

Using Land

as you read

What You'll Learn

- **Identify** ways that land is used.
- **Explain** how land use creates environmental problems.
- **Identify** things you can do to help protect the environment.

Why It's Important

Using land responsibly will help conserve this natural resource.

Review Vocabulary

erosion: a process that wears away surface materials and moves them from one place to another

New Vocabulary

- stream discharge
- sanitary landfill
- hazardous waste
- enzyme

Land Usage

You may not think of land as a natural resource. Yet it is as important to people as oil, clean air, and clean water. We use land for agriculture, logging, garbage disposal, and urban development. These activities often impact Earth's land resources.

Agriculture About 16 million km² of Earth's total land surface is used as farmland. To feed the growing world population, some farmers use higher-yielding seeds and chemical fertilizers. These methods help increase the amount of food grown on each km² of land. Herbicides and pesticides also are used to reduce weeds, insects, and other pests that can damage crops.

Organic farming techniques, as shown in **Figure 5**, use natural fertilizers, crop rotation, and biological pest controls. These methods help crops grow without using chemicals. However, organic farming cannot currently produce enough food to feed all of Earth's people.

Whenever vegetation is removed from an area, such as a construction site or tilled farmland, soil is exposed. Without plant roots to hold soil in place, nothing prevents the soil from being carried away by running water and wind. Several centimeters of topsoil may be lost in one year. In some places, it can take more than 1,000 years for new topsoil to develop.

Figure 5 Organic farms such as this one reduce the environmental impact of chemicals on land.

Compare and contrast organic farming and other techniques.



Reducing Erosion Some farmers practice no-till farming, as shown in **Figure 6**. They don't plow the soil from harvest until planting. Instead, farmers plant seed between the stubble left from the previous year.

Other methods also are used to reduce soil loss. One method is contour plowing. The rows are tilled across hills and valleys. When it rains, water and soil are captured by the plowed rows, reducing erosion. Other techniques include planting trees in rows along fields. The trees slow the wind, which reduces the amount of soil blown from the land. Cover crops, crops that are not harvested, also can be planted to reduce erosion.

Feeding Livestock Land also is used for feeding livestock. Animals such as cattle eat vegetation and then are used as food for humans. About sixty-five percent of the farmland in Texas is used for grazing cattle. Other regions of the United States such as the west and midwest also set aside land as pasture. Other land is used to grow crops to be fed to cattle. Many farmers raise corn and hay for this purpose. These crops provide cattle with a variety of nutrients and can improve the quality of the meat.



Mini LAB

Modeling Earth's Farmland

Procedure



1. Cut an apple into four quarters and set aside three. One quarter of Earth's surface is land. The remaining $\frac{3}{4}$ is covered with water.
2. Slice the remaining quarter into thirds.
3. Set aside two of the three pieces, because $\frac{2}{3}$ of Earth's land is too hot, too cold, or too mountainous to farm or live on.
4. Carefully peel the remaining piece. This represents the usable land surface that must support the entire human population.

Analysis

What may happen if available farmland is converted to other uses?

Figure 6 No-till farming can reduce erosion of topsoil.

Describe other techniques that can be used to reduce soil erosion.



Forested Land by Region

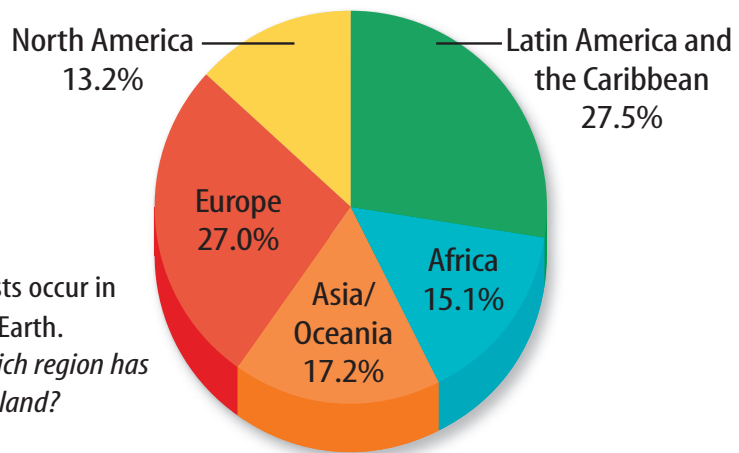


Figure 7 Forests occur in many regions on Earth.
Use Graphs Which region has the most forested land?

