LEAKY LANDFILLS

OBJECTIVES

The students will do the following:

1. Define the terms landfill, open dump, and sanitary landfill.

2. Construct and observe a model landfill.

3. List potential water pollution problems associated with unlined or leaking landfills.

BACKGROUND INFORMATION

Americans throw out more trash every day than any other nation in the world. On the average, each American discards four pounds (1.8 kg) of trash per day or 1,460 pounds (660 kg) a year! The United States currently relies on landfills to dispose of almost 160 million tons (320,000,000,000 pounds or 144 million metric tons!) of municipal garbage every year. However, in recent years, many questions have arisen about whether trash disposal in conventional landfills is the best possible solution. Unless wastes are carefully managed, they may contaminate drinking water supplies, release toxic vapors into the air, create explosive conditions, or otherwise threaten public health. Landfills are not a bad option if they are designed, constructed, and managed properly.

A poorly designed and run landfill can be unsafe or hazardous to the health of people and wildlife in the vicinity. When rain percolates through decomposing garbage in a landfill, it forms a liquid called leachate. This liquid can percolate through the ground into an aquifer or other body of water such as a stream or lake and pollute the water. Well-designed landfills are watertight to avoid contamination of underground water. Current United States Environmental Protection Agency standards now require double liners and leak detection systems in addition to groundwater monitoring for new landfills. This prevents landfills from polluting the land, air, and water. Unfortunately, properly operated landfills preserve garbage. The best alternatives for tomorrow’s waste challenges will include reducing the amount of waste generated, reusing and recycling products, and using other waste disposal alternatives such as composting. In some areas, there are already programs in place which require citizens to recycle certain products.

ADVANCED PREPARATION

A. Make transparencies of groundwater illustration (included in "Danger—Pesticides!") and "Cross-Section of a Landfill" (included).
PROCEDURE

I. Setting the Stage

A. Discuss what happens to the items they don't need any longer.
   1. Ask the students how many trash cans they have in their homes.
   2. Ask them what happens to the trash in those cans.
   3. Explain that trash or garbage from their homes that is transported in a garbage truck is probably taken to a landfill.
   4. Discuss litter and how it contributes to nonpoint source pollution.

B. Explain that a landfill is a place where wastes (trash and garbage) are dumped, then covered with a layer of soil each day. The soil helps to keep away pests like bugs and rats and prevents pollutants from washing off the site when it rains. (Use a transparency of the teacher sheet, "Cross-Section of a Landfill").

C. Open dumps are where people pile up trash in places such as ravines or along roadsides. Landfills look neater than the open dumps, but both can cause pollution problems.
   1. Ask students to describe what pollution problems they think landfills might cause.
   2. Explain that even though landfills appear nicer than open dumps, underground they can be "leaking" leachate into underground water. When rainwater percolates through decomposing garbage, it forms leachate which can contain harmful bacteria and chemicals.
   3. U.S. laws now require liners that prevent leachate from seeping into the ground and polluting groundwater.
   4. If the liner breaks, however, the liquid can seep through the opening. To discover a leak in the liner, the groundwater around the landfills is tested on a regular basis. If pollution is found, then it is suspected that the liner has a leak and authorities take the necessary steps to correct the problem.

D. Display the groundwater illustration from "Danger—Pesticides!"
   1. Point out the landfill.
   2. Emphasize that chemicals, oil, and other poisons that are put in unlined or leaking landfills can seep through the ground, under and around the landfill, and into the water.
   3. If water which supplies home or public wells gets contaminated, people using this water can get sick.
II. Activity

A. Explain that each student is going to do an experiment. Tell them that they are going to make a model landfill.

B. Have each student construct a landfill.

1. Use heavy duty scissors to cut liter bottles into two halves. (NOTE: The teacher should perform this step. You may want to tape the edge if it is jagged to prevent cuts.)

2. Have each student write his/her name on a piece of tape on the upper half of the container with a permanent ink pen. (NOTE: This is the end with the pour spout.)

3. Have the students plug the pour spout with cotton, a paper towel, or coffee filter.

4. Tell them they are going to create a landfill by alternating garbage with soil.

5. Tell them to begin by lining the bottom of the container with soil, and set the top portion into the bottom as shown in the illustration.

6. Use a large spoon to add one of the pollutants, such as plastic spoon pieces, food bits, vegetable oil, or foil, and then cover it with soil.

7. Continue layering soil and garbage until all types of items have been included.

8. Have each student observe his/her landfill for 10 days recording his/her observations on the student sheet. Some will notice the vegetable oil seeping out of the soil. Tell them that the oil represents harmful chemicals or oil which could seep into underground water supplies.

9. During the observation period, sprinkle each landfill with water every other day to keep them damp.

10. After ten days allow students to dump out the contents of their landfills onto newspapers. (NOTE: You may want to do this outside.)
a. Using a stick to prod around the dirt, have students look at each pollutant and discuss any changes. The foil, plastic, and styrofoam will not have changed (decomposed), but the fruits and vegetables will probably have begun to decompose. Did a syrupy liquid form during decomposition?

b. Ask students why some items have changed and some have not. (some are biodegradable; some are not)

c. What kinds of harmful things are in garbage? (bacteria, toxic chemicals)

d. Ask students if they think it is safe to touch rotting garbage. (no) Why not? (may contain harmful bacteria or chemicals)

e. Would they want to drink water with a couple of drops of the syrupy liquid in it? Why not? (no, because it may contain bacteria or chemicals which could make them sick)

III. Follow-Up

A. Tell students that landfills are now built with plastic liners to prevent seepage, but the liners could get torn.

B. Demonstrate by lining a cardboard box with a plastic garbage bag and assembling a landfill similar to the one above in the container. Or, dig a shallow hole outdoors, line it with plastic, bury some trash, and cover with soil. (NOTE: Get permission from the principal first.)

