Environment Canada
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Let's Not Take Water For Granted

A Resource Guide

FRESHWATER SERIES

Canada

Produced by authority of
the Minister of the Environment

A resource guide targeted at educators (Grades 5, 6, and 7)

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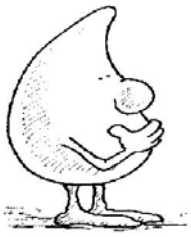
FOREWORD



Purpose

Let's Not Take Water For Granted has been written to help classroom teachers of grades 5, 6, and 7 use the information from the *Water Fact Sheets* and *A Primer on Fresh Water: Questions and Answers* produced by Environment Canada.

The teaching suggestions, reading material, and learning activities require little or no preparation time and are designed to be "teacher-ready." A number of activities in cross-curricula areas have been developed to meet a variety of teaching and learning styles. Teachers are encouraged to copy or adapt any of these activities and incorporate them into the curriculum.

Philosophy

The guiding philosophy behind the development of these materials is to build an awareness of "good environmental citizenship." The learning activities will provide the students with the basic knowledge to help them develop skills for positive action. Whenever possible, you are encouraged to promote this approach.

Format

The topics in the resource guide correspond to the order of the *Water Fact Sheets*. The materials are also cross-referenced with *A Primer on Fresh Water* and other Environment Canada publications.

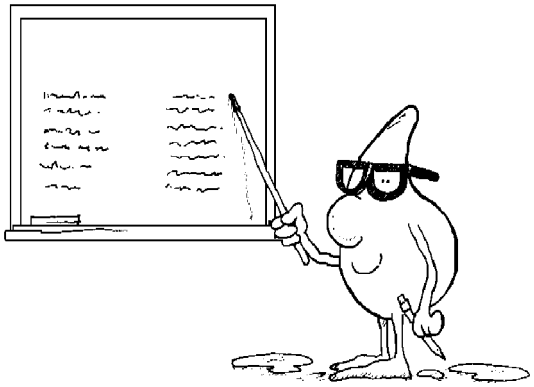
Within each topic, there are chapters consisting of teaching suggestions, Student Information, and Learning Activities. Tests are included to check the students' knowledge after completing one or more of the topics.

Throughout the resource guide, certain words in the Student Information and Learning Activities sections have been highlighted. These words correspond to the vocabulary list for each chapter and to the words in the vocabulary section at the end of the guide.

INTRODUCTION

To the teacher

This introductory section has been included to provide an overview for your students about the importance of water in their lives. As the students proceed through the topics you select, they will learn more about water in Canada, how we use it, and its important contributions to the lifestyle we enjoy in Canada.



Students can become interested in water because it is such an important part of their everyday lives. At the same time, they can also become concerned about pollution. The activities with each chapter will give them lots of opportunities to think about their own roles as good environmental citizens.

Before you begin, please become familiar with these materials and look for opportunities to integrate the subject matter into your curriculum.

Introductory activities

To help focus the students' thinking about water, try one or more of the following class activities and allow time for discussion and questions.

Activity 1 — Check Your Water Values

- Ask the students to take a few moments and list ten things that they really value, for example, family, friends, pets, etc.
- Ask them to rate their choices in order of importance. When they have finished, ask: Does water appear on the list? Where? Why did you place it where you did? If not, why not? (Give them an opportunity to write it in if they simply forgot to include it.)
- Discuss: Some people in the world would place water #1 on their list. Can you think of reasons why they would do this?
- Ask: Who would probably place a higher value on water, someone from Saskatchewan or Nova Scotia? From Canada or the Sahara Desert? Why?
- Ask the students to think about the following situations — even if none of these has happened to them personally, they should be able to imagine.
- Have you ever been in a situation where your water supply has been contaminated? dried up? frozen? Have you ever had to carry buckets of water for a long distance? What did you learn from your experience? If this has not happened to you, imagine what it would be like.
- You might point out that in certain parts of the world where water is very scarce, people their age spend a part of their day carrying water from a well to their homes sometimes the distances are quite long and often the water is not clean.
- Summarize by asking them to volunteer endings for the following sentence: "Water is important because . . . . "

Activity 2 — Remembering Water

Here is a chance to get the students thinking about the importance of water in their lives and to have fun testing their memory. Before they begin, remind them that water comes in three main states:

1. liquid (rain)
2. solid (snow, ice, etc.)
3. gas (vapour, steam)

- Ask students to sit in a large circle.
- Write the two following sentences on the board:
  " I like water because . . . ."
  " I use water to . . . ." (One use only.)
- Tell the students they are to choose one of the sentences and when their turn comes in the circle, they will have to complete the sentence.
- But, it's not quite that easy. They have to repeat the sentence completions of those who have gone before them.
- When it becomes too much to remember, start again and add variety by completing other sentences, for example, "Other people use water to . . . ."

Activity 3 — What? Me Without a Dishwasher?

Point out to your students that 100 years ago life was different from today. Most of the conveniences we enjoy and take for granted simply did not exist then.

- Write the following list on the board:

  - hot water supply
  - bathing
  - dishwashing
  - clothes-washing
  - bathroom
  - lawn-watering
  - swimming
  - car-washing

- Ask the students to read the list and think about one sentence they could use to expand on one of the topics. If you need to, guide their thinking with some questions: How do you get hot water? Do you have a dishwasher or do you wash dishes in the sink? Do you swim in a pool or at a nearby lake, river . . . ?

- Get the students thinking about water supply 100 years ago with a few simple anecdotes. For example,

  - if a fire broke out today, a fire truck would likely be at the site in little time. A hundred years ago many fires were put out by a bucket brigade. Describe a bucket brigade to them.

  - Washing clothes was more than simply tossing the duds into the suds. Someone, usually the mother, had to heat the water on the stove, scrub the dirty clothing on a washboard, and hang all pieces out on the clothesline. Then she would have the fun of ironing it. The students might be interested in knowing that today the washboard is used as a musical instrument in some offbeat bands.

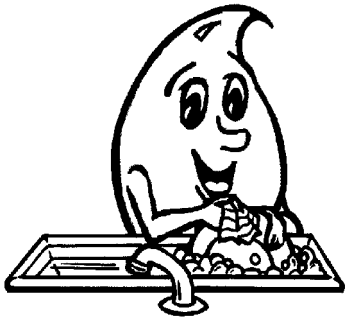
  - People 100 years ago did not have to wash the car — there was probably no car to wash. But, they might have had to scrub down old Dobbin.

  - In many places the lawn-mowing was done by the sheep; and if the grass did not get water, too bad.

  - Most people took a bath once a week - usually on Saturday night in a huge tin bathtub dragged into the middle of the kitchen. Water had to be heated on the stove.

  - No one worried about cleaning the swimming pool. If the weather got too hot there was the local swimming spot.

  - If people were really lucky (and rich), they had one indoor bathroom. Most people, however, had outdoor bathrooms (if you could call them that). No one lingered long in an outhouse, so family squabbles were at a minimum over that issue.



DISCUSSION

The importance of this introductory section is to get the students thinking about water and the part it plays in their lives. Water affects so much of what we do that we tend to take it for granted, and we tend to waste it. We all need to become better environmental citizens, and part of this process is knowing and understanding more about water so that we can take responsible action.

Point out to the students that apart from keeping us clean, we would not get very far without water. Simply put, we could not survive without water. As Canadians we are luckier than many people in other parts of the world in terms of our supply of water, but we are not without concerns. We do have more water than most nations, but it is not available to all of us in the same amounts. These amounts vary from region to region, and they vary by seasonal changes which bring us floods and droughts. Discuss with them the many ways that water is important to us, for example:

- our bodies are two-thirds water
- water helps in producing food and energy
- water is a source of recreation
- water keeps us clean

TOPIC 1. WATER — NATURE'S MAGICIAN

Chapter 1(A): Water — Visible and Invisible

Purpose

To provide information about the properties of water and the importance of water to life, and to focus on water being around for over 4 billion years.

Subject areas

History, Science, Language Arts, Math

Procedure

Note: It is important for students to know about the different properties of water so that they can have a better idea of the forms water takes as it moves around in the hydrologic cycle.

1. Generate a class discussion with the following topics or ideas:

   - Introduce the concept that water is a magical substance by discussing some of the different properties of water. For example, ask students how water is different in winter and in summer (ice, snow, sleet as opposed to warm rains and water for swimming); encourage them to talk about where they see examples of water vapour such as steam rising from boiling kettles or condensation forming on the outsides of glasses containing cold drinks.

2. Depending on the grade level of the students, you might want to introduce more complex concepts, for example:

   - Pure water at sea level boils at 100°C and freezes at 0°C. Point out that if a substance such as salt is dissolved in water, then the freezing point is lowered — that is why we spread salt on streets in winter to prevent ice formation.

   - Water is a good cooling and heating agent. If students live near water they can feel how water absorbs the heat of the day and cools the surrounding air. More mature students could be asked to research land and sea breezes.

3. Demonstrate to students (or assign as an activity to more mature students) that water is really molecules in motion. Introduce the phrase "capillary action" and show how water moves up the stalks of plants by using celery and coloured water. Point out that in the same way, blood, which is mostly water, moves through the smallest blood vessels, called "capillaries."

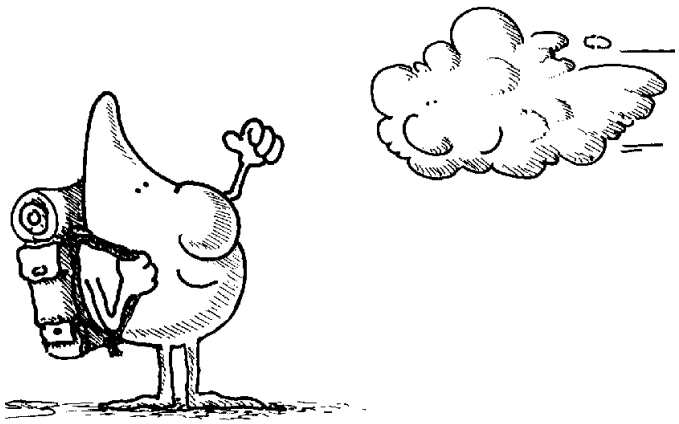
4. Ask how long they think a person can live without water. (About three days.)

Vocabulary

atom	***molecules***	***solvent***
atmosphere	***nutrients***	***vapour***
dissolve	***oxygen***	***vital***
hydrogen	***renewable***	

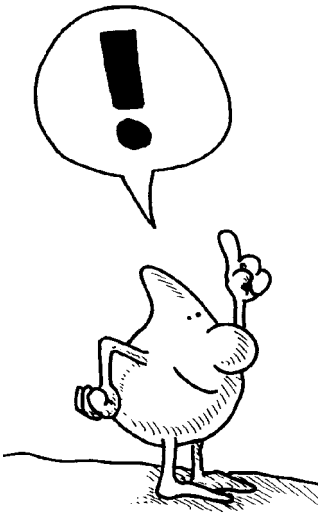
References

- Freshwater Series A-1: "Water — Nature's Magician"
- *A Primer on Fresh Water*: "Water — Forever on the move"



TOPIC 1. WATER — NATURE'S MAGICIAN

Chapter 1(A): Water — Visible and Invisible



Picture this. Friday night has arrived. You're going out for the evening. You dash home after basketball practice, grab the shampoo, leap into the shower, turn on the taps, and nothing happens! One single solitary drip of water clings stubbornly to the shower head. And that's all there is.

Hello? Your father has managed to save a small bucketful of water and you can have your share? Big deal. One litre. How are you going to wash the grease from your hair, sweat from your body, and fuzz from your teeth? Not a pretty picture, is it?

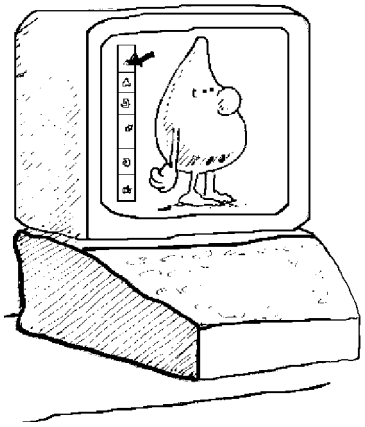
Let's not take water for granted

The title of this material asks us not to take water for granted. Do you? Do you ever think about the importance of water? All the different forms it comes in? All the different ways we use it?

We all know that water is the stuff we let flow down the bathroom drain while we hang around brushing our teeth. But it also comes in the form of ice, snow, vapour, and sleet.

The truth is, most of us don't think too much about water. We just use it, and in some cases we waste it.

Take a minute to think about all the ways you have used water in the past twenty-four hours. After you have made your mental list, ask yourself if there is another substance you can think of which you use the way you use water. What else can you drink, swim in, skate on, make snowballs with, and wash with, among other things?



Water as a solvent

An interesting fact about water is it can **dissolve** so many other substances. You probably dissolve substances in water every day without thinking about it. For example, when you stir sugar into a drink, or salt into your soup, you are using water as a solvent; and at school you use water to mix powdered paints to make different colours for art classes.

Because water is such a good solvent, it can dissolve **nutrients** and transfer them as **vital** food for plants and animals.

But, dissolved substances in water aren't always good. A drop of rain falling through the air dissolves atmospheric gases, and when these fall to the earth they can affect the land, lakes, and rivers. In another chapter we will look more closely at how dissolved acids in rain are transferred through the **atmosphere** and dropped on our lands, lakes, and rivers.

Water Facts

- 50-60% of your body is made of water
- pure water has no taste, no colour, and no smell
- water has a chemical name, H_2O - this means it is made up of **molecules** containing two **atoms** of **hydrogen** and one atom of **oxygen**
- blood is 82% water
- water turns to ice at 0°C and to **vapour** at 100°C
- all living things, from the tiniest insect to the tallest tree, need water to survive
- more than half of the world's animal and plant species live in the water
- water is a good **solvent** - it can dissolve many substances
- most of our food is water, for example:
  - tomatoes (95%)
  - spinach (91%)
  - milk (90%)
  - apples (85%)
  - hot dogs (56%)
  - beef (61%)
  - potatoes (88%)
- Canada has about 7% of the world's **renewable** freshwater supply
- water vapour forms a kind of "global blanket" which helps to keep the earth warm

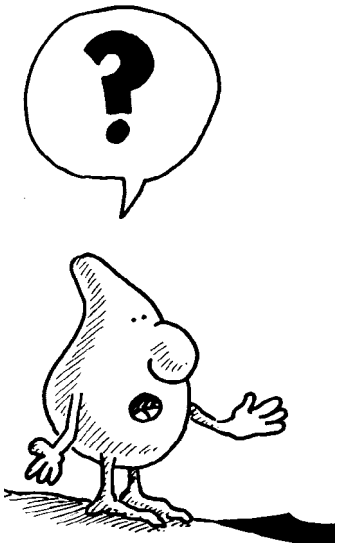
Where did all of our water come from?

That is a difficult question to answer, although scientists say that water has been here since the planet Earth was formed over 4 billion years ago.

The big bang theory about the forming of our planet states that water was created when hot gases from inside the earth erupted through volcanoes and geysers, and then cooled as the earth cooled. The gases then condensed to form a liquid which we call water. The amount of water formed then is the same amount we have today.

Did You Know?

Today 71% of the earth's surface is covered by salty oceans averaging 3.7 km deep. All five oceans are connected. Can you name them?



TOPIC 1. WATER — NATURE'S MAGICIAN

Chapter 1(A): Water — Visible and Invisible

Activity 1 — Math

Look back at your Student Information sheets. Based on the information in "Water Facts," calculate the following:

1. You are making fresh tomato sauce and you have brought in 3 kilograms of tomatoes from the backyard. How much water is in these tomatoes?

2. i) Weigh yourself. How much do you weigh? How much of you is water? If all the water were taken from you, how much would you weigh?

   ii) Combine your weight with the weight of two other friends. How much of all three of you is water? (How much of an ordinary bathtub would this water fill?)

3. In order to get dessert, you have to eat 600 grams of spinach. How much of this is water? Does this make you feel any better about eating spinach?