Forest Resources According to the Food and Agriculture Organization of the United Nations, approximately one-fourth of the land area on Earth is covered by forest. About 55% of this forest is found in developing countries. The remaining 45% occurs in developed countries. The distribution of Earth's forest according to region is shown in **Figure 7**.

Deforestation is the clearing of forested land for agriculture, grazing, development, or logging. It is estimated that the amount of forested land in the world decreased by 0.24% (94,000 km²) each year between 1990 and 2000. Most of this deforestation occurred in tropical regions.

 **Reading Check** What is deforestation?

Many people are concerned about forest conservation and management. For example, tropical rain forests contain diverse populations of plants and animals that don't live in other places. Many of these plants might be important for developing new medicines. Some people also worry that removing too much of these forests could lead to the extinction of some organisms. Scientists currently are doing research to better understand the effects of deforestation on species of plants and animals.

Cutting trees can have a regional effect on climate as well. Water from tree leaves evaporates into the atmosphere where it can condense to form rain. If many trees are cut down, less water enters the atmosphere and the region receives less rainfall. This is one way humans can affect the water cycle.

Development From 1990 to 2000, the number of kilometers of urban roadways in the United States increased by more than 13 percent. Highway building often leads to more paving as office buildings, stores, and parking lots are constructed.

Paving land prevents water from soaking into the soil. Instead, it runs off into sewers or streams. A stream's discharge increases when more water enters its channel. **Stream discharge** is the volume of water flowing past a point per unit of time. During heavy rainstorms in paved areas, rainwater flows directly into streams, increasing stream discharge and the risk of flooding.

Many communities use underground water supplies for drinking. Covering land with roads, sidewalks, and parking lots reduces the amount of rainwater that soaks into the ground to refill underground water supplies.

Some communities, businesses, and private groups preserve areas rather than pave them. Land is set aside for environmental protection, as shown in **Figure 8**. Preserving space beautifies the environment, increases the area into which water can soak, and provides space for recreation and other outdoor activities.



Figure 8 Some land in urban areas is preserved, such as this area near Portland, Oregon.

Discuss how preserving green space near cities helps protect the environment.

Applying Science

How does land use affect stream discharge?

It's not unusual for streams and rivers to flood after heavy rain. The amount of water flowing quickly into waterways may be more than streams and rivers can carry. Land use can affect how much runoff enters a waterway. Would changing the landscape increase flooding? Use your ability to interpret a data table to find out.

Identifying the Problem

The table above lists the percentage of rainfall that runs off land. Compare the amount of runoff for each of the land uses listed. Assume that all of the regions are the same size and have the same slope. Looking at the table, do you see a relationship between what is on the land and how much water runs off of it?

Rainfall Runoff Percentages

Land Use	Runoff to Streams (%)
Commercial (offices and stores)	75
Residential (houses)	40
Natural areas (forest and grassland)	29

