

# 12.0

Stewardship of our water systems is needed to ensure their sustainability.



Water is a precious resource that we all have a role in caring for. As an old proverb says, "We never know the worth of water until the well is dry."

## *What You Will Learn*

In this chapter, you will:

- compare your personal water consumption with that of others in the world
- use critical thinking to assess how issues related to water systems are reported by media sources
- analyze the impact of some scientific discoveries and technological innovations on water systems

## *Skills You Will Use*

In this chapter, you will:

- use a variety of forms to communicate with different audiences for a variety of purposes
- test a method of desalinating water
- use appropriate science and technology vocabulary in oral communication

## *Why This Is Important*

Understanding how valuable water is enables us to better understand the importance of working individually and together to protect and manage our water systems for current and future needs.

## *Before Writing*

Thinking  
Literacy

### **Descriptive Writing Tells Us...**

This chapter describes what stewardship and sustainability mean in relation to water systems. Predict one thing that you will learn about these terms. Scan the next page to check your prediction. Why are stewardship and sustainability “hot topics” for writers these days?

### **Key Terms**

- |                  |                  |
|------------------|------------------|
| • stewardship    | • bioremediation |
| • sustainability | • desalination   |
| • bias           | • impartial      |



## 12.0 Getting Started



**Figure 12.1** In Canada, where we have so much fresh water, it is easy to think that our water supply is limitless.

We are fortunate to live in one of the most water-rich countries on Earth (Figure 12.1). You have learned, however, that there are many reasons for us to be concerned about both our supply of water and our water quality. Natural events such as droughts and human activities such as farming and industrial development remind us that the supply of water is not endless. At the same time, the Walkerton story reminds us of how critical it is to safeguard the quality of our water.

For these reasons, taking action to protect our water systems is something we should all care about. We can do this by practising **environmental stewardship**. This means taking action to manage and maintain the environment to protect its well-being for current and future generations. At the same time, we need to use our water systems in a way that keeps them sustainable.

**Sustainability** is the ability of something to exist or be used at the same level for a long period of time without being

damaged, harmed, or reduced for future use. Therefore, when we develop our water systems to meet today's needs, we must do so in a way that protects the quality and supply of water for generations to come.

Niagara Falls is a good example of this. When the rushing water of the falls started being used to produce electricity, Canada and the United States realized that regulations were needed to protect this natural resource (Figure 12.2). Without such protection and concern for sustainable development, the supply of water for electricity production in the future could be affected.



**Figure 12.2** Canada and the United States must share the resources of Niagara Falls.

## D36 Quick Lab

### What Does Stewardship of Water Systems Look Like?

The schools and communities that take part in the Yellow Fish Road Program™ are helping to maintain a healthy watershed. They are practising environmental stewardship.

#### Purpose

To identify ways in which we can be stewards of our water systems.

#### Procedure

1. Working with a partner, look at the three photographs in Figure 12.3.
2. Consider how each photograph involves our water systems.

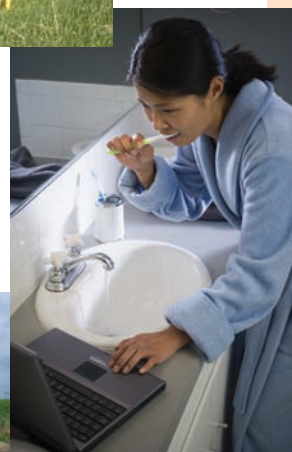
#### Questions

3. You are part of a stewardship group.
  - (a) Does your group identify any concerns for water systems in the photographs? Explain.
  - (b) Suggest one corrective action that your group recommends for any concern identified.

(a)



(b)



(c)



**Figure 12.3** Watching out for our water systems



**Here is a summary of what you will learn in this section:**

- Canadians are large consumers of water, on average, compared to people in other developed countries.
- Actions taken today to conserve water will protect our future supply.
- Individual actions add up, so what you do matters.

Researchers have estimated that Canadians each consume, on average, 335 L of water a day. This is water consumed for a variety of purposes, not just for drinking (Figure 12.4).

There are many ways in which we all use water during a day, often without really being aware of it. Try to imagine how it would be possible to shower, flush a toilet, brush your teeth, cook, and wash dishes and clothes if you did not have access to water.

Only in the United States is daily water consumption per person higher than it is in Canada. This is not something to be proud of.

Our water use per person in Canada has also changed over time. Today, each of us is consuming, on average, six times more water daily than people in this country did 100 years ago.



**Figure 12.4** Almost half of the water that Canadians use in the summer is sprayed onto lawns.

## D37 Starting Point

Skills **P** **C**



### Daily Water Use in an Average Canadian Home

Table 12.1 lists typical Canadian indoor activities that use water daily. The average consumption rate of 335 L per person per day is also shown.

1. Look at each activity. Think about your own water use. Then guess how many litres of water, out of the 335 L daily total, a person in Canada consumes for that activity.
2. Compare your guesses with the figures your teacher provides. Do any surprise you?

**Table 12.1** Daily Water Use in an Average Canadian Home

Activity	Amount of Water Used (L per person per day)
bathing and showering	
using the toilet	
laundry	
kitchen activities (for example, drinking and cooking)	
cleaning	
TOTAL	335

## Gathering Information in a Web

When writers want to explain something, they may use a “descriptive organizational pattern” to write some of the topic’s main features in chunks.

In section 12.1, you will read about water consumption and conservation. As you read, create a web to record what the writer tells you

about the benefits of water conservation and how we can reduce our water consumption. Once you have gathered information from the text, add to the web your own personal reasons and ideas for conserving water. Did you find any specific “signal words” for this pattern of writing?

## Comparing Water Consumption

The way water is distributed in many Canadian communities (removed from a water body, treated, stored, and sent to homes and businesses in pipes) does not happen everywhere else in the world. As Canadians, we are also fortunate to pay much less for treated water than the true cost of treating it. Compared to people living in other developed countries, we pay very little for the water that comes out of our taps. For these reasons and others, water use in other parts of the world is much lower than it is in this country (Figure 12.5).

