

Also covers: Academic Standard 7 (Detailed standards begin on page IN8.)

Our Impact on Water and Air



chapter preview

sections

1 Water Pollution

Lab Elements in Water

2 Air Pollution

Lab What's in the air?



Virtual Lab How can we conserve water?

Do you enjoy the outdoors?




At one time, all the water on Earth was like this. Clean water and air help create a pleasant outdoor experience. Too many substances released into air and water from human activity may damage these resources.

Science Journal Hypothesize what happens to the water in your home after the water goes down the drain.

Start-Up Activities



Is pollution always obvious?

Some water pollution is easy to see. The water can be discolored, have an odor, or contain dead fish. Suppose the water appears to be clean. Does that mean it's free of pollution? You'll find out during this lab.   

1. Pour 125 mL of water into a large jar.
2. Add one drop (0.05 mL) of food coloring to the water and stir.
3. Add an additional 125 mL of water to the jar and stir.
4. Repeat step 3 until you cannot see the food coloring.
5. **Think Critically** Calculate the concentration of food coloring in your jar with each 125-mL addition of water. Will the concentration of food coloring ever become zero by diluting the solution?

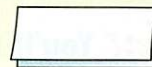


Preview this chapter's content and activities at in8.msscience.com

FOLDABLES™ Study Organizer

Pollution Make the following Foldable to compare and contrast the characteristics of water pollution and air pollution.

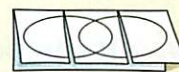
STEP 1 Fold one sheet of paper lengthwise.



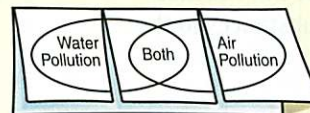
STEP 2 Fold into thirds.



STEP 3 Unfold and draw overlapping ovals. Cut the top sheet along the folds.



STEP 4 Label the ovals as shown.



Construct a Venn Diagram As you read this chapter, list the characteristics unique to water pollution under the left tab, those unique to air pollution under the right tab, and those characteristics common to both under the middle tab.

Water Pollution

as you read

What You'll Learn

- **Identify** types of water pollutants and their effects.
- **Discuss** ways to reduce water pollution.
- **List** ways that you can help reduce water pollution.

Why It's Important

All organisms on Earth depend on water for life.

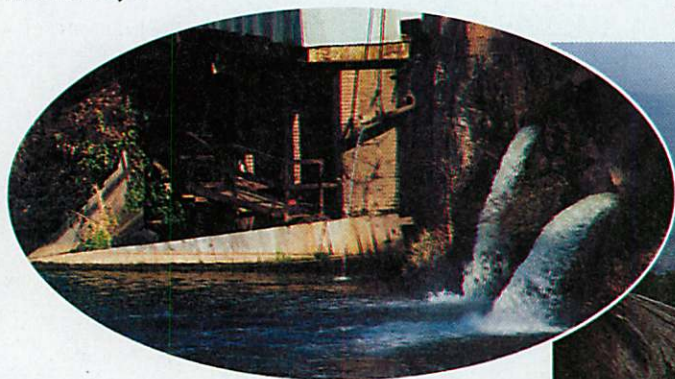
Review Vocabulary

pollution: the introduction of harmful substances to the environment

New Vocabulary

- point source pollution
- nonpoint source pollution
- pesticide
- fertilizer
- sewage

Figure 1 Water can be polluted in two ways.



Point sources include industrial wastes from outfalls.

Importance of Clean Water

All organisms need water. Plants need water to make food from sunlight. Some animals such as fish, frogs, and whales live in water. What about you? You cannot live without drinking water. What happens if water isn't clean? Polluted water contains chemicals and organisms that can cause disease or bring death to many living things. Some of the polluted water will eventually flow into Earth's oceans. However, the oceans are limited in their ability to absorb and recycle wastes naturally.

Sources of Water Pollution

Many streams and lakes in the United States are polluted in some way. Even streams that look clear and sparkling might not be safe for drinking.

Point source pollution is pollution that enters water from a specific location, such as drainpipes or ditches, as shown in **Figure 1**. Pollution from point sources can be controlled or treated before the water is released to a body of water.

However, many times bodies of water become polluted and no one knows exactly where the pollution comes from. Pollution that enters a body of water from a large area, such as lawns, construction sites, and roads, is called **nonpoint source pollution**. Nonpoint sources also include pollutants in rain or snow. Nonpoint source pollution is the largest source of water quality problems in the United States.