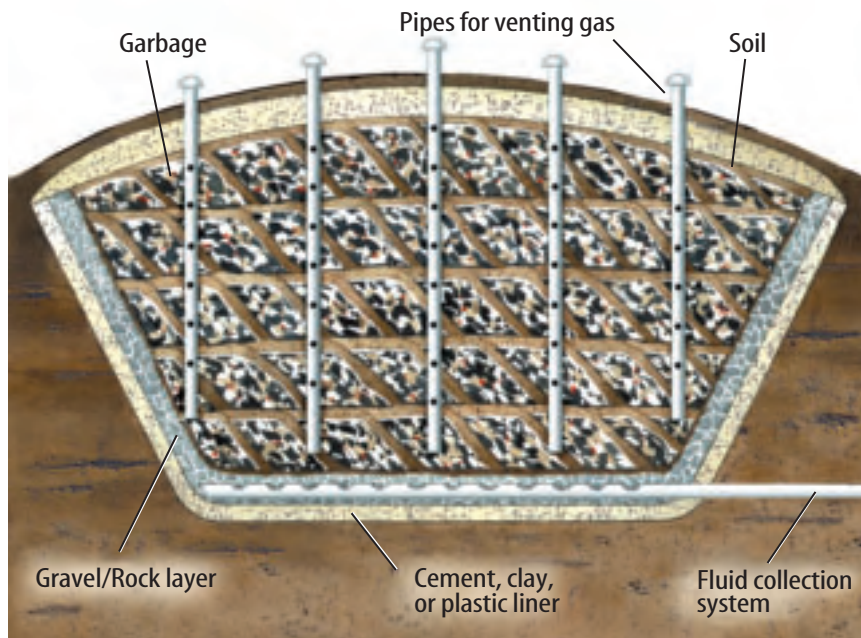
Solving the Problem

- Two years after construction of a commercial development near a stream, houses downstream flooded after a heavy rain. What contributed to the flooding?
- What are some ways that developers can help reduce the risk of flooding?



Figure 9 The majority of garbage is deposited in sanitary landfills designed to contain garbage and prevent contamination of the surrounding land and water.

Describe the problems associated with landfill disposal.



Sanitary Landfills Land also is used when consumed products are thrown away. About 60 percent of our garbage goes into sanitary landfills. A **sanitary landfill**, like the one illustrated in **Figure 9**, is an area where each day's garbage is deposited and covered with soil. The soil prevents the deposit from blowing away, helps decompose some materials, and reduces the odor produced by the decaying waste.

Sanitary landfills also are designed to prevent liquid wastes from draining into the soil and groundwater below. New sanitary landfills are lined with plastic, concrete, or clay-rich soils that trap the liquid waste. Because of these linings, sanitary landfills greatly reduce the chance that pollutants will leak into the surrounding soil and groundwater.

Since many materials do not decompose in landfills, or they decompose slowly, landfills fill with garbage, and new ones must be built. Locating an acceptable area to build a landfill can be difficult. Type of soil, the depth to groundwater, and neighborhood concerns must be considered.

Hazardous Wastes

Some of the wastes that are thrown away are dangerous to organisms. Wastes that are poisonous, that cause cancer, or that can catch fire are called **hazardous wastes**. Previously, everyone—industries and individuals alike—put hazardous wastes into landfills, along with household garbage. In the 1980s, many states passed environmental laws that prohibit industries from disposing of hazardous wastes in sanitary landfills. New technologies which help recycle hazardous wastes have decreased the need to dispose of them.



Nuclear Waste Wastes from nuclear power plants must be stored safely because radioactivity is dangerous. The U.S. government is currently studying a site in Nevada for nuclear waste disposal because the area is remote, little rain falls, and the underground water supply is far below the proposed storage facility. What is radioactivity and how can it harm the environment?

Household Hazardous Waste Unlike most industries, individuals discard hazardous wastes such as insect sprays, batteries, drain cleaners, bleaches, medicines, and paints in the trash. It may seem that when you throw something in the garbage, it's gone and you don't need to be concerned with it anymore. Unfortunately, some garbage can remain unchanged in a landfill for hundreds of years. You can help by disposing of hazardous wastes at special hazardous waste-collection sites. Contact your local government to find out about collections in your area.

Phytoremediation Hazardous substances can contaminate soil. These contaminants may come from nearby industries or leaking landfills. Water contaminated from such a source can filter into the ground and leave the toxic substances in the soil. Some plants can help fix this problem in a method called phytoremediation (FI toh ruh mee dee AY shun). *Phyto* means “plant” and *remediation* means “to fix or remedy a problem.”

During phytoremediation, roots of certain plants such as alfalfa, grasses, and pine trees can absorb metals, including copper, lead, and zinc from contaminated soil just as they absorb other nutrients. **Figure 10** shows how metals are absorbed from the soil and taken into plant tissue.