4. How much water are you getting in a beef steak which weighs 500 grams?

5. Make up two questions for a friend based on "Water Facts."

Activity 2 — History, Language Arts

Use a time line to show how long water molecules have been around and what important happenings they might have witnessed. (In the interest of saving paper and trees, limit the important events to the past 2000 years.)

OR

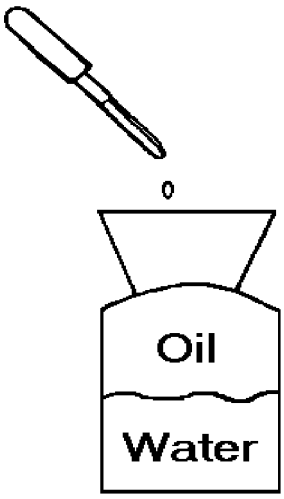
Use a water molecule to tell a story or relate a historical fact about your favourite period in history. If you could go back in time, what time would you go back to?

- when knights were around
- when dinosaurs roamed the earth
- when explorers came to Canada
- when your grandparents were children

Choose any time that interests you.

Remember, as a water molecule you can go anywhere — in the air, in water, underground, in any city or country in the world — and you can give a water-bird's eye-view of what really happened. So, make sure you point out how you (a young water molecule) were used back then.

Activity 3 — Science



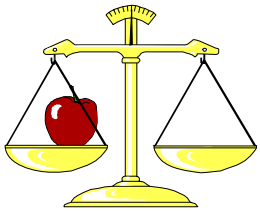
Water is the world's greatest solvent. Demonstrate to your class how water dissolves substances that other liquids will not.

- Take a small glass jar and fill it half with cooking oil and half with water. Add one drop of food colouring. Describe what happens.
- Water dissolves many substances. This can be good for us and it can be bad for us. Explain.

Activity 4 — Math and Science

Discover for yourself how much water is in an apple (or any fruit/vegetable).

If your teacher or librarian can help you with instructions, use this exercise to make the head of an apple doll.



- Peel an apple. Weigh it. For this you will need a set of scales or weights. Record the weight of the apple.
- Put the apple in a dry place for twelve or fourteen days and wait. Keep an eye on it and you will see it begin to shrivel up.
- At the end of this time, weigh the apple again. What is the difference in weight? What percentage of its weight has disappeared? Where did it go?
- Did your experiment with the apple support the information about most of our food being water?
- Try the same experiment with another fruit or vegetable, for example, a zucchini. Compare the percentage of weight lost with the apple's loss.
- What is the main conclusion you would draw from this experiment? Write your conclusion down.

Do a reverse of this experiment:

- Take some fruits or vegetables that have already been dried, for example, apricots, prunes, apples, or raisins.
- Weigh them and record the weights. Soak them in water.
- Note the changes. What happens? How long does this take? What is the difference in weight?
- Research: Why are some fruits dried? Who uses them this way? What other foods are dried?

Activity 5 — Science

Find out how much water is in a citrus fruit like an orange, lemon, or lime, and make a "pomander" as well.

Note: A pomander is a ball of mixed fragrant substances sometimes used in a closet or cupboard.

- Weigh the citrus fruit.
- Take a ribbon and tie it around the fruit. (You can hang the pomander from this later.)
- Press cloves into the skin of the fruit about one clove head apart.
- When the fruit is covered with cloves, wrap it in tissue paper and put it aside for five or six weeks.
- At the end of this time, take the fruit out and weigh it. Record the weight and compare it with the original weight. How much weight has been lost? What percentage of the original weight is this?
- Now that your experiment is finished, you have a gift for your mother or father to hang up in a closet or cupboard.

Activity 6 — Research, Science

Check your home or your school. Does either place have a humidifier or a dehumidifier? If not, do research in your library to find out about these appliances. Prepare answers to the following:

- What is the purpose of each?
- Are there times of the year when the amount of water is more? Less? Why do you think this is so?
- Explain in detail how either works. Prepare an illustration to present your information clearly.
- Try to conduct a "hands-on" experiment to find out how much water passes through either appliance in a day or a week.

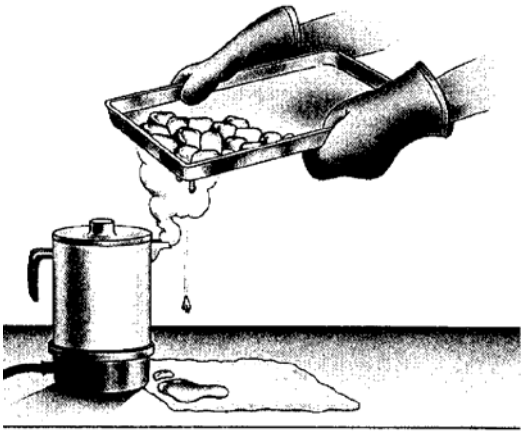
Activity 7 — Science

This is your chance to show that different temperatures allow water to exist as a solid (ice), a liquid, and a gas (or vapour).

Ask your teacher for help (or if you are working at home, ask your parents).

You will need:

- an electric kettle
- water
- a cookie sheet (with sides)
- ice cubes
- kitchen mitts



What to do:

- boil water in an electric kettle
- using kitchen mitts, hold the cookie sheet full of ice cubes over the steam from the spout

What did you see? Answer the following questions:

- What happened to the water which boiled? (This is called evaporation. How would you describe evaporation?)
- What happened to the ice?
- What happened to the outside of the pan which contained the ice? (This is called condensation. How would you describe condensation?)
- Would the same process have occurred if the water had not been heated?
- What would happen if you placed the pan of water in the freezer?

Write a conclusion explaining how different temperatures affect the different forms of water.

TOPIC 1. WATER — NATURE'S MAGICIAN

Chapter 1(B): The Hydrologic Cycle

Purpose

To review the hydrologic cycle and emphasize the endless and continuing motion of water molecules.

Subject areas

Language Arts, Environmental Studies, Social Studies, Math, Art, Science

Procedure

1. Using the diagram on the Student Information sheet, review the concept of the water cycle. If this is new to students, discuss tricycles, bicycles, seasonal cycles, or their school time table cycle.

    - Go over the vocabulary of the hydrologic cycle.

    - Review with students that the three **primary** kinds of water include atmospheric water or vapour, surface water, and groundwater. Ask them if they can name some of each, for example:

        atmospheric — vapour, snow, rain, hail
        surface — oceans, icecaps, wetlands
        groundwater — aquifers, artesian wells

        Each kind of water is part of the hydrologic cycle.

    - Ask if there is more water around today than there was 100 years ago.

        Point out that the water here today is the same water that their great grandfathers used 100 years ago; and the same water has been here for approximately 4 billion years since the earth was formed. This water keeps going around and around in one of nature's cycles.

2. Use a world map to point out to students where British Columbia, Brazil, and Bangladesh are located. Emphasize that the same water we use has travelled to a lot of places — a Canadian living in any province or territory has likely been rained on by water drops that fell on other countries.

Vocabulary

condensation	***groundwater***	***prehistoric***
disperse	***hydrologic cycle***	***recycling***
evaporation	***percolate***	***saturated***
evapotranspiration	***precipitation***	***transpiration***

References

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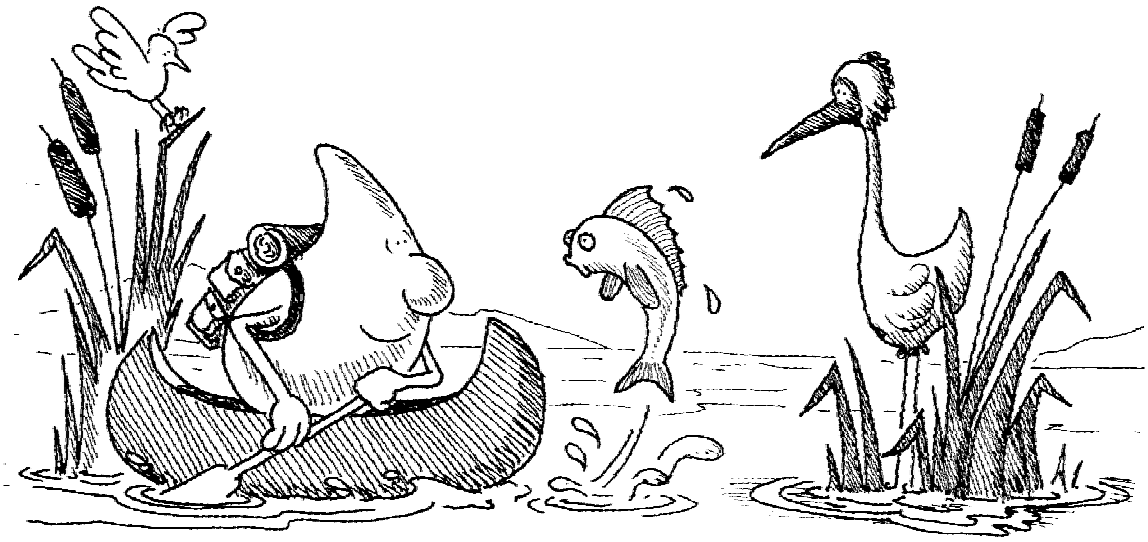
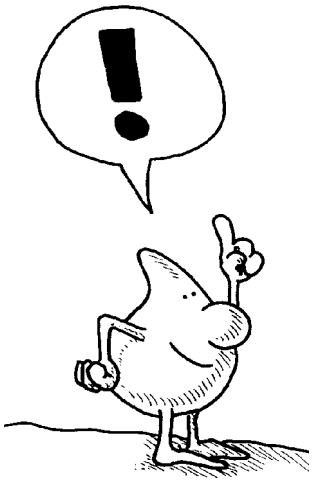




TOPIC 1. WATER — NATURE'S MAGICIAN

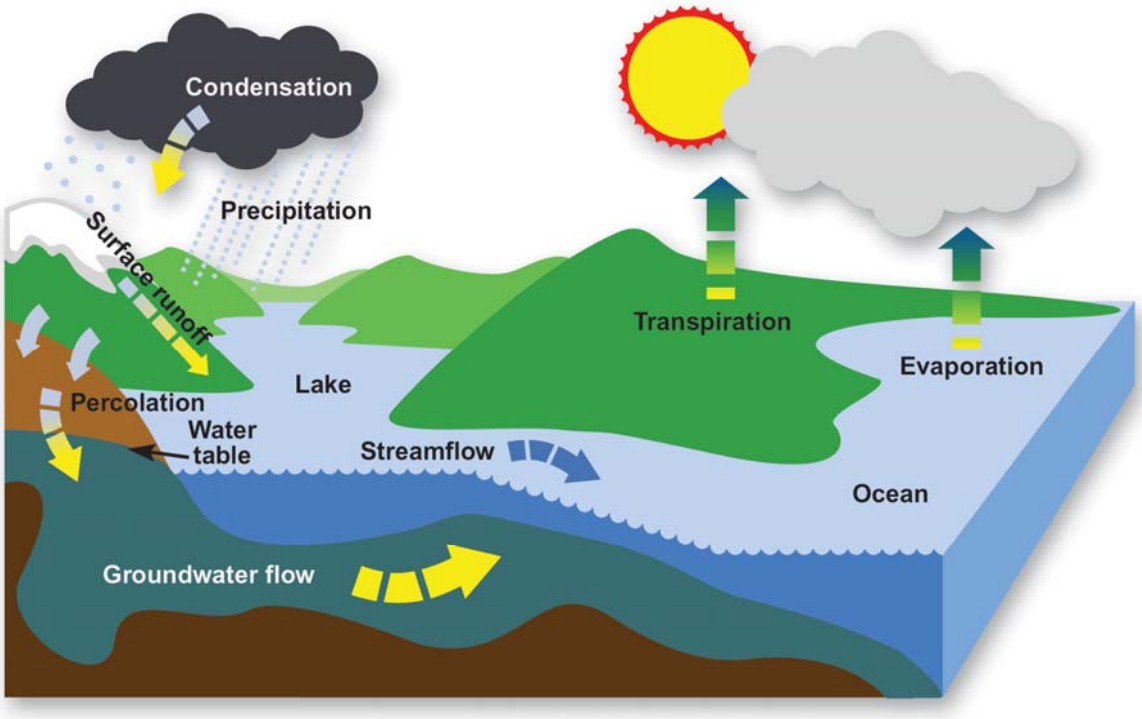
Chapter 1(B): The Hydrologic Cycle

It's Monday morning. Very early. And you hear your Social Studies teacher say something to the class about looking at the **hydrologic cycle**.

You're probably not quite ready for something too new right now. But relax. It's the water cycle being recycled with a new name, the hydrologic cycle. The question is, how much do you know or remember about the water/hydrologic cycle?

Let's refresh our memories with the following diagram.

The hydrologic cycle



How the hydrologic cycle works

If you observed or performed Activity 7 the last chapter, you saw how heat changed water from liquid to steam, and from solid to liquid. In the same way, water molecules in the atmosphere need the sun's power or energy to keep moving and changing. After all, if there were no heat from the sun, the water would be frozen and we would not be here reading about it.

Water molecules group together to form clouds (this is called **condensation**), and these clouds are moved about the earth by air currents. As these clouds become **saturated**, or full of water, **precipitation** occurs and the water droplets fall to earth.

When water reaches the earth, the drops **disperse**. Some run off as surface water and others **percolate** through the ground to become part of the **groundwater** supply.

Once again, the sun's energy works on from the surface water changing the water to vapour, a process called **evaporation.** This vapour rises into the atmosphere to form new clouds and continue the hydrologic cycle. Water also enters the atmosphere from the leaves of trees — this is called **transpiration**.

And round and round the water goes, showing why this process is called a cycle.

How old is water?

A very interesting fact about water is that it doesn't go away. The same water molecules running down your drain or resting in your water glass might be the very ones that your great, great, great grandfather used to water his crops many years ago. Or, some **prehistoric** animal may have drunk the very same molecules that you are preparing to drink right now.

Think about it. Use your imagination to consider the stories one drop of water could tell if it could talk. It's difficult to believe that we are still **recycling** the same water that a young dinosaur might have frolicked in millions of years ago.

Did You Know?

The water cycle maintains a very delicate balance on a global scale. For every drop of precipitation which falls, an equal amount must disappear into the atmosphere through evaporation or transpiration. When this balance is disturbed, water can become unfriendly and we may get floods or droughts.

The well-travelled water molecules

Because of wind currents and climate changes, water molecules get to visit all parts of the earth. Parts of the same rain which fell on you yesterday in Canada, may fall on the Brazilian and British Columbian rainforests next month, or they may seep into the ground through percolation and spend the next three years finding their way to the ocean or ending up in somebody's well.

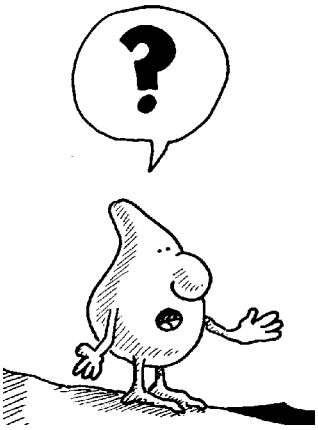
Some water molecules might spend the next 10 000 years in the underground water supply or frozen in a northern glacier!

Just think about your glass of water again. These water molecules might have been part of floods that rushed from the Himalaya Mountains and down the Ganges River to Bangladesh causing people to lose their homes, their crops and livestock, and sometimes their lives. Or, the water molecules may have just come back to the surface water supply after having spent a thousand years frozen in the Arctic ice.

We may not be exactly sure of where and when water first appeared, but we do know two facts:

1. water has been in motion constantly since it came; and

2. practically the same amount of water that was here at the beginning is still with us today — being recycled time and time again through the hydrologic cycle.