Country	L/Day
Israel	135
France	150
Sweden	200
Italy	250
United States	380
United Kingdom	200
Mozambique	10

**Figure 12.5** Comparison of water consumption rates per person in several countries

## The Benefits of Water Conservation

A family that draws water from a well and disposes of waste water in a septic system knows the two main benefits of water conservation. One benefit is having enough water when they need it. The other is not contaminating their water supply with an over-used septic system. Well-users pay attention to activities that remove a lot of water from their underground source, such as doing many loads of laundry in a day or letting lawn sprinklers run for hours. They are also careful not to dispose of harmful products down their drains.

People living in communities with a municipal water distribution system often pay less attention to water usage than well-users do. The city or town water supply is often taken for granted and activities that consume a lot of water are often not given any thought. However, conserving water in these communities also offers many benefits, including the following.



**Figure 12.6** As our population grows, so does our demand for water. However, our supply is limited to how much clean water treatment plants can produce.

- **Ensuring water supply:** Our supply of water is limited by how much our treatment plants can produce and the distribution system can store (Figure 12.6). Water conservation allows our treatment plants to work efficiently and allows our groundwater sources to recharge.
- **Putting less demand on water distribution and collection systems:** The pipes beneath our streets are as old as the communities themselves. Many underground pipes are in need of repair (Figure 12.7).
- **Saving money:** In some communities, homes and businesses are now being charged for the amount of water they use. Using less water means having a lower water bill to pay.

## Reducing Water Consumption

Knowing *why* to conserve water and finding ways to inform others about the issues is the first step in reducing how much water we use. Learning *how* to conserve water is the next step. There are many ways in which individuals and communities can accomplish this.



### Adopting Improved, Water-Efficient Machines and Devices

Appliances such as dishwashers and washing machines have been redesigned in recent years to operate with less water. Shower heads that reduce the rate of flow of water can save as much as 60 L of water in a typical shower. New technology in toilets uses as little as 3 L of water per flush compared to more than 13 L of water per flush in older models.

**Figure 12.7** Repairs to aging water distribution pipes and wastewater collection pipes are extremely expensive and disruptive.



Most farms and golf courses use automated sprinkler systems for watering. These systems can be programmed to turn on early in the morning or late at night and will shut off after a set period. The sprinklers also often work by dripping the water onto the ground instead of spraying it overhead (Figure 12.8). As well, technology exists for automated carwashes, public laundry facilities, and industries to recycle their water by filtering and re-using it.

## Changing How We Pay for Water

In most Canadian municipalities, households and businesses pay the same amount (called a flat rate) for water use, no matter how much or how little they consume. Many other municipalities, however, have installed water meters on homes and businesses. These meters keep track of exactly how much water a household or business consumes. The users then pay for that amount. This means that what people pay for water might start being closer to what it actually costs to provide treated water.

A study of water use in Canadian homes found that when water use is monitored with meters, people use one-third less water a day than when water use is not metered (Figure 12.9).

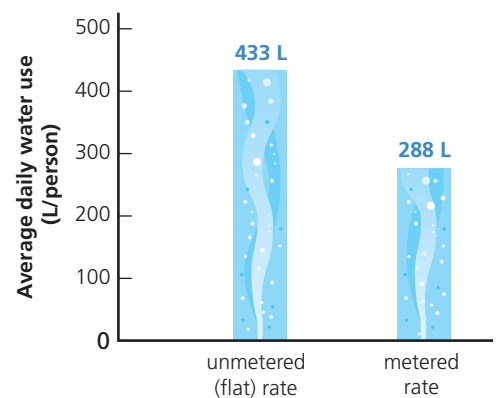
## Taking Direction from Government

Numerous government regulations and programs are aimed at protecting water resources. For example, many building codes (the rules for how someone builds a house or an office tower) now require that only water-efficient toilets be installed in new buildings. Some municipalities, such as the City of Toronto, also offer home-owners a rebate if they replace old toilets in already existing homes. This means that if a home-owner purchases one of the water-efficient toilets from a certain list, the city will refund the person part of the purchase cost.

As well, many municipalities have bylaws restricting water use during drought periods.



**Figure 12.8** Drip irrigation means that less water is lost to evaporation and more goes into the soil.



**Figure 12.9** Environment Canada reports that when people know they have to pay for the volume of water they use, the consumption rate drops significantly.

### Take It Further

How does a meter measure water consumption? How does a municipality calculate a water bill? Find out at ScienceSource.



**D39** *Inquiry Activity***Toolkit 2****SKILLS YOU WILL USE**

- Recording and organizing data
- Analyzing patterns

## Be a Water Watchdog

In the Starting Point activity on page 340, you examined the daily water consumption of Canadians. Now it is time to evaluate how much water you personally consume in one day.

### Question

Why is it important to evaluate your personal water use?

### Materials & Equipment

- observation sheet from your teacher
- 5-L bucket
- watch or clock with a second hand
- 1-L container

### Procedure

1. Choose one 24-h period on a weekend, when you will be at home to carry out this investigation. On that day, you are going to record how much water you use for every activity you do that requires you to run water.
2. Showering: Holding the 5-L bucket up to the shower head, turn on the cold water for 1 min at the pressure you would normally use to shower. Turn off the water and measure how much water has filled the bucket. Multiply this amount by the number of minutes of your usual shower.
3. Toilet flushing: If your home has an older-model toilet, multiply the number of times you flush it by 13.5 L. Otherwise, if you know the actual volume of water your toilet uses, multiply by that figure.
4. Cooking: For anything that is cooked with water (for example, hot cereal, pasta, rice, soup), measure how much water is used.
5. Drinking: Measure all the water you drink in the 24-h period.
6. Dishwashing: If you wash dishes by hand, fill the 5-L bucket first before pouring the water into the sink or washbasin. Measure how much water in total you use (you may need more than 5 L or less). If you have a dishwasher, look in the operating manual to see how much water it uses per load. For either case (handwashing or using the dishwasher), divide the amount of water required by the number of people in your household to get your individual use figure. Multiply that figure by the number of times dishes are washed that day.
7. Teeth brushing: Put the 1-L container under the sink faucet when you brush your teeth. Do not let the container overflow. Measure the total amount that ran until you finished brushing.

### Analyzing and Interpreting

8. Look at the data your teacher gave you in the Starting Point activity. Explain how your water use compared per activity and per day with the average Canadian's water use.
9. What other activities using water that involve you indirectly were not counted in this activity?