What happens to these plants after they absorb metals? If livestock were to eat contaminated alfalfa, the harmful metals could end up in your milk or meat. Plants that become concentrated with metals from soil eventually must be harvested and either composted to recycle the metals or burned. If these plants are destroyed by burning, the ash residue contains the hazardous waste that was in the plant tissue and must be disposed of at a hazardous waste site.



Breaking Down Organic Pollutants

Living things also can clean up pollutants other than metals. Substances that contain carbon and other elements like hydrogen, oxygen, and nitrogen, are called organic compounds. Examples of organic pollutants are gasoline, oil, and solvents.

Organic pollutants can be broken down into simpler, harmless substances, some of which plants use for growth. Some plant roots release enzymes (EN zimez) into the soil. **Enzymes** are substances that make chemical reactions go faster. Enzymes from plant roots increase the rate at which organic pollutants are broken down into simpler substances. Plants use these substances for growth.

Reading Check How do enzymes affect organic pollutants in soil?

Figure 10 Metals such as copper can be removed from soil and be absorbed by plant tissues.

State why this vegetation can't be fed to livestock.

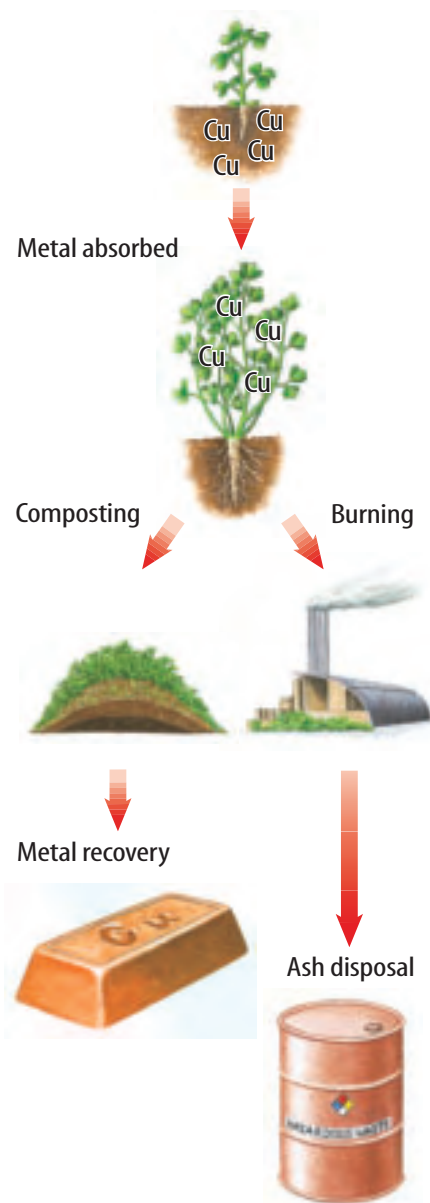




Figure 11 Many countries set aside land in the form of national parks as natural preserves.

Discuss how natural preserves might benefit humans and other living things.

Natural Preserves

Not all land on Earth is being utilized to produce usable materials or for storing waste. As shown in **Figure 11**, some land remains mostly uninhabited by people. National forestlands, grasslands, and national parks in the United States are protected from many problems that you've read about in this section. In many other countries throughout the world, land also is set aside for natural preserves. As the world population continues to rise, the strain on the environment may worsen. Preserving some land in its natural state will benefit future generations.

section 2 review

Summary

Land Usage

- Pesticides and herbicides may be used on farms to grow more food per km².
- No-till farming can reduce erosion.
- Development can increase runoff.
- A sanitary landfill is designed to protect soil and groundwater.

Hazardous Wastes

- New technologies help recycle hazardous wastes.
- Hazardous wastes can be broken down by enzymes or phytoremediation.

Natural Preserves

- Many countries set aside land for protection.