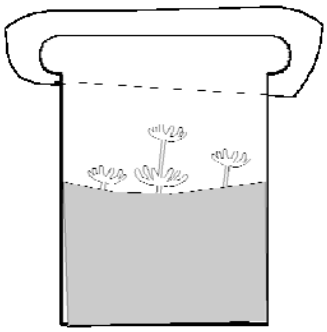


TOPIC 1. WATER — NATURE'S MAGICIAN

Chapter 1(B): The Hydrologic Cycle

Activity 1 — Science, Environmental Studies

You can show how a hydrologic cycle works with a simple demonstration in your classroom or at home. Try one of the following experiments:



1. Set up a terrarium.
   - Put soil in the bottom of a large glass jar and plant a few small plants.
   - Water the plants and cover the mouth of the jar or terrarium with plastic wrap.
   - Watch your terrarium for a couple of weeks.
   - Write down what you observe. How do you think this relates to life on the planet Earth?
2. Show how plants use and transpire water within the hydrologic cycle.
   - Take a potted plant and put a plastic bag over it. Use tape to keep the bag in place and use sticks to keep the bag from touching the leaves.
   - Set the plant in a sunny window.
   - Record what happens.
   - What conclusion would you make from this experiment?

3. Make a very simple model of the water cycle.

   You will need:

   - a small glass jar — a baby food jar will do
   - a small rock to fit in the bottom of the jar
   - water that has been coloured with food colouring
   - plastic wrap or lid to seal the jar

   What to do:

   - Place the rock in the jar and partially cover it with the coloured water. (Make sure you mark the level of the water on the outside of the jar.)
   - Seal the jar, then place it in the sun.
   - Come back to the jar after it has been sitting in the sun for a day. Record your observations.
   - Move the jar back into the shade. What happens?
   - What conclusion would you make from this experiment? Write your conclusion down.

Activity 2 — Social Studies, Language Arts

You probably wouldn't mind being able to travel to some of the exotic places that the water molecules travel to, but you wouldn't be so crazy about some of their other travels.

Take one of the following story topics and develop a story about a water molecule in motion. Give your water molecule a catchy name.

1. You are a water molecule who lives in the north and you are really keen to catch a ride to the sunny south. It takes you a whole year to get there and it is a lot of hard work. Describe what happens to you during the year.

2. A dirt cycle? You are a speck of dust lying in the yard minding your own business when the wind disturbs you and lifts you into the air, taking you higher and higher.

   You bump into a cloud where you meet millions of other specks, just like you, and you kind of enjoy this life on cloud nine, drifting around in the blue before you find yourself being covered by moisture.

   Something drastic happens to disturb your peaceful life. What is it? Tell about your awful experiences.

3. Back in the 1890s you were frozen into a glacier and you have just now been released back into the atmosphere. You don't understand what has happened to the earth in the past 100 years. Everything has changed. You try to find out from others; and you try to tell them what happened to you. Some molecules are helpful, others are not. Write about one of your conversations or write a play.

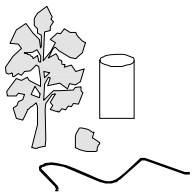
Activity 3 — Art

Now that you know how the hydrologic cycle works, why not prepare your own colourful diagram showing in detail how it works. If you are feeling really creative, give your diagram some texture with cotton wool for clouds and other fabrics or materials for sand, grass, trees, and water.

Activity 4 — Science, Math

As you saw in the diagram of the hydrologic cycle, trees send moisture back into the air through transpiration. How can you measure approximately the amount of water one tree sends back? First of all, you have to start small — begin your measurement with one single leaf over twenty-four hours and calculate the rest.

You will need:



- a plastic sandwich bag
- a small pebble
- some string
- a set of scales
- and, last but not least, a tree with a broad leaf such as a maple or oak

What to do:

- Place the pebble in the bag.
- Weigh the bag, pebble, and string carefully. Record the weight.
- Tie the bag (with the pebble in it) around a leaf on a tree. Be careful not to disturb or damage the branch.
- After twenty-four hours, carefully weigh it again.
- How many milligrams of water do you have in your bag?
- Make up five math questions you could ask another person based upon what you have just learned about one leaf. For example:
  - If a tree has 10 000 leaves, how much moisture will it transpire in a day? In a month? In a year?
  - If you had 20 trees in your backyard, how much moisture would they transpire?
  - How would you go about calculating the number of leaves on one tree? You really don't want to count them all, do you?

Activity 5 — Language Arts

Create your own word search.

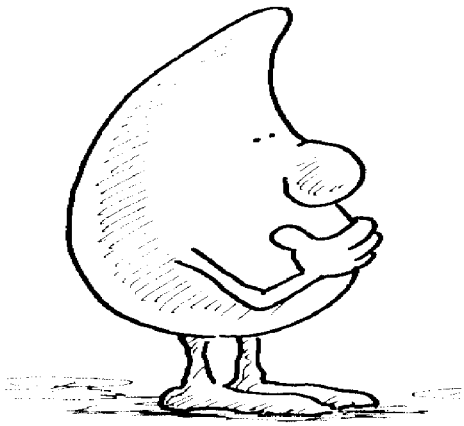
This chapter uses vocabulary that you may not be familiar with.

- Read back over the information and select words to make your own word search. (You must know the meaning and spelling of every word you include!)
- Ask your teacher for graph paper to keep your lines straight.
- Remember, the words can go in any direction — forwards, backwards, up, down, and diagonally. You can also use other water words to fill in smaller spaces.
- Whichever words you use should be included in a list underneath your puzzle.

Activity 6 — Language Arts

Another word sometimes used to mean transpiration is the long word, **evapotranspiration**. As you can see, it is a combination of evaporation and transpiration. Try one or both of the following exercises:

1. How many four-letter words can you from evapotranspiration? List them. Remember, you are not to use a letter more times it appears in evapotranspiration, for example, you cannot use "tattle" because there are only two "t"s in evapotranspiration.
2. Make a list of the three- and four- get letter words you get from evapotranspiration that relate to allowed environmental issues. (Make a side than bet with your neighbour.)



Activity 7 — Art, Storytelling

You may be surprised to learn that raindrops are not tear-shaped. Rather they are shaped like small hamburger buns. Combine your artistic and storytelling skills and create your own comic strip character on a journey through the hydrologic cycle.

TOPIC 2. WATER — HERE, THERE AND EVERYWHERE

Chapter 2

Purpose

To gain an appreciation of the quantity of water Canada has in its different regions and in relation to other countries of the world.

Subject areas

Math, History, Environmental Studies, Language Arts

Procedure

1. Ask students to look at the diagram "World's water system" in their information sheets to get an idea of how much of the world's water supply is available to us.

2. Try the following demonstration to show students how water is distributed throughout the hydrologic cycle and how much fresh water is available to us:

    - Fill a 75-litre garbage can with water. This represents the world's water supply.
    - Take out 1.65 litres in another container — this represents water frozen in glaciers and polar ice caps.
    - Take out 480 millilitres — this represents the world's underground water supply.
    - Take out 13 millilitres — this represents all the lakes and rivers in the world.
    - Take out 15 drops — this represents the water in the atmosphere.
    - The water left in the garbage can represents the world's water supply in the oceans.

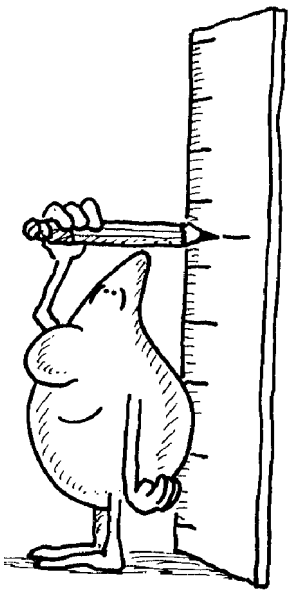
Point out to the students that we have a lot of water in the world, but only a small amount is available as fresh water in lakes, rivers, and groundwater supplies.

3. After they have read the Student Information sheets, ask the students to study the map and note how many of our rivers flow to the north. Point out to them that the majority of the Canadian people live in Canada's south.

4. The learning activities contain examples of math problems and exercises developed from information in the charts and diagrams on lakes and rivers. As an alternative, have students work in teams and use the information provided to develop problems for the other teams.

Option: Tell the students you will select problems for the next math quiz from the problems they develop. Set a time limit or a limit on the number of problems. Encourage students to be creative, but not to make the problems impossible for the other teams.

5. Ask the students to think about different ways officials measure or find out the amount of water in any water body.

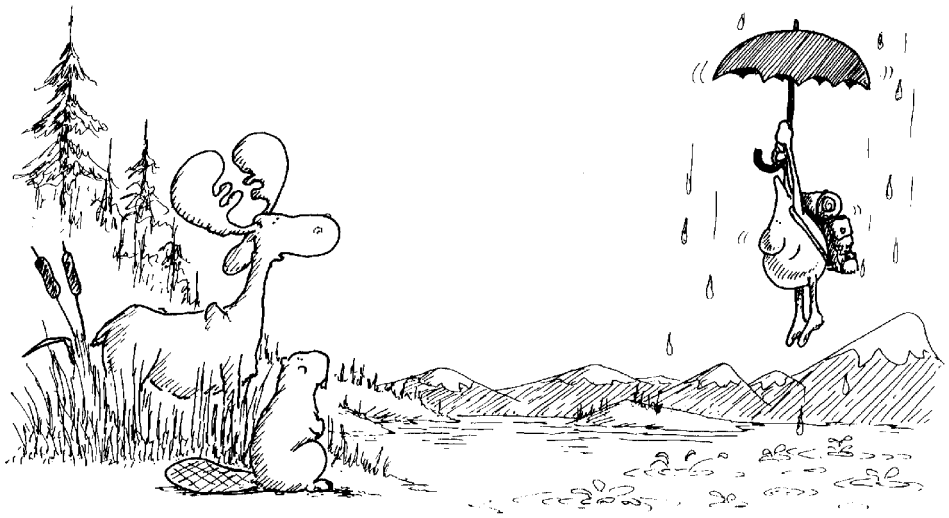


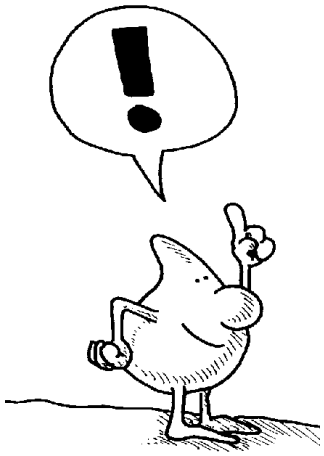
Vocabulary

basin	***desertification***

References

- Freshwater Series A-2: "Water — Here, There and Everywhere"
- *A Primer on Fresh Water*: "Water — In Canada"



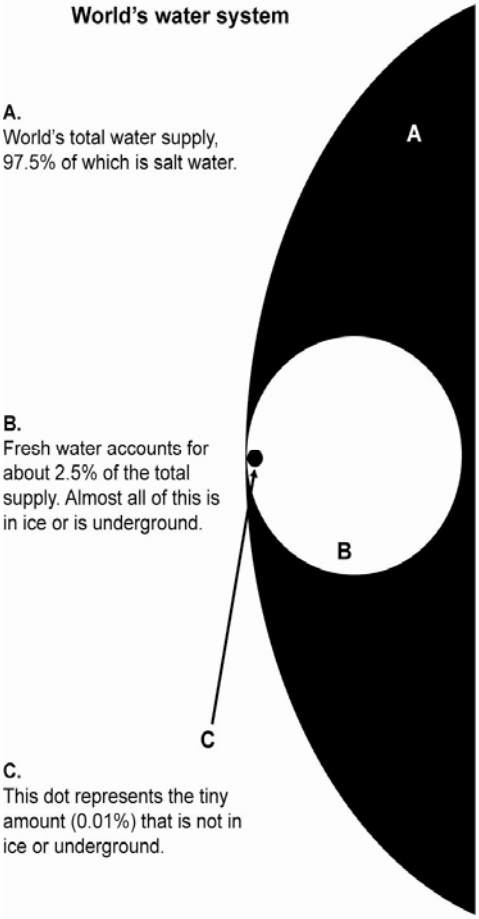


TOPIC 2. WATER — HERE, THERE AND EVERYWHERE

Chapter 2

Are you a daydreamer? Do you ever sit in class and let your mind wander, even when you know you should be paying attention? Well, let it wander for awhile just now. Take a look at the globe or the big world map on the wall and imagine that you are looking at the earth from an astronaut's point of view. What colours do you see? You probably see more blue than any other colour.

You could be forgiven for thinking, "So, what's this fuss about water? Looks like a lot of water to me." And, you are right, there is plenty of water. So, what is the problem?



The problem is, we don't get to use most of that water. At present, only 0.01% of all that water can be used by us. The rest is salt water in our oceans or glacial ice (that is ice which has been frozen in glaciers for centuries). To get a good idea of how much 0.01% represents look at the diagram, "World's water system." Not too much is it?

Another problem with the world's water supply is that the water that is available is not always where we would like it to be. If you need examples of this fact, just listen to the news stories of the day:

- Water shortages in Saskatchewan, Alberta, and Manitoba
- Hot, dry summer in California
- Flooding along the Saint John
- River in New Brunswick
- Drought in Somalia and Ethiopia
- Cold, wet summer in Newfoundland
- Flooding in Bangladesh
- **Desertification** in African countries

Just how much water does Canada have?

If you live in parts of Saskatchewan, you feel there is enough water; if you Vancouver or Newfoundland, you're quite sure there is plenty. The amount of water you have depends on where you live in Canada.

When we consider how much fresh water belongs to Canada, we also have to keep in mind that Canada shares fresh water with another country. Look at the won't map and you can see how we share the live in Great Lakes and the St. Lawrence River with the United States. An interesting fact is that the Great Lakes and St. Lawrence River **basin** contain almost one- fifth of the world's fresh surface water. So what we have is two large nations sharing control over 20% of the world's freshwater supply.

World's largest lakes

The following chart lists the largest lakes in the world. From this information you can easily see much of the fresh water Canada has access to — and this chart does not include the fresh water found in the rivers.

Rank (by area)	Name	Area (km^2)	Maximum depth (m)
1	Caspian Sea	374 000 – 436 000	946 – 1 025
2	Superior*	82 100 – 83 300	307 – 406
3	Victoria	62 940 – 69 900	80 – 92
4	Huron*	59 500 – 59 800	223 – 229
5	Michigan	57 016 – 58 100	265 – 285
6	Tanganyika	32 000 – 34 000	1 435 – 1 470
7	Baikal	31 500	1 620 – 1 741
8	Great Bear*	30 200 – 31 792	137 – 445
9	Great Slave*	27 000 – 28 570	156 – 614
10	Erie*	25 657 – 25 720	64
11	Winnipeg*	24 387 – 24 600	19 – 28
13	Ontario*	18 760 – 19 480	225 - 273
22	Athabasca*	7 935 – 8 080	60 –124
29	Winnipegosis*	5 370 – 5 470	12

*Partly or entirely within Canada

Sources: Adapted from Peter H. Gleick. *Water in Crisis*. New York: Oxford University Press, 1993.

Here are a few other facts about Canada's water supply:

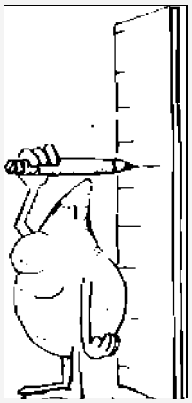
- Canada has about 7% of the world's renewable freshwater supply. (So does China, but more people live in China.)
- Over half of Canada's fresh water drains north, while 85% of Canadians live within 300 kilometres of the U.S. border.
- Canada probably has more lake area than any other country in the world.
- Canada's glaciers contain more water than the Great Lakes.
- The Mackenzie River, over 4000 kilometres long, is Canada's longest river.
- Canada's rivers and lakes contain enough water to flood the country to a depth of more than 2 metres.

How Do You Measure Water Anyway?

How do we know how much water is in any body of water? After all, it's not as if you could measure it with a measuring cup.

Even as you sit at your desk reading this, people who work for environmental departments are measuring the levels and flow of water in hundreds of identified rivers and lakes across the country.