1. Have the students discuss the pros and cons of landfill liners.

   a. Explain that a good landfill design attempts to minimize the amount of leachate formed by minimizing infiltration of rainwater and runoff. They also contain, remove, and/or treat the liquid so it cannot contaminate groundwater.

   b. Individuals can help by not throwing harmful garbage away which might someday leak into groundwater. Home hazardous wastes should be collected and disposed of on community hazardous waste collection days.

2. What else could we do to reduce the risks of harmful chemicals leaking from landfills into water supplies? (use less harmful chemicals; use incinerators to burn the chemicals instead of landfilling them. NOTE: This may cause air quality problems.) Use bacteria and other organisms to digest the chemicals and convert them to nontoxic waste. (NOTE: This is only appropriate for certain types of chemicals.)

IV. Extension

A. Instead of dumping the contents of all the students’ landfills out after ten days, leave some of the landfills set up for a month or more and then dump the contents out onto newspaper.

B. Observe what happens. Some materials will be around for years and years to come, others will break apart and go back into the soil.

   1. Find out how many years it takes for different things to decompose.

   2. Have the students observe what happened to glass, plastic, and aluminum.
a. Talk about how we can reduce the waste we generate.

b. Discuss how recycling could reduce the amount of wastes going to landfills. For example, people could write on both sides of paper instead of one side. Or waste computer paper could be saved and the backs used as scratch paper.

RESOURCES


CROSS-SECTION OF A LANDFILL

Unlined Landfill

Lined Landfill
# LEAKY LANDFILLS

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<tr>
<th>Day</th>
<th>Observations</th>
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</table>

1. Describe what happened. ____________________________________________

2. Did a syrupy liquid form? _________________________________________


4. Which items didn’t change? Why? _______________________________
OBJECTIVES

The students will do the following:

1. Define the term runoff.

2. List potential urban water pollution sources.

3. Trace the movement of water in underground storm sewer systems (not connected to the wastewater treatment plant).

4. Cite examples of litter that could potentially pollute a nearby water source.

BACKGROUND INFORMATION

Rainwater running off roofs, lawns, streets, and parking lots can wash a variety of water pollutants into lakes and streams. These pollutants include nutrients from garden fertilizers; bacteria from pet wastes and rotting litter; sediment from erosion; toxic chemicals such as pesticides, gasoline, and trace metals from emissions and grinding car parts (lead, mercury, and cadmium); zinc from roofs and gutters; and road salt or sand.

In developed areas, these pollutants usually collect on hard-surfaced parking lots and streets where they remain until a heavy rain washes them into nearby storm sewers. Sometimes these pollutants collect in such high concentrations that they kill fish when they are washed all at once by a heavy rain into a water body. This is called shock-loading. To prevent this from happening, urban planners are now planting grass filter strips, diversion ditches, and holding ponds to collect the runoff. This slows down the runoff and allows it to seep slowly into the ground so that less pollution enters storm sewers or washes into water bodies. A grass filter strip is an area of land planted with grass where water can flow instead of running into a storm drain. A diversion ditch is a channel lined with grass or riprap (rocks) used to direct water away from an area. Diversion ditches divert water to open land or ponds where it can collect and be slowly absorbed into the ground.

Wastewater treatment plants are regulated as point sources. Therefore, urban runoff channeled into wastewater treatment plants is considered point source pollution.
ADVANCED PREPARATION

A. Gather materials needed to conduct activity.

B. Copy the illustrations of urban nonpoint sources included in "Can You 'Point' It Out" and "I Spy" (optional, included).

C. Copy illustration of "Uncombined Storm Drain/Sewer System" (included).

PROCEDURE

I. Setting the Stage

A. Explain to students that in urban areas, much of the land is covered with asphalt roads, paved parking lots, and sidewalks. Show illustrations of urban nonpoint sources (optional, included).

B. Explain that hard surfaces are solid and do not let water soak through, so most of the rainwater runs across them, downhill into the nearest storm sewer and then into nearby streams.

C. Note that anything that is deposited on these surfaces can wash into storm drains. Show illustration of uncombined storm drains/sewer system (included).

D. Explain that water can become polluted when oil, gasoline, and litter on the parking lots run into nearby water bodies.

II. Activity

A. Tell the students that this lesson includes two experiments which will introduce them to major types and dangers of water pollution in the city.

B. Explain that the first experiment will show what happens to some surface water in urban areas.

1. Conduct experiment.

   a. Place the piece of brick, concrete, or asphalt and the piece of sod into separate shallow pans and set the pans on a table with students gathered around for observation.
b. Have students guess what will happen when water is poured on each surface.

c. Pour one cup (250 ml) of water on the hard surface and have a student describe what happened, then repeat the procedure on the piece of sod.

d. Explain that the excess water that does not soak in is called "runoff."

e. Have a student relate this experiment to what happens to runoff in the city. Runoff occurs much more in areas where there is concrete, paved roads, or other hard surfaces, and much less in areas covered with vegetation.

f. Explain that wastes from pets, birds, and rodents are often carried in the runoff, as well as litter, oil, chemicals, and pesticides.