Self Check

1. **List** six ways that people use land.
2. **Discuss** environmental problems that can be created by agriculture and trash disposal.
3. **Infer** what you can do that would benefit the environment.
4. **Describe** how development can increase flooding.
5. **Think Critically** Preserving land beautifies the environment, provides recreational space, and benefits future generations. Are there any disadvantages to setting aside large areas of land as natural preserves?

Applying Skills

6. **Form a Hypothesis** Develop a hypothesis about how migrating birds might be affected by cutting down forests.

What to Wear?

What items in your house will end up in a landfill? You might think about milk jugs or food scraps. What about old clothing? In this lab, you'll observe what happens to different types of clothes that are buried in a landfill.

Real-World Question

Do materials decompose at the same rate?

Goals

- **Compare** the decomposing rates of natural and artificial clothing materials.
- **Infer** the effect of these materials on landfills.

Materials

identical baking trays (2)
 garden soil
 clothing made of natural fibers (linen, cotton, wool, silk)
 clothing made of artificial materials (fleece, polyester, acrylic, rayon)
 toothpicks
 transparent tape
 scissors
 spray bottle filled with water

Safety Precautions



Procedure

1. Collect several articles of clothing and separate those made with natural fibers from those made from artificial materials.
2. Cut 3-cm squares of each type of clothing.
3. Cut 1-cm × 3-cm labels from a sheet of notebook paper, and write one label for each of your clothing squares. Tape each label to the tip of a toothpick.

4. Fill each tray halfway with garden soil. Lay your artificial cloth squares in one tray and your natural cloth squares in the other tray. Be certain the squares don't overlap. Thoroughly moisten all squares using the spray bottle.
5. Identify each clothing square by attaching a toothpick label.
6. Cover your squares with soil. Moisten the soil and place the trays in a dark place. Keep the soil moist for three weeks.
7. After three weeks, dig up your samples and observe each square. Record your observations in your Science Journal.



Conclude and Apply

1. **Compare** the amount of decomposition of the two types of materials.
2. **Infer** the effects of clothing made with natural materials on landfills.
3. **Infer** the effects of clothing made with artificial materials on landfills.
4. **Research** materials used to manufacture clothing. Determine if the material is made from recycled products such as plastic bottles.

Communicating Your Data

Compare the types of clothing worn by your classmates with the types you used in your experiment. Contrast the results of their experiments with your observations. For more help, refer to the **Science Skill Handbook**.

Conserving Resources

as you read

What You'll Learn

- **Identify** three ways to conserve resources.
- **Explain** the advantages of recycling.

Why It's Important

Conserving resources helps reduce solid waste.

Review Vocabulary
consumption: using up materials

New Vocabulary

- conservation
- composting
- recycling

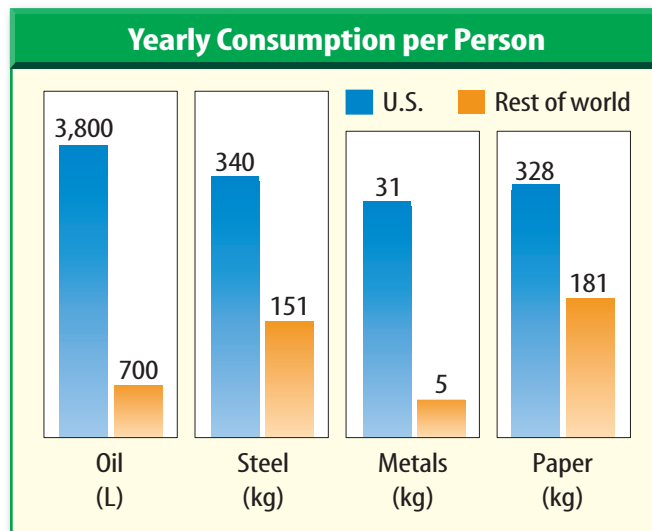
Resource Use

Resources such as petroleum and metals are important for making the products you use every day at home and in school. For example, petroleum is used to produce plastics and fuel. Minerals are used to make automobiles and bicycles. However, if these resources are not used carefully, the environment can be damaged. **Conservation** is the careful use of earth materials to reduce damage to the environment. Conservation can prevent future shortages of some materials, such as certain metals.

