

STEM Applications



1. **TECHNOLOGY** Design a plant stand that has no more than four or five pieces. The plant stand should be made of commonly available, inexpensive materials. Plan a production system to mass-produce the plant stand. Create a graph or chart to show all of the steps in the production process. If the materials are available, ask classmates to help you test your production plan by producing a batch of plant stands.
2. **ENGINEERING** Identify a product you use every day that is manufactured using traditional methods. Plan a sustainable manufacturing system in which the product could be manufactured. Your plan should minimize waste and account for what happens to the product after its useful life is over. Present your plan to the class.
3. **ENGINEERING** Using the cradle-to-cradle design philosophy, design and make a cabinet that will hold up to 40 CDs or DVDs. Create a sustainable manufacturing plan to produce the cabinet. Document your plan in a report, using charts and graphs to show the various steps of production. Make a poster showing the planned life cycle of the cabinet.
4. **TECHNOLOGY** Research to find a manufacturing company that has switched from traditional to lean manufacturing. Assess the products output before and after the switch. Write a report explaining what is different in the new system. State whether the company's goal of reducing waste was achieved. List the overall positive and negative effects of the change.

Technology and the Environment

The LifeStraw Personal contains filters that make polluted water safe to drink.



Better by
Design

Mikkel Vestergaard Frandsen and the LifeStraw® Personal

Safe drinking water is hard to find in many Third World countries. Many people in undeveloped areas suffer from diseases they catch by drinking polluted water, and many of them even die. Mikkel Vestergaard Frandsen developed a straw called LifeStraw Personal that makes polluted water safe to drink. Contaminated water is drawn in through the lower end. The straw kills 99.999% of water-borne bacteria and viruses. By the time the water reaches the person's mouth, it is safe to drink. The filters in the straw can process about 185 gallons (700 liters)

of water. This is enough to provide drinking water for one person for about a year. It is inexpensive, light, and portable and can be carried on a string around the neck. This makes it perfect for people in Third World countries who need a reliable source of drinking water.

LifeStraw Personal does not require batteries and can be used anywhere.



"We must use our innovative skills to save the lives of millions of people who are dying needlessly."



Preview and Prediction

Before you read this chapter, glance through it and read only the heads of each section. Based on this information, try to guess, or predict, what the chapter is about. Use the Reading Target graphic organizer at the end of the chapter to record your predictions.

Reading
Target

Key Terms

acid rain
carbon monoxide (CO)
clear-cutting
composting
hazardous materials
hazardous waste
household hazardous waste
landfill
nitrogen oxides (NO_x)

ozone
radioactive waste
recycling
smog
sulfur dioxide (SO₂)
sustainable lifestyle
watersheds
wetlands

Objectives

After reading this chapter, you will be able to:

- Describe the effects of technology on air quality.
- Identify sources of land and soil pollution.
- Explain how the use of technology can affect water quality.
- Identify different types of hazardous waste and explain their effects on the environment.
- Explain how people can reduce harmful effects of technology on the environment.

Useful Web sites:

www.lifestraw.com

www.controllingpollution.com/water-pollution-facts/

People have been using technology to improve their lives for hundreds of years. For many years, people did not realize that the technology they used might have unintended, and often harmful, effects. Today, we know that technology can have both intended and unintended effects. Some of the unintended effects can be harmful.

For example, the cars and airplanes that provide us with fast, reliable transportation also produce a large amount of air and noise pollution. Batteries leak chemicals into the soil, contributing to land and water pollution. In fact, concern for the effects of technology on the environment is growing rapidly. We are starting to see just how much our technological activity is affecting Earth.

Technology has an impact on every part of Earth: land and soil, water, and air. It also has other harmful effects, such as increased noise. This chapter looks at the effects of technology on the environment. It also explores how we can use technology to help reverse some of the harmful effects.

Air Quality

Until the Industrial Revolution, people never thought much about air quality. There was no need, because the air was relatively clean. The major pollutants were smoke and ash from wood and coal fires used for heating and cooking.

Advances in technology that made the Industrial Revolution possible also greatly increased the amount of smoke, ash, and chemicals in the air. Some of the larger cities started to experience smog. *Smog* is a combination of smoke and fog. See Figure 16-1. When the smoke comes



Figure 16-1. The smog that often blankets major cities can be harmful to humans, animals, and even plants.

from factories or automobile exhaust, smog can contain chemicals that are harmful to our respiratory systems. It may cause symptoms ranging from coughing and sneezing to nausea. It can also irritate our eyes and throats. For people who are at higher risk, such as children, seniors, and people with chronic diseases, the effects can be even more harmful.

