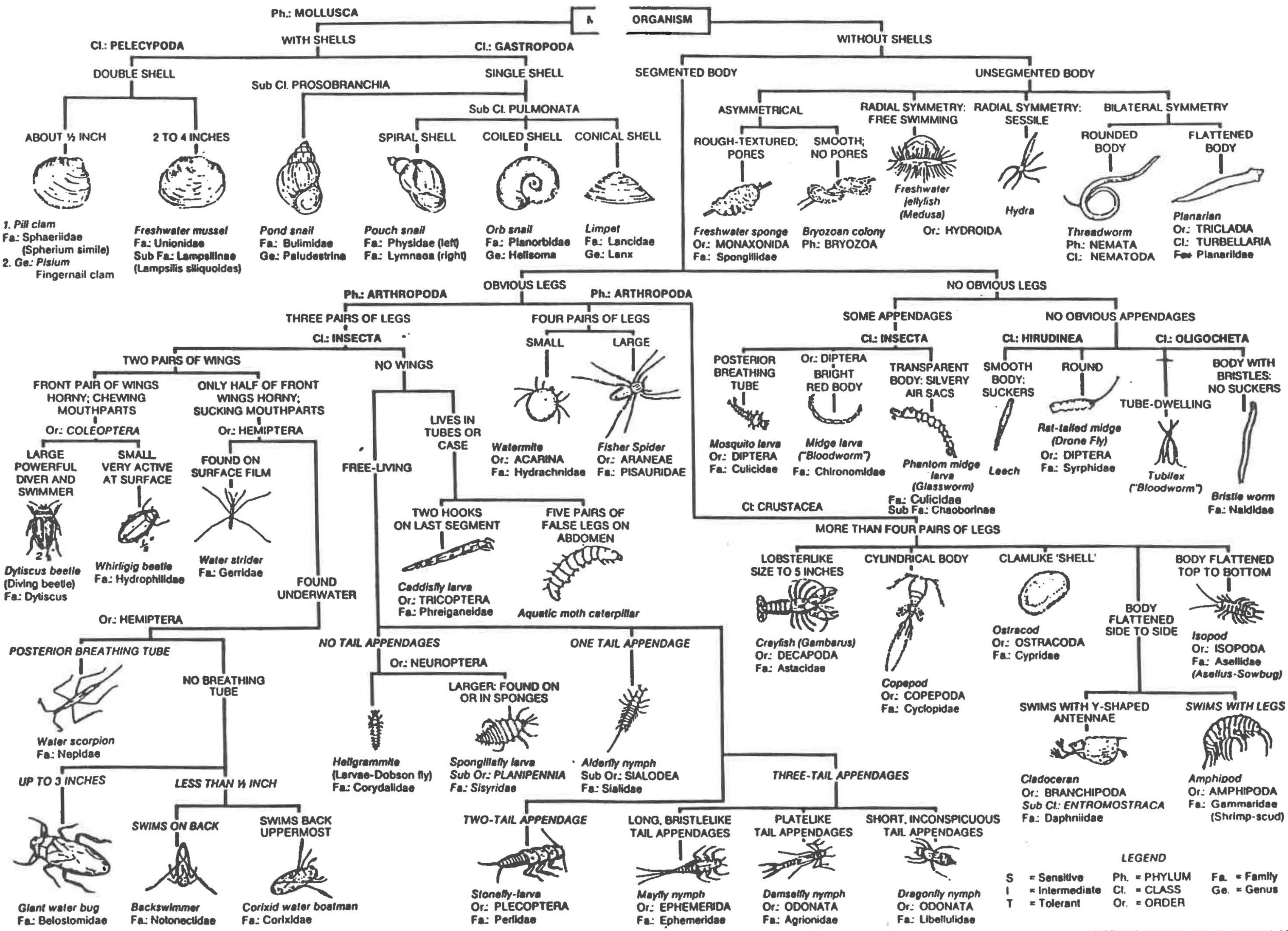
2. Facultative - Can tolerate some pollution:



3. Tolerant to pollution:



Key to the Major Invertebrate Species of Stream Zones.



USDA - Soil Conservation Service 4-28-75

APPENDIX F

AIR AND WATER QUALITY MATH EXERCISE SHEETS

SMOKE GETS IN YOUR EYES ACTIVITY SHEET (AIR QUALITY 7 MODULE)

Visible Emission Observation Form

SOURCE NAME	OBSERVATION DATE	START TIME	STOP TIME

ADDRESS

CITY | STATE | ZIP

PHONE | SOURCE ID NUMBER

PROCESS EQUIPMENT | OPERATING MODE

CONTROL EQUIPMENT | OPERATING MODE

DESCRIBE EMISSION POINT
START STOP

HEIGHT ABOVE GROUND LEVEL
START STOP

HEIGHT RELATIVE TO OBSERVER
START STOP

DISTANCE FROM OBSERVER
START STOP

DIRECTION FROM OBSERVER
START STOP

DESCRIBE EMISSIONS
START STOP

EMISSION COLOR
START STOP

PLUME TYPE CONTINUOUS ☐
FUGITIVE ☐ INTERMITTENT ☐

WATER DROPLETS PRESENT
NO ☐ YES ☐

IF WATER DROPLET PLUME
ATTACHED ☐ DETACHED ☐

POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED
START STOP

DESCRIBE BACKGROUND
START STOP

BACKGROUND COLOR
START STOP

SKY CONDITIONS
START STOP

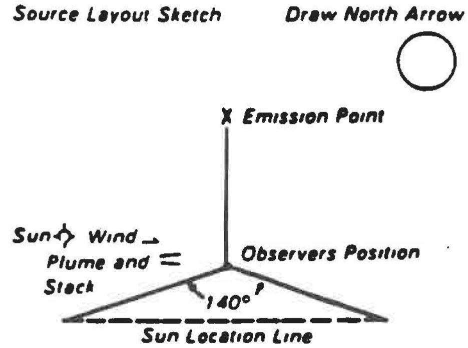
WIND SPEED
START STOP

WIND DIRECTION
START STOP

AMBIENT TEMP
START STOP

WET BULB TEMP | RH.percent

Source Layout Sketch   Draw North Arrow



MIN \ SEC	0	15	30	45	MIN \ SEC	0	15	30	45
1					31				
2					32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

AVERAGE OPACITY FOR HIGHEST PERIOD | NUMBER OF READINGS ABOVE % WERE

RANGE OF OPACITY READINGS
MINIMUM MAXIMUM

OBSERVER'S NAME (PRINT)

OBSERVER'S SIGNATURE | DATE

ORGANIZATION

COMMENTS

I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS
SIGNATURE

TITLE | DATE

CERTIFIED BY | DATE

VERIFIED BY | DATE

SMOKE GETS IN YOUR EYES ACTIVITY SHEET (AIR QUALITY 7 MODULE)

SOURCE NAME: ADMIRAL POWER PLANT

ADDRESS: 112 OCEAN ROAD

CITY: ADMIRAL CITY | STATE: VA | ZIP: 23451

PHONE: 804-425-5101 | SOURCE ID NUMBER: NEDS 45721

PROCESS EQUIPMENT: OIL FIRED BOILER | OPERATING MODE: BASE LOAD

CONTROL EQUIPMENT: ELECTROSTATIC PRECIPITATOR | OPERATING MODE: RAPPING

DESCRIBE EMISSION POINT: START BRICK STACK 23' DIA. STOP ✓

HEIGHT ABOVE GROUND LEVEL: START 100' STOP ✓ | HEIGHT RELATIVE TO OBSERVER: START 100' STOP ✓

DISTANCE FROM OBSERVER: START 400' STOP ✓ | DIRECTION FROM OBSERVER: START NNE STOP ✓

DESCRIBE EMISSIONS: START LOFTING PLUME STOP ✓

EMISSION COLOR: START GREY/WHITE STOP ✓ | PLUME TYPE: CONTINUOUS ☑ FUGITIVE ☐ INTERMITTENT ☐

WATER DROPLETS PRESENT: NO ☑ YES ☐ | IF WATER DROPLET PLUME: ATTACHED ☐ DETACHED ☐

POINT IN THE PLUME AT WHICH OPACITY WAS DETERMINED: START 10' ABOVE STACK EXIT STOP ✓

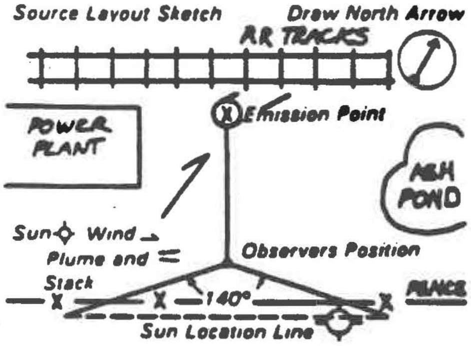
DESCRIBE BACKGROUND: START SKY STOP W/ BROKEN CLOUDS

BACKGROUND COLOR: START BLUE STOP BLUE/WHITE | SKY CONDITIONS: START CLEAR STOP PARTLY CLOUDY

WIND SPEED: START 15 mph STOP 20 mph | WIND DIRECTION: START SW STOP ✓

AMBIENT TEMP: START 85°F STOP ✓ | WET BULB TEMP: 54°F | RH percent: 8.5%

Source Layout Sketch — Draw North Arrow



COMMENTS: USES #6 OIL

I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS
SIGNATURE: William P. Jance
TITLE: SHIFT MANAGER | DATE: 7-15-82

OBSERVATION DATE: 15 JULY 1982 | START TIME: 1330 | STOP TIME: 1342

MIN \ SEC	0	15	30	45	MIN \ SEC	0	15	30	45
1	30	35	55	55	31				
2	55	50	40	30	32				
3	35	35	35	35	33				
4	30	35	35	35	34				
5	30	30	30	30	35				
6	35	35	35	35	36				
7	30	30	35	35	37				
8	35	40	60	55	38				
9	60	40	55	60	39				
10	50	45	35	30	40				
11	30	30	30	30	41				
12	30	30	30	30	42				
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25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