2. Ask the students to speculate about where the runoff goes.

a. Ask the students if they have ever seen a storm sewer drain.

b. Show the illustration depicting a storm drain system and ask if they have ever seen water flowing into a storm drain.

c. Ask them where they think the water comes from that goes into the storm sewer. [For example, precipitation falls on solid surfaces like parking lots, roads, and houses and flows across these surfaces (runoff) until it enters an open storm drain.]

d. Tell students that it is not safe to play around storm drains.

e. Refer back to the storm sewer system and trace the route of various pollutants into the system, through the system, and into a water body.

C. Explain that the second experiment will show what happens to oil and water when they are mixed together as runoff.

1. Conduct experiment.

a. In small teams or as a class demonstration, provide a clear container half-filled with tap water.

b. Add several drops of food coloring to the water to show a contrast between the vegetable oil and the water. Mix the water and coloring with a plastic spoon in front of the class and comment on how well they mix together with adequate stirring.

c. Add two tablespoons (30 ml) of vegetable oil to the container and stir. Have the students describe what they observed.

d. Allow the contents to stand for approximately three minutes (longer if needed for oil and water to separate), then have the students share their observations.

e. Ask them if they can make the water and oil mix.

f. After several attempts students should see they do not mix.

g. Tell them the vegetable oil is like motor oil and gasoline from cars. Explain how motor oil can be washed into storm sewers when it leaks from cars or when people change their oil and pour it on the ground or down a storm sewer.
h. Pour the oil/water mixture on the piece of brick, concrete, or asphalt. What happened? (it remains in one place or runs downhill)

2. Discuss why oil and gas runoff is harmful to bodies of water.
   a. Explain how rain washes oil and gas from city streets and parking lots into storm sewers.
   b. Discuss what happens to roads/highways after it rains. Why are drivers asked to slow down? (sometimes, if it hasn't rained for a while, oil and gas which has leaked from cars can make the road slicker than usual, cars can lose control, and wreck)
   c. Explain that some of the chemicals in the oil are poisonous. For example, used motor oil contains heavy metals. Oil can also cover the entire surface of the water. When this happens, oxygen cannot pass into the water. Fish need oxygen and if oxygen is unavailable, they die.
   d. Also discuss the effects that the floating oil has on other wildlife, such as shorebirds and aquatic insects. Oil covers shorebirds’ feathers and bodies and makes their feathers lose their water resistance. Have them imagine wearing a wet coat all the time. Tell them the birds get cold and die.

III. Follow-Up

A. Discuss how litter contributes to urban water pollution.
   1. Have the students describe what kinds of litter they frequently see in their community.
   2. Have them discuss what happens to some of the litter after a heavy rain. For example, some is washed down storm sewer systems.
   3. Discuss the effect that litter has on bodies of water, for example, aesthetic effects. Some litter obstructs waterways and makes them unsafe places for water recreation.
   4. Have the students create a plan for their community to reduce the amount of litter in their area. Write the plan and pass it out to be taken home.

B. Have the students create a "micro-litter" poster.
   1. Assign the students to selected sites on the school grounds to collect all of the litter, large and small. (CAUTION: Advise students not to pick up broken glass or dangerous items. Have the students bring heavy work gloves from home to wear to protect their hands.)
   2. Bring the litter back to the classroom and have the students glue this litter onto one or more pieces of posterboard or cardboard, or create a mural using a long sheet of newsprint or brown wrapping paper.
   3. Have the students brainstorm to come up with a catchy environmental message about reducing nonpoint source water pollution by preventing litter.
   4. Add the messages to the poster and display it in a prominent place in the school or community.
IV. Extension

A. Get permission for students to go into other classrooms and tell other students how litter ends up in our water and what effect this has on water bodies. Have the students share their "micro-litter" posters as part of the presentation.

B. Have the students design "litter bags" to be used in their parents' cars to prevent trash from being thrown out of the car.

RESOURCES


"Protecting Minnesota's Waters...The Land Use Connection," Minnesota Pollution Control Agency, 520 Lafayette Road, St. Paul, Minnesota 55155, (612) 296-6300, 1986.

UNCOMBINED STORM DRAINS/SEWER SYSTEM

TO RIVER OR STREAM
OBJECTIVES

The students will do the following:

1. Explain how a homeowner can contribute to the problem of urban nonpoint source pollution.

2. Describe the household waste stream and how harmful household products reach water bodies.

3. Explain which products found in their homes can become potential pollutants, determine which environmentally safer products could be substituted for the potentially hazardous products, and determine how to safely dispose of household products.

BACKGROUND INFORMATION

Americans throw away more trash every day than any other nation in the world. On the average, Americans discard four pounds of trash per day per person or 1,460 pounds (660 kg) a year. Most of this waste is disposed of in landfills, almost 160 million tons (320,000,000,000 pounds; 144,800,000,000 kg) of municipal garbage every year.