Air pollution damages more than human health, however. It also has harmful effects on the environment. It affects forests and national parks, as well as agricultural crops. The Environmental Protection Agency (EPA) has identified six specific types of air pollution. Each of these pollutants causes specific damage both to human health and to the environment.

Ground-Level Ozone

Ozone is a gas that is formed when other common air pollutants mix with sunlight. Most of the pollutants that combine to form ozone are produced by automobiles and factories.

When ozone is located in the upper atmosphere, it helps protect the Earth. At ground level, however, it can cause respiratory problems in humans and animals. It can also damage plants. In fact, ground-level ozone can damage the leaves on many types of plants. This prevents the plants from producing food (photosynthesis). See **Figure 16-2**. Ozone can also weaken a plant's defenses against disease and insects.

Particle Pollution

Particles in the air can also cause air pollution. Some particles are natural, such as dust raised by a high wind. Others are generated by human activities and technology. These include soot, smoke, and chemicals (including acids) emitted from power plants, factories, and automobiles. They mix with liquid droplets and are transported through the air as water vapor or rain.

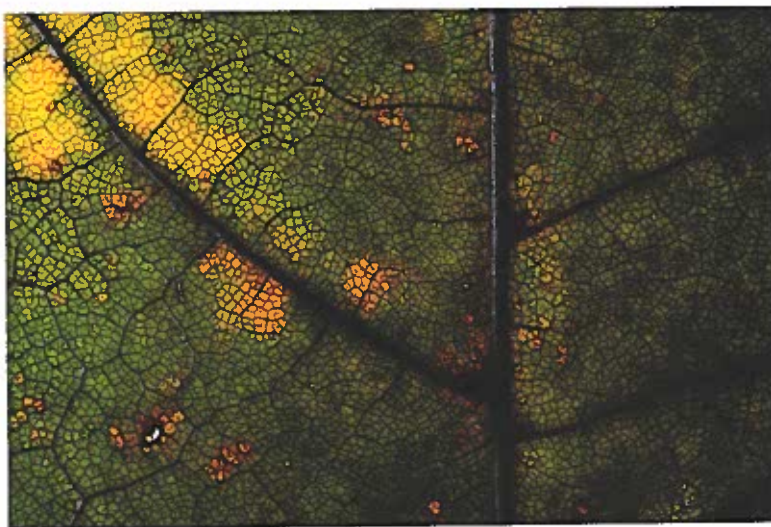


Figure 16-2. Too much ground-level ozone is toxic to plants. It enters through the pores, or *stomata*, of the leaves, causing reddish areas like those shown here.

Particle pollutants are classified as coarse and fine, depending on their size. Fine particles have more potential to harm human health. However, both coarse and fine particle pollutants affect the environment. When particle pollutants mix with rain, they often fall to the ground as *acid rain*. Acid rain can cause lakes and other bodies of water to become acidic, endangering fish and animals.

Carried on the wind, particle pollutants can also change the nutrient balance of an area. This affects the types of plants that can grow in the area. These particles may also reduce crop harvests by slowing plant growth.

Carbon Monoxide

Most vehicles on the road today burn fossil fuel. Because the engines are not 100% efficient, waste gases are produced. One of the most harmful waste gases is *carbon monoxide (CO)*. Carbon monoxide gas is poisonous, but it is also colorless and odorless, so you may not know when it is present. Vehicles account for about 56% of carbon monoxide emissions overall in the United States. See **Figure 16-3**. The percentage is higher in large cities. Other sources of carbon monoxide include industry and forest fires.

Carbon monoxide is hazardous to everyone, even people who are in excellent health. In addition to heart and lung problems, it can cause vision problems and even affect the central nervous system. Environmentally, carbon monoxide is not a direct threat. However, it combines with other gases to form ground-level ozone.

Nitrogen Oxides

Nitrogen dioxide (NO_2) and other nitrogen-containing gases are also a result of engines that use fossil fuels. The EPA groups all of the nitrogen-containing gases into a single category called *nitrogen oxides (NO_x)*. Although these gases are not emitted in vehicle exhaust, they form soon after the exhaust comes in contact with the surrounding air.