AVERAGE OPACITY FOR HIGHEST PERIOD: 40% | NUMBER OF READINGS ABOVE 40% WERE 11

RANGE OF OPACITY READINGS: MINIMUM 30% MAXIMUM 60%

OBSERVER'S NAME (PRINT): V.E. PROFFIT

OBSERVER'S SIGNATURE: V. E. Proffit | DATE: 15 JULY 82

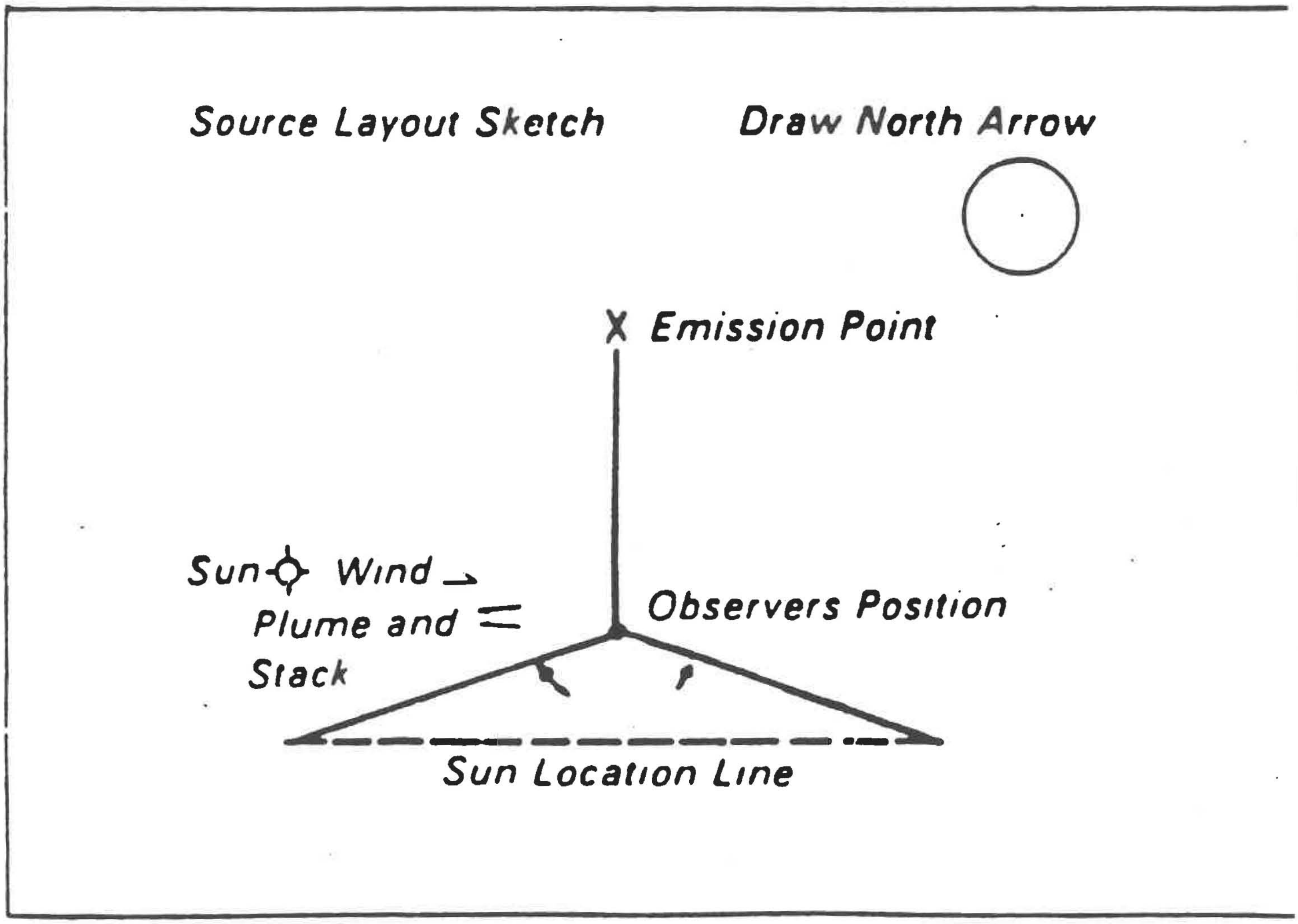
ORGANIZATION: STATE AIR POLLUTION CONTROL BOARD

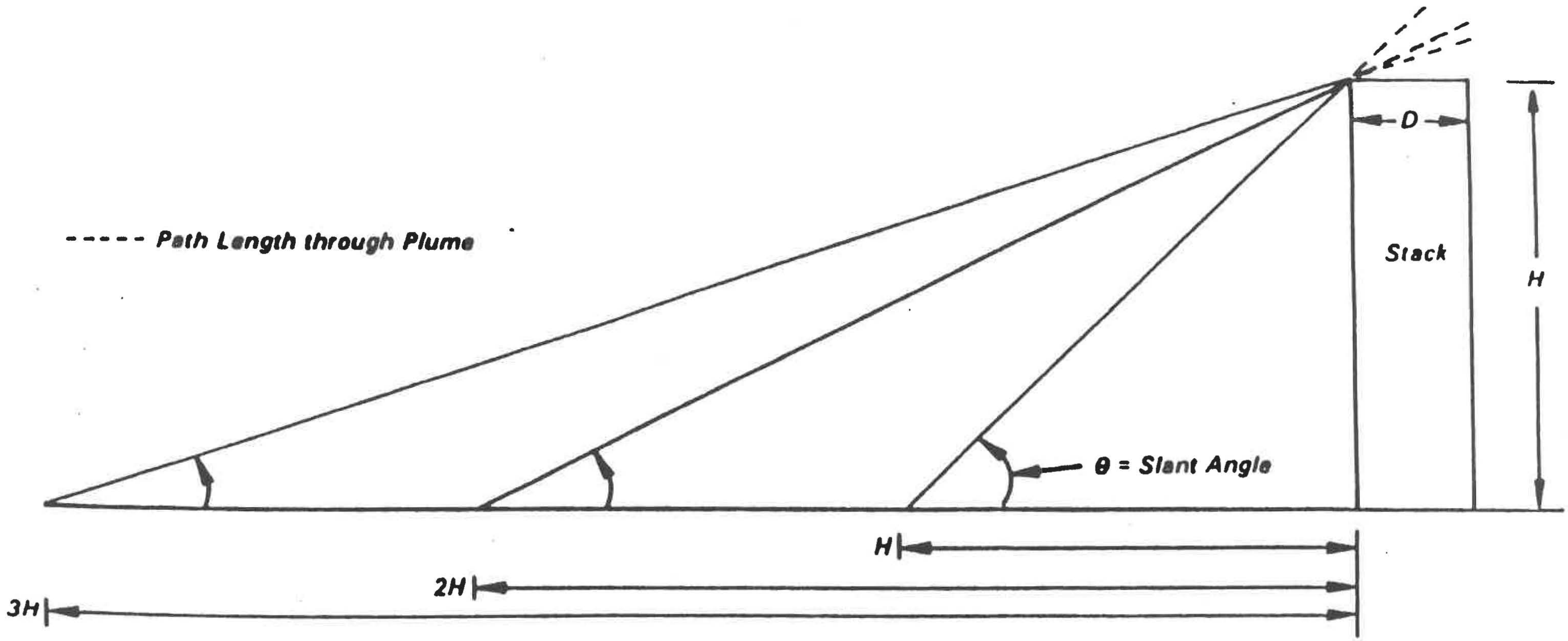
CERTIFIED BY: EASTERN TECHNICAL ASSOC. | DATE: 18 MAY 1982

VERIFIED BY: RDA | DATE: 15 AUG 1982

Visible emission observation form.

SMOKE GETS IN YOUR EYES ACTIVITY SHEET (AIR QUALITY 7 MODULE)





Variation of observation angle and pathlength with distance from an elevated source.

SMOKE GETS IN YOUR EYES ACTIVITY SHEET (AIR QUALITY 7 MODULE)

LET'S GET GRAPHIC ACTIVITY DATA SHEET (AIR QUALITY 8 MODULE)

Figure 1

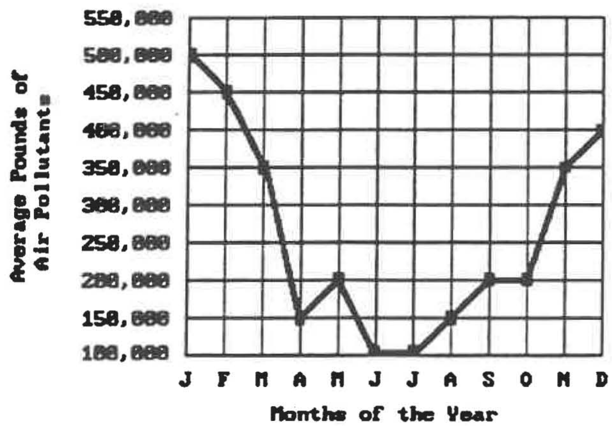
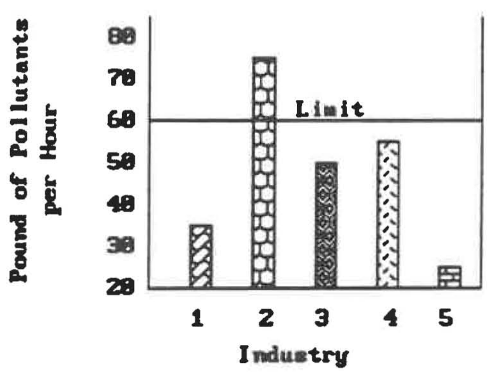


Figure 2



LET'S GET GRAPHIC ACTIVITY DATA SHEET (AIR QUALITY 8 MODULE)

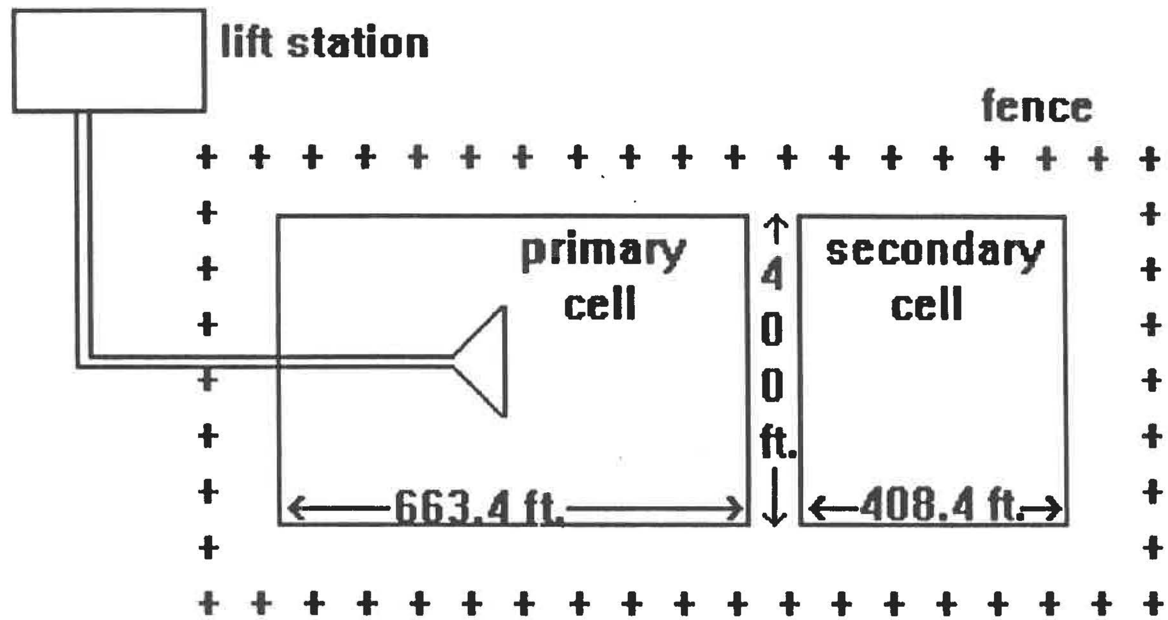
Table 1. Air Sampler Date and Temperature

Sample Date	Temperature °F	Sample Date	Temperature °F	Sample Date	Temperature °F
1-6-91	6	2-5-91	41	3-7-91	30
1-12-91	21	2-11-91	38	3-13-91	37
1-18-91	38	2-17-91	36	3-19-91	46
1-24-91	24	2-23-91	31	3-25-91	49
1-30-91	No Data	3-1-91	38	3-31-91	42

Table 2. Air Sampler Date and Filter Weight

Sample Date	Filter Weight in Grams	Sample Date	Filter Weight in Grams	Sample Date	Filter Weight in Grams
1-6-91	4.1	2-5-91	4.6	3-7-91	4.4
1-12-91	No Data	2-11-91	4.5	3-13-91	4.4
1-18-91	4.2	2-17-91	4.4	3-19-91	4.4
1-24-91	4.4	2-24-91	4.5	3-25-91	4.3
1-30-91	No Data	3-1-91	4.4	3-30-91	4.3

WATER RECTANGLES WATER QUALITY 10 MODULE



WASTEWATER LAGOONS

WATER RECTANGLE LAGOON PROBLEMS

You have just been hired to operate the two-cell lagoon system at Save, South Dakota. Anxious to start off on the right foot, you examine the files only to find the previous operator kept no records of his/her activities. After further investigation, you discover the mayor is not exactly certain where the lagoons are located, but he does remember receiving an odor complaint last July. The auditor, bless her heart, has managed to dig up a copy of the plan shown on the previous page. With this information, the results of recent samples sent to Hilding Test Labs, and what you know about lagoon design, you assemble the following data:

DATA:

Primary cell is 653.4 ft by 400 ft
Secondary cell is 408.4 ft by 400 ft
Primary cell depth is 5 ft with 3 ft available for storage
Secondary cell depth is 6 ft with 4 ft available for storage
Influent BOD is 275 mg/l*
Secondary cell BOD is 20 mg/l

* mg/l = milligrams per liter. One (1) gram is approximately equal to 0.035 ounces and one (1) liter is approximately equal to 1.05 quarts. When you know grams divide by 28 to obtain ounces; for example, 1 gram divided by 28 = 0.035 ounces. When you know liters divide by 0.95 to obtain quarts; for example, 2 liters divided by 0.95 = 2.10 quarts.