### Skill Builder

10. List two sources of error that affected how you determined your water use.

### Forming Conclusions

11. Write a sentence explaining why it is important to evaluate your personal water use.
12. Make a two-step plan of action to reduce your personal water consumption.

### Key Concept Review

- (a) How does Canada rank compared to the rest of the world in terms of daily water consumption per person?  
(b) Give two reasons why Canada has this ranking.

### Connect Your Understanding

- Give a “water-wise” alternative to each activity below.
  - hosing off a driveway to clean it
  - watering outdoor plants with a hose
  - letting the tap run to get cold water

### Practise Your Skills

The table in the next column shows the amount of water it takes to produce 1 kg of four common products. Use the information to answer the next two questions.

Product (1 kg)	Water (L)
steel	95
paper	324
potatoes	1 000
beef	99 980

- How much more water does it take to produce:
  - 1 kg of paper than 1 kg of steel?
  - 1 kg of potatoes than 1 kg of paper?
  - 1 kg of beef than 1 kg of potatoes?
- Explain why so much more water is needed to produce beef than potatoes.

For more questions, go to ScienceSource.



## D40 Thinking about Technology, Society, and the Environment



### You and Your Water Bill

How much does your water cost? It is hard to know because we do not have to pull money out of our wallets to pay every time we turn on a tap in our kitchen or bathroom.

#### What to Do?

- Your teacher will give you a copy of his or her home water bill or that of the school and will show you how to read it. Your teacher will also give you a price list of bottled water products of different sizes.

- As a class, figure out a way to compare the cost of regular municipal tap water with the cost of bottled water. Calculate the average cost of each for a standard volume.

#### Consider This

- Many people feel that Canadians pay too little for municipal water. Think about how our behaviour might change if the price we had to pay for tap water doubled. Brainstorm a list of the advantages and disadvantages of such an increase in municipal water charges.

**Here is a summary of what you will learn in this section:**

- People hold very differing opinions about how human activities affect water systems.
- Media such as newspapers, television, radio, and the Internet often present information about water issues from a biased viewpoint.
- Thinking critically about water issues is necessary if we are to make good decisions about managing our water systems.

Imagine that you and your classmates are asked to come up with a plan for improving your school building. Do you think you would all start with having exactly the same ideas about what is needed? It is not likely. We all bring our own unique ideas and values to any topic or issue.

This is the case with the management of water resources. Different groups have very different opinions about how water should be managed, protected, and shared so that water's sustainability is assured. They also hold different views about how human activities could affect local, national, and even international water systems.

## Bottled Water vs. Tap Water

Consider the issue of removing and selling water from freshwater systems. As you learned in Chapter 11, this is what the bottled water industry does (Figure 12.10). The growing export of our water resources has created great controversy. A controversy is a disagreement that goes on for some time.

Many people against the use of bottled water point to several facts. One is that bottled water costs about \$1 for a 500-mL container. Tap water costs just pennies a litre. It would take a lot of increase in the price of municipal water to reach the price of bottled water. Another fact is that the treated tap water across Canada is of good quality and can be consumed safely.



**Figure 12.10** Those plastic or glass containers of water you see everywhere are part of a multibillion-dollar industry.



Those people in favour of bottling water point to other facts. One is that the industry creates many jobs. Another is that bottled water can be shipped to areas that do not have treated water supplies. Furthermore, bottled water can be life-saving in emergencies when a supply of safe drinking water is not available.

When you read or hear facts like these in a newspaper, on an Internet website or blog, or on a radio or television report, you might not be able to tell whether the media source is in favour of bottling water or not. The viewpoint or opinion of the person providing the news report may not be evident. On the other hand, that person may present the news with a clear bias. A **bias** is an obvious opinion about an issue. By knowing what biases a reporter or broadcaster might have, you can better judge the content of the information presented.

If facts about an issue are presented in a fair and unbiased way, we say that the speaker is being **impartial**.

## D41 *Starting Point*

Skills **A** **C**



### Finding Messages behind Words

When people write or speak about a subject, you can often tell a lot about whether they are for or against something by their choice of words. Read the three statements below and then answer the questions that follow.

- (a) "Our town doesn't need to worry about conserving water. After all, there is a huge lake right in our backyard!"
- (b) "Some people get all excited because they think a few litres of water disappearing is a big deal."
- (c) "The study carried out by the government found that 6000 L more water than the

standard rate is being removed from the reservoir."

1. Suppose these sentences were spoken by a news reporter. Which one or ones show that he or she:
  - (a) has a bias? Explain.
  - (b) is impartial? Explain.
2. (a) Which statements show that a message is implied (that is, meant but not stated) in the words?
  - (b) What is the message that you think is being implied?



**Figure 12.11** Always ask yourself if the media source you are listening to or reading might be biased in how it addresses water issues.

## Bias behind the Reporting of Issues

Media sources such as newspapers, magazines, television, radio, and websites often contain biased information on an issue. It is helpful to know who wrote an article that you are reading so that you can determine whether the information discussed might be biased. For example, a report about the bottled water industry written by the president of MegaBlue Bottled Water may not tell you the same information as a report written by the president of the local “Don’t Sell Our Water!” association. Each source would want to convince you that its viewpoint is the right one, and that would influence the information provided.

The same is true when you watch a television documentary or listen to a radio program about a topic (Figure 12.11). It is important that you know who is behind the information before you evaluate its meaning.



## Issues Involving Water Systems

Removing and selling water from freshwater systems has become the topic of a national and international debate. However, it is just one of many issues related to the sustainable development of our water systems.

Another example is the world’s largest hydroelectric dam project, Three Gorges Dam. It is built across the Yangtze River in China (Figure 12.12). It has received much global attention. If you were to read only reports by the Chinese government about the project, you might think that the benefits of the hydroelectric power generated at the dam were a good use of technology. Yet, you would be getting only part of the story. Other media sources report how the project has forced nearly 1.5 million people to move, flooded dozens of towns and villages, destroyed animal habitat, and threatened important archaeological sites.

**Figure 12.12** The damming of the Yangtze River in China is an issue because many people have different viewpoints about its benefits.