Figure 16-3. In spite of strict laws about automobile emissions, vehicles produce more than half of the carbon monoxide emissions in the United States.



Nitrogen oxides can cause both short-term and long-term health issues. Short-term issues include an inflamed throat and difficulty breathing. Long-term issues include asthma and emphysema.

Like carbon monoxide, nitrogen oxides alone do not cause environmental damage. However, they contribute to both ground-level ozone and particle pollution, which can cause significant environmental damage.

Sulfur Dioxide

Most *sulfur dioxide* (SO_2) pollution is generated by power plants and industrial processes. Ocean-going ships and locomotives also contribute to pollution levels. See **Figure 16-4**. High levels of sulfur dioxide can lead to breathing problems, especially in people who have asthma. Sulfur dioxide is also a typical component of acid rain.

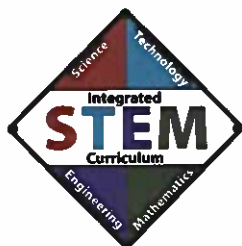
Airborne Lead

Until the early 1980s, lead from automobile fumes was a major source of air pollution. Lead has serious effects on our health. It can affect almost every system in the body. It is doubly hazardous because it does not leave the body. It builds up in the bones. It is also an environmental hazard. After being deposited by airborne sources, it can decrease the growth rate of plants and animals in the area. It has also been linked to a loss of biodiversity.

Fortunately, laws regulating the use of lead have resulted in a huge decrease in the level of lead in the air. When the government began requiring the use of lead-free gasoline, lead levels in the air dropped dramatically. Today, lead content in the air is significant only near manufacturers of products containing lead and near some utilities and waste incinerators.



Figure 16-4. Trains provide an economical method of transporting goods across the country, but the exhaust from the locomotive contains sulfur dioxide. How could this problem be prevented?



Science Application

Monitoring Carbon Dioxide Levels

Although people are still arguing about exactly *what* change is taking place, most people agree that Earth's climate is changing. One of the gases believed to be responsible for climate change is carbon dioxide (CO_2). Burning fossil fuels and many other human activities produce large amounts of CO_2 . When CO_2 builds up in the Earth's atmosphere, it can cause a "greenhouse effect." In other words, it can trap heat near the Earth's surface, causing the air and water to become warmer. Therefore, scientists have been closely monitoring levels of carbon dioxide gas in the air.

Science Activity

Research online to find CO_2 levels for a period of at least 10 years at a location of your choice. Draw a graph to show the change in CO_2 level over time. On your graph, the horizontal axis should show years and the vertical axis should show the CO_2 levels.

Join the points using a smooth curve. This curve shows the general trend. Assuming that your curved line will continue in the same direction(s), extend your curve to the year 2050. Your extended line represents a prediction. What can you say about your prediction? What factors could cause your prediction to be incorrect?

Land and Soil

Technology and human behavior also affect the land and soil. Some of the effects are good. For example, technology has provided ways to keep soil from eroding on hillside farms. However, some of the effects are harmful. Our activities result in several different kinds of land and soil issues. Many of these issues are related to the careless use of technology.

Technology-Related Waste

One issue around the world is the safe and complete disposal of waste material. Technology is responsible for several different kinds of wastes.

Industry

For example, industry creates waste at every step. Waste is produced when the raw material is prepared for use in the manufacturing process. It is generated during manufacturing of the product and of its packaging materials. When the product is used, the packaging is discarded, creating more waste. The product itself may also be discarded after use. See **Figure 16-5**.

Agriculture

Agricultural technology helps farmers produce a good crop. Machines reduce the time they have to spend in the fields. Chemicals help them produce large, healthy crops with minimal insect damage. Some agricultural waste consists of the fertilizers, pesticides, and other farm chemicals. Agricultural waste also includes manure from cattle and other farm animals, although this waste is not a direct effect of technology.

Some agricultural waste products run off the land and pollute rivers, streams, and lakes. However, many chemicals soak into the soil and affect the plants that grow there. Some chemicals may enter the plants and then be eaten by animals or humans.

Mining

Mining waste includes all of the filtrates and other wastes that result from the removal of raw minerals from the ground. It also includes wastes caused by the initial processing of the minerals at the mine. The specific types of waste depends on the type of mineral being mined. The wastes enter the environment by various means. For example, undetected leaks in underground storage tanks are one cause of land pollution.