Now you can proceed to answer the following questions.

1. What is the surface area of each cell in square feet and in acres?

2. What is the volume in gallons of storage available in each cell? (Note: Assume the sides of both cells are nearly vertical.)

3. In order to determine if you have adequate storage for a 180-day detention time, you need to know the influent flow to the lagoons. Alas, there is no flow measurement device installed in your system. However, after calibrating your lift station pumps and installing hour meters, you gather the following data:

Capacity of pump one is 95 gallons per minute (gpm)	
Capacity of pump two is 91 gpm	
Minutes per week pump one ran:	2913
Minutes per week pump two ran:	1343

Use this information to find the influent flow in million gallons per day (MGD). Is there adequate storage for 180 days? Assume no seepage or evaporation?

4. Calculate the organic loading of your primary cell. If the design limit for organic load on a primary cell is 30 pounds (lbs) BOD/acre/day, is your primary cell organically overloaded?

5. Calculate the organic loading on the entire system (cell one and cell two). If the design limit for organic load on a lagoon system is 20 lbs BOD/acre/day, is your system organically overloaded?

APPENDIX F WATER RECTANGLES

APPENDIX G

HAZARDOUS WASTE INFORMATION PACKET

HAZARDOUS WASTE INFORMATION FOR THE GREAT DEBATE MODULE

What is a Hazardous Waste?

A waste is any solid, liquid, or contained gaseous material that you no longer use, and either recycle, throw away, or store until you have enough to treat or dispose of.

As a result of doing business, a company may generate wastes that can cause serious problems if not handled and disposed of carefully. Such wastes could:

- Cause injury or death; or
- damage or pollute land, air, or water.

These wastes are considered **hazardous**, and they are currently regulated by federal and state laws.

There are two ways a waste may be brought into the hazardous waste regulatory system: **listing,** and identification through **characteristics**.

- **Listed wastes.** Waste is considered hazardous if it appears on any one of four lists of hazardous wastes contained in federal regulations. These wastes have been listed because they either exhibit one of the characteristics described below or contain any number of toxic constituents that have been shown to be harmful to health and the environment. The regulations list over 400 hazardous wastes, including wastes derived from manufacturing processes and discarded commercial products. Many of the listed hazardous wastes that are generated by small businesses are listed at the end of this packet.

- **Characteristic wastes.** Even if a waste does not appear on one of the lists, it is considered hazardous if it has one or more of the following characteristics:

It is easily combustible or flammable. This is called an **ignitable** waste. Examples are paint wastes, certain degreasers, or other solvents.

It dissolves metals, other materials, or burns the skin. This is called a corrosive waste. Examples are waste rust removers, waste acid or alkaline cleaning fluids, and waste battery acid.

It is unstable or undergoes rapid or violent chemical reaction with water or other materials. This is called a **reactive** waste. Examples are cyanide plating wastes, waste bleaches, and other waste oxidizers.

A waste sample is tested and shows toxicity. Wastes are **toxic** if an extract from the waste is tested and found to contain high concentrations of heavy metals (such as mercury, cadmium, or lead) or specific pesticides that could be released into the groundwater.

Industry may generate other hazardous wastes beyond the examples mentioned above. It is the responsibility of the industry to determine if they have a hazardous waste. A list of typical hazardous wastes for small businesses is found in Table 1.

Acutely Hazardous Wastes

Some wastes are considered to be "acutely hazardous." These are wastes that have been determined to be so dangerous in small amounts that they are regulated the same way as are large amounts of other hazardous wastes.

Acutely hazardous wastes, for example, may be generated using certain pesticides. They also include dioxin-containing wastes.

TABLE 1

Type of Business	Types of Hazardous Waste Generated
Building Cleaning and Maintenance	Acids/Bases, Solvents
Chemical Manufacturers	Acids/Bases, Cyanide Wastes, Heavy Metals/Inorganics, Ignitable Wastes, Pesticides, Solvents
Cleaning Agents and Cosmetics	Acids/Bases, Heavy Metals/Inorganics, Ignitable Wastes, Pesticides, Solvents
Construction	Acids/Bases, Ignitable Wastes, Solvents
Educational and Vocational Shops	Acids/Bases, Ignitable Wastes, Pesticides, Reactives, Solvents
Equipment Repair	Acids/Bases, Ignitable Wastes, Solvents
Formulators	Acids/Bases, Cyanide Wastes, Heavy Metals/Inorganics, Ignitable Wastes,Pesticides, Reactives, Solvents
Funeral Services	Solvents, Formaldehyde
Furniture/Wood Manufacturing and Refinishing	Ignitable Wastes, Solvents
Laboratories	Acids/Bases, Heavy Metals/Inorganics, Ignitable Wastes, Reactives, Solvents
Laundries and Dry Cleaners	Dry Cleaning Filtration Residues, Solvents
Metal Manufacturing	Acids/Bases, Cyanide Wastes, Heavy Metals/Inorganics, Ignitable Wastes Reactives, Solvents, Spent Plating Wastes
Motor Freight Terminals and Railroad Transportation	Acids/Bases, Heavy Metals/Inorganics, Ignitable Wastes, Lead-Acid Batteries, Solvents
Other Manufacturing: 1) Textiles, 2) Plastics, 3) Leather	Heavy Metals/Inorganics, Solvents
Pesticide End Users and Application Services	Heavy Metals/Inorganics, Pesticides, Solvents
Printing and Allied Industries	Acids/Basis, Heavy Metals/Inorganics, Ink Sludges, Spent Plating Wastes, Solvents
Vehicle Maintenance	Acids/Bases, Heavy Metals/Inorganics, Ignitable Wastes, Lead-Acid Batteries, Solvents
Wood Preserving	Preserving Agents

Wastes listed at the end of this packet with an asterisk (*) have been designated as acutely hazardous. If a business generates more than 1 kilogram (kg) [approximately 2.2 pounds] of acutely hazardous waste in a calendar month or stores more than that for any period of time, they are subject to all of the regulations that apply to industry that generates more than 1000 kilograms of hazardous waste per calendar month.

TABLE 2

CATEGORIES OF HAZARDOUS WASTE GENERATORS

1 barrel = about 200 kilograms of hazardous waste which is about 55 gallons

Generators of No More Than 100 kg/mo	100-1000 kg/mo Generators	Generators of 1000 kg/mo or More
If an industry generates no more than 100 kilograms (about 220 pounds or 25 gallons) of hazardous waste and no more than 1 kg (about 2 ponds) of acutely hazardous waste in any calendar month, they are a conditionally-exempt small quantity generator and federal hazardous waste laws require them to: ☛Identify all hazardous waste they generate ☛Send this waste to a hazardous waste facility, or a landfill or other facility approved by the state for industrial or municipal wastes. ☛An industry must never accumulate more than 1000 kg of hazardous waste on their property. (If a business accumulates more they become subject to requirements applicable to 100-1000 kg/mo generators.)	If an industry generates more than 100 and less than 1000 kg (between 220 and 2,200 pounds or about 25 gallons to under 300 gallons) of hazardous waste and no more than 1 kg of acutely hazardous waste in any month, they are a 100-1000 kg/mo generator and federal hazardous waste laws require them to: ☛Comply with the rules for managing hazardous waste, including the accumulation, treatment,storage,and disposal requirements noted below.	If an industry generates 100 kg (about 2,200 pounds or 300 gallons) or more of hazardous waste, or more than 1 kg of acutely hazardous waste in any month, they are a generator of 1000 kg/mo or more and the federal laws require the industry to: ☛Comply with *all* applicable hazardous waste management rules.

100-1000 KG/MO GENERATOR

REQUIREMENTS

EPA IDENTIFICATION NUMBERS

If a business generates more than 100 kg of hazardous waste in any calendar month, they must obtain a U.S. EPA Identification Number. Transporters and facilities that store, treat, or dispose of regulated quantities of hazardous waste must also have U.S. EPA Identification Numbers. These twelve-character identification numbers used by EPA and state are part of a national data base on hazardous waste activities.

MANAGING HAZARDOUS WASTE ON-SITE

Storing Hazardous Waste On-Site

A business may store no more than 6000 kg of hazardous waste on site for up to 180 days, or for up to 270 days if the waste must be shipped to a treatment , storage, or disposal facility (TSDF) that is located over 200 miles away. If they exceed these time or quantity limits, they will be considered a storage facility and must obtain a storage permit (see below) and meet all the federal storage requirements. These time limits on storage are longer than the 90 days allowed for generators of 1000 kg/mo or more. A business is allowed to store waste for as long as 180 or 270 days so they have time to accumulate enough hazardous waste to ship it off-site for treatment or disposal economically.

They can store hazardous waste in 55-gallon drums, tanks, or other containers suitable for the type of waste generated providing they follow certain common sense rules that are meant to protect human health and the environment, and reduce the likelihood of damages or injuries caused by leaks or spills of hazardous wastes.

If a business stores hazardous waste in **containers**, they must:

☛Clearly mark each container with the words "Hazardous Waste," and with the date collection began.

☛Keep containers in good condition, handle them carefully, and replace any leaking ones.

☛Not store hazardous waste in a container if it may cause ruptures, leaks, corrosion, or other failure.

☛Keep containers closed except for when they are filled or emptied.

☛Inspect the container for leaks or corrosion every week.

☛Make sure when storing ignitables or reactive wastes, containers are placed as far as possible from the facility property line to create a buffer zone.

☛NEVER store wastes in the same container that could react together to cause fires, leaks, or other releases.

☛Make sure the stored waste is taken off-site or treated within the 180 (or 270) days.

If storing waste in **tanks**, a business must follow similar common sense rules:

☛No hazardous waste storage in a tank if it may cause ruptures, leaks, corrosion, or otherwise cause the tank to fail.

☛Keep a tank covered or provide at least two feet of freeboard (space at the top of the tank) in uncovered tanks.

☛If tanks have equipment that allow the waste to flow into them continually, provide waste feed cutoff or bypass systems to stop the flow in case of problems.

☛Inspect any monitoring or gauging systems on each operating day and inspect the tanks themselves for leaks or corrosion every week.

☛Use buffer zone requirements for tanks containing ignitable or reactive wastes. These requirements specify distances considered as safe buffer zones for various liquids based on the characteristics of all combustible and flammable liquids.

☛Ensure stored waste is taken off-site within 180 (or 270) days.

Treating Hazardous Waste On-Site

Treatment may occur on site without a special permit providing:

☛It is treated within the accumulated 180 (or 270) days.

☛It complies with the container and tank regulations described above.
☛Steps are taken to prepare for and prevent accidents as described below.