Not only are Americans disposing of more waste, we are disposing of different kinds of wastes. We are using many materials that did not exist 50-100 years ago. There are new chemicals, medicines, insecticides, home permanents, detergents, plastics, paints, synthetic rubbers, glues, and so on. These products contain materials that do not exist in nature and are not broken down naturally in the soil or water by bacteria or fungi. Some of these new kinds of wastes can injure living things and are called hazardous wastes. A hazardous waste is any discarded substance whose chemical or biological nature makes it potentially dangerous to people and other organisms in nature. People have always produced hazardous wastes. But in the twentieth century, the amount produced has increased substantially!

In this "age of convenience," people use more potentially hazardous products in our homes than ever before. Common home hazardous wastes include transmission fluid, antifreeze, paint, paint thinner, batteries, fluorescent lamps, insecticides, flea powder, epoxy, oven cleaner, drain openers, metal polish, chlorine bleach, lighter fluid, shoe polish, expired prescription medicines, home permanents, nail polish, disinfectants, and toilet bowl cleaners. The list can go on and on. Used motor oil, while not considered hazardous by U.S. law, can also pose serious health risks to humans and the environment if it is deposited into storm sewers.

Most home hazardous wastes are being disposed of in sanitary landfills not designed to prevent them from polluting groundwater supplies. A sanitary landfill is a large outdoor place for waste disposal where waste is layered and covered with soil each day. Current EPA standards require double liners and leak detection systems to prevent contaminated leachate in landfills from percolating into the ground and polluting water supplies.
However, some harmful home wastes are disposed of improperly. For example, homeowners sometimes dispose used motor oil or leftover fertilizers and pesticides by pouring them on the ground or into storm sewers. Sinkholes, ravines, and abandoned water wells are sometimes used to dump garbage. Dumping garbage uncovered onto the ground, or depositing wastes directly on the land where wastes are exposed to the atmosphere, is called open dumping. Many people do not realize there is a connection between what is deposited on land and water pollution. People need to be made aware that improper waste disposal practices can cause water pollution. However, the best solution to this problem is to reduce the amount of waste generated, substitute safer products, reuse and recycle products, and use other disposal alternatives such as composting.

ADVANCED PREPARATION

A. Make one copy per student of figures and tables.

B. Make one copy per student of the home survey (optional).

PROCEDURE

I. Setting the Stage

A. Explain that homes are filled with products to make life easier, but they can become pollutants when "thrown out with the trash."

B. Have the students guess how much waste each person throws out in a day (average number of pounds or kilograms).

C. Point out that the average household contains 3-10 gallons (or 10-40 liters) of materials that are potentially harmful to human health or the environment. Then discuss what kinds of waste can be hazardous. Have each student list these materials and estimate the volume of combined hazardous chemicals in his/her home. These may include pesticides, herbicides, fertilizers, oil-based paints, solvents, car batteries, and expired medicines.

D. Discuss what happens to the chemicals in "empty" containers (flea powders, bleach, drain openers, etc.) that, in the course of their use, enter water bodies either directly or indirectly (flushing the toilet).

E. Explain what leachate is. As rainwater percolates through the landfill, rotting garbage decomposes and forms a syrupy liquid called leachate. Leachate can seep into the ground and pollute groundwater. It can contain sediment, bacteria, nutrients, and toxic chemicals.

F. Note that people can reduce nonpoint source pollution from household activities by (1) reducing the use of potentially harmful household, garden, and automotive products; (2) substituting safer products where they can; and (3) reducing the volume of waste they generate.

G. Explain that they are going to closely examine household product use, pollution potential, and alternatives to potentially harmful products.

II. Activity

A. Conduct investigation.

1. Divide the students into teams of 2-3.
2. Distribute a copy of Figure 1, Table 1, and Table 2 to each team.

3. Using Tables 1 and 2 and the key on Figure 1, have the students decipher the code for the symbols used to represent the types of pollutants associated with the numbered household sites. (NOTE: The types of pollutants refers to the four major categories—sediment, nutrients, bacteria, and toxics.)

4. Record the symbols in Table 1 in the appropriate rows.

5. In Table 1, have the students list specific solutions to reduce the potential nonpoint source pollution from each household site.
   a. What current practices contribute to nonpoint source pollution?
   b. How could they reduce this nonpoint pollution?

B. Review how household toxic substances can enter waterways as nonpoint sources of pollution. (NOTE: If their home has a septic tank, wastes dumped down the drain or toilet are nonpoint pollutants. If their home is hooked to the municipal sewer system, dumping wastes down a drain or toilet is a potential point source pollutant instead.)

III. Follow-Up

A. Conduct home survey.

1. Have the students make a list of all the cleaning products and other substances they use. Then have them write down all of the ingredients in these products. (NOTE: You may want to concentrate on different areas in the home such as under the sink, in the garage, or in the medicine cabinet. Or you might want to have them monitor their garbage cans or drains such as the sink, tub, toilet, or washing machine, and make a list of what is going where.)

2. Have the students examine the ingredients in household products they listed from their homes and, using Table 3, determine the proper disposal practices of these substances.
   a. What toxic substances may reach a water supply through surface runoff?
   b. What toxic substances may reach a water supply from a leaking landfill?
   c. If hooked to municipal sewer system, what products end up at the wastewater treatment plant?
   d. If they live in a home with a septic tank, what toxic substances go down the drain and into the backyard?
   e. How many students use groundwater as their primary source of drinking water? What toxic substances could reach their water supply?

B. Investigate one product.

1. Ask the students to select a potential nonpoint source pollutant, preferably a household product they can bring from home.