A careless approach to surface or open-pit mining can cause other environmental damage. All vegetation is stripped away during the mining process, leaving the land bare and unprotected. See **Figure 16-6**. This can lead to soil erosion and loss of habitat for wildlife. In the United States, surface mining is regulated at the state and federal levels. Mines that are no longer in use are reclaimed and an attempt is made at restoration.



Figure 16-5. Manufactured items generate waste at every stage of their development and use. Most products are eventually discarded in a landfill.

Figure 16-6. Surface mining exposes the bare land, placing it at risk for erosion and other problems. Many countries are now taking steps to reclaim the land to prevent erosion and restore habitat.



Garbage

Technology also contributes to another type of environmental hazard: garbage. Many people use disposable products such as Styrofoam™ cups and disposable diapers without thinking about what will happen to them after they are discarded. Also, with new, improved products being created at a record pace, people tend to throw away their older electronic products. Where do these products go?

Many of them are transported to landfills. A *landfill* is an area that has been prepared to receive garbage. Landfills are lined to prevent leaks into the soil. The garbage is then buried at the prepared landfill site. The EPA has established standards for all landfills in the United States, although the landfills are run by state or local governments.

However, some garbage never makes it to the landfill site. People who are careless about where they discard their trash add to the environmental problems. See **Figure 16-7**. Trash that is discarded by the side of the road cannot be treated to prevent soil contamination. It may also leak hazardous chemicals into the Earth. Discarded automobile batteries, for example, may leak lead into the soil. Discarded plastics can also harm wildlife. See **Figure 16-8**.

Technology-Related Damage

The environment is also affected by practices such as clear-cutting forests. *Clear-cutting* is a method of harvesting lumber in which all of the trees in the selected area are cut down using bulldozers, cables, and other technology. See **Figure 16-9**. Clear-cutting destroys the forest ecosystem. It affects not only animals, but also other plants that depended on the trees for shade. Because the soil is no longer held in place by plant roots, soil erosion also occurs. Nutrients are often washed out of the soil, leaving it barren.



Figure 16-7. Garbage thrown by the side of the road is not just ugly. It can cause damage to the environment.



Figure 16-8. Plastics are a particular threat to wildlife. What will happen if this duck cannot remove the plastic ring from its beak?

Some of the leisure activities people enjoy can also cause harm to the land and soil. See **Figure 16-10**. When used carelessly, off-road vehicles and all-terrain vehicles (ATVs) can damage or destroy vegetation. This, too, can lead to soil erosion.

Water Quality

All living things—humans, animals, and plants—depend on the quality of water. People and most land animals require clean drinking water. Sea life requires clean saltwater.

The same water has been on Earth for centuries. Earth has a natural cycle that cleans the water for reuse. In this cycle, water is filtered through wetlands and natural watersheds. See **Figure 16-11**. *Wetlands* are land areas that are filled with water, such as marshes and swamps. *Watersheds* are areas of land that drain into a lake or river. Between them, wetlands and watersheds remove many kinds of pollutants, including pesticides and metals.



Figure 16-9. Clear-cutting removes all vegetation from the soil.



Figure 16-10. ATVs and off-road vehicles can destroy vegetation and lead to soil erosion if they are used unwisely.

Figure 16-11. Wetlands play an important role in the Earth's natural filtration system.



These natural systems are enough to take care of pollutants that occur naturally, as well as much of the pollution caused by humans. Unfortunately, wetlands and natural watersheds are disappearing. People have filled in many of the swamps and built structures on them.

At the same time, the rate at which pollution enters rivers, lakes, and even the oceans is increasing. The pollutants that affect air quality and soil can affect water quality as well. Mineral runoff from mines and even raw sewage is sometimes pumped directly into them. See Figure 16-12. Oil spills and agricultural runoff that includes pesticides and fertilizers are also sources of water pollution. Finally, trash people have thrown out often winds up in the water. See Figure 16-13.