If a business does not meet each of these requirements and they treat hazardous waste on site, they must obtain a hazardous waste treatment permit as described below.

Disposing of Hazardous Waste On-Site
A business **may not** dispose of a hazardous waste on site unless they have obtained a disposal permit as described below. Under certain circumstances, it may be legal to dispose of certain types of hazardous waste on-site without a permit: Farmers may dispose of their own waste pesticide provided they triple rinse the empty pesticide container and dispose of the pesticide residue on their own farm in a manner consistent with the instructions on the pesticide label. Even if not a farmer, a business may be allowed to dispose of certain hazardous wastes by discharging them directly into the sewer drain. However, this is not considered good management practice and in many communities it may be illegal. Be sure to check with the local wastewater or sewage treatment office or the state hazardous waste management agency.

Obtaining a Permit to Store, Treat, or Dispose of Hazardous Waste On-Site
If an industry stores, treats, or disposes of hazardous waste on-site in any manner other than those permissible ones described above, they must obtain a permit. Obtaining a permit to store, treat, or dispose of hazardous wastes on-site can be a costly and time consuming process. Obtaining a storage, treatment, and/or disposal permit requires a business to go through demanding permit processing steps. The entire process may take from one to three years because of the amount of detail needed to ensure protection of human health and the environment.

Figure 1 is a sample copy of a completed notification form showing the kinds of information required.

Preparing for and Preventing Accidents
Whenever hazardous waste is generated and stored on-site, the owner/operator must take the precautions and steps necessary to prevent any sudden or accidental release to the environment. This means the owner/operator must carefully operate and maintain the facility to reduce the possibility of fire, explosion, or release of hazardous waste.

The facility must have appropriate types of emergency communication and fire equipment for the kinds of waste handled at the site. The owner/operator must attempt to make arrangements with the local fire, police or hospital officials as needed to ensure they will be able to respond to any potential emergencies that could arise. Some of the steps that might need to be taken for emergencies at a facility are:
☛Installing and maintaining emergency equipment such as an alarm, a telephone or a two-way portable radio, fire extinguishers (using water, foam, inert gas, or dry chemicals as appropriate to the waste type), hoses, automatic sprinklers, or spray equipment in the plant so it is immediately available to the

employees if there is an emergency.

☛Providing enough room for emergency equipment and response teams to get into an area in the facility in the event of an emergency.

☛Writing to local fire, police, and hospital officials or state or local emergency response teams explaining the types of waste handled and asking for their cooperation and assistance in handling emergency situations.

Manning for Emergencies

A contingency plan is a plan that attempts to look ahead and prepare for any accidents that could possibly occur. It can be thought of as a set of answers to a series of "what if" questions. For example: "*What if* there is a fire in the area where hazardous waste is stored?" or "*What if* there is a spill of hazardous waste or a containers leaks?" Emergency procedures are the steps to follow if you have an emergency, that is, if one of the "contingencies" or "what ifs" occurs. While a specific written contingency plan is not required, it may be a good idea to make a list of these questions and answer them on paper. This also may be helpful in informing employees about their responsibilities in the event of an emergency.

Emergency phone numbers and locations of emergency equipment must be posted near telephones and all employees must know proper waste handling and emergency procedures. The owner/operator must appoint an employee to act as **emergency coordinator** to ensure that emergency procedures are carried out in the event an emergency arises. The responsibilities of the emergency coordinator are generally the she/he be available 24 hours a day (at the facility or by phone) and know whom to contact and what steps to follow in an emergency. For most small businesses, the owner/operator may already perform these functions.

It is important to avoid potential risks in this area. If there is a serious emergency and the fire department is to be called or there is a spill that extends outside the plant or that could reach surface waters the National Response Center must be called. Anyone who was supposed to call and did not is subject to a $10,000 fine, a year in jail or both. An owner/operator of a business who fails to report a release also may have to pay for the entire cost of repairing any damage, even if the facility was not the single or the main cause of the damage.

SHIPPING HAZARDOUS WASTE OFF-SITE

Choosing a Hazardous Waste Hauler and Designated Waste Management Facility

Carefully choosing a hauler and waste management facility is important. The hauler will be handling the facility waste beyond its control while the **facility is still responsible** for the proper management. Similarly, the waste management facility will be the final destination of the hazardous waste for treatment, storage, or disposal.

Preparing Hazardous Wastes for Shipment

When preparing hazardous waste for shipment, the waste must be put into containers acceptable for transportation and properly labeled. The haulers are able to assist businesses.

The Uniform Hazardous Waste Manifest

A hazardous waste manifest is a multicopy shipping document that must be filled out and used to accompany hazardous waste shipments.

The manifest form is designed so shipments of hazardous waste can be tracked from their point of generation to their final destination--the so called "cradle-to-grave" system. The hazardous waste generator, hauler, and designated facility must each sign this document and keep a copy. The designated facility operator also must send a copy back to the generator. This latter step assures the generator the shipment has arrived. The generator must keep this copy, which will be signed by the hauler and designated facility, on file for three years.

Shipping the hazardous waste off-site does not reduce the generators liability. The generator is potentially liable under Superfund for **any** mismanagement of the hazardous waste. The manifest helps track the waste during shipment and makes sure it arrives at the proper destination.

A sample copy of a hazardous waste manifest has been filled out in Figure 2.

"GOOD HOUSEKEEPING" AND A SAFE ENVIRONMENT

Good hazardous waste management can be thought of simply as using "good housekeeping" practices such as: using and reusing materials as much as possible; recycling or reclaiming waste; treating waste to reduce its hazards; or reducing the amount of waste generated. To reduce the amount of waste generated:

☛Do not mix nonhazardous wastes with hazardous ones. For example, nonhazardous cleaning agents should not be put in the same container as a hazardous solvent or the entire contents becomes subject to the hazardous waste regulations.

☛Avoid mixing several different hazardous wastes. Doing so may make recycling difficult, if not impossible, or make disposal more expensive.

☛Avoid spills or leaks of hazardous products. (The materials used to clean up such spills or leaks also will become hazardous).

☛Make sure the original containers of hazardous products are completely empty before throwing them away. Use **ALL** the product.

☛Avoid using more of a hazardous product than needed. For example, use no more degreasing solvent or pesticide than needed to do the job. Also, do not throw away a container with unused solvent or pesticide in it.

Reducing hazardous waste means saving money on raw materials and reducing costs to business for managing and disposing of the hazardous waste.

Bibliography

U.S. Environmental Protection Agency. 1986. *UNDERSTANDING THE SMALL QUANTITY GENERATOR HAZARDOUS WASTE RULES: A Handbook for Small Business*. EPA/530-SW-86-019.

FIGURE 1

SAMPLE "NOTIFICATION OF HAZARDOUS WASTE ACTIVITY" FORM*

(Continued)

ID — For Official Use Only													
C												T/A	C
W													1

X. Description of Hazardous Wastes *(continued from front)*

A. Hazardous Wastes from Nonspecific Sources. Enter the four-digit number from 40 *CFR* Part 261.31 for each listed hazardous waste from nonspecific sources your installation handles. Use additional sheets if necessary.

1	2	3	4	5	6
F008	F011				
7	**8**	**9**	**10**	**11**	**12**

B. Hazardous Wastes from Specific Sources. Enter the four-digit number from 40 *CFR* Part 261.32 for each listed hazardous waste from specific sources your installation handles. Use additional sheets if necessary.

13	14	15	16	17	18
K069					
19	**20**	**21**	**22**	**23**	**24**
25	**26**	**27**	**28**	**29**	**30**

C. Commercial Chemical Product Hazardous Wastes. Enter the four-digit number from 40 *CFR* Part 261.33 for each chemical substance your installation handles which may be a hazardous waste. Use additional sheets if necessary.

31	32	33	34	35	36
37	**38**	**39**	**40**	**41**	**42**
43	**44**	**45**	**46**	**47**	**48**

D. Listed Infectious Wastes. Enter the four-digit number from 40 *CFR* Part 261.34 for each hazardous waste from hospitals, veterinary hospitals, or medical and research laboratories your installation handles. Use additional sheets if necessary.

49	50	51	52	53	54

E. Characteristics of Nonlisted Hazardous Wastes. Mark 'X' in the boxes corresponding to the characteristics of nonlisted hazardous wastes your installation handles. *(See 40 CFR Parts 261.21 — 261.24)*

☒ 1. Ignitable *(D001)* ☐ 2. Corrosive *(D002)* ☐ 3. Reactive *(D003)* ☐ 4. Toxic *(D000)*

XI. Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature	Name and Official Title *(type or print)*	Date Signed
Josephine K. Doe	JOSEPHINE DOE OWNER	6/1/86

EPA Form 8700-12 (Rev. 11-85) Reverse

Instructions for filling out this form are provided, along with the form, by EPA.

FIGURE 2

SAMPLE "UNIFORM HAZARDOUS WASTE MANIFEST" FORM*

Please print or type (Form designed for use on elite (12-pitch) typewriter.) Form Approved. OMB No. 2000-0404 Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST

1 Generator's US EPA ID No: VAD001234567 — Manifest Document No. 00001

2 Page 1 of

Information in the shaded areas is not required by Federal law.

3 Generator's Name and Mailing Address:
GENERAL METAL PROCESSING CO.
501 MAIN ST.
SMALLTOWN, VA 23000

4 Generator's Phone (804) 555-0509

A. State Manifest Document Number

B. State Generator's ID

5 Transporter 1 Company Name: SAFETY HAULER — 6 US EPA ID Number: VAD008912345

C. State Transporter's ID

D. Transporter's Phone

7 Transporter 2 Company Name — 8 US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone

9 Designated Facility Name and Site Address:
DISPOS-ALL, INC
1800 NORTH AVE
FRIENDLY TOWN, VA 23000

10 US EPA ID Number: VAD006789123

G. State Facility's ID

H. Facility's Phone

	11 US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	12 Containers No	12 Containers Type	13 Total Quantity	14 Unit Wt/Vol	I. Waste No
a.	HAZARDOUS WASTE, LIQUID OR SOLID, NOS ORM-E, NA9189	002	DM	00110	GAL	
b.	WASTE CYANIDE SOLUTION, NOS UN1935	001	DM	00055	GAL	
c.	WASTE FLAMMABLE LIQUID, NOS UN1993	001	DM	00055	GAL	
d.						

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15 Special Handling Instructions and Additional Information

16 **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment.

Printed/Typed Name	Signature	Month Day Year
JOSEPHINE K. DOE	Josephine K. Doe	08 30 86

17 Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month Day Year

18 Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Month Day Year

19 Discrepancy Indication Space

20 Facility Owner or Operator Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19

Printed/Typed Name	Signature	Month Day Year

GENERATOR / TRANSPORTER / FACILITY

EPA Form 8700-22 (Rev. 4-85) Previous edition is obsolete

******Information in the shaded areas is not required by Federal law, but this or other additional information may be required by your state.***

EPA HAZARDOUS WASTE NUMBERS FOR WASTE STREAMS COMMONLY GENERATED BY SMALL QUANTITY GENERATORS

The Environmental Protection Agency recognizes that generators of small quantities of hazardous waste, many of which are small businesses, may not be familiar with the manner in which hazardous waste materials are identified. This Appendix has been assembled to aid 100-1000 kg/mo small quantity generators in determining the EPA Hazardous Waste Numbers for their wastes. These numbers are needed to complete the "Notification of Hazardous Waste Activity," Form 8700-12.

This Appendix contains lists of EPA Hazardous Waste Numbers for each waste stream identified in Table 2 in Chapter 1 of the handbook. Note that acutely hazardous wastes are identified with an asterisk (*).