Reduce, Reuse, Recycle

Developed countries such as the United States use more natural resources than other regions, as shown in **Figure 12**. Ways to conserve resources include reducing the use of materials, and reusing and recycling materials. You can reduce the consumption of materials in simple ways, such as using both sides of notebook paper or carrying lunch to school in a nondisposable container. Reusing an item means finding another use for it instead of throwing it away. You can reuse old clothes by giving them to someone else or by cutting them into rags. The rags can be used in place of paper towels for cleaning jobs around your home.

Figure 12 A person in the United States uses more resources than the average person elsewhere.



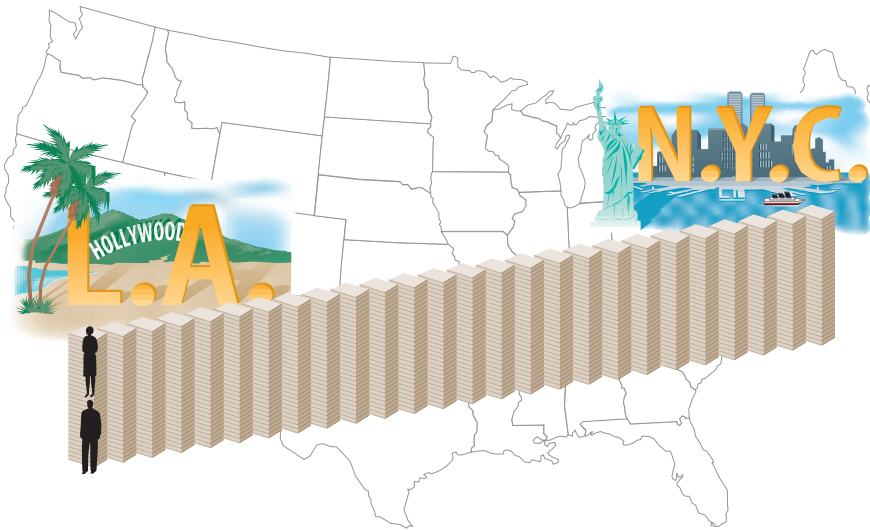


Figure 13 People in the United States throw away enough office and writing paper each year to build a wall 3.6 m high stretching from New York City to Los Angeles.

Reusing Yard Waste Outdoors, you can do helpful things, too. If you cut grass or rake leaves, you can compost these items instead of putting them into the trash. **Composting** means piling yard wastes where they can decompose gradually. Decomposed material provides needed nutrients for your garden or flower bed. Some cities no longer pick up yard waste to take to landfills. In these places, composting is common. If everyone in the United States composted, it would reduce the trash put into landfills by 20 percent.

Recycling Materials Using materials again is called **recycling**. When you recycle wastes such as glass, paper, plastic, steel, or tires, you help conserve Earth's resources, energy, and landfill space.

Paper makes up about 40 percent of the mass of trash. As shown in **Figure 13**, Americans throw away a large amount of paper each year. Recycling this paper would use 58 percent less water and generate 74 percent less air pollution than producing new paper from trees. The paper shown in the figure doesn't even include newspapers. More than 500,000 trees are cut every week just to print newspapers.

Companies have found that recycling can be good for business. For example, companies can recover part of the cost of many materials by recycling the waste. Some businesses use scrap materials such as steel to make new products. These practices save money, benefit the environment, and reduce the amount of waste sent to landfills.

Figure 14 shows that the amount of material deposited in landfills has decreased since 1980. In addition to saving landfill space, reducing, reusing and recycling can reduce energy use and minimize the need to extract raw materials from Earth.

Mini LAB

Classifying Your Trash for One Day

Procedure

1. Label a table with the following columns: *Paper*, *Plastic*, *Glass*, *Metal*, and *Food Waste*.
2. Record items you throw out in one day. At the end of the day, count the number of trash items in each column.
3. Rank each column by number from the fewest trash items to the most trash items.