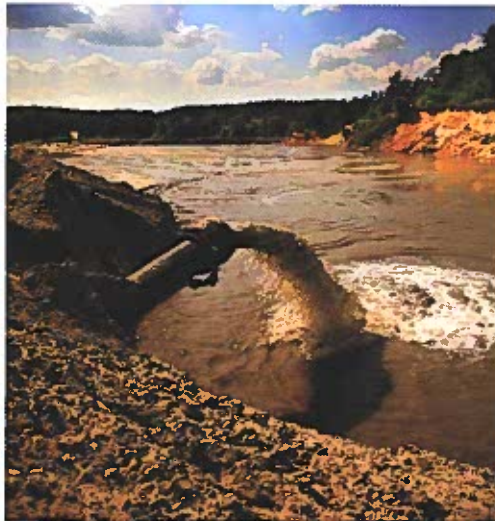


Figure 16-12. In many areas of the world, raw sewage, runoff from mining operations, and other harmful wastes are piped directly into rivers and lakes.



Figure 16-13. Sometimes people do not think about how their trash affects the environment.

Acid rain is an indirect source of water pollution. When acid rain falls on land, it affects the land and soil, but when it falls over water, the water becomes more acidic. When this happens, fish and other wildlife that depend on the water begin to die. If the water becomes very acidic, even the plants in and around the water cannot survive.

Hazardous Wastes

Hazardous materials are materials that have been identified by the government to be harmful to people and the environment. When these materials are waste products, they are known as *hazardous waste*. Laws regulate the transport, storage, and disposal of hazardous materials and hazardous waste.

Hazardous waste comes from many sources. Mining and other industrial processes can result in hazardous waste. Many agricultural pesticides also contain chemicals that are considered hazardous. Other sources are less commonly known. For example, medications such as epinephrine and some blood thinners are considered hazardous if their concentration is above a certain level. Metals such as mercury, silver, and lead are also considered hazardous in certain concentrations.

Household Hazardous Waste

In fact, many of the products we use every day are considered hazardous. See **Figure 16-14**. The EPA defines *household hazardous waste* as anything that is:

- Corrosive—causes metals and other materials to break down
- Toxic—poisons people or animals



A



B



C

Figure 16-14. Many of the products we use every day are considered hazardous. Care must be taken when using and discarding these products. A—many household cleaners; B—some medications, including prescription medications; C—pesticides and fertilizers.

- Flammable—catches fire easily
- Reactive—combines with other chemicals to form a dangerous mixture or product

These products include many cleaning products, battery acid, used motor oil, and pesticides, among others.

Radioactive Waste

Radioactive waste is a special type of hazardous waste that gives off energy in the form of radioactive particles. Nuclear power plants, uranium mining, some scientific research, and even some medical treatments produce radioactive waste.

Some forms of radiation are helpful. For example, radioactive particles can be used as “tracers” to help doctors diagnose an illness. Radiation can also be used to treat some types of cancer. However, all types of radiation can damage living organisms. See **Figure 16-15**. Therefore, radioactive materials must be handled carefully and disposed of properly.

The length of time a material remains radioactive varies. Some materials are radioactive for only a few minutes, hours, or days. Others remain radioactive for much longer. For example, uranium can be radioactive for millions or even billions of years.

What should we do with radioactive waste that will remain radioactive for such long periods? How can we protect not only ourselves and today’s environment, but future generations also? Government agencies such as the Nuclear Regulatory Commission, the Department of Energy, and the EPA regulate the disposal of radioactive waste. The Department of Transportation regulates how the waste can be transported. In addition, individual states are responsible for laws to protect us from the dangers of radioactive waste now and in the future.

Figure 16-15. Major nuclear accidents like the one at the Chernobyl power plant can kill every living thing within many miles. Because the radioactive material was uranium, the land may remain radioactive for millions of years.



Making a Difference

So far, this chapter has described the harmful effects of technology on our health and on the environment. Can technology be used to fix problems caused by the improper use of technology? Yes! Technology is now being used in several ways to help reduce various types of pollution.

For example, “scrubbers” have been developed for coal-fired electricity plants. Scrubber technology breaks down the waste gases produced by burning the coal. In fact, scrubbers can reduce the levels of sulfur dioxide released into the air by as much as 97%. See **Figure 16-16**.

Farmers are using satellite technology to pinpoint problem areas in their fields. This helps them target specific areas, reducing the amount of pesticide they use. See Chapter 14 for more information about this practice.

New laws and higher public awareness of pollution, technology, and the environment are also helping. As the general public becomes more aware of the issues, more people letting their representatives in Congress know what they think. This helps pass laws restricting the types of technological activities that industries can perform. It also helps convince companies to rethink their use and waste of technological and other resources.

New technology can also be used to fix problems that were not originally caused by the use of technology. For example, technology can be used to repair damage caused by natural disasters such as hurricanes, floods, and tornados. It also provides the means to rescue people and animals who have become stranded by these and other natural disasters.