Nonpoint sources cannot be traced to a single location.



Sediment The largest source of water pollution in the United States is sediment. Sediment is loose material, such as rock fragments and mineral grains, that is moved by erosion. Rivers always have carried sediment to oceans, but human activities can increase the amount of sediment in rivers, lakes, and oceans. Each year, about 25 billion metric tons of sediment are carried from farm fields to bodies of water on Earth. At least 50 billion additional tons run off of construction sites, cleared forests, and land used to graze livestock. Sediment makes water cloudy and blocks sunlight that underwater plants need to make food. Sediment also covers the eggs of organisms that live in water, preventing organisms from receiving the oxygen they need to develop.

Agriculture and Lawn Care Farmers and home owners apply **pesticides**, which are substances that destroy pests, to keep insects and weeds from destroying their crops and lawns. When farmers and home owners apply pesticides to their crops and lawns, some of the chemicals run off into water. These chemicals might be harmful to people and other organisms, such as the frog in **Figure 2**.

Fertilizers are chemicals that help plants grow. However, rain washes away as much as 25 percent of the fertilizers applied to farms and yards into ponds, streams, and rivers. Fertilizers contain nitrogen and phosphorus that algae, living in water, use to grow and multiply. Lakes or ponds with high nitrogen and phosphorous levels, such as the one shown in **Figure 3**, can be choked with algae. When algae die and decompose, oxygen in the lake is used up more rapidly. This can cause fish and other organisms to die. Earth's nitrogen cycle is modified when fertilizers enter the water system.

 **Reading Check** *How do fertilizers cause water pollution?*

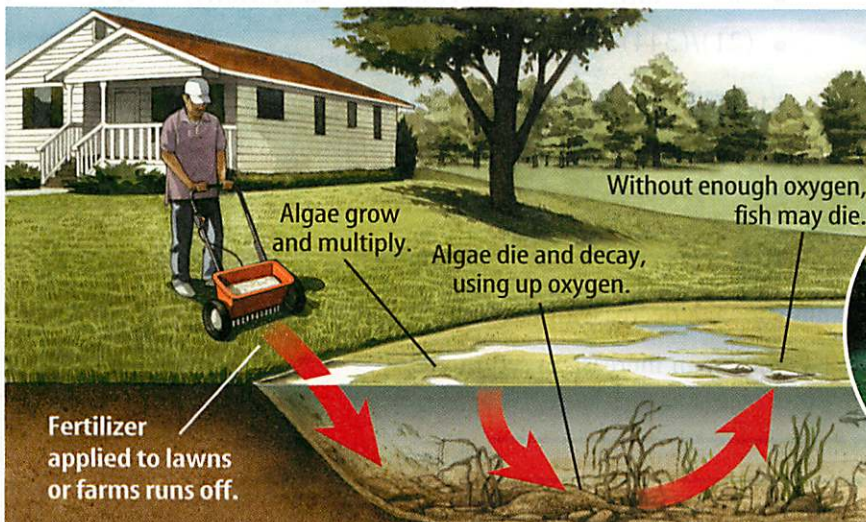


Figure 2 Research suggests that some pesticides in the environment could lead to deformities in frogs, such as missing legs.

Figure 3 Nitrogen and phosphorus in fertilizer cause algae to grow and multiply. Fish can die when algae decompose, using up oxygen.



Human Waste When you flush a toilet or take a shower, the water that goes into drains, called **sewage**, contains human waste, household detergents, and soaps. Human waste contains harmful organisms that can make people sick.

In most cities and towns in the United States, underground pipes take the water you use from your home to a sewage treatment plant. Sewage treatment plants, such as the one in **Figure 4**, remove pollution using several steps. These steps purify the water by removing solid materials from the sewage, killing harmful bacteria, and reducing the amount of nitrogen and phosphorus.

Applying Math

Calculate Percentages

SURFACE WATER POLLUTION

This table shows the number of sampling stations that have an increased or a decreased level of pollution in a 10-year period. What percent of stations has shown an increase in nitrogen over a 10-year period?