2. Have them determine the following:
   a. Why is this product a potential nonpoint source pollutant?
b. What toxic substances does this product contain?

c. What is the typical disposal method? What is the proper procedure for disposal?

d. What alternative products could be substituted? Are they safer for the environment? Why?

e. Have students bring the alternative products to class.

f. You may also have them conduct research to find safer alternative products to substitute for the hazardous ones and produce advertisements for these products.

3. When the students have completed their research, have each student present information on his/her product, the safer alternative, and their advertisements to the class.

4. After the presentations, ask the class to develop a plan to reduce the use of all potentially harmful substances in their homes. Have this plan typed up and give a copy to each student to take home.

5. You might also give students a copy of Table 3 for a home reference.

IV. Extension

A. Have your class visit a local open garbage dump. (CAUTION: To avoid potentially risky situations, visit the site yourself before bringing the students. Check to see if there is safe access to the site, ample parking, and that students can view the site without coming in contact with the garbage. If the site is on private property, get landowner permission in advance. NOTE: Parental permission should be obtained in advance.)

1. Discuss the difference between an open dump and sanitary landfill. Which is more likely to be a nonpoint source of pollution?

2. Have the students identify the site's location on a map and estimate the size of the dump.

   a. Why do people living in surrounding areas use this area as a solid waste disposal site?

   b. What type of garbage do they dump?

   c. What kinds of nonpoint problems could result from this site?

   d. Is there any evidence that animals inhabit the dump? What kinds of animals? Do they present health and safety problems? Be sure to include animals such as flies and mosquitoes, rats, raccoons, dogs, and cats.

3. Briefly describe the uses of the land areas immediately adjacent to the dump property.

   a. Are they residential, farmland, or public land?

   b. What are property values in this area?

   c. What kinds of problems does the dump present to adjacent landowners?

   d. Are there any waterways within or near the dump site? Do they receive runoff water from the refuse area?
e. What problems might the dump cause for native communities of living things? What other evidences of pollution can you find in the dump area?

4. Consider alternatives.

a. What waste disposal alternatives are there for the people using this dump?

b. Is there a sanitary landfill or some "greenbox" system nearby?

5. Discuss how the people dumping here could reduce the amount of waste they generate. Recycling of certain wastes might be a good example. Can the disposal site be reclaimed? How? What could you or your class do to remedy this problem?

6. If this is a case of illegal dumping, decide if you or the class should get involved in this type of controversy? Why or why not? If possible, you may want to involve the class in getting the site cleaned up. The first step is to contact the local waste authority.

B. Have your students drive around the area and map open dumping or garbage problems using a city map or a topographic map. Have them write down the address and a description of the problem and bring it back to class. You may want to have them take pictures. Invite a local government official to the class and share the results. Investigate how the class can work to correct the problem.

RESOURCES


FIGURE 1: HOME IS WHERE THE HAZARD IS

SITES:
1 - Chimney smoke
2 - Leaves and grass clippings; lawn fertilizer
3 - Deicing compounds and sand
4 - Vehicle exhaust; wear of tires, brakes, and other moving parts; oil, and other fluid leaks
5 - Human litter; household waste
6 - Pet wastes
7 - Excessive application of chemical and organic fertilizers and pesticides; bare soil between rows
8 - Careless hazardous material storage, use, and disposal
9 - Improperly maintained septic system in inadequate soils
TABLE 1: TYPES OF POLLUTANTS FROM HOUSEHOLD SITES AND RECOMMENDED SOLUTIONS

Using Figure 1, determine nonpoint source pollutant type and decipher key.

<table>
<thead>
<tr>
<th>Site</th>
<th>Type of Pollutants</th>
<th>Specific Solution</th>
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<tbody>
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KEY

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### TABLE 1: TYPES OF POLLUTANTS FROM HOUSEHOLD SITES AND RECOMMENDED SOLUTIONS

**ANSWER KEY**

Using Figure 1, determine nonpoint source pollutant type and decipher key.

<table>
<thead>
<tr>
<th>Site</th>
<th>Type of Pollutants</th>
<th>Specific Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Δ</td>
<td>Make sure that hazardous products are not burned in the fireplace.</td>
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<td>2</td>
<td>⊗ Δ</td>
<td>Use fertilizers and pesticides sparingly according to manufacturers recommendations. Use self mulching mowers and mulches around landscaping to fertilizer and condition the soil and prevent weeds. Start a compost pile and put leaves, grass clippings, and yardbrush in it instead of sending them to the landfill.</td>
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<td>3</td>
<td>Δ ◊</td>
<td>Shovel the walks and streets instead of using deicing materials. Use sand or cat litter sparingly when necessary to melt ice.</td>
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<tr>
<td>4</td>
<td>Δ</td>
<td>Keep your car tuned and in good working condition. Attend to leaks immediately. Dispose of used fluids appropriately at your local gas station or a home hazardous waste collection station.</td>
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<tr>
<td>5</td>
<td>⊗ ◊ Δ ⊗</td>
<td>Dispose of all trash properly. Reduce, recycle, and reuse when you can. Before you dispose of anything, consider whether it can be recycled or reused. Source separate your trash at home.</td>
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<tr>
<td>6</td>
<td>⊗ ⊗ ◊</td>
<td>Use commercially available pooper-scoopers to collect waste and compost it.</td>
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<td>7</td>
<td>Δ ◊ ◊</td>
<td>Buy resistant plants. Use fertilizers and pesticides sparingly; better yet, try organic gardening. Many non-toxic pesticides can be purchased or prepared. Maintain your garden by weeding and mulching to prevent insect and diseases.</td>
</tr>
<tr>
<td>8</td>
<td>Δ</td>
<td>Buy only products you need in the amounts you require. Give leftover products to others in need. Read cautions on products and store appropriately. Make sure lids are tight and containers are not damaged to prevent leaks. Disposed of hazardous products appropriately at a home hazardous waste collection station.</td>
</tr>
<tr>
<td>9</td>
<td>Δ ⊗ ◊</td>
<td>Maintain the system properly. Have it inspected every 2-3 years and pumped if needed. Never flush hazardous products down household drains. Make sure the drainfield is marked so you won't puncture it accidentally during a home improvement or gardening operation. Inspect the system routinely and repair the system immediately if it damaged.</td>
</tr>
</tbody>
</table>