Closer to home, the impact of human activities on the long-term health of the Great Lakes has been debated for decades (Figure 12.13). One issue is the destruction of Great Lakes coastal wetland habitats. Across southern Ontario, development for housing and agriculture has reduced or altered wetlands by approximately 70 percent. In the past, people viewed swamps and marshes as wastelands and did not understand their importance (Figure 12.14). Today, pro-development and anti-development groups continue to express their viewpoints about which activities near the Great Lakes should be permitted.

All issues relating to our water systems — whether they affect the local, national, or global community — require careful and critical thinking. We must reason through all issues by asking questions, separating facts from opinions, and examining viewpoints.



**Figure 12.13** How to maintain the health of the Great Lakes and their shorelines (such as Lake Superior's, shown here) is a hotly debated issue.



**Figure 12.14** When wetlands become filled up and built on, the habitat they provide for wildlife is destroyed.

### Take It Further

There are national standards for how drinking water should be monitored and managed in First Nations communities. Learn the various viewpoints about these guidelines. Begin your research at ScienceSource.

## D42 During Writing

Thinking Literacy

### Writers Make Decisions with RAFTS

RAFTS is a writing strategy that writers use to remind themselves of several decisions they need to make as they begin the writing process. The letters stand for **R**ole of writer, **A**udience, **F**ormat, **T**opic, and **S**trong verb.

Using the information on your water consumption and conservation web, write a description of five behaviours people could change to reduce their water consumption. Use the RAFTS strategy to finish making your writing decisions. Then complete your writing piece.



- Selecting media
- Determining bias

## Exploring a Great Lakes Issue

More and more people in Ontario are concerned about the quality and supply of water in the Great Lakes. In this activity, you will look critically at how an issue involving the Great Lakes is reported by a range of media sources.

### Issue

The impacts of rising and falling water levels in the Great Lakes

### Background Information

The level of water in the Great Lakes rises and falls all the time. This has been happening since the glaciers receded after the last ice age. Most changes in Great Lakes water levels occur naturally. If the water flowing into them equals the water flowing out of them, then levels remain the same. Usually, however, changes in evaporation, precipitation, and spring run-off cause the water levels to change. Human activities such as diverting water in and out of locks and canals also change water levels.

High water levels are a concern for many reasons, including increasing the chances of flooding. Concerns over low water levels include difficulty securing boats to high docks and loading and unloading a ship's cargo (Figure 12.15).



**Figure 12.15** Companies that use ships to transport products such as road salt from one port to another on the Great Lakes are very concerned about water levels.

## Analyze and Evaluate

1. Working with a small group, find at least five different reports, articles, or radio or television programs about the water levels in the Great Lakes–St. Lawrence River basin. Make sure that you choose a range of media types and sources.
2. As you read, listen to, or watch the information presented, make notes about the facts that are given.
3. Answer the following questions to evaluate the viewpoints or opinions of your media sources.
  - (a) What is the main purpose of the piece? For example, is it to provide facts or to put blame on something?
  - (b) Who is the main audience or group of readers that the piece is directed to? Examples include scientists and researchers, the general public, schoolchildren, or special interest groups.
  - (c) How does the information in each of the sources compare with the others?
4. Explain why one media source would take a different position from that of another media source.
5. Think of the issue of changing water levels in the Great Lakes. Has your research found any decisions that have been made? Explain.

### Key Concept Review


1. Why is it important to question what you read, watch, or listen to in the media?
2. What is the difference between a fact and an opinion?

### Connect Your Understanding

3. Suppose you belong to a stewardship group looking at ways to improve the health of your local watershed. What media sources might you access for information on the subject?

### Practise Your Skills

4. Many coastal communities depend on tourism to provide income and jobs to its citizens. Describe what viewpoint the following individuals might have.
  - the mayor of a coastal city
  - members of an environmental group

For more questions, go to ScienceSource. 

## D44 *Thinking about Science, Society, and the Environment*



### Mini Media Analysis

Water-related topics are written about and reported on every day. Many are about controversies over who has the right to use water when, why, for how long, and in what amount. When we read, watch, or hear media stories, it can be difficult sometimes to know whether the information we are getting is based on facts, opinions, or personal interests.

#### What to Do

1. Choose a water-related issue that has made headlines recently. Then find at least three different media sources that have reported on the matter.
2. Read, watch, or listen to each report critically. Analyze the way that each source has presented the information. For example, ask yourself:
  - Does the information provided in the report seem accurate? If science or technology information is provided, where can I check to see if it is factual?
  - Does the source seem impartial or biased? What evidence makes it seem that way?
3. Write a summary of your media analysis, stating your conclusions about how balanced each report's presentation was.
4. Think about everything else you read, watch, and listen to in the media daily. Is it only about water issues that biased reporting might occur? Explain your answer with several examples.

# Water Sustainability through Science and Technology

## Here is a summary of what you will learn in this section:

- Using our water systems in a sustainable way will enable us to protect our natural ecosystems and protect the quality and supply of water for future generations.
- Science and technology offer solutions to many water-related problems, but the impact of any innovation on local and global water systems must always be assessed.

The connection between land and water reminds us that stewardship of one must involve stewardship of the other if our water systems are to be sustainable. Many organizations, government departments, businesses, farmers, waterfront owners, and individuals just like you are working together to improve water quality and protect our supply so that it is sustainable.

## D45 Starting Point

Skills **A** **C**



### Looking More Closely at Solutions

Scientific and technological solutions to problems often create a new set of issues. Therefore, when we are trying to solve a problem in one part of the environment and society, it is important to consider how that might affect other parts.

With a partner, think about the problem below and the two proposed solutions shown in the table. For each solution given, list in your notebook what needs to be considered for all parts of (a) the environment and (b) society.

#### Problem:

A company discharges wastes from manufacturing processes as smoke through a tall chimney called a stack. Chemicals in the smoke are creating acid rain, which, in turn, is killing fish in a nearby lake.

Proposed Solution	Environmental Considerations	Societal Considerations
1. Update the stack with new technology that reduces the amount of chemicals released by 75 percent. This technology is very expensive.		
2. Install a much taller stack that discharges the smoke higher into the atmosphere and lets the smoke spread out over a larger area. This technology is less expensive than Proposed Solution 1.		