Trends in River and Stream Water Quality

Measured Pollutant	Total No. of Stations Examined	No. of Stations With Decrease in Pollutant Level	No. of Stations With Increase in Pollutant Level
Sediments	324	36	6
Bacteria from sewage	313	41	9
Total phosphorus	410	90	21
Nitrogen	344	27	21

Solution

- This is what you know:* Nitrogen: number of stations with an increase = 21
total number of stations examined = 344
- This is what you need to find:* percentage: _____%
- This is the equation you need to use:*
 - $\% = (\text{stations with increase}) / (\text{total stations}) \times 100$
 - $(21) / (344) \times 100 = 6.1\%$
- Check your answer:* Multiply the total stations by the percent in decimal form to obtain the number of stations with an increase.

Practice Problems

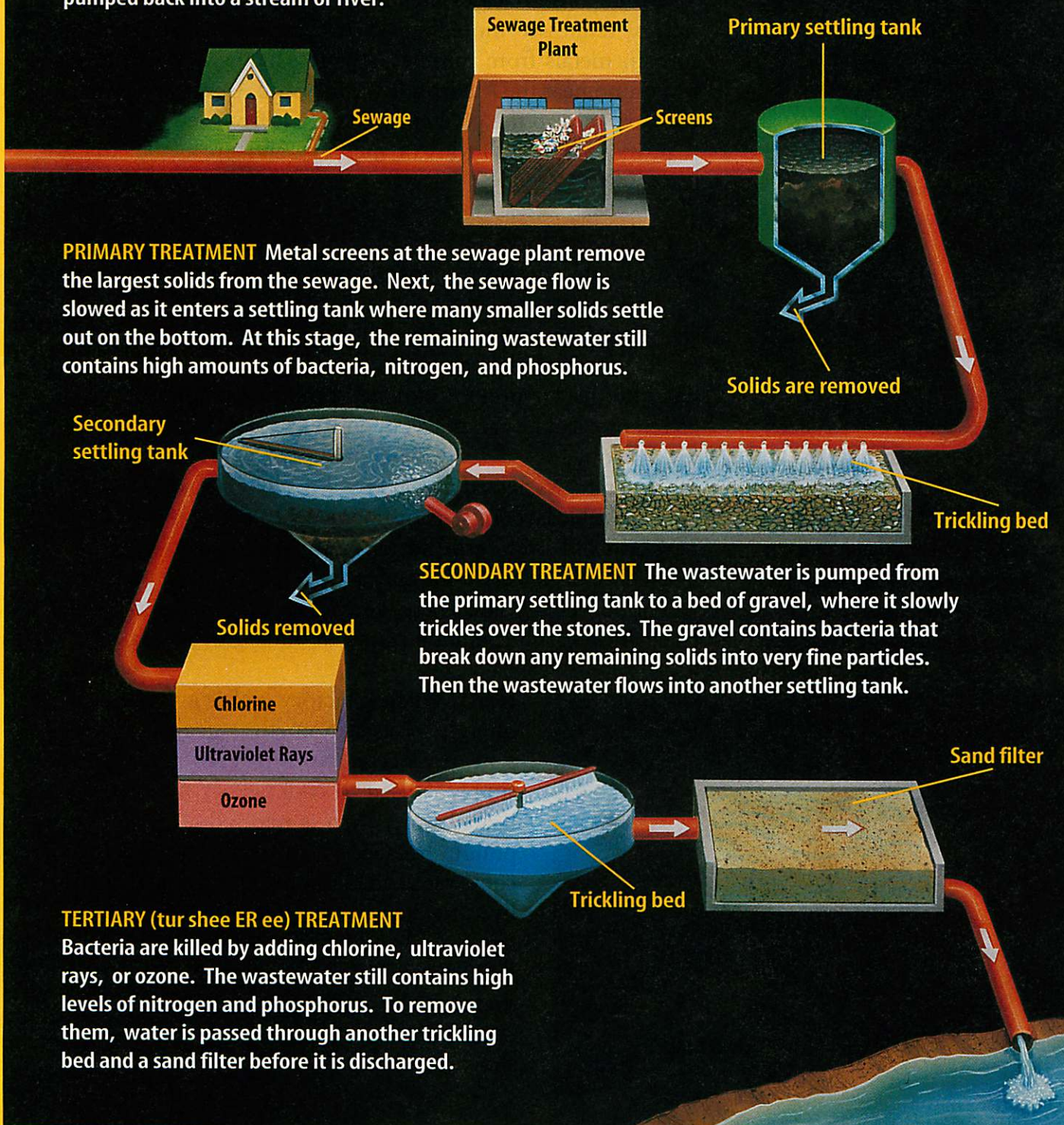
- What percent of stations has shown a decrease in bacteria?
- What percent of stations has shown an increase in sediment?