Figure 16-16. Many coal-burning power plants have begun using scrubber technology to minimize air pollution.

Reduce, Reuse, Recycle

Some people think there is not much they can do as individuals to make a difference. That is not so. Everyone can help. A good rule to follow is “reduce, reuse, recycle.”

Reducing Waste

How can we reduce the amount of trash or waste we throw away? We can start by changing our buying habits. For example, we can avoid replacing electronics such as cell phones unnecessarily. Is it really necessary to own the “latest and greatest” if our current phones meet our needs?

When a purchase is necessary, we can avoid buying disposable goods when reusable goods are available. Items such as paper plates and plastic cups are often used once and are then thrown away. See **Figure 16-17**. Instead, we can buy inexpensive dishes that can be washed and used again and again.

We can also choose products that have less packaging. When you buy a new product, as soon as you get home you open the packaging and throw it away. The packaging is instant waste. The EPA estimates that packaging makes up about 30% of the waste we generate every year.

Another important part of reducing waste is reducing the toxicity of the waste we produce. This helps keep hazardous materials to a minimum. For example, read the package before buying disposable batteries to be sure they contain little or no mercury. Use “green” cleaning products that contain no phosphates or other harmful chemicals.



Figure 16-17. A—Many people buy disposable plastic cups for parties because they are colorful and festive. B—Non-disposable plastic cups can be just as colorful and greatly reduce the amount of plastic we throw away.

Technology Application

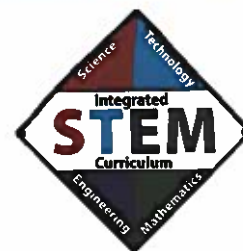
Finding Substitutes

We use many household products every day without thinking about their effect on the environment. It is easy to use other products that are not as harmful to the environment. The hard part is remembering to think about it! If we make a habit of considering the alternatives on a regular basis, it becomes much easier to do.

Technology Activity

The household items listed below often contain harsh chemicals that are harmful to the environment. Make a table that has two columns. In the first column, list each household item. In the second column, describe alternative methods, products, or technologies that can be used to reduce the harmful effect. Research each item if necessary to find alternatives.

- Drain cleaner
- Flea products for pets
- Toilet bowl cleaner
- Lawn mower gas and oil
- Household pesticides
- Oven cleaner
- Furniture polish



Reusing Items

If we think about it, we can find many ways to reuse products we already own. If an item breaks, can it be repaired? Repairing an item is sometimes less expensive than buying a new one. In these cases, repair can save money as well as reduce the amount of trash we throw away.

Some items can be used for different purposes. For example, if the handle breaks on your favorite mug, you can use the mug as a pencil holder. Your family might use the wood from an old wooden bench to make a coffee table. Before throwing out broken items or items you no longer need, think about other purposes they might serve.

Other ideas for reusing items include:

- Refilling printer cartridges instead of throwing them away
- Holding a garage sale to sell unwanted items to someone who wants them
- Donating unwanted items to charity

All of these ideas can help us reduce the amount of trash we throw away. See Figure 16-18.

Figure 16-18. Garage sales, yard sales, and moving sales are good ways to help other people reuse items we no longer want or need.



Recycling

Some items cannot be reused, or cannot be reused safely. *Recycling* is the process of treating materials to make them usable again. Recycling has many advantages. It conserves natural resources such as trees and minerals. At the same time, it reduces the pollution caused by the harvesting of the natural resources. In many cases, recycling products requires less energy than producing new products. Finally, recycling reduces the amount of waste that must be sent to a landfill or incinerated.

Recycling programs exist in almost every community. Some communities recycle only a few types of materials, such as paper and aluminum. Many communities now also accept glass, plastic, and other types of materials for recycling. See **Figure 16-19**. Check with your town or community to find out what types of materials are accepted in your area. If items for recycling are not picked up by the local garbage service, you can generally find a collection center in the community that accepts items for recycling.



Figure 16-19. Even public places such as parks and community centers now provide bins for recycling various items.

Separating items to be recycled from other trash is the first step in recycling. Making sure the items get to a collection center is the second step. Everyone can do these two steps. Processing the collected items and making them into new products is the responsibility of manufacturers. However, everyone can participate in the last step. We can all choose to buy recycled items, when available, instead of newly manufactured items. See **Figure 16-20**.