To Use This Appendix

1. Locate your business type in Table 2 in Chapter 1. This will help you to identify the waste streams common to your activities.
2. Find each of the waste streams that you identified in Table 2 in the more detailed descriptions in this Appendix. Review the more detailed descriptions of typical wastes to determine which waste streams actually result from your activities.
3. If you determine that you actually do generate a particular waste stream, report the four-digit EPA Hazardous Waste Number in Item X of Form 8700-12, "Notification of Hazardous Waste Activity."

The specific instructions for completing Item X (Description of Hazardous Wastes) of the notification form are included in the notification package. You should note, however, that specific EPA Hazardous Waste Numbers beginning with:

- "F" should be entered in Item X, Section A.
- "K" should be entered in Item X, Section B.
- "P" or "U" should be entered in Item X, Section C.
- "D" should be entered in Item X, Section E.

The industries and waste streams described here do not provide a comprehensive list, but rather serve as a guide to potential small quantity generators in determining which of their wastes, if any, are hazardous. Except for the pesticide and wood preserving categories, this Appendix does not include EPA Hazardous Waste Numbers for commercial chemical products that are hazardous when discarded unused. These chemicals and their EPA Hazardous Waste Numbers are listed in Title 40 of the Code of Federal Regulations (40 CFR) in Section 261.33.

If the specific EPA Hazardous Waste Number that should be applied to your waste stream is unclear, please refer to 40 CFR Part 261, reprinted in the Notification Form 8700-12 package. In those cases where more than one EPA Hazardous Waste Number is applicable, all should be used. If you have any questions, or if you are unable to determine the proper EPA Hazardous Waste Numbers for your wastes, contact your state hazardous waste management agency, or the RCRA/Superfund Hotline (see Appendix A).

Solvents:

Solvents, spent solvents, solvent mixtures, or solvent still bottoms are often hazardous. This includes solvents used in degreasing (identified as F001) and paint brush cleaning and distillation residues from reclamation. The following are some commonly used hazardous solvents (also see ignitable wastes for other hazardous solvents, and 40 CFR 261.31 for most listed hazardous waste solvents):

Benzene	F005
Carbon Disulfide	F005
Carbon Tetrachloride	F001
Chlorobenzene	F002
Cresols	F004
Cresylic Acid	F004
O-Dichlorobenzene	F002
Ethanol	D001
2-Ethoxyethanol	F005
Ethylene Dichloride	D001
Isobutanol	F005

Isopropanol	D001
Kerosene	D001
Methyl Ethyl Ketone	F005
Methylene Chloride	F001 F002
Naphtha	D001
Nitrobenzene	F004
2-Nitropropane	F005
Petroleum Solvents (Flashpoint less than 140°F)	D001
Pyridine	F005
1,1,1-Trichloroethane	F001 F002
1,1,2-Trichloroethane	F002
Tetrachloroethylene (Perchloroethylene)	F001 F002
Toluene	F005
Trichloroethylene	F001 F002
Trichlorofluoromethane	F002
Trichlorotrifluoroethane (Valclene)	F002
White Spirits	D001

Acids/Bases:

Acids, bases, or mixtures having a pH less than or equal to 2 or greater than or equal to 12.5, are considered corrosive (for a complete description of corrosive wastes, see 40 CFR 261.22, Characteristic of corrosivity). All corrosive materials and solutions have the EPA Hazardous Waste Number D002. The following are some of the more commonly used corrosives:

Acetic Acid	Nitric Acid
Ammonium Hydroxide	Oleum
Chromic Acid	Perchloric Acid
Hydrobromic Acid	Phosphoric Acid
Hydrochloric Acid	Potassium Hydroxide
Hydrofluoric Acid	Sodium Hydroxide
	Sulfuric Acid

Dry Cleaning Filtration Residues:

Cooked powder residue (perchloroethylene plants only), still residues, and spent cartridge filters containing perchloroethylene or valclene are hazardous and have the EPA Hazardous Waste Number F002.

Still residues containing petroleum solvents with a flashpoint less than 140°F are considered hazardous and have the EPA Hazardous Waste Number D001.

Heavy Metals/Inorganics:

Heavy metals and other inorganic waste materials exhibit the characteristic of EP Toxicity and are considered hazardous if the extract from a representative sample of the waste has any of the specific constituent concentrations as shown in 40 CFR 261.24, Table 1. This may include dusts, solutions, wastewater treatment sludges, paint wastes, waste inks, and other such materials which contain heavy metals/inorganics (note that wastewater treatment sludges from electroplating operations are identified as F006). The following are EP Toxic:

Arsenic	D004
Barium	D005
Cadmium	D006
Chromium	D007
Lead	D008
Mercury	D009
Selenium	D010
Silver	D011

Ignitable Wastes:

Ignitable wastes include any liquids that have a flashpoint less than 140°F, any non-liquids that are capable of causing a fire through friction, absorption of moisture, or spontaneous chemical change, or any ignitable compressed gas as described in 49 CFR 173.300 (for a complete description of ignitable wastes, see 40 CFR 261.21, Characteristic of ignitability). Examples are spent solvents (see also solvents), solvent still bottoms, ignitable paint wastes (paint removers, brush cleaners and stripping agents), epoxy resins and adhesives (epoxies, rubber cements and marine glues), and waste inks containing flammable solvents. Unless otherwise specified, all ignitable wastes have the EPA Hazardous Waste Number of D001.

Some commonly used ignitable compounds are:

Acetone	F003
Benzene	F005
n-Butyl Alcohol	F003
Chlorobenzene	F002[1]
Cyclohexanone	F003
Ethyl Acetate	F003
Ethylbenzene	F003
Ethyl Ether	F003
Ethylene Dichloride	D001
Methanol	F003
Methyl Isobutyl Ketone	F003
Petroleum Distillates	D001
Xylene	F003

Ink Sludges Containing Chromium and Lead:

This includes solvent washes and sludges, caustic washes and sludges, or water washes and sludges from cleaning tubs and equipment used in the formulation of ink from pigments, driers, soaps, and stabilizers containing chromium and lead. All ink sludges have the EPA Hazardous Waste Number K086.

[1] Chlorobenzene is listed by EPA as a hazardous waste due to its toxicity and has been assigned EPA Hazardous Waste Number F002. It has a flashpoint, however, of less than 140°F and is therefore included here as an ignitable waste.

Lead-Acid Batteries:

Used lead-acid batteries should be reported on the notification form *only* if they are not recycled. Used lead-acid batteries that *are* recycled do not need to be counted in determining the quantity of waste that you generate per month, nor do they require a hazardous waste manifest when shipped off your premises. (Note: Special requirements do apply if you recycle your batteries on your own premises—see 40 CFR Part 266.)

Lead Dross	D008
Spent Acids	D002
Lead-Acid Batteries	D008

Pesticides:

The pesticides listed below are hazardous. Wastes marked with an asterisk (*) have been designated acutely hazardous. For a more complete listing, see 40 CFR 261.32 and 261.33 for specific listed pesticides, and other wastes, wastewaters, sludges, and by-products from pesticide formulators. (Note that while many of these pesticides are no longer in common use, they are included here for those cases where they may be found in storage.)

*Aldicarb	P070
*Aldrin	P004
Amitrole	U011
*Arsenic Pentoxide	P011
*Arsenic Trioxide	P012
Cacodylic Acid	U136
Carbamic Acid, Methylnitroso-, Ethyl Ester	U178
Chlordane	U036
*Copper Cyanides	P029
1,2-Dibromo-3-chloropropane	U066
1,2-Dichloropropane	U083
1,3-Dichloropropene	U084
2,4-Dichlorophenoxy Acetic Acid	U240
DDT	U061
*Dieldrin	P037
Dimethylcarbamoyl Chloride	U097

Pesticides *(Continued)*:

*Dinitrocresol	P047
*Dinoseb	P020
Disodium Monomethanearsenate	D004
*Disulfoton	P039
*Endosulfan	P050
*Endrin	P051
Ethylmercuric Chloride	D009
*Famphur	P097
*Heptachlor	P059
Hexachlorobenzene	U127
Kepone	U142
Lindane	U129
2-Methoxy Mercuric Chloride	D009
Methoxychlor	D014
*Methyl Parathion	P071
Monosodium Methanearsenate	D004
*Nicotine	P075
*Parathion	P089
Pentachloronitrobenzene	U185
Pentachlorophenol	U242
Phenylmercuric Acetate	D009
*Phorate	P094
*Strychnine	P108
2,4,5-Trichlorophenoxy Acetic Acid	U232
2-(2,4,5-Trichlorophenoxy)-Propionic Acid	U233
*Thallium Sulfate	P115
Thiram	U244
*Toxaphene	P123
Warfarin	U248

Reactives:

Reactive wastes include reactive materials or mixtures which are unstable, react violently with or form explosive mixtures with water, generate toxic gases or vapors when mixed with water (or when exposed to pH conditions between 2 and 12.5 in the case of cyanide or sulfide bearing wastes), or are capable of detonation or explosive reaction when heated or subjected to shock (for a complete description of reactive wastes, see 40 CFR 261.23, Characteristic of reactivity). Unless otherwise specified, all reactive wastes have the EPA Hazardous Waste Number D003. The following materials are commonly considered to be reactive:

Acetyl Chloride	Organic Peroxides
Chromic Acid	Perchlorates
Cyanides	Permanganates
Hypochlorites	Sulfides

Spent Plating and Cyanide Wastes:

Spent plating wastes contain cleaning solutions and plating solutions with caustics, solvents, heavy metals, and cyanides. Cyanide wastes may also be generated from heat treatment operations, pigment production, and manufacturing of anti-caking agents. Plating wastes are generally Hazardous Waste Numbers F006-F009, with F007-F009 containing cyanide. Cyánide heat treating wastes are generally Hazardous Waste Numbers F010-F012. See 40 CFR 261.32 for a more complete description of plating wastes.

Wood Preserving Agents:

The wastewater treatment sludges from wastewater treatment operations are considered hazardous (EPA Hazardous Waste Number K001—bottom sediment sludges from the treatment of wastewater processes that use creosote and pentachlorophenol). In addition, unless otherwise indicated, specific wood preserving compounds are:

Chromated Copper Arsenate	D004
Creosote	U051
Pentachlorophenol	F027

APPENDIX H

GROUND WATER INFORMATION PACKET

GROUND WATER

An aquifer is any rock or sediment that allows economically significant amounts of ground water to be withdrawn from it. Aquifers are found near the surface and at depth throughout South Dakota. Examples of aquifers include 1) sand and gravel layers (i.e., buried river systems/floodplains), and 2) fracture systems in carbonate (i.e., limestone) or crystalline rocks (i.e., granite, quartzite). In both cases, the aquifers have connected open pore spaces through which fluid may flow.

The depth to water in an aquifer can be measured. Water levels may fluctuate and change for a variety of reasons. Aquifers are generally grouped into one of two categories. Either they are called unconfined aquifers or confined aquifers (see figure 1). In an unconfined aquifer, the surface of the water in the aquifer is in equilibrium with atmospheric pressure. The water table defines and separates the saturated zone below from the unsaturated zone above. An unconfined aquifer is usually located close to the surface of the earth. As an analogy – consider a glass filled with ice cubes and pop, with a straw in it. The ice cubes are equivalent to the grains of sand and gravel. The pop is like the ground water that flows around and between the "grains" in the aquifer. The straw is like a well – it can be used to "pump" water out of the aquifer.

Confined (artesian) aquifers are generally located deeper in the earth. Rock or sediment layers of low permeability (confining layers) located beneath the aquifer and above the aquifer, restrict the vertical movement of ground water into and out of the aquifer system. In a confined aquifer, water is generally subject to pressure greater than atmospheric pressure. Water in wells completed in the aquifer will rise above the top of the aquifer. The level to which water will rise is called the potentiometric surface (see figure 1). The potentiometric surface is analogous to the water table in an unconfined system. A potentiometric surface may be higher than the surface of the earth (i.e., up in the air). A well in this special situation is called a flowing well.