One place where we can look to see examples of sustainable practices is in our farming communities. Farmers use land and water management techniques and participate in programs that protect and enhance our watersheds. For example, the Ontario Environmental Farm Plan educates farmers in using plants along streams (Figure 12.16). These plants reduce the amounts of chemicals and nutrients produced by farm practices entering the local watershed.

Ongoing research in science and technology continues to offer solutions to many problems involving our water systems. However, a solution to any problem must always be assessed in terms of how it affects the environment and society.

## Sustainability Solutions Using Bioremediation

The technique of using living organisms to clean up contamination in land and water is called **bioremediation**. A subset of bioremediation is phytoremediation, which is the technique of using plants as environmental clean-up remedies (as discussed in the farm example, above). Scientists often use the term bioremediation to apply specifically to clean-up remedies involving microorganisms.

Bacteria are the microorganisms most often used in cleaning up problems with our water systems. For instance, the petroleum industry employs bacteria to clean up after oil spills and leaks have occurred. Some types of bacteria use the petroleum chemicals as food. These chemicals can harm people and animals, but oil-loving bacteria break down the chemicals into natural substances, including carbon dioxide gas, a type of alcohol, and water (Figure 12.17).

Bioremediation, while safe, relies on the natural processes of bacteria. Therefore, one disadvantage of this technology is that it takes a long time to complete. Another is that scientists who are knowledgeable about the technology are needed to carry out the remediation. This can mean hiring the services of someone to do the work. For some small companies, that can be expensive.



**Figure 12.16** A strip of plants between the stream and the nearby farm helps to filter contaminants and reduce pollution in the watershed.

### WORDS MATTER

"Bio" is a prefix meaning life. "Phyto" is a prefix meaning plant. The word "remediation" comes from "remedy," which is something that corrects.



**Figure 12.17** Bioremediation at work cleaning toxic waste in soil to protect ground and surface water

## Water Supply Solutions Using Desalination Technology

Maybe you have heard the lines “Water, water everywhere, Nor any drop to drink.” They are from the poem “The Rime of the Ancient Mariner” by 19th century poet Samuel Taylor Coleridge. If you can imagine being far out at sea without fresh water to drink, you will know what Coleridge’s mariner meant by those words. However, many countries with a scarce supply of fresh water are today using technology to turn ocean water into drinking water. **Desalination** is the process of removing salt from water.

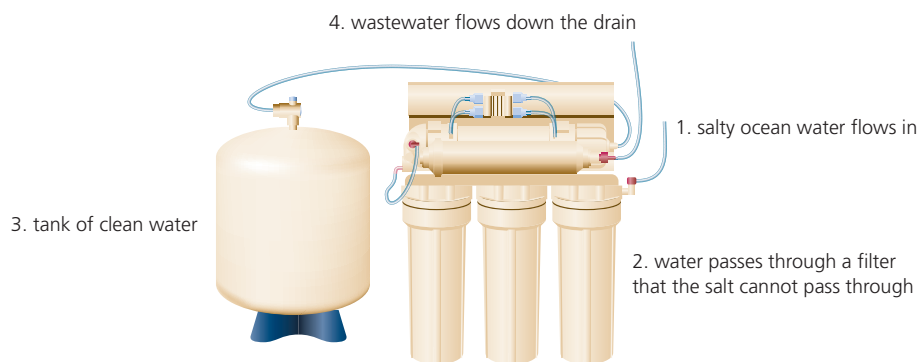
Desalination plants operate in many parts of the world (Figure 12.18). Ocean-going ships also have desalination

equipment on board. Desalination can be accomplished in several ways. One way is illustrated in Figure 12.19.

As with any technological solution, desalination does have some disadvantages. The waste water from a desalination plant contains a heavy concentration of salt, which is discharged back into the ocean. This unusually high concentration of salt can be toxic even to saltwater organisms if they are exposed to it for long periods. The waste water that flows out of the desalination plant and into the ocean also contains chemicals that are toxic to marine life.



**Figure 12.18** Africa’s largest desalination plant is in Algeria. It can produce 200 000 m<sup>3</sup> of drinking water daily from the Mediterranean Sea.



### Take It Further

What other parts of the world use desalination technology? Begin your research at ScienceSource.

**Figure 12.19** Reverse osmosis. In this set-up, salt water is pushed through a membrane or filter that the salt cannot get through. This is one way to desalinate water.

- Predicting
- Drawing conclusions

## Changing Salt Water into Fresh Water

In this activity, you will model a simple method of desalinating water.

### Question

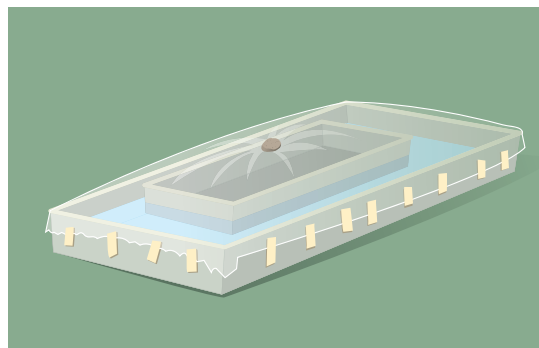
How can fresh water be made from salt water?

#### Materials & Equipment

- 1-L container of salt water (35 mL of salt dissolved in 1 L of fresh water)
- 2 pans: 1 wide and flat, 1 smaller to fit inside the wide pan
- plastic wrap
- tape
- small rock
- 2 medicine droppers
- 2 glass slides

### Procedure

1. Set the smaller pan in the larger one. Pour the salt water into the bottom pan so that the water surrounds the smaller pan but does not spill into it.
2. Cover the whole set-up with one large piece of plastic wrap. Tape the edges to the pan. Place the small stone on the plastic over the smaller pan to make a small depression.
3. Set the pans in a sunny location in the classroom (Figure 12.20). Predict what will happen to the salt water in the large pan.
4. Make a chart and record your observations daily for the next week.
5. After one week, take samples of the water. Use one medicine dropper to place two drops of water from the large pan onto a glass slide.



**Figure 12.20** Lab set-up

Do the same for the water sample from the small pan, using the other medicine dropper and glass slide. Allow the two samples to dry and record your observations.

### Analyzing and Interpreting

6. Explain how the dried samples on the slides differed.
7. How did what happened to the salt water compare with your prediction?
8. What purpose did the depression in the plastic serve?