For more practice, visit
[in8.msscience.com/
math_practice](http://in8.msscience.com/math_practice)

Figure 4

Sewage from most towns and cities is treated at municipal sewage treatment plants. Wastewater entering a sewage plant contains organic matter, paper, grease, bacteria, nitrogen, and phosphorus. As shown below, the wastewater from homes and businesses is purified in three stages—primary, secondary, and tertiary—before it is pumped back into a stream or river.



PRIMARY TREATMENT Metal screens at the sewage plant remove the largest solids from the sewage. Next, the sewage flow is slowed as it enters a settling tank where many smaller solids settle out on the bottom. At this stage, the remaining wastewater still contains high amounts of bacteria, nitrogen, and phosphorus.

SECONDARY TREATMENT The wastewater is pumped from the primary settling tank to a bed of gravel, where it slowly trickles over the stones. The gravel contains bacteria that break down any remaining solids into very fine particles. Then the wastewater flows into another settling tank.

TERTIARY (tur shee ER ee) TREATMENT Bacteria are killed by adding chlorine, ultraviolet rays, or ozone. The wastewater still contains high levels of nitrogen and phosphorus. To remove them, water is passed through another trickling bed and a sand filter before it is discharged.

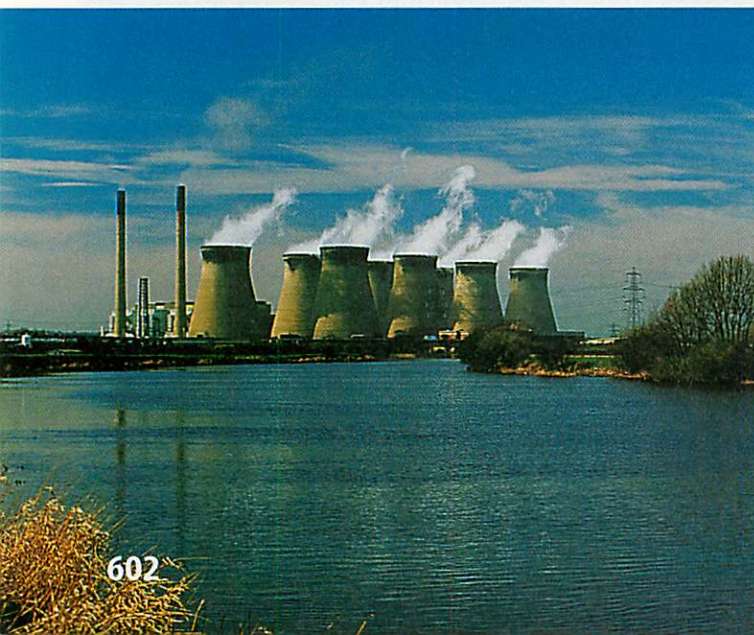


INTEGRATE Career

Environmental

Engineering Earth's atmosphere and oceans have a limited capacity to absorb wastes and recycle materials naturally. However, overabundance of pollutants has negative effects. Environmental engineering offers opportunities to work in environmental protection. Major areas include air pollution control, water supply, wastewater management, and storm water management.

Figure 5 During the manufacture of many products, such as electricity from this power plant, water is needed for cooling the machinery. Heated water remains in large towers and ponds until it has cooled to a temperature that is safe for fish and other organisms.



Metals Many metals such as mercury, lead, nickel, and cadmium can be poisonous, even in small amounts. For example, lead and mercury in drinking water can damage the nervous system. However, metals such as these are valuable in making items you use such as paints and stereos. Before environmental laws were written, a large amount of metals was released with wastewater from factories. Today, laws control how much metal can be released. Because metals remain in the environment for a long time, metals released many years ago still are polluting bodies of water today.

Mining also releases metals into water. For example, in the state of Tennessee, more than 43 percent of all streams and lakes contain metals from mining activities. In the mid 1980s, gold was found near the Amazon River in South America. Miners use mercury to trap the gold and separate it from sediments. Each year, more than 130 tons of mercury end up in the Amazon River.

Oil and Gasoline Oil and gasoline run off roads and parking lots into streams and rivers when it rains. These compounds contain pollutants that might cause cancer. Gasoline is stored at gas stations in tanks below the ground. In the past, the tanks were made of steel. Some of these tanks rusted and leaked gasoline into the surrounding soil and groundwater. As little as one gallon of gasoline can make an entire city's water supply unsafe for drinking.