They approach this task in various ways:



- from a bridge
- by wading in a stream
- by boat
- by cable strung across a river
- through the ice in winter

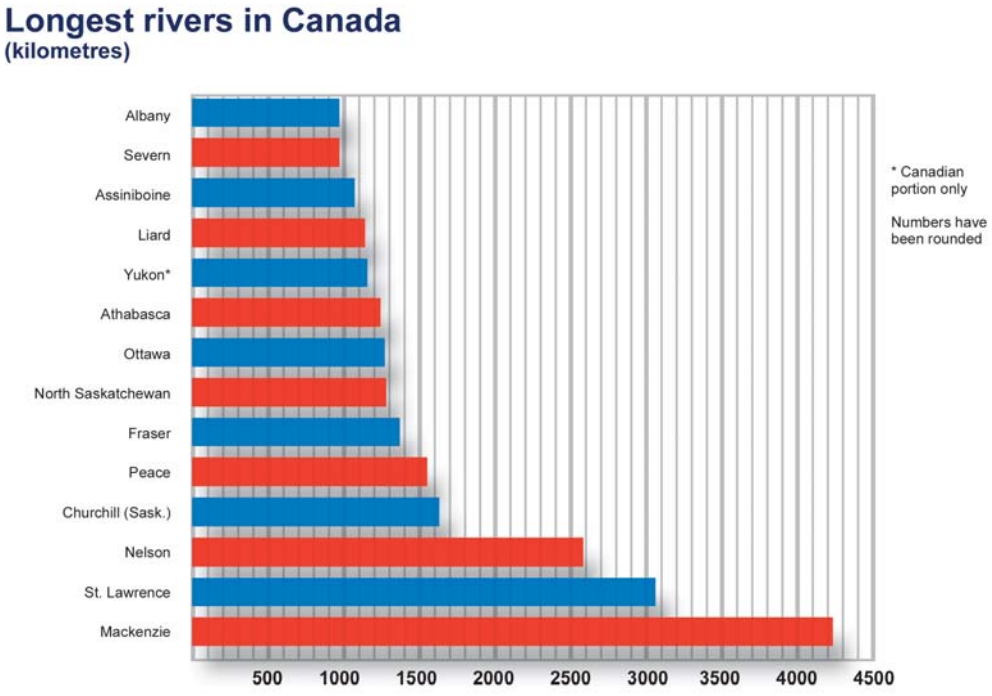
Although some rivers (perhaps including yours) may not be measured, these people can estimate the streamflow based on information they get from the many locations they do measure.

TOPIC 2. WATER — HERE, THERE AND EVERYWHERE

Chapter 2

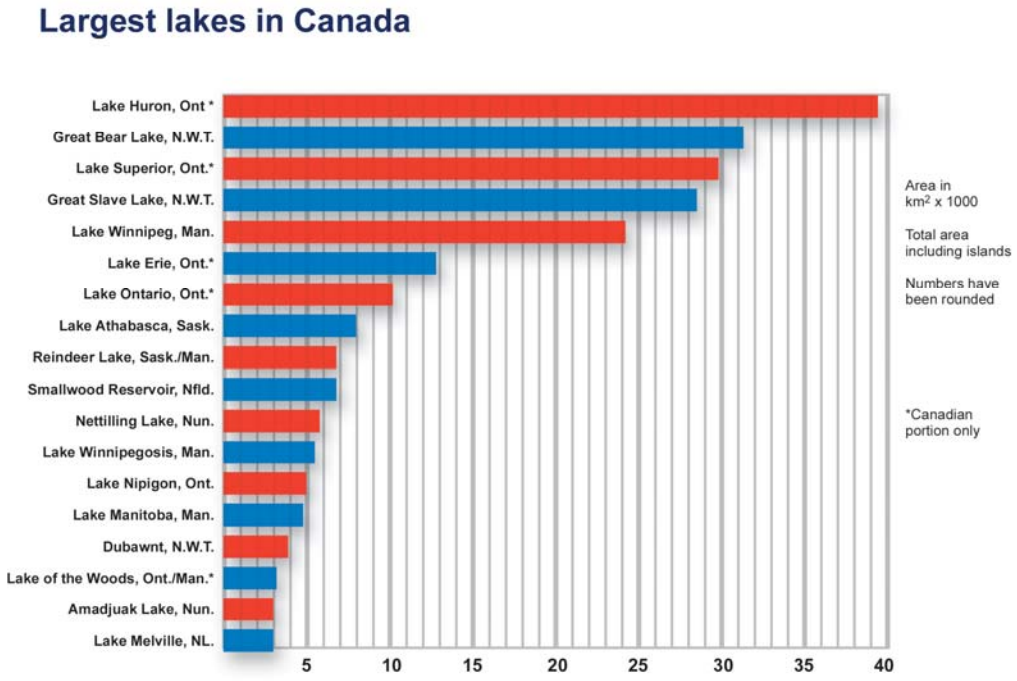
Activity 1 — Math, Interpreting Charts

1. Study the chart, "Longest rivers in Canada." Estimate the approximate lengths of each of the rivers. Compare lengths.



- How much longer is the Mackenzie than the Albany?
- Is the total length of the North Saskatchewan, the Churchill, and the Yukon longer than the Mackenzie? What is the difference?
- What is the total length of all the rivers?
- Why does the Yukon have an asterisk (*) by it?
- How much longer is the St. Lawrence than the Fraser?

2. Look at the chart "Largest lakes in Canada." Make up five problems similar to those about the longest rivers. Give these questions to a partner.



3. Make up another type of chart for one of the above graphs to show the same information.

Activity 2 — Math Problem Solving

Use the following math problems as examples and develop problems of your own from the graphs provided in Activity 1.

- The St. Lawrence River is approximately 3100 km in length. If you had a boat that travelled16 km an hour, how long would it take you to travel the length of the St. Lawrence River?
- Suppose you decided to walk the length of the river and you average 6 km an hour walking for 7 hours per day. How many days would this take you?
- If your walking trip began June 15, on what date would you finish?
- Suppose you could drive the whole length of the river by car. Estimate the time it would take if you averaged 100 km/hour.
- The Mackenzie River is approximately 4200 km long. How long would it take you to travel the river by boat? Car? On foot?
- Your problems . . . .

Activity 3 — Environmental Studies

The chart below shows typical river flows in all areas of Canada.

- Check the river(s) in your province or territory. What is the difference between the highest flow and the lowest? Find out when the highest flow usually occurs; the lowest. Why?
- Select one river from each of the other provinces/territories in Canada and find the differences between highest and lowest flows for each. Which river has the greatest difference between high and low flows?
- Make up two questions to ask a friend.

Typical river flows

(from lowest to highest daily average, m^3/s)

Location	River	Annual average	Daily average	
			Highest	Lowest
Prince Edward Island	Dunk River at Wall Road	2.55	84.7	0.212
Saskatchewan	Qu'Appelle River near Lumsden	5.44	436	0
New Brunswick	Lepreau River at Lepreau	7.37	340	0.028
Manitoba	Manigotagan River near Manigotagan	8.93	103	0.065
Ontario	Rideau River at Ottawa	37.2	583	1.48
Newfoundland	Gander River at Big Chute	119	1 170	2.78
Alberta	Athabaska River at Hinton	175	1 200	10.8
Yukon	Yukon River at Whitehorse	243	646	32.6
Saskatchewan	South Saskatchewan River at Saskatoon	254	3 940	14.2
Quebec	Rivière aux Outardes à la Centrale de Chute-aux-Outardes	387	2 830	10.5
New Brunswick	Saint John River below Mactaquac	809	11 100	21.5
Ontario	Ottawa River at Britannia	1 180	5 060	245
Newfoundland	Churchill River above Upper Muskrat Falls	1 740	6 820	253
British Columbia	Fraser River at Hope	2 720	15 200	340
Ontario	Niagara River at Queenston	5 880	9 760	2 440
Ontario	St. Lawrence River at Cornwall	7 350	10 700	4 500
Northwest Territories	Mackenzie River at Norman Wells	8 480	33 300	1 680

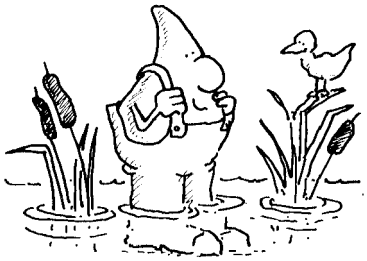
Source: Water Survey of Canada, 1999

Activity 4 — Math

Estimation

Environment officials do not go and stand in the middle of every stream and pond in Canada. But they can estimate the stream flow based on information they keep from the hundreds of sources they do measure.

- Sometimes we need to measure something accurately, other times we can estimate. What are some of the things you have estimated? For example:
  - how long it will take you to get somewhere
  - how many jelly beans are in a jar
  - how much time it will take you to finish this assignment
  - how many balls you can sink in twenty-five throws at the basket
  - how long it will be before a parent tells you to turn down the music or get off the phone



- Brainstorm: Why do we estimate? Talk about some situations where we ask others to give us an estimate. How does that help us?
- Officials often have to estimate how much of the budget they should set aside for snow removal, for pollution cleanup, for repairs, etc. What do they base the estimates on? Why can they not say exactly how much money to budget?
- Are any of the bills which come into your house estimated bills?
- Estimate is often called a "guesstimate" by some people. That's how lottery numbers are picked out, or long-range weather predictions are made. When have you guesstimated about something?
- What do you think are some of the reasons why Environment Canada estimates water levels and rate of flow instead of measuring exactly?
- Research: Find out more about one of the methods used to measure the amount and flow of water.

Activity 5 — Language Arts

Poets have a way of using words to create pictures or sounds for the readers of poetry. Two of these poetic devices are described below.

Read through these and write a poem (or descriptive paragraph) of your own to talk about water.

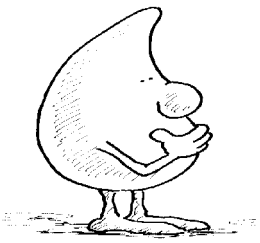
Alliteration — a number of words begin with the same letter, for example, "the rising river roared and rumbled."

- Try to make a tongue twister such as "Sally selling seashells by the seashore."

Onomatopoeia — words make the actual sound of what they are describing, for example, buzz, drone, slurp. Or, in the case of water, "the slow slapping and lapping of waves on the rocks."

- How many sounds can you make that make the sound of water? For example, the sound of water on a tin roof; long slow tides on a beach; the sound of walking through swamps in rubber boots.

Brainstorm with your class and make a list of "water sounds." Use these to help with your descriptive writing. Or, get silly. Make up your own words for water sounds and make a riddle: What colour is a raindrop? Plink!

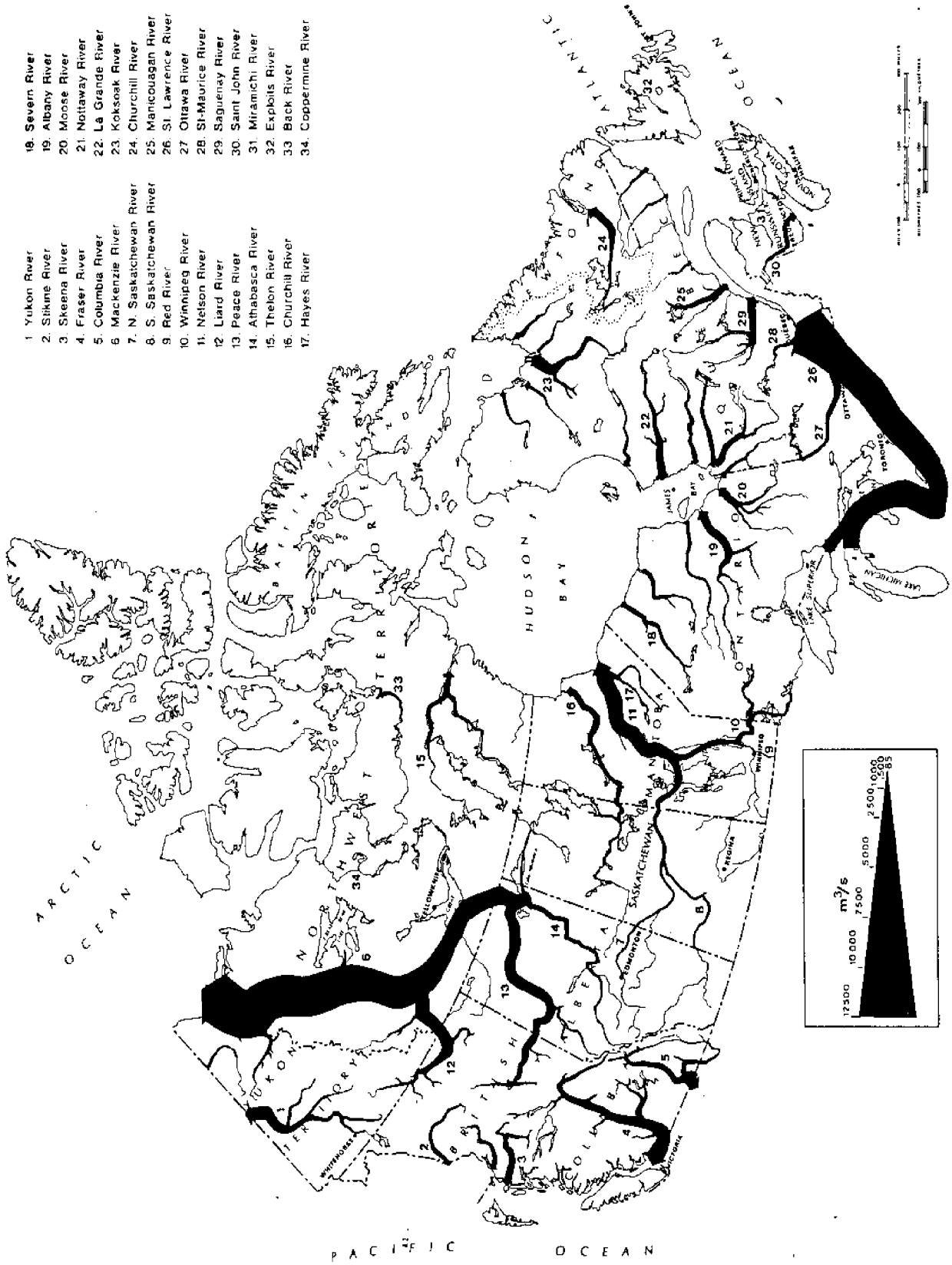


Activity 6 — History and Map Study

When the early explorers first came to Canada, they came to the east coast and gradually moved inland, mostly in search of furs. As you know, there were no roads or cars then, so they had to move by water whenever they could, using the vast network of lakes and rivers.

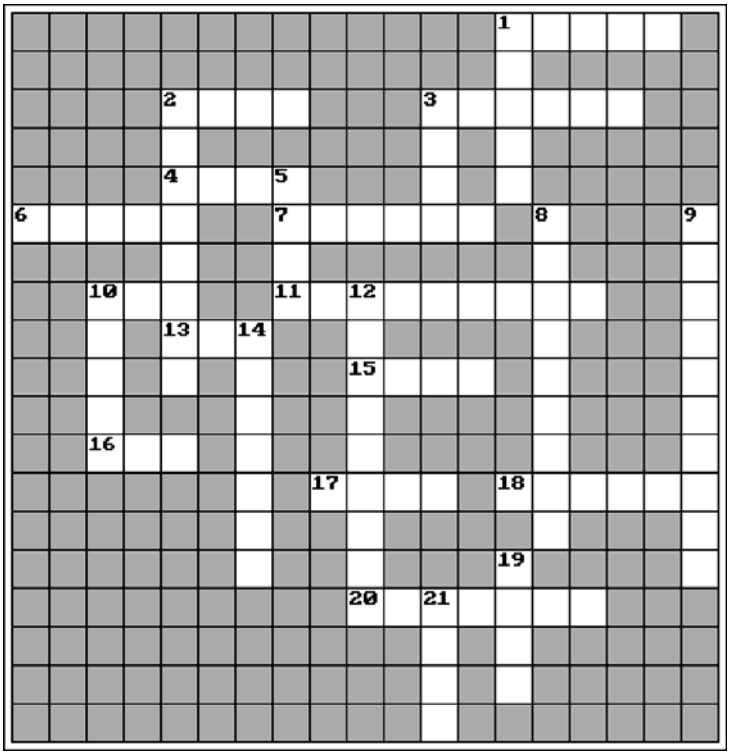
Study the map on the next page closely. Trace the route one of these explorers could have taken to get from Halifax to Vancouver 400 years ago.