Other Things We Can Do

We can do many other things to help reduce the harmful effects of technology on the environment. For example, instead of using commercial products for household plants and gardens, we can compost. **Composting** is a method of mixing organic matter such as food waste and lawn clippings and allowing them to decay. This results in nutrient-rich soil that can be used to grow all kinds of plants and vegetables. With today's technology, composting is possible even in apartments and condominiums. Composting reduces the amount of garbage we throw away and at the same time produces rich soil for use with both vegetable plants and decorative plants.

Think Green

Composting

Even if you live in a small apartment, you can set up a working composting system. In fact, you can get started for little or no cost, and in the long run, you can save money or even make money.

You will need a few basic components to get started. First, you need a plastic box or garbage can of a size that is manageable in your home. It does not have to be large. You will also need some soil and grass clippings or dry leaves. If you do not have grass clippings or leaves, you can substitute plain, black-and-white newspaper or cardboard. Finally, you will need a tray to put under the compost box to catch leaks.

To create your composting system, punch holes in the sides and bottom of the compost box. Set the box on the tray. Then add two or three inches of soil to the bottom of the box. Add some grass clippings or dry leaves. Now you are ready to start composting.

The list of items you can compost is long. Examples include pet hair, lint, leaves, grass clippings, paper towels, potato peels, freezer-burned frozen vegetables, coffee grounds, and tea bags. You can search on the Internet for many other items that can be composted.

Be careful not to add things to your compost pile that are harmful to you or the environment. Examples of things *not* to compost include cooking oil, meat products, diseased plants, paint, and motor oil.



Figure 16-20. Items made from recycled materials can be both functional and beautiful. All of the furniture in this photo was created from recycled materials.



People who live in single-family homes can also help the environment and reduce water use by planting trees, shrubs, and grasses that are native to the area. These plants are already adapted for the climate and do not need much, if any, additional watering. By using native plants and composting, people can enjoy a beautiful, low-maintenance yard while helping the environment.

Using less electricity or gas for heating and cooling is another good way to reduce our impact on the environment. In winter, we can put on a sweater and turn the thermostat down a few degrees to use less heat. In summer, we can turn the thermostats up to reduce the air-conditioning. Ceiling fans set on their lowest setting, in combination with minimal air-conditioning, can keep homes comfortable even in hot climates. Also consider opening windows instead of using heating or cooling.

Plastic shopping bags are a serious problem in many communities. People bring home their groceries and then throw the bags away. We throw away millions of bags every day. Because the plastic does not decompose, this generates a huge amount of trash, most of which is not recycled. Some stores accept used plastic bags for reuse. An even better way to fix the problem, however, is to avoid using plastic bags. Instead, we can substitute cloth bags that can be used again and again. Many grocery stores now sell cloth bags at a very low cost. Some stores may even give a small discount when you use their bags. See **Figure 16-21**.

One major way to help reduce air pollution is to use alternative forms of transportation. In some areas, it may be possible to walk or ride a bicycle to school or work. When this is not possible, consider carpooling or using public transportation. Reducing the number of vehicles on the roads is the surest way of reducing the pollutants in vehicle exhaust.



Figure 16-21. We have many options for transporting groceries and other products from a store. Which of the options shown here is best for the environment?

In short, we can try to live a sustainable lifestyle. As you learned in Chapter 2, a sustainable design is a design that has little or no negative impact on the environment. We can extend that concept to include everything we do each day. Living a *sustainable lifestyle* means we do things such as eating, playing, exercising, and going to school or work while causing little or no environmental impact. Scientists and technologists are working to develop more sustainable products and practices. The sustainable design concept has been extended to include new (or reused) homes. Perhaps soon it will be extended successfully to include transportation and other major areas of our lives.

People used technology for hundreds of years without realizing that some of their activities might have a harmful effect on the environment. In earliest times, the effects were not as harmful because technologies such as building a fire to keep warm were used on a much smaller scale.

The introduction of industry in the 1700s and 1800s dramatically increased the harmful effects of technology on air quality. Later inventions of pesticides and other chemicals have had a similar effect on land, soil, and water. We are just now beginning to understand that the careless use of technology can harm not only the environment, but also our health.

Now that we are more aware of the issues, we can begin to use technology and other resources—such as human intelligence—to solve them.

We have already begun to make a difference, but much remains to be done.