Federal laws passed in 1988 require all new gasoline tanks to have a double layer of steel or fiberglass. In addition, by 1998, all new and old underground tanks must have had equipment installed that detects spills and must be made of materials that will not develop holes. These laws help protect soil and groundwater from gasoline and oil stored in underground tanks.

Heat When a factory makes a product, heat often is released. Sometimes, cool water from a nearby ocean, river, lake, or underground supply is used to cool factory machines. The heated water then is released. This water can pollute because it contains less oxygen than cool water does. In addition, organisms that live in water are sensitive to changes in temperature. A sudden release of heated water can kill a large number of fish in a short time. Water can be cooled before it is released into a river by using a cooling tower or pond, as shown in **Figure 5**.

Reducing Water Pollution

One way to reduce water pollution is by treating water before it enters a stream, lake, or river. In 1972, the United States Congress amended the Water Pollution Control Act. This law provided funds to build sewage-treatment facilities. It required industries to remove or treat pollution in water discharged to a lake or stream. The Clean Water Act of 1987 made additional money available for sewage treatment and set goals for reducing point source and nonpoint source pollution.

Another law, the Safe Drinking Water Act of 1996, strengthens health standards for drinking water. This legislation also protects rivers, lakes, and streams that are sources of drinking water.

International Cooperation Several countries have worked together to reduce water pollution. Lake Erie is on the border between the United States and Canada. Prior to the 1970s, phosphorus and nitrogen from sewage, soaps, and fertilizers entered Lake Erie from homes, yards, and farms, causing algae to grow and reproduce. The lake became a green, soupy mess. In the summer, the algae died and sank to the lake bottom. As the dead algae decayed, large areas of the lake bottom no longer had oxygen and, therefore, no life.

Pollutants also were discharged from many steel, automobile, and other factories along Lake Erie. **Figure 6** shows how on June 22, 1969, greasy debris on a large river flowing through Cleveland, Ohio, caught fire. This event was a wake-up call for everyone concerned about the quality of water in the United States and around the world.

In the 1970s, the United States and Canada made two water-quality agreements. These agreements set goals for reducing pollution in the Great Lakes. As a result of these agreements, limits were placed on the amount of phosphorus and other pollutants allowed into Lake Erie.

Today, the green slime is gone and the fish are back. However, more than 300 human-made chemicals still can be found in Lake Erie, and some of them are hazardous. The United States and Canada are studying ways to remove them from the lake.



Reading Check

Which countries worked together to control water pollution in Lake Erie?

Figure 6 Because of laws passed since 1972, Lake Erie's water has improved.



A fire on the Cuyahoga River in Cleveland, Ohio, alerted people in the United States to water pollution problems.



Today, millions of people enjoy this natural resource.



Hazardous Wastes

Some wastes are called hazardous because they are carcinogenic (kar sih nuh JEH nik). What does carcinogenic mean? What may happen if hazardous wastes seeped into a drinking water supply?



Topic: Water Conservation

Visit in8.msscience.com for Web links to information about water conservation.

Activity Turn on a faucet until it drips. Collect the water for 10 min. Calculate how much water goes down the drain each day.

How can you help?

Through laws and regulations, the quality of many streams, rivers, and lakes in the United States has improved. However, as **Figure 7** shows, much remains to be done. Individuals and industries alike need to continue to work to reduce water pollution. You easily can help by keeping contaminants out of Earth's water supply and by conserving water.

Dispose of Wastes Safely When you dispose of household chemicals such as paint and motor oil, don't pour them onto the ground or down the drain. Hazardous wastes that are poured directly onto the ground move through the soil and eventually might reach the groundwater below. Pouring them down the drain is no better because they flow through the sewer, through the wastewater-treatment plant, and into a stream or river where they can harm the organisms living there.

What should you do with these wastes? First, read the label on the container for instructions on disposal. Don't throw the container into the trash if the label tells you not to. Store chemical wastes so that they can't leak. Call your local government officials and ask how to dispose of these wastes in your area safely. Many communities have specific times each year when they collect hazardous wastes. These wastes then are disposed of at special hazardous waste sites.