### Skill Builder

9. Why were you instructed to dissolve 35 mL of salt in 1 L of water? What did this concentration represent?

### Forming Conclusions

10. Describe how fresh water was made from salt water. Use the following words in your explanation: evaporation, condensation, salinity, desalinate.



### Key Concept Review

1. When assessing solutions to problems involving our water systems, what needs to be considered?
2. Give one advantage and one disadvantage of bioremediation.
3. (a) Define the word “desalination.”  
(b) Describe one desalination method.

### Connect Your Understanding

4. The desalination plant in Algeria shown in Figure 12.18 on page 354 cost an estimated \$250 million to build. Why would the country have spent so much money to build this structure?
5. The term “brownfields” is used to describe unused properties in urban areas that have been contaminated by hazardous materials such as petroleum. What is one way in which municipalities could clean up brownfields? Explain.

### Practise Your Skills

6. Bioremediation offers many possibilities for decontaminating water and land sites in a watershed. Cleaning sites contaminated with petroleum is just one use. Think about how this technology could be applied more widely. What other problems can you think of where bioremediation might offer a possible solution? Make a chart listing your ideas and the societal impacts of each.
7. You have been given two unmarked containers. In one is a sample of salt water and in the other a sample of fresh water. You are asked to identify which is which, without tasting them. Explain the procedure you would use to do this.

For more questions, go to ScienceSource.



## D47 Thinking about Technology, Society, and the Environment



### Fog Water

In some parts of the world, polluted ground water and little precipitation mean that potable water is in short supply. Thanks to the work of many scientists and technologists, however, ways of collecting water from the air have been developed. “Fog catchers” are large screened panels that are installed outside like big sections of fencing. When fog or mist blows against them, the water droplets in the air condense, drip down the panels into pipes, and collect in storage tanks. These systems are fairly simple and inexpensive to build and operate.

1. Consider this scenario: A community has been using 12 fog catcher panels for a year, but now decides it could get much more water by increasing the number of panels across its area to 100.
2. Think about the intended and unintended consequences that such a step might have. Make a list of both. Then explain whether you feel the advantages of expanding this technology’s use outweigh the disadvantages for the community.



## A Tea Cup of Storm Clouds

If you have tea-drinkers in your house, you have a good opportunity to see a fascinating display of miniature weather.

First, you need a cup of very hot tea with no milk or sugar. Sit the cup under a bright light bulb or on a table or counter in the early morning sun. Watch carefully and you will see a pattern on the surface of the tea. The pattern will be made up of irregular white patches separated by thin black lines. These patches will change their shape from moment to moment.

The whitish areas you are seeing are places where hot tea is rising to the surface. The black lines are where cooler tea is sinking beneath the surface.

Why, you might ask, would warm tea be a different colour than cold tea? In fact, there is no colour difference in the tea. The whitish areas are not tea at all, but droplets of water suspended in the air.

When hot tea rises and reaches the surface, individual particles of water from the tea evaporate, breaking away and rocketing into the air. These particles are much too small to see, but there are millions of them. They do not go far. They cool quickly, slow down, and collect together to form tiny but visible droplets of water. Normally, these droplets would be pulled right back down into the tea by gravity. However, all the other particles that are still evaporating from the surface keep the droplets suspended

about a millimetre above the tea. So, what you are seeing in the whitish areas are really miniature clouds that are floating above the tea.

Eventually, as the tea cools, the clouds disappear. Imagine if you were miniaturized and floating in a nano-boat on the tea. It would be as if the storm had passed and the sky had cleared.



Unstable weather above a cup of hot tea

## Key Concept Review

1. Describe one thing you can do in your home, in your school, and in your community to reduce your personal water consumption. **k**
2. Identify the following statements as being true or false. If a statement is false, rewrite it so that it is true. **k**
  - (a) Ontarians live in one of the richest water areas on Earth, so our water supply is not threatened.
  - (b) We pay about the same price for treated tap water as it costs to produce.
  - (c) Judging the content of information on our water issues is easier when you know what biases the writer might have.
  - (d) All scientific discoveries and technologies developed to help clean up our water systems are always safe.
3. For each word below, write a sentence that uses the word and shows its meaning. **k**
  - (a) controversy
  - (b) viewpoint
  - (c) critical thinking
4. Explain what bioremediation is and how it works. **k**

## Connect Your Understanding

5. Do you think that the price we pay for our water should cover the costs to produce it? Give reasons for your answer. **a**
6. Name five behaviours that people could change in order to reduce their personal water consumption. **a**
7. All kinds of cargo are transported by ship along Canadian waterways each year. Explain why a reliable water level in our Great Lakes is important to the shipping industry. **a**

## After Writing

Thinking Literacy

## Reflect and Evaluate

Exchange your writing piece on reducing water consumption with a partner. How did knowledge of the “descriptive organizational pattern” for writing help you when you were reading your partner’s work? Was this pattern an easy way to organize and present your information? What other organizational pattern did you use or could you have used? Share your experiences and ideas with the class.



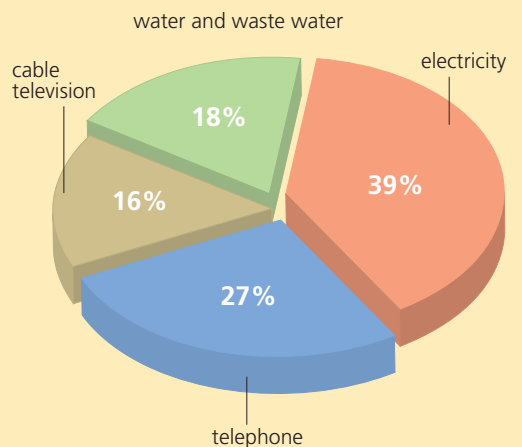
8. Look back at Figure 11.17 on page 326, which shows the human-made wetland at the Kortright Conservation Centre. Explain the technology behind this solution to waste water treatment. **a**
9. Many groups, such as conservation authorities, provide stewardship education.
  - (a) What educational messages about our water systems might they give? **t**
  - (b) How does educating the public help to protect and preserve our water systems? **a**

## Unit Task Link

How would acting out a part of life in an African village that is short of water help you to understand water's value?