**End
Note**

Summary

- Air quality is affected by pollutants that include toxic gases and airborne particles.
- Land and soil pollution can be caused by waste or other damage from technology, as well as by garbage we throw away.
- Most sources of air and land pollution also affect the quality of our water.
- Hazardous materials and hazardous waste require proper handling, storage, and disposal.
- We can do many things to help reduce harmful effects of technology on the Earth.

Reading Target

Preview and Prediction

Copy the following graphic organizer onto a separate sheet of paper. Do not write in this book. In the left column, record at least six predictions about what you will learn in this chapter. After you have read the chapter, fill in the other two columns of the chart.

What I Predict I Will Learn	What I Actually Learned	How Close Was My Prediction?

Test Your Knowledge

Write your answers to these review questions on a separate sheet of paper.

Critical Thinking

1. Particle pollutants are classified as coarse or fine. The finer the particles are, the more hazardous they are considered to human health. Why do you think this is so?
2. Although lead poisoning has been greatly reduced since the 1980s, some lead poisoning still occurs, even in humans. Why is lead poisoning still a threat?

Apply Your Knowledge

1. Do research to find out more about acid rain. If necessary, refer to the pH chart in Chapter 4 (Figure 4-8). At what level of acidity does lake water become dangerous to wildlife? At what level does it become dangerous to swimmers?
2. Choose one product and list its impacts, both positive and negative, on society and on the environment.
3. Look around your neighborhood. What kinds of trash or garbage do you see? Plan a strategy to convince people in your neighborhood to dispose of their trash properly.
4. Using ATVs and other off-road vehicles in environmentally sensitive areas can destroy habitat for wildlife. Form a group with three or four classmates and brainstorm a plan that would ensure that people who own these vehicles can still enjoy them, while preventing damage to sensitive areas.
5. Make a poster showing how watersheds help remove pollutants from water.
6. Prepare a multimedia presentation to show examples of each category of household hazardous waste listed by the EPA.
7. As a class project, design and implement a school-wide system to compost organic waste produced at your school.
8. It takes about a year for garden waste to change into good compost on a compost heap. Design and make a composting system that speeds up this process. It should be attractive and environmentally sound.
9. Use the Internet to investigate ways in which the following products are recycled: aluminum foil, antifreeze, appliances, asphalt, batteries, bottles, books, boxes, cans, cars, CDs and DVDs, cellular phones, clothes, concrete, furniture, medicine, metals, oil, paint, paper, plastics, and eyeglasses.
10. Do research to find out what plants are native to your area. Design a landscaping plan for your school that includes at least 70% native plants.

Apply Your Knowledge *(Continued)*

11. Research one career related to the information you have studied in this chapter. Create a report that states the following:

- The occupation you selected
- The education requirements to enter this occupation
- The possibilities for promotion to a higher level
- What someone with this career does on a daily basis
- The earning potential for someone with this career

You might find this information on the Internet or in your library. If possible, interview a person who already works in this field to answer the five points. Finally, state why you might or might not be interested in pursuing this occupation when you finish school.

STEM Applications



1. **SCIENCE** Perform an experiment to see what can happen to soil if no plants are growing in it. You will need two equally sized containers of soil: one planted with plants or grass, and one without (bare soil). Design your experiment to see the effect of the following events on the soil in both containers:

- Windstorm
- Heavy rain

You decide how to simulate the weather conditions. Compare the soil in the two pans. What can you conclude? Document your experiment and record your results.

2. **ENGINEERING** Imagine that you are marooned on a desert island in the middle of the Pacific Ocean. The island contains sand, rocks, seashells, and a few coconut palm trees, but nothing else. There is no fresh water on the island. Your first priority must be to create a source of fresh water for drinking. Design and make a device that removes the salt from saltwater, using only materials that are available on the island.



Humans have the ability to think and reason. How can we use our abilities to protect endangered species?

Preparing for Your Career

Better by
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Ariel Shlien created The Mad Science Group

Ariel Shlien is an entrepreneur who, together with his brother Ron, cofounded Mad Science. Their passion for science led them to develop activities that they performed at parties, as well as workshops at local schools and community centers. They provide a unique assortment of hands-on programs, live presentations, theatrical productions, and innovative products. The company is now franchised globally, in all major cities in North America and in 29 countries worldwide. They deliver over 200,000 presentations a year to 4.8 million children and their families.

The Mad Science Group makes learning science fun.

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