Analysis

1. Compare your rankings with those of others in your household.
2. What activities can you change to decrease the amount of trash you produce?



Figure 14

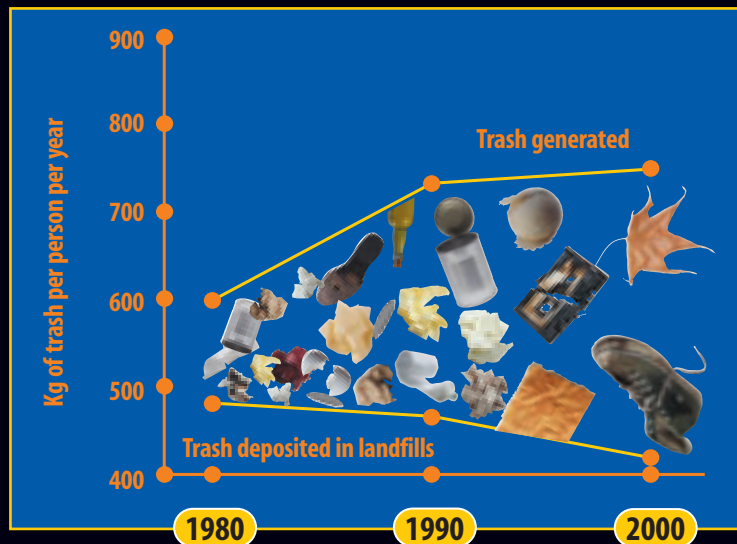
Although trash production in the United States is increasing, the amount of trash deposited in landfills is decreasing. In 1980, 82 percent of discarded trash ended up in a landfill. Today, only 55 percent is taken to the dump—thanks to the use of waste-reducing methods such as those shown below.



▲ RECYCLING In 1980, about nine percent of trash was recycled. Now nearly 30 percent of America's trash is reused.

▶ WASTE TO ENERGY Some waste material can be burned to produce electricity. This plant in Rochester, Massachusetts, burns trash to generate electricity for a local paper company.

Landfill Use in the United States



◀ COMPOSTING Yard trimmings placed in a pile will decompose and form a substance called compost. Compost then can be used on flowers and vegetables to help them grow.



Recycling Methods What types of recycling programs does your state have? Many states or cities have some form of recycling laws. For example, in some places people who recycle pay lower trash-collection fees. In other places a refundable deposit is made on all beverage containers. This means paying extra money at the store for a drink, but you get your money back if you return the container to the store for recycling.

 **Reading Check** *How have states and cities encouraged people to recycle?*

There are several disadvantages to recycling. More people and trucks are needed to haul materials separately from your trash. The materials then must be separated at special facilities like the one shown in **Figure 15**. In addition, demand for things made from recycled materials must exist, and items made from recycled materials often cost more.

The Population Outlook The human population explosion already has had an effect on the environment and the organisms that inhabit Earth. It's unlikely that the population will begin to decline in the near future. To make up for this, resources must be used wisely. Conserving resources by reducing, reusing, and recycling is an important way that you can make a difference.



Figure 15 In recycling facilities like this one, materials must be separated before they can be reused.

section 3 review

Summary

Resource Use

- Earth's resources are used to make products.
- Conservation of resources can help prevent future shortages.

Reduce, Reuse, Recycle

- There are many simple ways to reduce the amount of materials you use.
- Composting yard waste reduces trash in landfills and provides nutrients for plants.
- Recycling materials can save money, benefit the environment, and save landfill space.

Self Check

1. **List** four advantages and two disadvantages of recycling.
2. **Compare and contrast** reducing and reusing materials.
3. **List** two simple ways that you and your classmates can reduce your consumption of Earth materials.
4. **Think Critically** Why is it more important to conserve resources as the human population increases?

Applying Skills

5. **Research Information** Contact a sanitary landfill near you. Find out how long it will take for your community's landfill to be full. How will waste be disposed of after the landfill is full?

A World Full of People

Goals

- **Demonstrate** the world's human population increase in the next decade.
- **Predict** the world's population in 50 years.
- **Record, graph, and interpret** population data.