**KEY**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Pollutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>◊</td>
<td>Sediment</td>
</tr>
<tr>
<td>⊗</td>
<td>Nutrients</td>
</tr>
<tr>
<td>Δ</td>
<td>Toxics</td>
</tr>
<tr>
<td>⊗</td>
<td>Bacteria</td>
</tr>
</tbody>
</table>
# TABLE 2:
## TYPES OF NONPOINT SOURCE POLLUTANTS AND GENERAL SOLUTIONS

<table>
<thead>
<tr>
<th>Household Pollutant Type</th>
<th>Symbol</th>
<th>Sources</th>
<th>General Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Precipitation</td>
<td></td>
<td></td>
<td>Decrease use of fossil fuels; properly maintain vehicles and chimneys.</td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
<td>Clean up and compost organic waste; properly maintain septic tank.</td>
</tr>
<tr>
<td>Toxics</td>
<td></td>
<td></td>
<td>Minimize use and production of toxins; clean up and dispose of toxins properly.</td>
</tr>
<tr>
<td>Nutrients</td>
<td></td>
<td></td>
<td>Compost organic wastes; use fertilizers only when necessary.</td>
</tr>
<tr>
<td>Pathogenic</td>
<td></td>
<td></td>
<td>Clean up and compost domestic animal waste; properly maintain septic tank.</td>
</tr>
<tr>
<td>Sediment</td>
<td></td>
<td></td>
<td>Minimize the amount of bare soil by using ground cover (e.g., such as mulch, grass, or gravel); minimize access to water supply by diverting runoff.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
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TABLE 2:
TYPES OF NONPOINT SOURCE POLLUTANTS AND GENERAL SOLUTIONS
ANSWER KEY

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Acid Precipitation</td>
<td>Δ</td>
<td>1, 4</td>
<td>Decrease use of fossil fuels; properly maintain vehicles and chimneys.</td>
</tr>
<tr>
<td>Organic</td>
<td>© ◊</td>
<td>2, 5, 6, 9</td>
<td>Clean up and compost organic waste; properly maintain septic tank.</td>
</tr>
<tr>
<td>Toxic</td>
<td>Δ</td>
<td>2, 3, 4, 5, 7, 8, 9</td>
<td>Minimize use and production of toxins; clean up and dispose of toxics properly.</td>
</tr>
<tr>
<td>Nutrient</td>
<td>©</td>
<td>2, 5, 7</td>
<td>Compost organic wastes; use fertilizers only when necessary.</td>
</tr>
<tr>
<td>Pathogenic</td>
<td>Ø</td>
<td>5, 6, 9</td>
<td>Clean up and compost domestic animal waste; properly maintain septic tank.</td>
</tr>
<tr>
<td>Sediment</td>
<td>◊</td>
<td>2, 7</td>
<td>Minimize the amount of bare soil by using ground cover (e.g., such as mulch, grass, or gravel); minimize access to water supply by diverting runoff.</td>
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<td>Toxics</td>
</tr>
<tr>
<td>Ø</td>
<td>Bacteria</td>
</tr>
</tbody>
</table>
TABLE 3: SOURCE REDUCTION AND PROPER DISPOSAL OF TOXIC HOUSEHOLD PRODUCTS

KEY:  
1. Pour down household drain with water, unless you have a septic tank. If so, first read the product label to determine if the product could damage the septic tank. If so, then 2.

2. Do not pour down drain. Be sure the material is properly contained before it is put out for collection or carried to a sanitary landfill.

3. Hazardous wastes should be given to a licensed hazardous waste contractor or saved for a community-wide collection day, even if the containers are empty.