Water moves into an aquifer through a recharge area. In an unconfined surficial aquifer, surface water (i.e., rainfall, snowmelt) percolates down through the soil and unsaturated sediments to the water table. In a confined aquifer, recharge may come from surface connections or from relatively slow movement of water through leaky confining layers.

Considering the lack of abundant surface water sources in the state, aquifers are a very important resource in South Dakota. They offer a large, reliable source of water for domestic, stock, public-supply, irrigation, and industrial use.

GROUND WATER QUALITY

Water is not pure H_2O; it contains a variety of chemicals. Most of these chemicals occur in small quantities and often do not adversely affect the taste, smell, or the hardness of the water. A few chemical parameters may affect a person's health, even at low concentrations, while others may simply be nuisances.

The United States Environmental Protection Agency (U.S. EPA) has established enforceable as well as recommended drinking water standards for public water supplies. Listed in Table 1 are some parameters that are commonly examined in ground water. This table also lists the cause or impact of excessive concentrations of these parameters and their recommended or enforceable drinking water limit. Also listed in Table 1 are the average, maximum and minimum values for some water-quality parameters. These data are from water samples collected from private wells and monitoring wells located in the Big Sioux aquifer in eastern South Dakota.

The water quality of municipal and rural-water system supplies is routinely checked. Monitoring water quality in a private water well is the responsibility of the owner/user. As a minimum, the bacteria and nitrate levels should be checked annually in a private well. All water quality records should be kept to provide a history of the water quality in that well.

Ground-water quality varies significantly throughout South Dakota. Most ground-water supplies in South Dakota exceed EPA's total dissolved solids (TDS) recommended limit of 500 milligrams per liter (mg/L). Even so, most of these supplies are safe to drink. In most cases, the TDS value is high because the water contains an excess of calcium, magnesium, bicarbonate, or sulfate ions. Locally in some ground-water supplies, elevated nitrate concentrations have been found in excess of the drinking water standard of 10 mg/L.

Two common chemical constituents with potentially harmful effects on people include nitrates and fluoride. Nitrates found in ground water are of concern because in high concentrations they may cause methemoglobinemia ("blue baby syndrome"). Nitrates are converted to nitrites by bacteria in an infant's digestive tract. These nitrites are toxic to the infant because they may make the blood cells unable to carry oxygen throughout the child's body. Eventually, the child may begin to turn blue due to oxygen starvation of body tissues. This syndrome is particularly of concern for pregnant women and infants up to 12 months of age. The U.S. EPA's limit for fluoride concentrations continues to be controversial. Regardless, in high concentrations fluoride causes mottling of tooth enamel.

Water quality varies in an aquifer depending on a number of different natural factors or as a result of human-related activities. In nature, the rocks through which the water flows may dissolve slightly, thus altering the water quality.

Contaminants in ground water may also result from human-related activities. Unconfined aquifers which are located very close to the earth's surface are very susceptible to contamination from a variety of sources. These sources may include things such as chemical spills on the land surface, leaking underground storage tanks, and pesticides applied over large areas (like a golf course or a farm field). Some nitrate contamination in South Dakota today appears to be related to fertilizer and animal-waste products. The improper timing of fertilizer application or the overapplication of fertilizer may allow excess nitrates to leach into the ground water. Poor well construction may allow contaminated surface water to seep into the ground water along the outside of a well casing. If a well is placed too close to a septic field, pumping may pull (induce) contaminated water into the well. Even the depth of the sample collected relative to the water table may determine whether or not a particular contaminant is detected in the water-quality analyses. For example in South Dakota, nitrates have been found at elevated concentrations in the upper part of surficial, unconfined aquifers, whereas concentrations tend to be lower in the bottom of the aquifers. Aquifers may also be exposed to potential sources of contamination via well abandonment techniques and underground waste injection.

WELL CONSTRUCTION

Well construction is not as simple as it may seem! There are several different ways to dig a hole in the ground and construct a well in it. South Dakota has regulations concerning the methods and materials that can be used. The following paragraphs are simple generalizations about well construction.

Wells are constructed for different purposes. They may be used to supply large quantities of water to public water supply systems, to supply smaller quantities to private homes, or to simply monitor the quality of the ground water. Sometimes monitoring wells are grouped in what is called a nest. A nest typically consists of two or more closely spaced wells completed at different depths. Nested wells are used to detect water-quality changes with depth in an aquifer.

After a hole has been drilled to the desired depth, the well pipe or casing is placed in the hole. There are special tools designed to allow the drilling rig to "hang on to" the casing as it is installed. Generally, the first piece of casing to go down the hole is the well screen. This is a piece of casing with slots in it (see figure 1). The purpose of the slots is to allow water to flow into the casing, yet keep unwanted materials (sand and gravel) out.

Once the desired length of well screen is chosen, unslotted well casing is attached. Casing is added until the desired total length is obtained. Usually the casing sticks out above the ground a short distance. Casing materials commonly consist of plastic or steel. Today, great care is taken to make sure that the seams between these pieces of casing will not leak. Sometimes centralizers are added to the casing at various intervals along the length of the casing to help keep the casing centered in the hole.

After the casing is placed down the hole, filter pack is added in the space between the hole wall and the outside of the casing. Filter pack is a certain size of sand or gravel. The amount of filter pack placed in this space is calculated to fill the space to above the top of the well screen. The purpose of the filter pack is to create a highly permeable zone around the well that will help keep the aquifer materials out of the well.

Next, grout (low permeability sealing material) is put in the remaining space to inhibit the migration of fluids up hole as well as down hole. This grout may consist of bentonite and/or cement. Bentonite is a type of clay mineral that swells in the presence of water creating a substance of low permeability. When bentonite is used, generally a thick slurry of bentonite and water is mixed and pumped down the annular space. Within minutes to hours the bentonite/water slurry thickens to a gel similar to Jello. In many situations bentonite is not used and cement is the only grouting material. The cement is always mixed with water in the proper proportions and pumped down the hole then allowed to harden in place.

Once the well casing is in place, the well has to be developed. To develop a well means to flush out the loose clay, silt, and fine sand-sized particles in the filter pack and in the aquifer close to the well screen. One of several methods is to lower a small diameter pipe down the well and alternate blasting air out through the well screen with pumping the water out of the well. This blast-and-pump method is repeated until the well-screen area is determined to be "clean" (developed).

Now the well is ready for use! If the well is designed to produce water regularly, a permanent pump is installed inside the well, and the well can be used.

Figure 1. Generalized diagram of confined and unconfined aquifers.

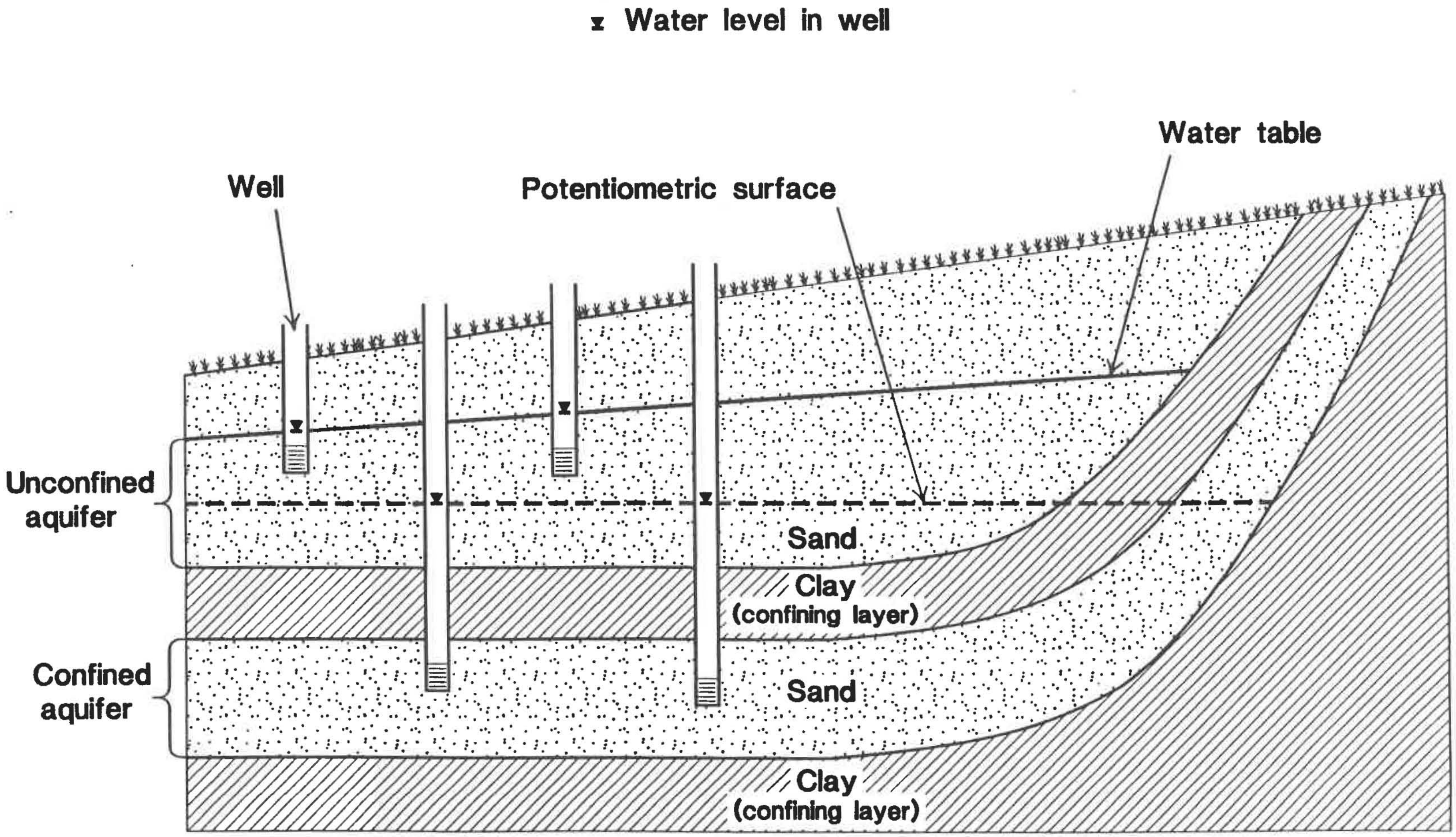


TABLE 1

PARAMETER	Big Sioux Aquifer FW* mg/L	Big Sioux Aquifer MW* mg/L	EPA Drinking Water Standards Recommended mg/L	EPA Drinking Water Standards Enforceable mg/L	CAUSE/IMPACT
TOTAL DISSOLVED SOLIDS			500		This refers to the total amount of dissolved materials; primarily calcium, magnesium, sulfate, chloride and sodium. The limit is based on taste not health considerations.
Avg.	977	673			
Max.	3470	3040			
Min.	290	244			
HARDNESS (calculated)					Hardness due to calcium and magnesium, and to a lesser extent iron and manganese, often reduces the effectiveness of soap and can cause incrustations in teapots, water heaters, etc.
Avg.	704	515			
Max.	2455	1920			
Min.	248	72			
SULFATE			250		There is a taste effect at levels above 500 mg/L. Although levels above 600 mg/L initially have a laxative effect, tolerance usually develops fairly quickly.
Avg.	291	227			
Max.	1725	1720			
Min.	25	<5			
CHLORIDES			250		Levels from 250-500 mg/L can cause an objectionable taste.
Avg.	52	10			
Max.	313	62			
Min.	<2	<1			
SODIUM					Levels above 500 mg/L when combined with chloride, produced a salty taste. Higher levels are associated with hypertension and heart disease.
Avg.	38	32			
Max.	133	142			
Min.	6	4			
POTASSIUM					Since there is normally a small range of values, high levels may indicate contamination from potash in commercial fertilizers.
Avg.	5.8	4.7			
Max.	17.0	21.2			
Min.	0.3	>0.1			
NITRATE (as nitrogen)				10	High levels often indicate contamination from animal or human wastes or fertilizers. Levels above 10 mg/L may cause "blue baby" disease (methemoglobinemia) in infants under 12 months.
Avg.	17.1	1.9			
Max.	120.0	19.0			
Min.	<0.1	<0.1			
IRON			0.3		Levels above 0.3 mg/L may produce a taste effect and cause staining of plumbing fixtures.
Avg.	1.1	0.7			
Max.	11.6	4.6			
Min.	<0.05	<0.01			
MANGANESE			0.05		Levels exceeding 0.2 mg/L may cause staining of plumbing fixtures, while levels above 0.5 mg/L may cause a taste effect.
Avg.	0.6	0.7			
Max.	2.8	5.0			
Min.	<0.05	<0.01			
FLUORIDE			2.0	4.0	Public water supplies are fluoridated to a level of 1.2 mg/L to inhibit tooth decay. Levels above 2.0 can cause discoloration (mottling) of teeth. Levels above 4.0 cause skeletal damage.
Avg.	0.42	0.38			
Max.	1.89	1.02			
Min.	0.20	0.10			