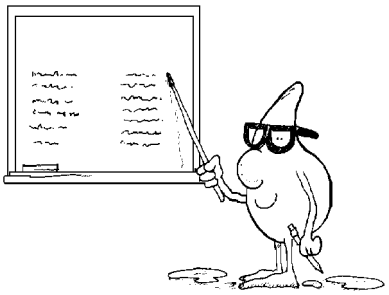
Research: Find three rivers which were named after early explorers. Give a brief biography of one of these explorers.



Annual Large River Flow In Canada

TEST 1
Crossword Puzzle





Across

1. Water turns to ___ at 100°C.
2. People like to camp and _____.
3. When we don't get _____ water, we experience droughts.
4. You should not allow the tap to ____ — it wastes water.
6. Without this, a person would die in about three days.
7. H_2O means that water contains one atom of ___ and two atoms of (2 down).
10. According to the ____ bang theory, water has been on earth over four billion years.
11. Water can be used over and over. It is a _____ resource.
13. Cook an _____ in water for breakfast.
15. We should _____ our water supply to find out if it is safe to drink.
16. The antonym of wet is _____.
17. You can catch fish using a rod and _____.
18. Clean water should be the concern of all _____.
20. Water can dissolve many substances. It is a good _____.

Down

1. If we pollute water, we _____ it for our use. (Rhymes with oil.)
2. H_2O means that water contains one atom of (7 across) and two atoms of _____.
3. One of the Great Lakes is Lake _____.
5. We should not _____ hazardous household products down the drain.
8. All _____ of water contain hydrogen and oxygen.
9. The blanket of air around the earth is called the _____.
10. This is 82% water.
12. Water can dissolve _____ as food for plants and animals.
14. Let's not take water for _____.
19. ____ from the sun makes our lakes warm for swimming.
21. Repair a _____ promptly — don't waste water.

Fill in Blanks

1. _____% of the blood in your body is water.
2. The scientific symbol for water is _____.
3. Water has been around since the earth was formed over _____billion years ago.
4. Another name for the water cycle is the _____cycle.
5. Water vapour enters the atmosphere by _____from bodies of water and by _____from plants.
6. Clouds are formed when water droplets come together as _____.
7. Rain, snow, hail, and sleet are all forms of _____.
8. _____% of the world's total water supply is fresh water.

True or False

T F 1. Water is two parts oxygen and one part hydrogen.

T F 2. More than one-half of the world's animal and plant species live in water.

T F 3. Without water, every single living thing on earth could not survive.

T F 4. There is less water on earth today than when the earth was formed.

T F 5. Canada's largest river is the St. Lawrence.

T F 6. Canada has approximately 7% of the world's freshwater supply.

T F 7. Most of Canada's rivers drain north.

T F 8. Water makes up 95% of your body.

T F 9. Water turns to ice at 100°C.

T F 10. Canada's glaciers contain more water than do the Great Lakes.

Water Puzzle

Find the water-related words in this puzzle. Learn how to spell all the words and look up the definition for each.

air	groundwater	rain	transpiration
basin	hydrologic	recycle	use
condensation	ice	river	vapour
disperse	percolate	saturate	vital
dry	pour	snow	
evaporation	precipitation	tap	

M O T A N R T C P O U R

V I T Y O V C O U N S I

N N R V I I I N D O E A

I D U A T T G D E I E G

A O O P A A O E S T T R

R V P H T L L N E A A O

S B A S I N O S R R L U

A E V A P O R A T I O N

T S P T I E D T I P C D

U N A U C N Y I C S R W

R O R Y E O H O E N E A

A W C E R X H N G A P T

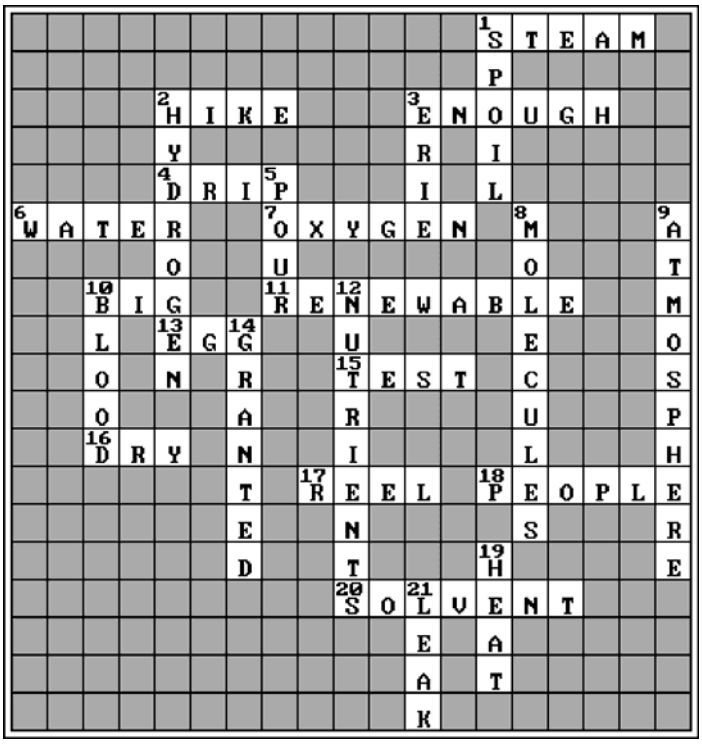
T L A C P R E V I R A E

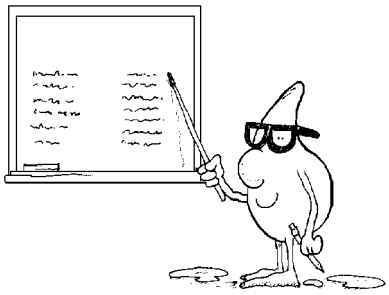
E E S R E P S I D T T R

Match the Meanings

1.	evaporation	( )	method by which water reaches groundwater
2.	condensation	( )	full of water
3.	precipitation	( )	method by which plants send water into atmosphere
4.	transpiration	( )	water molecules form clouds
5.	saturated	( )	sun’s energy turns water to vapour
6.	percolate	( )	water falls to earth

TEST 1
Crossword Puzzle





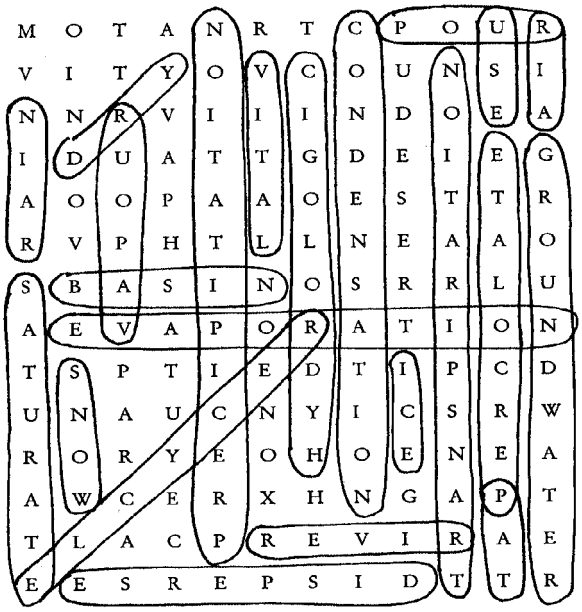
Fill in Blanks

1. **82**% of the blood in your body is water.
2. The scientific symbol for water is **H_2O**.
3. Water has been around since the earth was formed over **four** billion years ago.
4. Another name for the water cycle is the **hydrologic** cycle.
5. Water vapour enters the atmosphere by **evaporation** from bodies of water and by **transpiration** from plants.
6. Clouds are formed when water droplets come together as **condensation**.
7. Rain, snow, hail, and sleet are all forms of **precipitation**.
8. **Around 2**% of the world's total water supply is fresh water.

True or False

1. **False**. Water is two parts hydrogen and one part oxygen.
2. **True**. More than one-half of the world's animal and plant species live in water.
3. **True**. Without water, every single living thing on earth could not survive.
4. **False**. There is the same amount of water on earth today as when the earth was formed.
5. **False**. Canada's largest river is the Mackenzie.
6. **True**. Canada has approximately 7% of the world's freshwater supply.
7. **True**. Most of Canada's rivers drain north.
8. **False**. Water makes up approximately 67% of your body.
9. **False**. Water turns to vapour at 100°C.
10. **True**. Canada's glaciers contain more water than do the Great Lakes.

Water Puzzle



Match the Meanings

1. evaporation	(**6**)	method by which water reaches groundwater
2. condensation	(**5**)	full of water
3. precipitation	(**4**)	method by which plants send water into atmosphere
4. transpiration	(**2**)	water molecules form clouds
5. saturated	(**1**)	sun's energy turns water to vapour
6. percolate	(**3**)	water falls to earth

TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(A): Are You Sure It's Good?

Purpose

To have students understand the concept of water quality, how we measure water quality, and why we need to maintain water quality.

Subject areas

Environmental Studies, Science, Social Studies, Language Arts, Health

Procedure

1. Help the students focus on the topic of water quality by asking some of the following questions:

   - What does water taste like?
   - Do you think the water from your taps is good? Why? Who monitors it?

2. How do we measure water quality? What indicates if water quality is good or bad?

   - Point out that different uses of water need different water quality. For example, water can be clean enough for swimming or irrigation, but it might not be clean enough for drinking.
   - Ask: Do we really need water of pure quality to flush our toilets?

3. Lead a class discussion: "We have an obligation to return water to streams, oceans, and lakes as clean as possible and with the least waste."

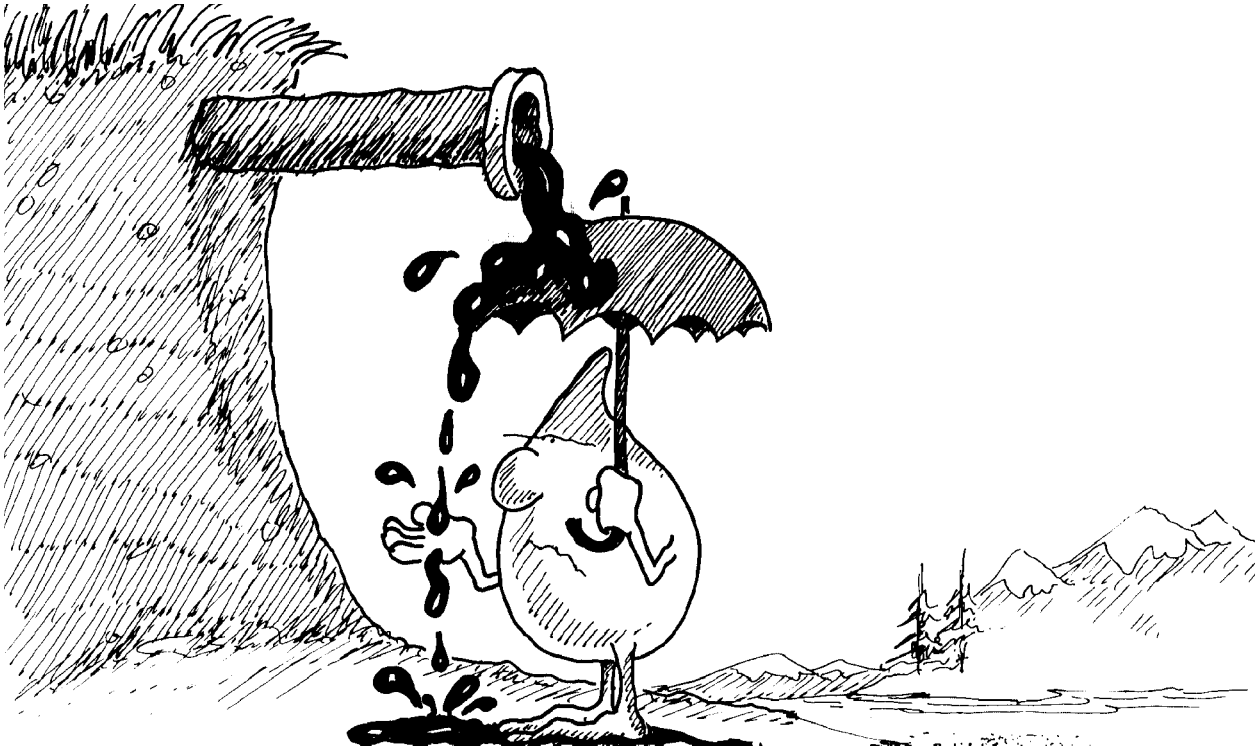
   - Why is water quality important?
   - What is the responsibility of industry and business?
   - What can you do as an individual?
   - What is your responsibility?

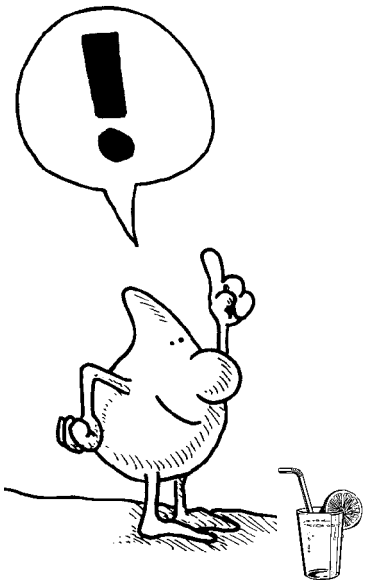
Vocabulary

contaminate *desalinization* *herbicides* *Irrigate*	*monitor* *pesticides* *sanitation*	*sediments* *stringent* *toxic*

References

- Freshwater Series A-3: "Clean Water — Life Depends on It!"
- *A Primer on Fresh Water*: "How Good is It?"





TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(A): Are You Sure It's Good?

Is this good enough to drink?

Lucky you! It's holiday time and you and your family are going on a vacation to Mexico (or Africa, or India, or China, or Russia, or Asia). Pick a destination.

Whichever country is your destination, one of the first pieces of advice you will be given is, "Whatever you do, don't drink the water!"

You will also be warned against eating any fruit or vegetable that can't be peeled. You will not take water for granted again after this trip.

It's time to count your lucky stars. You live in one of the few countries in the world where you can *usually* drink water straight from the tap and the water fountain in your school.

What about water quality in Canada?

Because of Canada's **stringent** guidelines for good drinking water, we can be sure that water quality guidelines are always being **monitored** so that our health is being protected. At the same time, our water looks good, tastes good, and is generally free from bad smells or colours.

But, it's not easy being pure. Industries and technologies are introducing new chemicals into our water supply every year. Therefore, water quality guidelines have to be continually monitored and revised to keep the water quality we depend upon; and, we have to keep learning about the new chemicals being added to our water.

After your trip abroad you will understand why people from other countries envy us Canadians; we have plenty of water and it is generally safe to use. A scary fact is that in developing nations, 80% of diseases are water- related!

Take a moment to think about this:

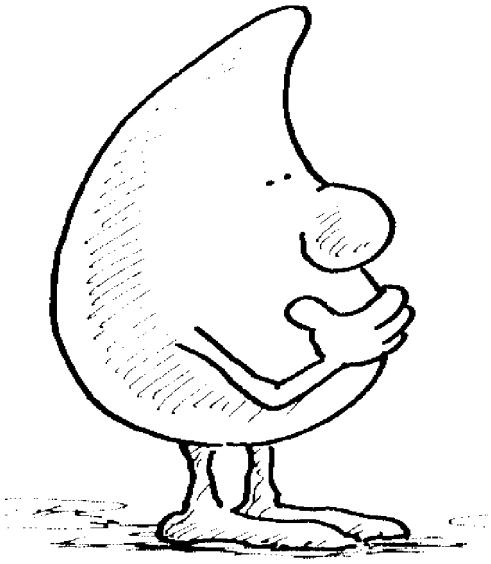
Officials estimate that every day throughout the world 34 000 deaths are caused by **contaminated** water and poor **sanitation** — that equals 100 jumbo jets crashing every day!

What do we mean by water quality?