## Practise Your Skills

10. The pie chart on the right shows a breakdown of monthly household expenses for an average Canadian family. From the data in the pie chart, explain why households are more interested in saving electricity than in saving water. Use figures from the graph to support your answer. **t**



Comparison of some monthly household expenses for an average family

## D48 Thinking about Society and the Environment



### Group Actions

Even though many separate actions can bring about a change, it often takes the actions of individuals and groups working together to create a sustainable solution to a problem with our water systems.

Think of an example that illustrates what this statement means. Your example can be one from your local area or one that applies provincially, nationally, or internationally.

### Consider This

1. Group action is necessary to bring about change. At the same time, however, the greater the number of people involved in solving an issue, the harder it can be to reach a solution that will make everyone happy. Working with a partner, discuss why you think this is the case.
2. What are some ways that people can work together to resolve differences of opinion?

# UNIT *D* Summary

## 10.0 Water on Earth exists in different states and is always moving and changing.

### KEY CONCEPTS

- Water on Earth exists in three states: liquid, solid, and gas.
- In a watershed, water from all sources on the land drain to one main water body.
- Activities in one part of a watershed affect all living things downstream.
- Water influences our climate and creates our weather.

### CHAPTER SUMMARY

- Water in all three states covers approximately 70 percent of Earth's surface and cycles constantly between the surface and the atmosphere.
- Of the two kinds of water on Earth, salt water is more abundant, but humans can drink only fresh water.
- Large water bodies influence the climate of coastal areas.
- Glaciers and ice sheets are affected by changes in temperature and precipitation. In turn, changes to glaciers and ice sheets influence water systems.

## 11.0 Monitoring water systems is critical for maintaining water supply and quality.

### KEY CONCEPTS

- Our supply of water on Earth is limited.
- The supply and quality of our water is threatened by natural events and human activity.
- Our sources of drinking water must be protected.

### CHAPTER SUMMARY

- Proper management of our water supply is needed so that there is enough for all living things and for the future.
- Canadians obtain drinking water from below- and aboveground sources, and it must be treated and tested before it is safe to drink.
- Protecting our drinking water sources from pollution and overuse is the first step in ensuring water's sustainability.
- Treating water and waste water is expensive and does not remove all contaminants.

## 12.0 Stewardship of our water systems is needed to ensure their sustainability.

### KEY CONCEPTS

- Sustainable water systems provide the quality and supply of water for the future.
- Through stewardship action, our water systems can be properly managed, maintained, and enhanced.
- Issues involving our water systems must be examined critically.

### CHAPTER SUMMARY

- Canadians are large consumers of water, and conservation is necessary to protect our future supply and Earth's ecosystems.
- Thinking critically about water issues involves asking questions, separating facts and opinions, and examining viewpoints for biases.
- Science and technology offer solutions to problems involving our water systems, but their impact on the environment and society must be assessed.

## The Worth of Water

### Getting Started

The United Nations considers access to clean drinking water to be a fundamental human right. Yet this is not the reality for more than one billion people worldwide. We rarely have to think about putting a value on water. One way to do it, however, is to measure the time and effort needed to gather and store it for our use.

### Your Goal

Using a simulation, you will share the experience of a student your age who lives in rural Sierra Leone, in western Africa. Your task will be to supply your family with enough water for their daily routine, collecting that water from the community well.

### What You Need to Know

Your teacher will help you research (1) the volume of potable water that a family of four in a rural west African country uses in a day, and (2) how much water a young person might carry per trip to the well. You will then use appropriate sizes of containers to represent your home cistern (storage container) and the container you will carry.

Your teacher will also set a distance in your schoolyard to represent the distance between your village and the well. The well will be represented by an outdoor hose. A pathway will be laid out for you to follow as though you were travelling to and from the well.

### Steps to Success

1. With a team of three or four, walk from your "home" to the well along the set path, each carrying a water container. At the well, fill your container.
2. Return home along the same path. Empty your container into the cistern and return to the well for a refill. Repeat as often as it takes to fill the cistern.
3. When finished, sit down with your team to discuss the activity. Was it physically difficult? What would it feel like if you had to do this every day?
4. On your own, compose a first-person story as though you are a student in Sierra Leone describing the responsibility of taking water to your family. Include events that might occur during the travel to and from the well and your feelings about how you view this duty.
5. With your whole class, consider the information you learned in this unit about the volume of water required for a family's use in Canada. Develop a graphic organizer to contrast the information about family water consumption in Sierra Leone to that in Canada.

### How Did It Go?

6. Suppose that your family in Canada had access only to the same amount of water per day as the family in Sierra Leone. Examine your graphic organizer. What water use habits are you prepared to change?
7. Examine the length of the path set out by your teacher. How long would it take your team to get the required volume of water if the path were 1 km? What if it were 5 km?
8. International organizations such as OXFAM and UNESCO work to bring low-technology wells to villages in the developing world. What might be the effect on a community if the water supply was located only a short distance from the homes?



# UNIT D Review

## Key Terms Review

1. Create a concept map that illustrates your understanding of the following terms. **K**

- aquifer
- bias
- bioremediation
- chlorine
- contaminants
- desalination
- discharge
- groundwater zone
- heat capacity
- impartial
- polar ice-cap
- potable water
- recharge
- salinity
- septic tank
- stewardship
- sustainability
- water table

## Key Concept Review

10.0

2. Match the definition in Column A with the term in Column B. **K**

Column A	Column B
(a) a long, hollow shaft drilled into an aquifer	(i) oceans
(b) massive bodies of surface water that are referred to as Earth's water reservoirs	(ii) water table
(c) natural, underground freshwater reservoirs	(iii) river
(d) a large body of flowing fresh water that usually leads to a lake or ocean	(iv) aquifer
(e) the upper surface of the groundwater zone	(v) well
(f) land that is permanently or seasonally covered by shallow water	(vi) groundwater zone
(g) the underground water storage zone	(vii) wetland

3. Draw a diagram of the water cycle and label it with the following words. **K**

- evaporation
- transpiration
- precipitation
- condensation
- surface run-off
- ocean
- lake
- river
- ground water
- clouds
- atmosphere

4. Complete the following sentences by filling in the blanks with a word or words from this unit. **K**

- (a) The line created by the Rocky Mountains in North America that separates the direction of water flow is known as the \_\_\_\_\_.
- (b) An area with a small, localized climate is called a \_\_\_\_\_.
- (c) The \_\_\_\_\_ of a substance describes its ability to absorb heat.