Materials

small objects such as popcorn kernels or dried beans (1,000)
 large map of the world (the map must show the countries of the world)
 clock or watch
 calculator

Safety Precautions



Never eat or taste anything in the lab, even if you are confident that you know what it is.

Real-World Question

Every second, five people are born on Earth and two or three people die. As a result, there is a net increase of two or three people in the world every second of every day. That amounts to about 81 million new people every year. This is nearly equal to the population of Central Africa. What effects will this rapid increase in human population have on Earth? How crowded will different regions of Earth become in the next ten years?

Procedure

1. Copy the data table below in your Science Journal.
2. Lay the map out on a table. The map represents Earth and the people already living here.
3. Each minute of time will represent one year. During your first minute, place 78 popcorn kernels on the continents of your map. Each kernel represents 1 million new people.
4. Place one kernel inside the borders of developed countries such as the United States, Canada, Japan, Australia, and countries in Europe. Place 77 kernels inside the borders of developing nations located in South America, Africa, and Asia.
5. Continue adding 78 kernels to your map in the same fashion each minute for 10 min. Record the total population increase for each year (each minute of the lab) in your data table.

Population Data

Time (in years)	Total Population Increase
1	78 million
2	
3	
4	
5	Do not write in this book.
6	
7	
8	
9	
10	

Using Scientific Methods

Analyze Your Data

1. **Draw and label** a graph of your data showing the time in years on the horizontal axis and the world population on the vertical axis.
2. **Calculate** the world's population in 50 years by using an average rate of 71 million people per year.
3. **Determine** world population in ten years if only 4.5 million people are added each year.

Conclude and Apply

1. **Infer** how many new people will be added to Earth in the next 10 years. Determine the world's population in 10 years.
2. **Compare** the population growth in developed countries to the growth of developing countries.
3. **Discuss** ways the increase in the human population will affect Earth's resources in the future.



Communicating Your Data

Draw your graph on a computer and present your findings to the class. **For more help, refer to the Science Skill Handbook.**

It causes health risks, but how do we safely get rid of it?

A danger sign in a garbage dump alerts visitors to the presence of hazardous waste.

Hazardous Waste

**Danger: Hazardous Waste Area.
Unauthorized Persons Keep Out.**

During much of the 1980s, this sign greeted visitors to Love Canal, a housing project in Niagara Falls, New York. The housing project was closed because it had been built on a hazardous waste dump and people were getting sick. Exposure to hazardous waste can cause nerve damage, birth defects, and lowered resistance to disease.

The Environmental Protection Agency (EPA) estimates that U.S. industries produce about 265 million metric tons of hazardous wastes each year. Much of this waste is recycled or converted to harmless substances. About 60 million tons of hazardous waste, however, must be disposed of in a safe manner. Incineration, or burning, is one way to dispose of hazardous wastes. However, the safety of this method is hotly debated.

For Incineration

People in favor of incineration note that, if done correctly, it destroys 99.99 percent of toxic materials. Although the remaining ash must still

be disposed of, it is often less hazardous than the original waste material. Supporters also note that incineration is safer than storing the hazardous wastes or dumping them in landfills.

Against Incineration

Other people say that incinerators fail to destroy all hazardous wastes and that some toxins are released in the process. They also note that new substances are generated during incineration, and that scientists don't yet know how these new substances will impact the environment or human health. Lastly, they say that incineration may reduce efforts to reuse or recycle hazardous wastes.

While the debate goes on, scientists continue to develop better methods for dealing with hazardous wastes. As Roberta Crowell Barbalace, an environmental scientist, wrote in an article, "In an ideal environment there would be no hazardous waste facilities. The problem is that we don't live in an ideal environment ... Until some new technology is found for dealing with or eliminating hazardous waste, disposal facilities will be necessary to protect both humans and the environment."

Research Find out more about incineration. Then use this feature and your research to conduct a class debate about the advantages and disadvantages of incineration.

Science **online**

For more information, visit
earth.msscience.com/time