"Water, water everywhere, but not a drop to drink." You've probably been swimming in the ocean and tasted salt water. And you know that salt water doesn't taste good. This doesn't have to mean the ocean is polluted; it might mean that the salt water contains substances making it all right to swim in, but not to drink.

There is no single measure of water quality. Water that is used to **irrigate** fields may not be suitable to drink; and water that you swim in is a different quality from that needed for industrial use. Water samples are taken all the time to test the quality of water, to see if it contains chemicals that make it unfit for drinking or pollutants that make it unfit for swimming.

What affects water quality?



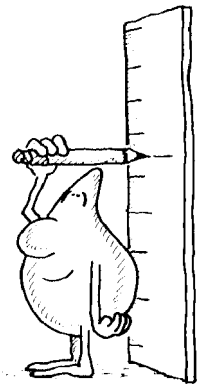
As mentioned earlier, it's not always easy to keep our water pure. From the introduction of new chemicals to natural causes, water quality can be affected by many factors.

For example, moisture in the atmosphere collects around dust, volcanic and natural gases, or any substances in the air like lead and **toxic** chemicals, and falls to the earth's surface as precipitation.

Runoff from land surfaces can drain into the water supply carrying all kinds of substances. In farming country this can mean animal wastes or fertilizer and **pesticides**; in the cities, street debris and chemicals end up in the water. One of the main problems in cities occurs after a storm when wastes from dogs and cats are washed into our storm drains and end up in our lakes and rivers. This is one reason why beaches near cities are closed after a major storm. Wastes from industries, mining, and forestry can also affect the water quality.

We ordinary householders affect water quality as well. We dump many things down our drains and into our toilets without thinking. Some of these substances are toxic, and our treatment plants cannot remove them from the water. We have to remember that everything we toss down the drain finds its way into the water system, and one of these days, you or someone else will be drinking that same water after it has been treated.

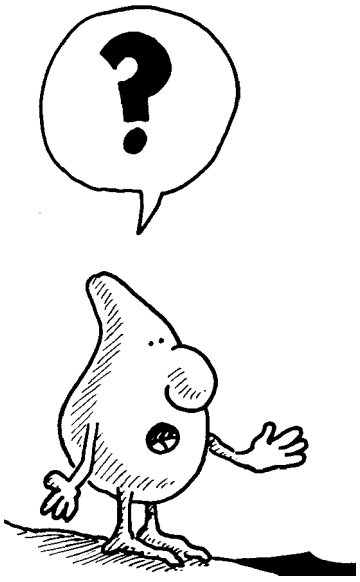
How do we measure water quality?



Scientists collect samples of water and living organisms from a lake or stream and analyse them in a laboratory with special instruments. Some of their instruments are so exceptional, they can detect one-thousandth of a teaspoon of salt in an Olympic-size swimming pool.

Did you know?

On the prairies, irrigation is the largest consumer of water. Irrigation can affect the quality of water because it runs back to the river, lake, or groundwater source carrying **sediments**, fertilizer, **herbicides**, and pesticides.



TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(A): Are You Sure It's Good?

Activity 1 — Environmental Studies

1. Many people in Canada buy bottled water to drink because they believe it is purer than water from the tap. Tests by the Consumers' Association of Canada and other organizations have found out that bottled water is no healthier than tap water and in some cases is not as good.

> In Canada, bottled water is considered to be a food and is regulated under Division 12 of the *Food and Drug Regulations*.

Find out the results of tests done on brands of bottled water. Make a graph to show the conclusions.

2. Find out about additives (chemicals added to our water supply) such as chlorine and/or fluoride in the water.

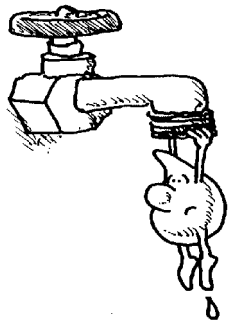
   - Why are these additives used? Are they used in your drinking water? Why or why not? (Some communities have voted against adding any chemicals to their water supply.)

3. Contact your local municipality to find out the types and numbers of chemicals that are monitored in your local drinking water; compare your results with the chemicals that are tested in bottled water.

Activity 2 — Social Studies, Language Arts

Conduct some marketing research.

There are several models and types of water filters that fit on taps and claim to filter out impurities from the water.



- Visit a shop selling these. Investigate the costs and find out how they work and how good they are.
- Make up a report for your class explaining what water filters do.
- Include whether or not you recommend them and which model you consider the best. Justify your choice.

Activity 3 — Research Skills, Science

Make a "still."

- Your first task is to find out what the word "distillation" means — and then find out what a "still" is. (You may learn that having a "still" may be illegal — but that's not the kind meant here.)
- Go to your library and find a book that tells you how to find and make your own apparatus for distilling water.
- After you have a working model, demonstrate distillation to the class using a sample of water to which you have added salt and a little food colouring.
- Explain the scientific process of distillation.
- In which situations does distillation have a practical use as far as drinking water is concerned?
- Do you think this is an economical way for countries without good water supplies to produce their own water from salt water, a process called **desalinization**? Explain.

Activity 4 — Environmental Studies

What do you think of the following?

> Icebergs are made up of distilled and frozen water. Some business people have suggested that we can break off chunks of northern icebergs and tow them down to the dry California coast where they can be melted and used to irrigate the farmland there.

Can this idea work? Be creative and prepare a report about this project. Pretend you are one of these business people trying to sell your idea to others. Answer some of the following questions:

- What are the benefits?
- How do you "break off a chunk?"
- How will you tow this chunk?
- What are some other questions/problems that others may ask you?
- How will you answer these questions?

Activity 5 — Health

- In most parts of Canada we can get drinking water samples tested free by the provincial or territorial Department of Health. Invite a speaker to explain this process to your class.
- Prepare a list of questions for your our speaker beforehand about the quality of drinking water in your community.

TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(B): Pollution

To provide an overview of the different ways we pollute our water resources and to focus on our role in actively cleaning up.

Subject areas

Science, Language Arts, Environmental and Social Studies, Art, Health, Geography

Procedure

1. Lead a class discussion about Canada as a tourist's paradise. Show the students an advertisement which shows Canada as a land with pristine lakes, rivers, and streams.

2. Ask them to come up with examples of local, provincial, and national situations which show we are not as pure as we would like to be. Think about agriculture, mining and forestry operations, industries, municipal dumps, etc.

3. Ask the students how they contribute to pollution. How many cars do their families own? Do they use fertilizers or pesticides on their lawns? Continue by asking how the convenience of today's lifestyles can have a negative effect on the environment.

    - Lead them to discuss that pollution is caused by many groups and individuals; the solutions will have to come from everyone.

4. The students will likely have heard about acid rain. Explain to them that acid rain is one of the phenomena known as LRTAP — long-range transport of airborne pollutants. Go over the information about measuring acid rain and review the pH scale with them.

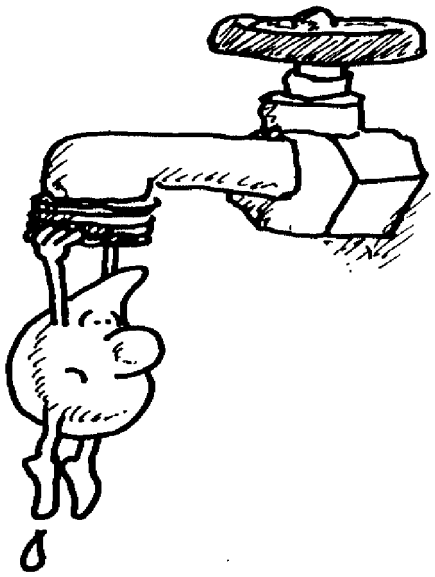
    - Point out to them that pollutants released into the air or into the water have no political or geographical boundaries. Pollutants are carried by winds and currents.

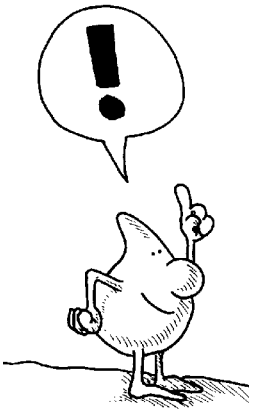
Vocabulary

acid rain	***degradable***	***eutrophication***

References

- Freshwater Series A-3: "Clean Water — Life Depends on It!"
- *A Primer on Fresh Water*: "Water — How Good is It?"





TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(B): Pollution

Is Canada a water paradise?

Remember that trip you went on with your family to a country where the water was not clean enough to drink? And how lucky you felt to be from a country which has so much good, clean, sparkling water? Well, just a minute. Before you get carried away with how environmentally clean Canada is, consider the following:

- Do you live in a part of Canada where local beaches are closed every summer because of pollution?
- Has your well ever been polluted by underground storage areas or other industrial wastes?
- Do you feel safe eating fish from your local river or lake?
- Does your city or municipality dump its untreated sewage right into the harbour or river near where you live? (Many Canadians live in regions that do not provide sewage treatment.)
- Have you heard stories about fish being polluted by mercury poisoning in Canada as well as other countries?

- Are there manufacturing plants or industries nearby which dump untreated chemicals into a water body? Many factories do.
- Do any of these polluted areas affect you?

The sad truth is . . .

If you were to survey large water bodies across Canada, for example, the Great Lakes or the St. Lawrence River, you would find out that we are spoiling the quality of our water. We are doing this with human wastes, animal wastes, and chemical substances. And many of our treatment processes are unable to cope with the increasing complexity and number of chemicals being added to the system.

Our water supply is having a harder and harder time cleansing itself. Normally nature has its own "purification cycle" whereby it uses energy from the sun, oxygen, bacteria, and carbon dioxide to purify itself. Unfortunately, this purification process does not work on some of the more toxic chemicals we are adding to our air and water supply.

How have we polluted our water supply?

Let's look at some of the ways we have affected the quality of our water.

1. We allow non-persistent (**degradable**) pollutants such as domestic sewage, fertilizers, some household cleaners, and some industrial wastes into our water supply areas. These degradable pollutants can be broken down slowly.

2. Our waters have become home to persistent pollutants, the most rapidly growing type of pollution. The damage takes decades or centuries to break down, if at all.

   These include some of the following:

   - some pesticides, for example, DDT
   - some waste from landfill sites
   - petroleum products
   - PCBs, dioxins
   - metals such as lead and mercury

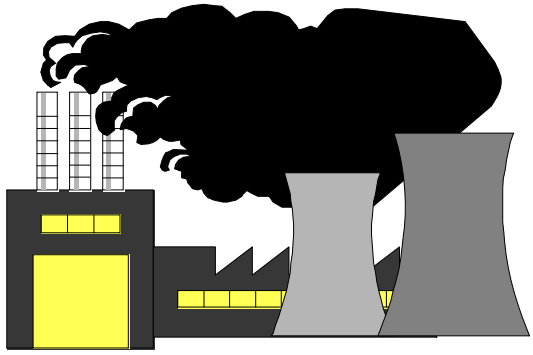
3. We have other kinds of pollution:

- floating debris and garbage — dumped directly into our lakes and rivers where they may be carried away by the currents only to turn up somewhere else

- thermal pollution — after artifically heated water is used in power plants, it is released back to the water body where it can disturb the chemistry of the source

- dams — affect the land behind them through flooding and often accumulating sediments in the reservoir

- dredging — can disturb the natural ecological balance through removal of aquatic life and by the deposit of material



Did You Know?

One litre of oil can contaminate up to 2 million litres of water.

Acid rain: Long-range transport of airborne pollutants (LRTAP)

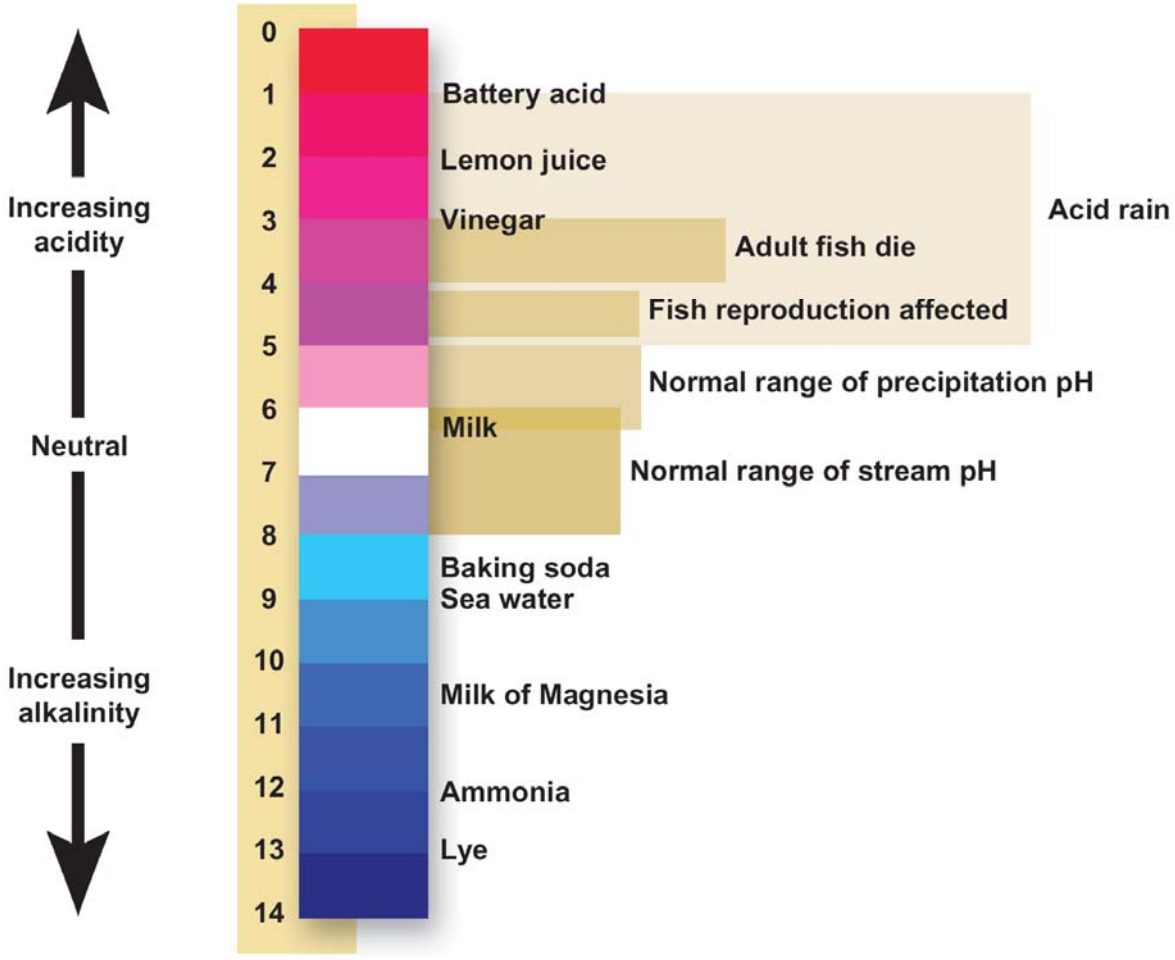
As you know, pollution caused in one province, territory, or country does not stay in the area where it occurred. We find airborne pollutants like **acid rain** in our northern lakes — carried there by wind currents from the south of Canada, from the United States, and even from Europe. Remember, the air above us does not recognize borders.

Acid rain comes from rainwater contaminated with chemicals from sources such as iron and steel mills, pulp and paper mills, oil refineries, and motor vehicle exhaust.

How do we measure acid rain?

By its pH. Scientists measure the acidity of rain by its pH factor, which stands for "potential for hydrogen," on a scale of 0 to 14.

The pH scale



The zero end of the scale is the maximum in acidic content, while the 14 is the other end of the scale, the highest possible alkaline content.

This is not too hard to remember if you realize that zero is something like a test mark. It's bad. You would think that pure rainwater would be right in the middle of the scale, but it stands at 5.5, since there is always some natural acid in rain.

Is it all gloom and doom?

There is much that can be done about pollution, but it will take all nations of the world working together. After all, we all share the same atmosphere and the same hydrologic cycle — you won't find borders to keep out air pollution or water pollution.