5. Write down whether each of the following statements is true or false. Give one piece of evidence from this unit to support your answer. **K**

- (a) Large bodies of water have a moderating effect on the climate of a nearby region.
- (b) Water takes the same amount of time to absorb heat as soil does.
- (c) Rising temperatures and an increase in precipitation over a long period of time have a minimal effect on massive ice formations.

## 11.0

6. Describe three natural events that can affect the depth of the water table. **k**
7. (a) Explain how overuse of water threatens drinking water supplies. **k**  
(b) Describe two human activities that contribute to overuse. **k**
8. What three tests are regularly carried out on drinking water to ensure that it is safe? **k**
9. The following steps are part of the treatment process for municipal waste water. Place them in the sequence in which they occur. **t**
  - (a) Clean water is returned to the river or lake.
  - (b) Waste water from homes and businesses is sent to the treatment plant through underground pipes.
  - (c) In the aeration tanks, micro-organisms digest the organic wastes.
  - (d) A coarse screen removes large debris such as toys, false teeth, and rags.
  - (e) Settling tanks separate the floaters and the sinkers. The remaining liquid is sent to the aeration tanks.
  - (f) Liquid from the secondary tanks can contain harmful microorganisms, so it is usually disinfected with chlorine.
10. Which of the following statements about wetlands are true and which are false? Rewrite the false statements to make them true. **k**

- (a) Wetlands have no impact on our drinking water.
- (b) Marshes and swamps are both types of wetlands.
- (c) Wetlands are not important ecosystems.

## 12.0

- 11 Explain the term “sustainable development” as it applies to our water systems. **k**
12. Give one example of a biased statement and one of an impartial statement. **a**
13. Copy the following table into your notebook. In the Positive column, list benefits of the technology. In the Negative column, list drawbacks to the technology. In the third column, note interesting facts or comments about each technology. **t**

Examining Technological Innovations Using Water Systems

Technology	Positive	Negative	Interesting Fact
1. bioremediation			
2. desalination			

## Connect Your Understanding

14. The large amount of snowfall in areas near the Great Lakes is often referred to as “lake effect snow.” Explain why that term is used. **a**

# UNIT D Review (continued)

**15.** The owners of a small hotel that draws water from a well submit a water sample for testing. The test result indicates the presence of *E. coli*, so the public health department issues a Boil Water Advisory. This tells the hotel owners to boil their water before consuming it. Answer the following questions about this situation.

- Why is drinking water tested for bacteria such as *E. coli*? **k**
- What is the purpose of boiling the water? **t**
- What could an unsatisfactory test result indicate? **t**
- What further investigations are necessary? **a**

**16.** Swimming pool water contains chlorine. Why should backyard swimming pools not be emptied down storm drains? **t**

**17.** Some bottled water companies remove water from municipally treated supplies. They are required to have a permit to remove the water. Do you think they should also pay for the treatment that the water received? Explain your answer. **t**

**18.** In the washrooms of some facilities such as airports, train stations, and shopping malls, water taps operate on sensors. Putting your hands under them starts the water flow. When you remove your hands, the water shuts off. Explain the benefit of this technology in terms of our water systems. **t**

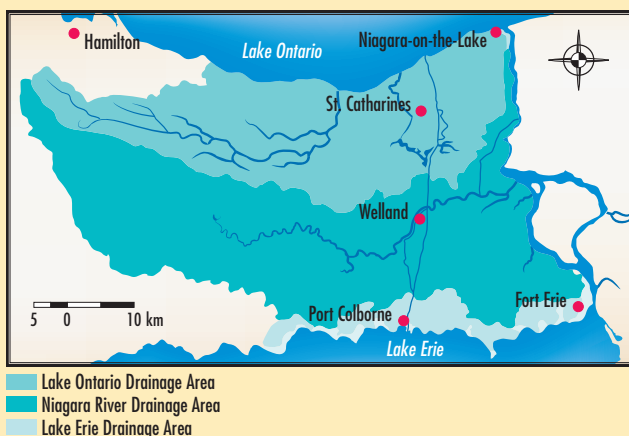
**19.** Reflect back on all you have learned in this unit.

- List five things that you did not know before about Earth's water systems. **t**
- Beside each of the things you noted in (a), describe one way that this new knowledge will affect your actions and attitude from now on. **a**

## Practise Your Skills

**20.** The map below shows the Niagara Peninsula watershed.

- Into which large waterfall does most of this watershed's water drain? **k**
- Does the rain that falls during a thunderstorm over Welland reach the ground water of Hamilton? Explain. **t**
- To what major ocean watershed does all water from this smaller watershed drain? **a**



**21.** Imagine that you are camping in the woods with friends. You brought enough drinking water with you, but you need to use lake water to wash your dirty dishes.



Write a plan for: **a**

- (a) the safe use of lake water for washing dishes.
- (b) disposal of dish water so that there is minimal impact on the environment.

## Revisit the Big Ideas

**22.** Weather is an important part of our lives. Read the following statements about weather. Explain how water systems are involved in each one. **t**

- (a) Weather forecasts explain how the weather will change over a short period of time.
- (b) Cloud types and patterns can be used to interpret the weather.

(c) In the daytime, air rises over warmer land and cooler air moves in from the nearby water.

**23.** You have learned that water is an important five-letter word. For each letter, write down the name of something that depends on a sustainable use of water. **a**

**24.** How crucial is water to our lives? Write a one-page essay to answer this question. First, write down all the responses you can think of. Then organize these ideas into a logical point-form outline. Finally, develop your ideas into sentences and paragraphs that describe how crucial water is to our lives. **c**

**D49**

## Thinking about Science, Technology, Society, and the Environment



### Water for All

Each photograph in Figure 12.21 shows one or more ways that water plays a role in supporting the world around us.

1. How are human lives dependent on or improved by each use shown?
2. What competing water uses could harm or disrupt the existing uses shown in each photograph? Would the impacts be social, cultural, political, environmental, or a combination of these? Explain.

**Figure 12.21** Water everywhere

(a)



(b)



(c)



(d)