4. Recyclable material which should be taken to an appropriate recycling center. If one is not available, then 3.

<table>
<thead>
<tr>
<th>Household Products</th>
<th>Proper Disposal</th>
<th>Source Reduction - Solutions, Alternatives, and Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Grooming Products</td>
<td>1</td>
<td>Use pump spray or other nonaerosol versions of personal grooming products. For example, use cream, stick, or roll-on deodorants, pump spray hair spray, etc.</td>
</tr>
<tr>
<td>Air Fresheners</td>
<td>1</td>
<td>To freshen and deodorize the air, open a window, or use an exhaust fan, or do both. Sprinkle baking soda in odor-producing areas or set vinegar out in an open dish. Place an open box of baking soda in the refrigerator to absorb food odors.</td>
</tr>
<tr>
<td>Carpet Deodorizers</td>
<td>1</td>
<td>To deodorize carpets, sprinkle baking soda over the entire carpet. Use approximately 1 cup (0.24 l) per medium-sized room. Vacuum after 30 minutes.</td>
</tr>
<tr>
<td>Carpet and Rug Cleaners</td>
<td>1</td>
<td>To clean carpets and rugs, mix 1/2 cup (0.12 l) mild liquid dishwashing detergent with 1 pint (0.47 l) boiling water; let cool. Whip the paste into a stiff foam using an electric mixer. Apply it to the carpet with a damp sponge. Rub gently. Work in 4x4-foot (1.2 x 1.2 m) sections. Wipe off the suds with a clean cloth. To rinse, add 1 cup (0.24 l) of white vinegar to 1 gallon (3.79 l) of lukewarm water. Rinse each section and wipe the carpet dry as you go.</td>
</tr>
</tbody>
</table>

Or sprinkle cornstarch or a mixture of 2 parts cornmeal with 1 part borax on the rug, let set 1 hour, then vacuum. For tougher stains, repeatedly rinse with vinegar in soapy water.
TABLE 3: SOURCE REDUCTION AND PROPER DISPOSAL OF TOXIC HOUSEHOLD PRODUCTS (continued)

<table>
<thead>
<tr>
<th>Household Products</th>
<th>Proper Disposal</th>
<th>Source Reduction - Solutions, Alternatives, and Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramic Tile Cleaner</td>
<td>2</td>
<td>Measure 1/4 cup (.06 l) baking soda, 1/2 cup (0.12 l) white vinegar, and 1 cup (0.24 l) of ammonia into a bucket. Add 1 gallon (3.79 l) of warm water and stir until the baking soda dissolves. Or, mix borax and lemon juice to make a paste. Rub on paste and let set 2 hours before scrubbing.</td>
</tr>
<tr>
<td>Disinfectants and Germicides</td>
<td>2</td>
<td>Wash items with soap and water, or with borax or sodium carbonate (washing soda) in water. For mildew stains, chlorine bleach may be used although it should be used carefully and disposed of properly.</td>
</tr>
<tr>
<td>Drain Cleaners</td>
<td>1</td>
<td>Prevent clogging by covering drains with a screen to keep out grease, food scraps, and hair. To loosen blockage, mix 1 cup (0.24 l) each of baking soda and salt, add 1 cup (0.24 l) of white vinegar and pour down drain. Wait 15 minutes. Flush drain thoroughly with boiling water. Use a rubber plunger or plumber's snake if drain is seriously clogged.</td>
</tr>
<tr>
<td>Floor Wax and Strippers</td>
<td>3</td>
<td>To polish linoleum and vinyl floors without commercial wax, mix 1 part thick boiled starch with 1 part soap suds. Rub the mixture on the floor, and polish dry with a clean, soft cloth. To remove old wax, pour a small amount of club soda on a section of floor. Scrub well, let soak for a few minutes, then wipe clean.</td>
</tr>
<tr>
<td>Furniture Polish</td>
<td>3</td>
<td>Use olive oil, lemon oil, beeswax, or beeswax and olive oil. Or mix 2 teaspoons (30 ml) lemon oil and 1 pint (0.47 l) olive oil in a spray bottle.</td>
</tr>
<tr>
<td>Mothballs</td>
<td>3</td>
<td>Place cedar chips or sprigs of dried Tanzy around clothes, or store clothes in cedar chest.</td>
</tr>
<tr>
<td>Oven Cleaner (lye base)</td>
<td>2</td>
<td>Use pump spray or nonaerosol versions. For example, liquid paste or powder oven cleaners. Better yet, prevent the need by wiping away grease and spills after preparing each meal. Wipe away charred spills with a nonmetallic bristle brush. To remove baked-on grease and spills, scrub with a baking soda, salt, and water paste. Or sprinkle with dry baking soda; scrub with a damp cloth after 5 minutes. Don't let baking soda touch wires or heating elements. Scour racks and burner inserts with steel wool.</td>
</tr>
</tbody>
</table>
# TABLE 3: SOURCE REDUCTION AND PROPER DISPOSAL OF TOXIC HOUSEHOLD PRODUCTS

(continued)