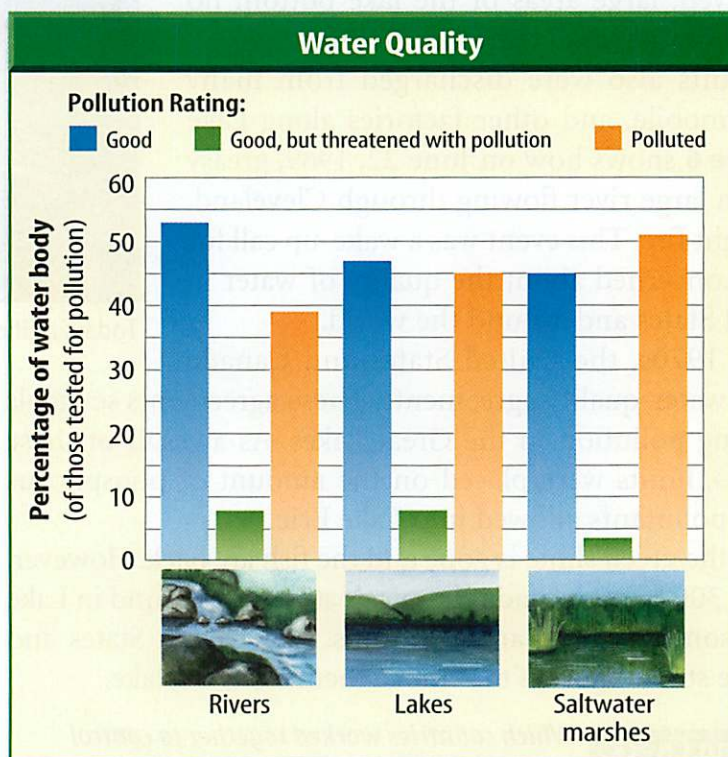


Figure 7 This graph shows that water pollution is still a problem in the United States.

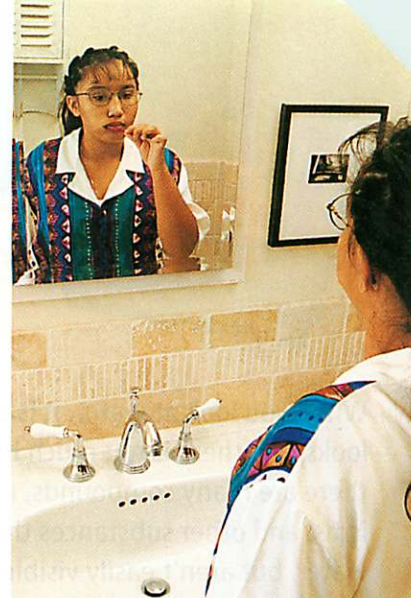
Determine the percentage of rivers that are listed as polluted.

Figure 8 Water pollution can be reduced if less water is used.



One drip every 5 s from a leaky faucet will waste nearly 7,500 L of water per year.

Toilets made before 1994 use nearly 12 L of water per flush. Replacing your old toilet with a new one can save 56 L of water in just ten flushes.



Turning off the water while brushing your teeth will save more than 19 L per day.

Conserve Water How much water do you use every day? You use water every time you flush a toilet, take a bath, clean your clothes, wash dishes, wash a car, or use a hose or lawn sprinkler. A typical U.S. citizen uses an average of 375 L of water per day. Unless it comes from a home well, this water must be purified before it reaches your home. After you use it, it must be treated again. **Figure 8** shows how using simple conservation methods can save water. Conserving water reduces the need for water treatment and reduces water pollution.

section 1 review

Summary

Importance of Clean Water

- All life on Earth needs water.
- Water pollution can harm living things.

Sources of Water Pollution

- Pollution enters water from point and non-point sources.
- Lawn and farm chemicals, sewage, metals, oil and heat all contribute to water pollution.

Reducing Water Pollution

- Federal laws and international agreements have helped reduce water pollution.

How can you help?

- Conserving water helps reduce pollution.

Self Check

1. **Compare and contrast** point source and nonpoint source pollution.
2. **Infer** how U.S. laws have helped reduce water pollution.
3. **Describe** ways you can conserve water.
4. **Think Critically** Southern Florida has many dairy farms and sugarcane fields. It also contains Everglades National Park—a shallow river system. What kinds of pollutants might be in the Everglades? How did they get there?

Applying Skills

5. **Use graphics software** to design a pamphlet that informs people how to reduce the amount of water they use.