FW* – Farm or house well   MW* – Monitoring well

Adapted from East Dakota Conservancy Sub-District, 1984, *The Big Sioux Aquifer Water Quality Study*, second in a series.

APPENDIX I

EXCERPTS FROM WILLA CATHER NOVELS TO ACCOMPANY IS2MOD

Willa Cather

O Pioneers © 1913, Houghton Mifflin

Evening and the flat land,
Rich and somber and always silent;
The miles of fresh-plowed soil,
Heavy and black, full of strength and harshness;
The growing wheat, the growing weeds,
The toiling horses, the tired men;
The long empty roads,
Sullen fires of sunset, fading,
The eternal, unresponsive sky.
Against all this Youth,
Flaming like the wild roses,
Singing like the larks over the plowed fields,
Flashing like a star out of the twilight;
Youth with its insupportable sweetness,
Its fierce necessity,
Its sharp desire,
Singing and singing,
Out of the lips of silence,
Out of the earthy dusk.

Part 1

The Wild Land

Chapter III

.... The Bergson wagon lurched along over the rough hummocks and grass banks, followed the bottom of winding draws, or skirted the margin of wide lagoons, where the golden coreopsis grew up out of the clear water and the wild ducks rose with a whir of wings.

Ivar found contentment in the solitude he had sought out for himself. He disliked the litter of human dwellings: the broken food, the bits of broken china, the old wash-boilers and tea-kettles thrown into the sunflower patch. He preferred the cleanliness and tidiness of the wild sod. He always said the badgers had cleaner houses than people, and that when he took a housekeeper her name would be Mrs. Badger. .... If one stood in the doorway of his cave, and looked off at the rough land, the smiling sky, the curly grass white in the hot sunlight; if one listened to the rapturous song of the lark, the drumming of the quail, the burr of the locust against the vast silence, one understood what Ivar meant.

Chapter V

...., and Emil wondered why his sister looked so happy. Her face was so radiant that he felt shy about asking her. For the first time, perhaps, since that land emerged from the water of geologic ages, a human face was set toward it with love and yearning. It seemed beautiful to her, rich and strong and glorious. Her eyes drank in the breadth of it, until her tears blinded her. Then the Genius of the Divide, the great, free spirit which breathes across it , must have bent lower than it ever bent to a human will before. The history of every country begins in the heart of a man or a woman.

Part II

Neighboring Fields

Chapter I

The Divide is now thickly populated. The rich soil yields heavy harvests; the dry, bracing climate and the smoothness of the land make labor easy for men and beasts. There are few scenes more gratifying than a spring plowing in that country, where the furrows of a single field often lie a mile in length, and the brown earth, with such a strong clean smell, and such a power of growth and fertility in it, yields itself eagerly to the plow; rolls away from the shear, not even dimming the brightness of the metal, with a soft, deep sigh of happiness.

.... The air and the earth are curiously mated and intermingled, as if one were the breath of the other. You feel in the atmosphere the same tonic, puissant quality that is in the tilth, the same strength and resoluteness.

Chapter V

Carl sat musing until the sun leaped above the prairie, and in the grass about him all the small creatures of day began to tune their tiny instruments. Birds and insects without number began to chirp, to twitter, to snap and whistle, to make all manner of fresh shrill noises. The pasture was flooded with light; every clump of ironweed and snow-on-the-mountain threw a long shadow, and the golden light seemed to be rippling through the curly grass like the tide racing in.

Willa Cather

My Antonia © 1918, Houghton Mifflin

Book 1

The Shimerdas

Chapter 2

.... This cornfield, and the sorghum patch behind the barn, were the only broken land in sight. Everywhere, as far as the eye could reach, there was nothing by rough , shaggy, red grass, most of it as tall as I.

As I looked about me I felt that the grass was the country, as the water is the sea. The red of the grass made all the great prairie the colour of wine-stains, or of certain seaweeds when they are first washed up. And there was so much motion in it; the whole country seemed, somehow, to be running.

I sat down in the middle of the garden, where snakes could scarcely approach unseen, and leaned my back against a warm yellow pumpkin. There were some ground-cherry bushes growing along the furrows, full of fruit. I turned back the papery triangular sheaths that protected the berries and ate a few. All about me giant grasshoppers, twice as big as any I had ever seen, were doing acrobatic feats among the dried vines. The gophers scurried up and down the ploughed ground. There in the sheltered draw-bottom the wind did not blow very hard, but I could hear it singing its humming tune up on the level, and I could see the tall grass wave. The earth was warm under me , and warm as I crumbled it through my fingers. Queer little red bugs came out and moved in slow squadrons around me. Their backs were polished vermilion, with black spots. I kept as still as I could. Nothing happened. I did not expect anything to happen. I was something that lay under the sun and felt it, like the pumpkins, and I did not want to be anything more. I was entirely happy. Perhaps we feel like that when we die and become part of something entire, whether it is sun and air, or goodness and knowledge. At any rate, that is happiness; to be dissolved into something complete and great. When it comes to one, it comes as naturally as sleep.

Chapter 3

I could hardly wait to see what lay beyond that cornfield; but there was only red grass like ours, and nothing else, though from the high wagon-seat one could look off a long way. The road ran like a wild thing, avoiding the deep draws, crossing them where they were wide and shallow.

And all along it, wherever it looped or ran, the sunflowers grew; some of them were a big as little trees, with great rough leaves and many branches which bore dozens of blossoms. They made a gold ribbon across the prairie. Occasionally one of the horses would tear off with his teeth a plant full of blossoms, and walk along munching it, the flowers nodding in time to his bites as he ate down toward them.

The land was growing rougher; I was told that we were approaching Squaw Creek, which cut up the west half of the Shimerdas' place and made the land of little value for farming. Soon we could see the broken, grassy clay cliffs which indicated the windings of the stream, and the glittering tops of the cottonwoods and ash trees that grew down in the ravine. Some of the cottonwoods had already turned, and the yellow leaves and shining white bark made them look like the gold and silver fairy tales.

Chapter 6

All those fall afternoons were the same, but I never got used to them. As far as we could see, the miles of copper-red grass were drenched in sunlight that was stronger and fiercer than at any other time of day. The blond cornfields were red gold, the haystacks turned rosy and threw long shadows. The whole prairie was like the bush that burned with fire and was triumphant ending, like a hero's death---heroes who died young and gloriously. It was a sudden transfiguration, a lifting-up of day.

Chapter 17

When spring came, after that hard winter, one could not get enough of the nimble air. Every morning I wakened with a fresh consciousness that winter was over. There were none of the signs of spring for which I used to watch in Virginia, no budding woods or blooming gardens. There was only---spring itself; the throb of it, the light restlessness, the vital essence of it everywhere: in the sky, in the swift clouds, in the pale sunshine, and in the warm, high wind---rising suddenly, sinking suddenly, impulsive and playful like a big puppy that pawed you and then lay down to be petted. If I had been tossed down blindfold on that red prairie, I should have known that it was spring.

Chapter 19

July came on with that breathless, brilliant heat which makes the plains of Kansas and Nebraska the best corn country in the world. It seemed as if we could hear the corn growing in the night; under the stars one caught a faint crackling in the dewy, heavy-odoured cornfields where the feathered stalk stood so juicy and green. If all the great plain from the Missouri to the Rocky Mountains had been under glass , ant the heat regulated by a thermometer, it could not have been better for the yellow tassels that were ripening and fertilizing the silk day by day. The cornfields were far apart in those times, with miles of wild grazing land between. It took a clear, meditative eye like my grandfather's to foresee that they would enlarge and multiply until they would be, not the Shimerdas' cornfields, or Mr. Bushy's, but the world's cornfields; that their yield would be one of the greatest economic facts, like the wheat crop of Russia, which underlie all the activities of men, in peace or war.

Book II

The Hired Girls

Chapter 14

On Sunday Morning I rose early and got out of Black Hawk while the dew was still heavy on the long meadow grasses. It was the high season for summer flowers. The pink bee-bush stood tall along the sandy roadsides, and the cone-flowers and rose mallow grew everywhere. Across the wire fence, in the long grass I saw a clump of flaming orange-coloured milkweed, rare in that part of the state. I left the road and went around through a stretch of pasture that was always cropped short in summer, where the gaillardia came up year after year and matted over ground with deep, velvety red that is in Bokhara carpets. The country was empty and solitary except for the larks that Sunday morning, and it seemed to lift itself up to me and to come very close.

We sat looking off across the country, watching the sun go down. The curly grass about us was on fire now. The bark of the oaks turned red as copper. There was a shimmer of gold on the brown river. Out in the stream the sandbars glittered like glass, and the light trembled in the willow thickets as if little flames were leaping among them. The breeze sank to stillness. In the ravine a ringdove mourned plaintively, and somewhere off in the bushes an owl hooted. ....

Games

The CAN MAN Game

Purpose

The CAN MAN Game is designed for teaching solid waste concepts.

Rules

Game rules have been intentionally left general. Educators and students are encouraged to alter the rules to fit their classroom situations.

The set time limit is usually 15 minutes. The game may last longer should the students wish to debate any concept blocks on the board.

Tokens and player pieces are not supplied with the game. Tokens can be bottle caps, soda can tab tops, old buttons, old washers or any other small waste material. If students cannot collect enough waste for tokens consider using such items as kernels of corn, small candy pieces such as M&Ms, soybeans or packing materials such as the biodegradable polystyrene pieces.

Player pieces can be anything such as old erasers or pieces crafted from waste materials in an art class. Encourage students to find something from home that is a waste material that could be used as a player piece.

The game lasts longer when using one die rather than two dice. The players may use two dice if they please, but they will go around the board more times during the set time period.

Normally the players move the direction the CAN MAN is facing; i.e., in a clockwise direction. They may go counter clockwise if they wish.

Concepts

Each square should be discussed with the students as to why the player carries out an action.