<table>
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<tr>
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<th>Source Reduction - Solutions, Alternatives, and Precautions</th>
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<tr>
<td>Silver Cleaners</td>
<td>3</td>
<td>Pour water into an aluminum or enameled pan with aluminum foil covering the bottom. Fill to depth of 2-3 inches (50-75mm); enough to cover silver with water. Add 1 teaspoon (5 ml) baking soda, 1 teaspoon (5 ml) salt, and heat until water boils. Add tarnished silver and boil 3 minutes. Remove silver, wash in soapy water, and polish dry. (Not for use on silver jewelry or flatware with hollow handles.)</td>
</tr>
<tr>
<td>Toilet Bowl Cleaners</td>
<td>1</td>
<td>Pour 1/2 cup (0.12 l) liquid chlorine bleach into toilet bowl. Let stand for at least 30 minutes, then scrub with a long-handled brush and flush. (Do not use with septic systems; use cleaner with label stating &quot;safe for use in septic tank.&quot;)</td>
</tr>
<tr>
<td>Window Cleaners</td>
<td>1</td>
<td>Measure 3 tablespoons (45 ml) ammonia, 1 tablespoon (15 ml) white vinegar and 3/4 cup (0.18 l) water into a clean spray bottle. Or use a solution of 2 tablespoons (30 ml) vinegar in 1 quart (0.95 l) water.</td>
</tr>
<tr>
<td>Home Workshop and Hobby Products: Paint (Oil-Based)</td>
<td>3</td>
<td>Use water-based paint whenever possible. Seal all paint cans with tight-fitting lids.</td>
</tr>
<tr>
<td>Paint Strippers, Glues, &amp; Adhesives, Turpentine, Varnish, Lacquers, Auto-Body Repair Compounds</td>
<td>3, 4 (except paint brush: clean with solvent, paint thinner, or turpentine)</td>
<td>Use outdoors or in a very large room with steady flow of dry (not humid) air. Ventilate well. Open all windows and doors, and use a large large exhaust fan to blow fumes out. Wear a paper dust mask when grinding or sanding. Use a dust attachment on power tools. Clean up dust and filings with a vacuum cleaner, not a broom. Don't soak brushes in solvents. Clean them immediately, and soak them in plain water or soap and water. Always wear protective goggles, gloves, and a work apron. Separate the work area from the living space as much as possible.</td>
</tr>
<tr>
<td>Garden and Lawn Fertilizers</td>
<td>2</td>
<td>Use only when necessary. Use mulch to retain moisture and reduce leaching of nutrients and soil erosion from runoff. Use well-aged compost instead of inorganic fertilizers.</td>
</tr>
</tbody>
</table>
### TABLE 3: SOURCE REDUCTION AND PROPER DISPOSAL OF TOXIC HOUSEHOLD PRODUCTS (continued)

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<th>Proper Disposal</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Pest and Weed Control</td>
<td>3</td>
<td>Spray plants with nonchemical compounds. Examples: Spray with a soap and water solution (3 tablespoons of soap per gallon of water) for aphids, mealybugs, mites, and whiteflies. Spray with pyrethrum, a product of a type of chrysanthemum, to control caterpillars, beetles, aphids, mites, leafhoppers, thrips, moths, and dozens of other fruit and vegetable pests. Introduce other predatory bugs, such as soldier bugs, ladybugs, pirate bugs, spiders, lacewings, and gall midges to control unwanted pests. Use bacterial pesticides, such as <em>Bacillus popilliac</em> for Japanese Beetles and <em>B. thuringiensis</em> for many types of insect larvae. Interplant with pest-repellent plants: marigolds, coriander, thyme, yarrow, rue, and Tanzy. Indoors, dispose of garbage to avoid attracting ants and roaches. Store food in pest-proof containers or in refrigerator or freezer. Clean up crumbs and food residue promptly. Use flypaper and fly swatters. To control fleas on dogs and cats, bathe animals every two to four weeks with pet shampoos containing insect-repellent herbs such as rosemary, rue, eucalyptus, and citronella. For termites, ask exterminator to use organophosphates, such as chlorpyrifos Dursban T.C., by Dow.</td>
</tr>
</tbody>
</table>

**CAUTION:** Never mix products containing ammonia with chlorine bleach, vinegar, toilet bowl cleaners, or rust removers.
<table>
<thead>
<tr>
<th>Room/Product</th>
<th>Ingredients</th>
<th>Disposal</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bathroom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garage</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Workshop</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Garden</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
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</tr>
</tbody>
</table>
ISOLATION OF DNA FROM AN ONION

INTRODUCTION: For many years DNA has been an elusive material to view in its natural form. All living things contain DNA in its cells or cell. Some organisms lend themselves to an easy extraction process, while others require more difficult procedures to extract the DNA.

DNA is a nucleic acid located in the cell’s nucleus. It is found making up the chromatin in which it is bound to several types of proteins. The nuclear and the cell membranes are a tough protective barrier, made of lipids and proteins, they need to be eliminated in order to release the DNA. It is very important that the directions be followed carefully to ensure good results.

MATERIALS PER GROUP

1. cm² piece of fresh onion
2. 100 ml beaker
3. 2 test tubes
4. graduated cylinder
5. glass stirring rod
6. 10ml ICE COLD 95% ethanol
7. 10ml liquid detergent/salt solution (**10ml detergent, 10g NaCl, 90ml H₂O**)
8. 10ml meat tenderizer solution (**5g meat tenderizer, 95ml H₂O**)
9. 25ml 5% salt solution (**5g NaCl, 100ml H₂O**)
10. phenol red indicator

PROCEDURE

1. Place a cm² piece of onion in the 100ml beaker with 10ml of the detergent /salt solution. Mash the onion with the glass rod.
   Doing this breaks up the cell membrane and nuclear membrane and neutralizes the negative ends of the phosphates groups in the membranes.

2. Pour the liquid, very carefully, from the mixture into a clean test tube. Add 3 or 4 drops of tenderizer solution and swirl the test tube to mix.
   This will denature any protein that will contaminate the DNA.

3. Carefully pour 10ml of ice cold ethanol down the side of the test tube to form a layer on the top of the onion mixture. Let stand for 3 minutes.

4. With a twirling motion of the glass rod, slowly move it through the interface (where the two solutions meet) of the two layers. Collect the mucus-like DNA and place it in a test tube containing 5% salt solution.

5. Add 5 drops of phenol red indicator to the DNA solution. The resulting dark pink should be due to the presence of DNA.