How can we control water pollution?

Since nature cannot cope with pollution from our growing populations and industries, governments and citizens must set out guidelines to protect the environment. Laws and regulations must keep pollutants in check.

Technology can also help reduce harm to the environment. For example, water treatment plants and wastewater treatment plants help keep our water clean.

We all have to play our part. Talk your parents into practising some of the following at home:

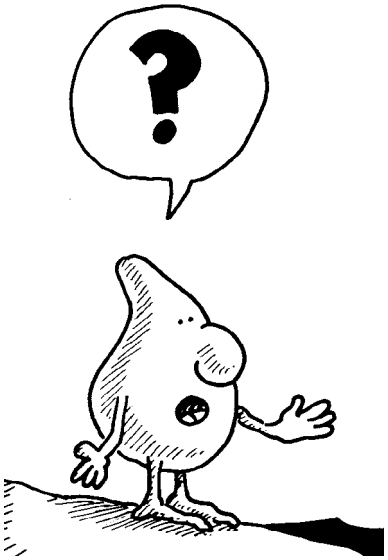
- don't use hazardous products
- don't misuse the sewage system
- don't use pesticides or herbicides in your garden
- don't dump hazardous products into storm drains
- learn all you can about becoming a good environmental citizen — and then practice your skills

A good news story

In the 1960s, Lake Erie experienced such serious **eutrophication** that fish were dying, and decomposing algae washing up on the beaches had to be removed by bulldozers.

The phosphorous (phosphate) from laundry detergents was the main problem. A law was passed to reduce this substance and, in 1972 phosphates were cut by 90%.

Since 1972, Lake Erie has made a remarkable recovery.



TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(B): Pollution

Activity 1 — Environmental Studies, Social Studies

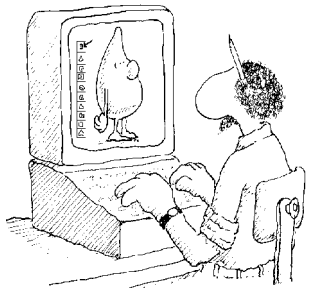
Water pollution in your town?

- Survey your local area.
- Find out what wastes go into the water bodies where you live.
- Explore the following:
    - industries such as pulp and paper, mining, chemical plants
    - manufacturing plants
    - garages, gas stations
    - dry-cleaning companies
    - farm run-off
    - untreated sewage

- What about airborne pollution from smoke stacks, for example, acid rain? Remember, what goes up must come down.
- Most cities in Canada wash their streets. What kinds of debris eventually make their way into water systems from this source?
- Prepare a report based on your findings.

Activity 2 — Environmental Studies

What pollution are YOU responsible for?



- Conduct surveys around your home, school and community. Before you begin your survey, prepare a list of questions to ask.
- Interview interested and concerned people. Find out how we as individuals contribute to pollution and what we can do about it. Remember, we all have to do our part.
- Display the results of your survey with graphs, charts, and posters.

Activity 3 — Social Studies, Art

You hear a lot of talk these days about being "proactive," in other words, taking responsibility and doing something about a problem before we have to *react*. Let's look at an example.

> Students at a school in Toronto were upset because fast food restaurants were packaging their food in materials which were not friendly to the environment. The students decided to do something about it.
>
> They boycotted the restaurant — made signs and posters to get people's attention, and wrote letters to the companies and to politicians. Their actions forced the companies to use new kinds of wrappers for their food.

That is just one example of a group of people being proactive. There are lots of other ways — and simpler things you could do. For example, look around the school and around your own house.

- Plan a campaign. What can you do to make your surroundings pollution-free?
- Design posters, buttons, or bumper stickers to broadcast your message.

Activity 4 — Social Studies

Scenario: You know that a business or industry (dry-cleaning plant, pulp and paper mill, mining operation, chemical plant, etc.) is polluting a nearby stream.

- What can you and your class do?
- Set up a step-by-step action plan.

Activity 5 — Environmental Studies

In your information sheets you read about different ways we pollute our water supply by dumping persistent and non-persistent pollutants, or with dredging, thermal discharge, acid rain, etc.

- Select one example of pollution that affects our water and research to find out more about this kind of pollution.
- Make a class presentation and clarify this pollution problem to others.

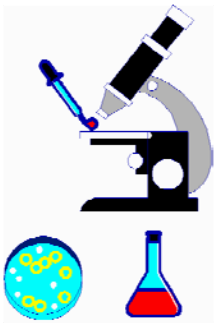
Activity 6 — Language Arts, Art

Collect headlines about pollution and acid rain.

- Start a bulletin board for clippings and news about water pollution, acid rain, and the international efforts to fight the causes. Make your display interesting so that people will want to look at it.
- Examples of recent newspaper headlines:
  - \$90-million price tag attached to river cleanup
  - Pollutants threaten nation's fresh water
- When you have completed the display, write a report to present to the class about what you have learned.

Activity 7 — Science

Can you boil away impurities?

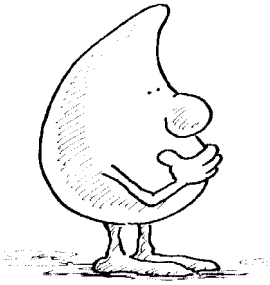


You will need:

- a 500-mL beaker to collect a speciman
- a microscope
- two slides for the microscope
- a means to boil your water sample

What to do:

- Collect a sample of water from a pond, a brook, or a puddle.
- Place a drop of the sample water on one of the slides. Observe it under magnification.
- Make notes of what you observe.
- Boil some of the remainder of the water sample for ten minutes.
- Let it cool and place a drop of the boiled water on the other glass slide. Observe it carefully.
    - Describe what has happened to the water sample when it was boiled.
    - Do you think boiling removed all impurities from the water? Justify your opinion.
    - Write up your findings.



Activity 8 — Language Arts

What if . . . ?

In groups of two to four students, make up some "what" if questions for the rest of the class. Each of your groups will make up four such situations and present them to the class for discussion.

Option: Select one of the "what if" situations to role play or act out.

Sample situations:

- What if you saw a neighbour pouring used car oil down a storm sewer?
- What if you watched your neighbour (for the umpteenth time) allowing his Great Dane to use your lawn for a bathroom without cleaning up?
- What if you were with a wilderness camping group and you met a group leaving garbage around?
- What if you were at a town meeting where politicians wanted to spray your local park with herbicides for weeds?

Activity 9 — Research: Geography, Science, Health

Each year 3 to 4 million people die of waterborne diseases, including 2 million children who die of diarrhea.

- Research one of the following diseases and prepare a report on it: diarrhea, polio, typhoid, cholera, leprosy, scabies, roundworm, malaria, sleeping sickness, river blindness, hookworm. Describe the disease, what its effects are on people, and explain how unsanitary water helps spread the disease.

or

- Choose a country where you suspect the quality of water may not be as good as Canada's. What kinds of diseases might you get there? What precautions should you take to avoid disease? What shots will you need? How do you find out this information? What are some of the diseases you can catch from contaminated water?

Activity 10 — Environmental Science

Adopt a stream.

In many parts of Canada, concerned citizens have organized groups to keep the environment free from pollution. For example, some groups (or individuals) will volunteer to keep a mile of highway free from litter, or students will adopt a ditch in their community to keep clean.

Why not organize your classmates (or community) to adopt a nearby body of water. Invite people from the community into your class to help set it up. Get as many people involved as you can.

Activity 11 — Language Arts

What's wrong with this ad?

> ***Mr. Mighty* Does the Job for You!!**
>
> Tired of seeing the mess left in your sink after the day's grease, paint, suds, and food remains have disappeared down your drain?
>
> Have no fear! *Mr. Mighty* is here!
>
> *Mr. Mighty* will rid your sink of all these ugly, leftover stains. Just spread *Mr. Mighty* around your sink, rub gently, rinse with warm water, and voilà! All that residue will flow into your drain and out of your life!

Have you seen ads which make the same promises?

- Take a week to monitor ads on TV. Or look for ads in magazines. Are there products similar to *Mr. Mighty*? Pick one and discuss what might be wrong with the approach.

> **Note:** Some products which claim to be excellent and safe to use for cleaning actually are. Make sure your research is accurate

- Find alternate solutions to cleaning up without using chemicals.
- Create your own ad for a cleaning product.

TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(C): How Is Water Treated?

Purpose

To help students recognize there is a water cycle made by humans as well as the hydrologic cycle made by nature; and to examine the treatment of water before and after use.

Subject areas

Science, Environmental Studies, Social Studies, Art, Language Arts

Procedure

1. Review the concept of the hydrologic cycle and point out to the students that we have had to create our own water cycle so that we can treat water before and after we use it.

    - Remind them of the point made in the last chapter, "Pollution," that because of new chemicals and other substances being added to water, nature's purification cycle needs help from humans to keep water pure.

2. Depending on the area of Canada you live in, students may be served by individual septic tanks or water and wastewater treatment plants. Chances are they will not have had occasion to think too much about their water supply and how it is cleaned. Lead a discussion about the necessity of cleaning our water both before and after use.

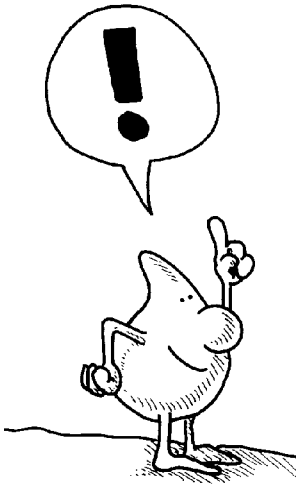
3. The topic of wastewater treatment can generate a great deal of interest. If possible, arrange a visit to a plant or invite a guest speaker into the classroom. When students realize how much water is wasted by them, they may be more conscious of misuse.

Vocabulary

aeration	***effluent***	***purify***
alum	***filtration***	***reservoir***
chlorine	***fluoride***	***sedimentation***
coagulation	***infrastructure***	***sewer***

References

- Freshwater Series A-3: "Clean Water — Life Depends on It!"
- Freshwater Series A-4: "Water Works!"
- *A Primer on Fresh Water*: "Water — How Good is It?"
- *Water, No Time To Waste: A Consumer's Guide to Water Conservation*



TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(C): How Is Water Treated?

Can dirty water be cured?

If you are like most people, you have not given ten seconds of thought to how water got into your house or why it comes out of a tap ready to drink whenever you feel like it. And you probably never think that the wastewater you flush through your toilets or let run from your drain will turn up again in your drinking water supply. But it does. It's like the old saying, "what goes around, comes around."

Except for areas where people get their drinking water directly from a well, most water that comes into Canadian homes has been **purified** or treated at a water purification plant so that we can drink it safely. Your homes and your school make up one part of a community water cycle made by humans.

And, once the water goes down the drain, it travels through wastewater pipes or a sewer system to another treatment plant, this time a sewage treatment plant, where it gets treated again before it is released into nature's cycle.

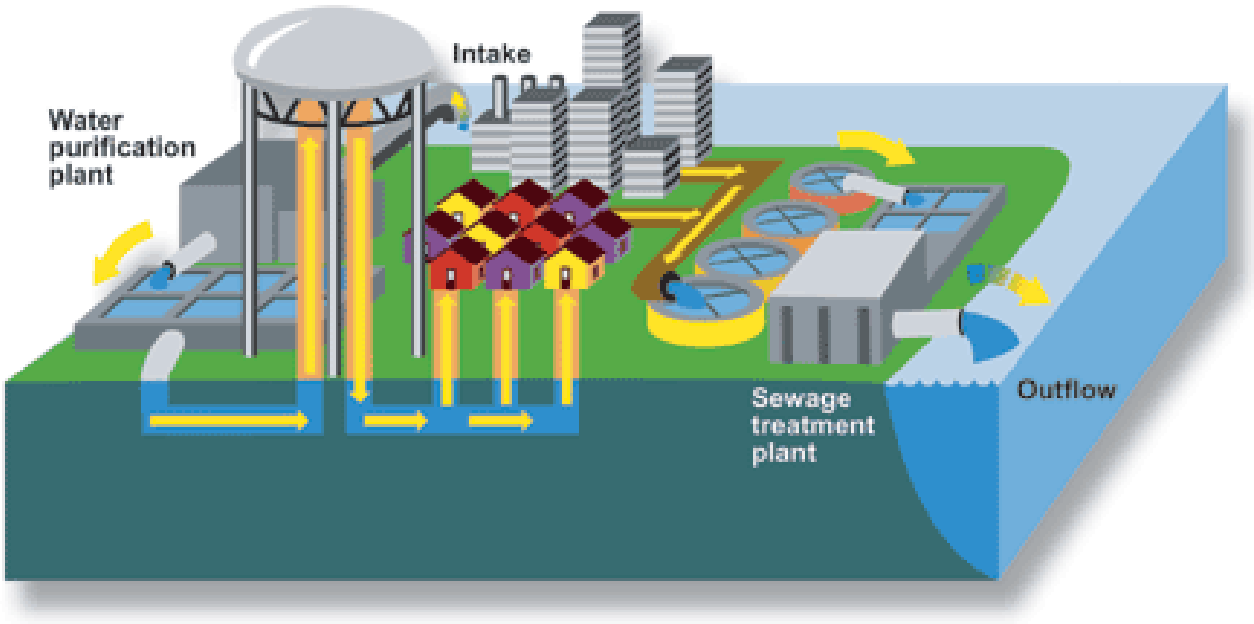
Another water cycle

Water is collected in a **reservoir** or lake, piped to a water purification plant, treated for our use, and pumped through pipes or water mains to our houses. After we have used the water (or sometimes wasted it), it leaves our houses through **sewer** lines and heads to a sewage treatment plant. There it goes through another treatment before it is released to nature's water system to be recycled yet again. And on it goes.

A word of caution here — both treatment plants are very different; it wouldn't do to get them mixed up!

Look at the diagram that follows and trace the route that water can take.

Municipal water supply and sewage treatment



One example of another water cycle.

Other areas of Canada rely on individual wells and septic tanks — but this is still part of another cycle — from your well, to the taps in your house, and out to the septic tank.

A closer look at where your water comes from

If you get a chance, try to visit a water purification plant and find out firsthand the treatment process water goes through before it begins its trip to the taps in your house or the water fountain at school. Remember, no matter how fresh water is, it usually picks up some impurities as it goes through the hydrologic cycle.

What happens in a water purification plant:

1. First there must be a source of water nearby. This could be a river or lake, or it could be a reservoir created by the building of a dam to hold the water back.

2. As this water is needed, it is carried by pipes into a purification plant where it is made safe for drinking by going through the following treatments:

   - First of all, water is sprayed into the air where it mixes with oxygen. This step is called **aeration**. The oxygen helps grow which in turn destroy some of the impurities.
   - The next step is **coagulation** where **alum** is added to the water. Alum forms sticky particles to which dirt and other particles cling.
   - In the next stage, **sedimentation**, these impurities settle to the bottom of a settling tank.
   - The water then goes to a filter tank where **filtration** occurs. Any impurities left in the water are filtered out through layers of bacteria sand, charcoal, and gravel.
   - In many communities, **chlorine** is added to the water to destroy any disease-causing germs that may remain; and in more and more communities, **fluoride** is added.

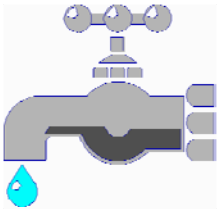
When water has gone through these steps, it is ready for your use. The clean water is pumped to large storage tanks and from there it is pumped into pipes that carry it to your homes, schools, businesses and industries.

What happens next?

So, that's the first half of the community water cycle. What happens to the water after it has been used and leaves your house or school? This is where it gets the name "sewage" or "wastewater," and goes into another set of pipes to be taken to the sewage treatment plant. As the name tells you, this is where water gets another series of treatments before it is released back into the environment.

Let's hope that your community or city has a method to treat waste and that waste does not get dumped directly into the nearest body of water.