> Example: You find markets before starting a recycling program. Take 1 token. The reason for gaining a token is the fact that most recycling programs succeed because they have found a market before they start collecting the material. It requires a great deal of work and time to sometimes find the markets. Be prepared for the transportation costs!
>
> Example: Make a commitment to reduce, reuse and recycle...then take 1 token. The reason for this block is like any other commitment; that is, to put into motion a positive action to protect our environment. This block leads to a simple writing and oral expression exercise.
>
> Example: You flatten your bimetal cans before taking them to a recycling center. Take 1 token. This block can lead to a <u>Project SAVE</u> activity on figuring volume and transportation costs. Students need to be aware that transportation costs are one of the biggest problems facing the recycling industry in South Dakota.

Example: The block on using a garbage disposal rather than composting is intended to tie the waste disposal issue to water quality. Each time a garbage disposal is used the waste must be treated before it reaches a South Dakota waterway. It costs extra money and energy to treat the excess waste. Instead of putting the material down the garbage disposal put it in a compost pile where it will be naturally broken down and can be reused in the garden, on the lawn or during new tree and shrub plantings.

Example: Many of the blocks in The CAN MAN Game are action oriented blocks so students will get an idea to start some type of recycling or reuse at home, school or in their organizations. Students are encouraged to adopt a highway mile which can be done through the department of transportation, there is a suggestion to start a recycling program at home, buy recycled products at school so there are more markets, reading labels to avoid the more toxic materials and keeping the beautiful South Dakota Parks clean for everyone to enjoy!

Notes

Finally, The CAN MAN Game is meant to stimulate thought, discussion and action regarding solid waste management. Educators using the game are encouraged to stress the positive about what CAN be done and that we CAN work together for a clean South Dakota. The game is designed to fit with the Project SAVE : Studies, Awareness, and Values of the Environment college credit classes offered through Capital University Center in Pierre.

Any comments, suggestions or questions about The CAN MAN Game should be directed to:

Project SAVE Coordinator
Environmental Education Programs
Technical and Support Services
Department of Environment and Natural Resources
523 E. Capital
Pierre, SD 57501

Graphics by nancy gordon

Printing funded by U.S. Environmental Protection Agency - Region VIII, Denver CO. and Capital University Center, Pierre SD.

Project SAVE - Studies, Awareness, and Values of the Environment

PROJECT S.A.V.E. BINGO DIRECTIONS

1) Provide a blank sheet of paper and a bingo sheet of paper to each student.

2) Have students cut out pictures from the bingo sheet and glue the pictures to a blank bingo card. The students should create their own bingo card arrangement.

3) Supply students with some type of recycled material to use as bingo beans. For example the students could save pop tabs prior to playing the game.

4) The teacher needs to cut apart picture sheet and put individual pictures in sack. Draw one picture at a time from the sack and call out the picture for the children to cover.

B I N G O

Project SAVE Fun Production

Copies may be made for classroom use.

		FREE		

Project SAVE
Studies Awareness and Values of the Environment

Developed at Sully Buttes Schools by:
Bea Stough, 2nd Grade Instructor
Tawana Grueb, Chapter Reading
Cindy Fiechtner, Chapter Math

South Dakota
Environment and Natural Resources
523 E. Capitol
Pierre, South Dakota 57501
1,000 copies of this game were printed at a cost of $1.70 each.

Supplies

- Obtain some dice and a round head fastener.

Make the spinner

- Cut a small slit in the center of the spinner (located in the bottom left corner of the WENDY WATER Board Game).
- From the back side of the game board push the two branches of the round head fastener through the small slit.
- Push open the two branches of the round head fastener so they are nearly flat against the game board.
- Give it a spin!

General Game Rules

To see who starts, roll the dice. The highest roll goes first. You may play single or with a partner. You may have a reader who will read the questions to players, or you may read for each other. If there are any questions or problems, see the teacher!

To begin and move off “start” you must answer a question correctly. Then if you answer correctly, you have a choice. You may move the amount of spaces as stated on the card, OR you can spin and take the chance of getting more spaces (or going backwards).

When you land in the Dirty River, you must play off each marked spot. This will take you awhile - but you are in the Dirty River because you did something wrong! So, you must pay the price.

Any other questions of problems? Ask the teacher.

Have fun!

Game Cards

Small areas in the earth where water trickles out from under the ground are called__________.

(springs)

Move ahead 1 space.

HEY! GREAT IDEA!
You put a weighted quart bottle in your toilet tank so you will save a quart of water with each flush. How much water would you save if you put a gallon jug in your tank?

(One gallon per flush)

Move ahead 1 space.

T or F
Sometimes the soil that runs into the water carries poisonous chemicals.

(T)

Move ahead one space.

T or F
A pool in a stream is a place where water does not move fast.

(T)

Move ahead one space.

If you have to take a bath, what can you do to help save water?

(Only fill the tub half way)

Move ahead one space.

NO! NO!
You did not turn off the water faucet all the way and it dripped all night!

Go back 4 spaces!!

Did you know that a gallon of water can run out your kitchen faucet in less than 60 seconds?
What is another name for 60 seconds?

(One minute)

Move ahead one space.

What is the only substance found on earth naturally in three forms?

(Water)

Move ahead 1 space.

What does Reduce, Reuse, and Recycle mean?

(Reduce the amount of waste we have. Reuse what waste we do have. Recycle paper, glass, cans; everything we can so it can be made into new things.)

Move ahead one space.

Plants hold ____________ in place. This keeps the stream clean.

(Soil)

Move ahead one space.

YIPES!
You threw an old boot into the river rather than recycling.

Go to the "boot spot".

A __________ is formed when many springs add together.

(Stream)

Move ahead one space.

What is the movement of water in a stream called?

(Current)

Move ahead 1 space.

T or F
A person uses less water when they shower than when they take a bath.

(T)
Move ahead one space.

Every hour 3,000 acres of rain-forest are demolished. How many acres are demolished in five hours?

(15,000 acres of land)
Move ahead 1 space.

All life needs ____________ to live.

(Water, food, shelter.)

Move ahead one space.

T or F
Soapy water is good for fish.

(F)

Move ahead one space.

What is one of the world's largest underground water sources?

(Ogallala or High Plains, groundwater source found from South Dakota to Texas)
Move ahead 1 space.

More than 189 million tons of solid waste are legally dumped off the Atlantic, Pacific, and Gulf Coasts every year. What could we do to stop this?

(Reduce, recycle, reuse)

Move ahead one space.

Explain why-
You should keep a jug of cold water in your refrigerator.

(Then you don't have to let it run to get cold.)
Move ahead one space.

Pass this card to your left.
That person loses a turn.

You go ahead 1 space.

Fast running water is usually

________.

(Cold)

Move ahead 1 space.

SHAME, SHAME, SHAME ON YOU! Your leaky faucet can lose up to 10 gallons of water per day. Until you fix this you are on the SHAME ON YOU LIST...
Go back 3 spaces.

T or F
Hazardous waste is not harmful to the environment.

(F)
Move ahead one space.

The water in pools is

________.

(Warm or Quiet)

Move ahead one space

How dare you!
You threw your old oil from your car into the street and it ran into the sewer system.
Think before you act!

Go to the start at the Dirty River!

You bought a front-loading washing machine that uses 40% less water than top loading machines.
SMART IDEA!

You can move ahead two spaces!

About what percentage of the human body is water?

(66%)

Move ahead 1 space.

T or F
Water drops cling tightly to each other.

(T)
Move ahead one space.

Water that seeps into the ground
from rain or streams
is called ________ .

(Ground water)
Move ahead 1 space.

Explain why- a lot of soil in the water is harmful to fish.

(Dirty water can plug up the fishes gills, so they can't breathe.)
Move ahead 1 space.

T or F
You should keep a jar of cold water in your refrigerator for drinking.

(T)

Move ahead 1 space.

What is the source of both groundwater and surface water?

(Rainfall or Snowfall)

Move ahead 1 space.

What is our primary source of drinking water in South Dakota?

(Groundwater)

Move ahead 1 space.

Great Job! You installed a water saving shower head! You will save two gallons of water per minute.
You can move ahead one space.
And you can move ahead again if you know how much water you would save in one hour!

(120 gallons of water in one hour)

Good Job!
You grow plants in your flower garden that do not need much water.

Move ahead 1 space.

Who has the responsibility to protect groundwater?

(All of us.)

Move ahead 1 space.

Your sewer system is dumping waste into the river.
You have been killing fish.

Go to the "dead fish" spot.

Littering is______ for a stream.

(Bad)

Move one space ahead.

Many springs form a ________.

(Stream)

Move ahead one space.

T or F
A pool in a stream is formed in a flat area.

(T)
Move ahead one space.

Rain, sleet, snow, and hail are examples of what?

(Precipitation)
Move ahead 1 space.

What can ruin our ground water.

(Landfill, septic tank, feedlot, fertilizer, pesticides, gas or oil leak, abandoned well)
Move ahead 1 space.

You always make sure the water faucets are shut off tightly.
YOU ARE SAVING WATER!

Move ahead 2 spaces.

What is Earth Day?

(It is a day that we celebrate and try to makes others aware of the problems we are facing with our environment. Also we can share the good things we have accomplished!)
Move ahead one space.

A stream makes a ________
or a ________ sound.

(bubbling or gurgling)

Move ahead 1 space.

About what percentage of the earth's surface is water?

(80%)

Move ahead 1 space.

Explain why-
Run-off from fields can be harmful to streams and to man.

(Too much soil in water hurts the animals and fertilizers can cause too many water plants.)
Move ahead 1 space.

GREAT JOB!
You turned off the water while you were brushing your teeth.
YOU ARE SAVING WATER!!

Go ahead 2 spaces.

300,000 acres of wetlands are lost per year thanks to development, construction, dredging and filling.
Why should we save the wetlands?

(We should save the wetlands because many plants and animals live there. It also helps keep the water cycle going.)
Move ahead one space.

When a stream slows down and the water becomes quiet it is called a ________.

(Pool)
Move ahead 1 space.

T or F
Deer, turkey, trees, grass and man all depend on water.

(T)
Move ahead one space.

What is the largest fresh water lake?

(Lake Superior)

Move ahead one space.

H2O stands for ________.

(Water)

Move ahead one space.

A ________ pulls the water into a pipe, and brings it into your house.

(Pump)
Move ahead one space.

Slow moving areas of water in streams are called ________.

(Pools)

Move ahead one space.

WHOOPS
You threw an old tire in the creek! That is not smart! Go to the "tire" spot in the dirty river.

Did you know that letting the water run while brushing your teeth can waste 10 gallons of water? If you brushed your teeth three times a day, how much water would you WASTE?

(30 gallons of water)
Move ahead one space.

General information. Did you know that it takes twenty trees to keep one baby in disposable diapers for two years?
How many trees would be used in four years?

(40 trees)
Move ahead 1 space.

T or F
Tiny animals live on tops of rocks in the stream.

(F)
Move ahead one space.

The story Wendy Water begins in the ________ of South Dakota.

(Black Hills)

Move ahead 1 space.

If all rivers flow into the ocean, why does the water level in the oceans stay the same?

(Water, or hydrologic cycle)
Move ahead 1 space.

Do we have more, less, or the same amount of water on earth than 2,000 years ago?

(Same)
Move ahead 1 space.

How long can a person live without water?

(Approximately 1 week.)
Move ahead one space.

T or F
The Missouri River is cleaner in South Dakota than Nebraska.

(T)
Move ahead 1 space.

About what percentage of the earth's water is fresh water?

(1%)

Move ahead 1 space.

What's the name of an artificial lake that collects and stores water?

(Reservoir)
Move ahead 1 space.

WHOOPS!
You were caught throwing a pop can into the river!

Go to the dirty river!!!

Pass this card to your left. That person let the lawn sprinkler run water down the street....and looses a turn.

**You turned your sprinkler off.
Go ahead 2 spaces!**