A closer look at a sewage treatment plant



Wastes can be easily removed from the majority of our homes, just the turn of a handle or tap and whoosh! It's gone. Where does it go from there? To a sewage treatment plant where it goes through one or more of the following steps:

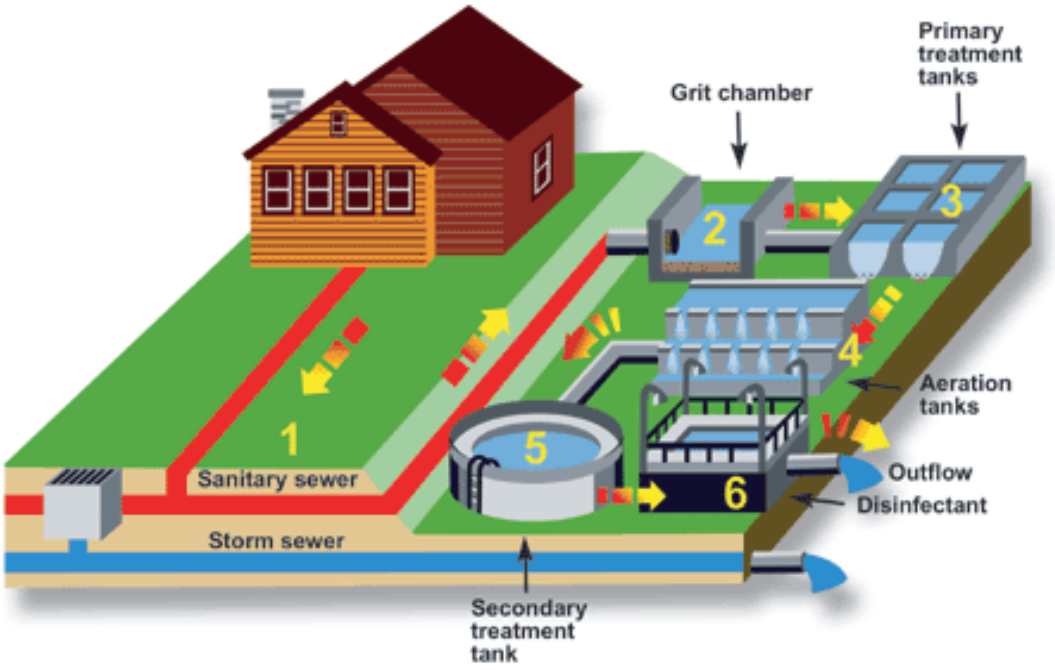
- Primary treatment — sand, grit, and other solids are separated from the liquids by screens and settling tanks

- Secondary treatment — air is added (aeration) to stimulate the growth of bacteria to consume most of the remaining waste materials
- Tertiary or advanced treatment — chemicals are added which remove nutrients that stimulate algae (tiny plants that use up oxygen needed by fish)

Sludge is what is left behind after wastewater is treated. When harmful microorganisms are removed, sludge is either burned, taken to landfills, or used to condition soil.

Processed wastewater is called **effluent** or "greywater." It is disinfected, tested, and returned to rivers and streams where the cycle begins again.

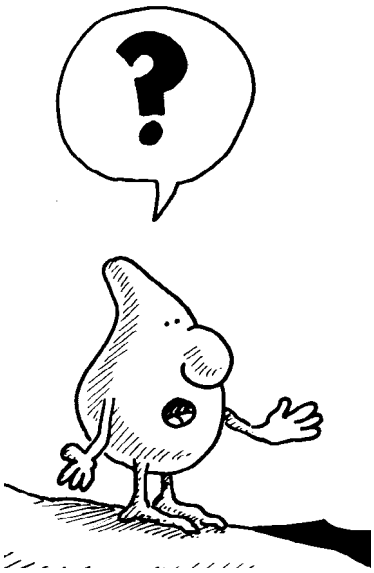
Typical sewage treatment process in Canadian municipalities



One example of wastewater treatment

You would not want to drink this processed wastewater right away. But by the time it comes gushing out of your taps again it has been given one more thorough cleansing back at the water purification plant. Remember, don't get the two treatment plants mixed up!

As a human race, we haven't looked after water very well. You've seen how we have spoiled the pristine quality of many lakes and rivers, and you know we would not be very healthy if we had to drink water straight from the lakes or rivers on our doorsteps. Fortunately, this is not the case. Our own water cycle (water purification and sewage treatment plants) helps keep us free from diseases which trouble developing countries.



TOPIC 3. CLEAN WATER — LIFE DEPENDS ON IT!

Chapter 3(C): How Is Water Treated?

Activity 1 — Social Studies

One of the best field trips some of us have been on hasn't really been to a field. Quite the contrary. It has been to a sewage treatment plant. Ask your teacher if you can arrange a tour to such a plant or to a water purification plant.

Plan your trip. Review any information can find about these plants.
Prepare questions in advance so that you can learn what it is you wish to know.

For example, how many kilometres of sewer pipes or water mains service the area where you live? How much does it cost? Find out about the taxes charged to individual houses. How many people work in a plant? What do they do?

In many cities the water mains or **infrastructures** are getting old and worn out. The costs are high to replace you these pipes. Is this the case where you live?

What about lead pipes? Are these being used where you live? Why? Why shouldn't they be used?

Contact the proper authorities. If a field trip is not possible, invite a speaker to visit your class. You will probably find that most water supply agencies are very eager to talk about these issues as they are becoming serious problems in many areas in Canada.

Activity 2 — Environmental Studies

In Ocala, Florida, the municipality has a great use for its "greywater," which is water that has gone through a treatment but is not good enough for humans to drink. The city officials there just direct this water to their municipal golf course it is used to water the greens and the fairways.

Is there a similar program where you live? Could there be? Is this a good use of processed water?

Check to see if some industries reuse water within their complexes before releasing it to the sewage treatment plant.

Think about it. Do we really need to where use "fresh water" from our water purification plants to water our lawns, wash our cars, and flush our toilets? Can't we use greywater? How much would this save in tax dollars?

Activity 3 — Language Arts

You would be surprised at the number of cities and communities in Canada which dump untreated wastewater straight into the harbour or nearest body of water. It's not a pretty sight. In Great Britain, for example, where many beaches on the ocean are becoming too polluted to swim in because of untreated waste, one solution was to build longer sewer pipes and dump the waste farther out at sea! What do you think of that solution?

Research to find out where in Canada untreated waste is dumped directly into the ocean or nearest body of water. Write about it. Find out why these places do not have sewage treatment plants. In one Canadian city, everybody wants such a plant but nobody wants it near them. This is called NIMBY, an acronym for "Not in my back yard," or GOOMBY, "Get out of my back yard."

Become a community activist. Write a letter to your municipality or newspaper about NIMBYs or GOOMBYs in your region.

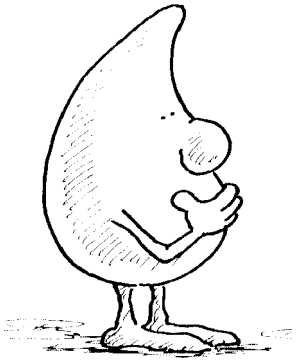
Think up your own acronym for people who do not want to become good environmental citizens.

Option: Imagine that you are a river flowing through one of those communities. Write a short story or a couple of paragraphs describing how it feels to you to have all this junk dumped in the middle. Be imaginative!

Think about some questions you would like to ask those people who continue to allow the dumping of raw sewage into water bodies.

Activity 4 — Science

Research to discover why old-fashioned lead pipes are a problem. What damage have they caused? What can be done about them? What can they be replaced with? What kinds of pipes service your community?

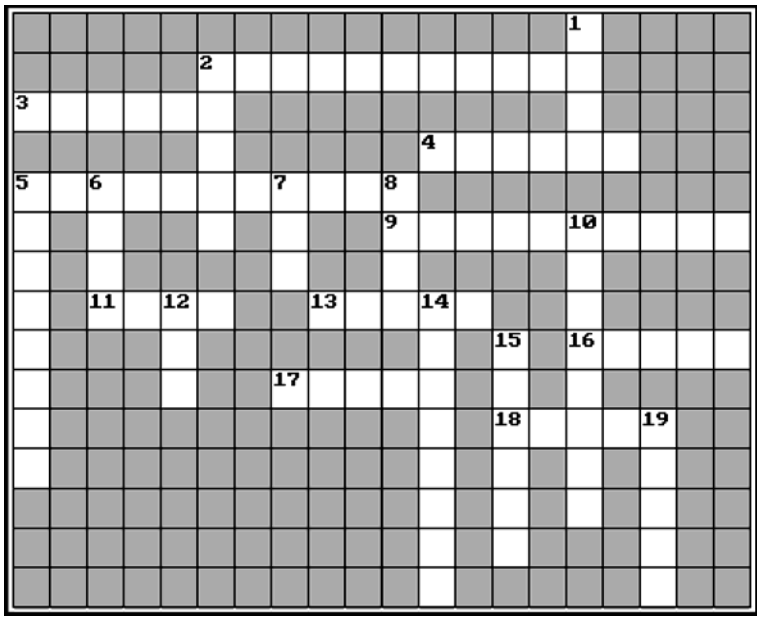


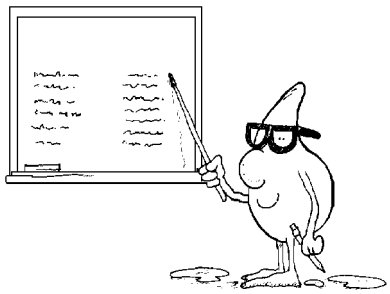
Activity 5 — Environmental Studies, Art

Trace your own community water cycle. If you are like most people, you have no idea of the route water takes to get to your house and the route wastewater takes when it leaves your house and goes to the treatment plant.

Find out from your local water works department and draw your own diagram showing the class where water comes from and where wastes go.

TEST 2
Crossword Puzzle





Across

2. Another word for pollute.
3. We need to ____ our water before we drink it.
4. A person swallows water or ____ it.
5. A step in water treatment where particles in water cling together.
9. Method by which farmers water their crops.
11. Name for pipe that carries water to your home.
13. Lake Huron is one of the ____ Lakes.
16. Water leaves the house by going down the _____.
17. Pipes that carry wastewater from your home.
18. Our water is usually purified in a treatment _____.

Down

1. A ____ in your pipes wastes water.
2. The hydrologic or water _____.
5. Chemical element used in water purification.
6. A chemical added in water treatment to help particles cling together.
7. When we need water, we turn on the _____.
8. Canada has less than ____ percent of the world's freshwater supply.
10. Rainwater contaminated by pollution from industry (two words).
12. Frozen water.
14. Process where oxygen is added to water in a treatment plant.
15. In many rural areas, wastewater goes into _____ Tanks.
19. A chemical substance which can harm organisms.

True or False

T **F** 1. On the prairies, pulp and paper industries use the most water.

T **F** 2. Another name for wastewater is sewage.

T **F** 3. Once wastewater is treated, it is released into rivers and streams.

T **F** 4. Water is purified for our drinking purposes at a sewage treatment plant.

T **F** 5. All Canadian households have their own septic tanks.

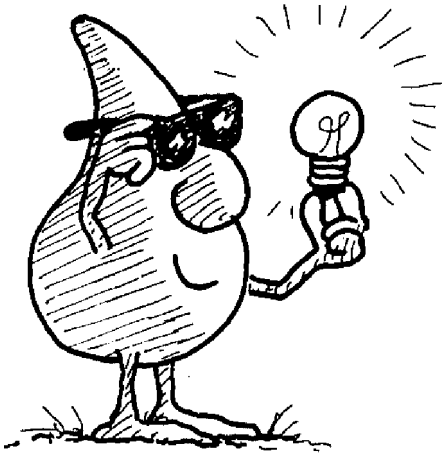
T **F** 6. All wastewater in Canada is treated before it is released back into nature.

T **F** 7. Rainwater stands at 0 on the pH scale.

T **F** 8. Acid rain falling in Canada comes from Canadian and American industries.

T **F** 9. Effluent and greywater mean the same thing.

T **F** 10. Oxygen is added to water in a treatment plant during the sedimentation stage.



Match the Meanings

Show that you understand what happens in water purification and sewage treatment plants.

1.	coagulation	( )	impurities percolate through layers of sand, charcoal and gravel
2.	sedimentation	( )	what is left behind after wastewater is treated
3.	filtration	( )	purifying chemicals are added to water before it goes to your home
4.	aeration	( )	alum is added to the water causing dirt and other particles to stick together
5.	sludge	( )	water is sprayed into the air where it mixes with oxygen
6.	primary treatment	( )	impurities settle to the bottom of the tank
7.	chlorination	( )	stage at which solids are separated from liquids in wastewater treatment

TEST 2
Crossword Puzzle

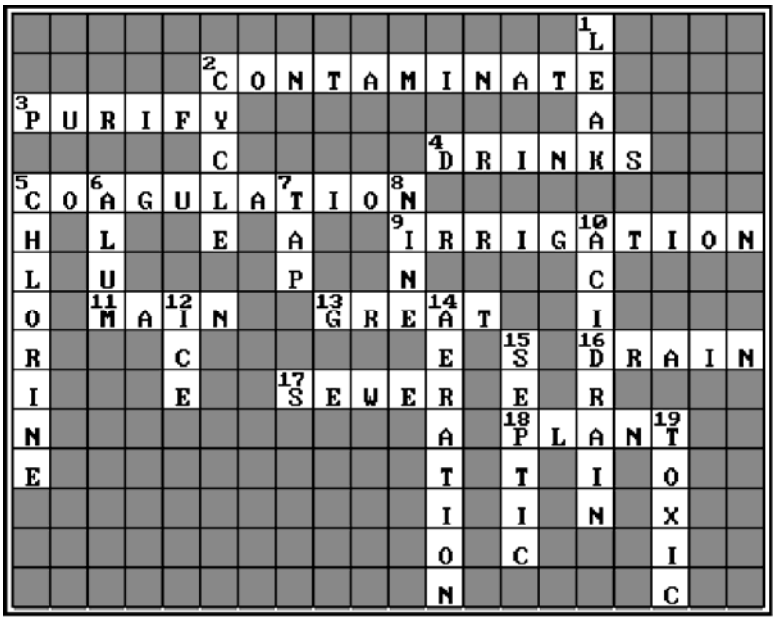
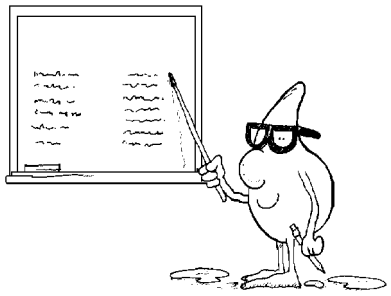


Figure 1



True or False

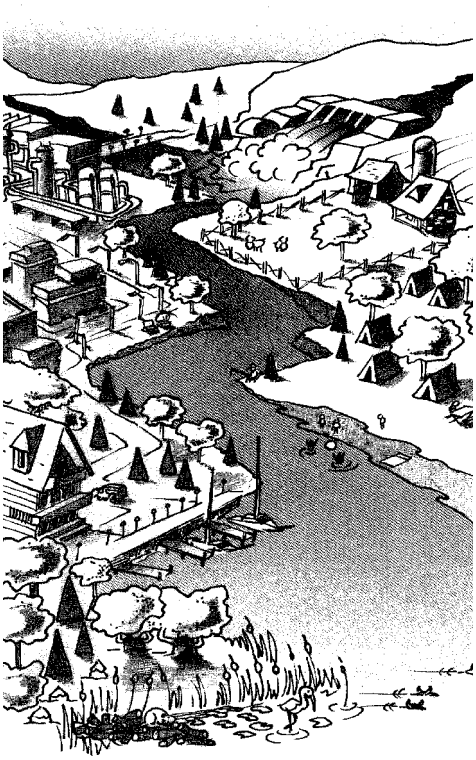
1. **False**. On the prairies, irrigation uses the most water.
2. **True**. Another name for wastewater is sewage.
3. **True**. Once wastewater is treated, it is released into rivers and streams.
4. **False**. Water is purified for our drinking purposes at a water purification plant.
5. **False**. Most Canadian households do not have their own septic tanks.
6. **False**. Some wastewater in Canada is not treated before it is released back into nature.
7. **False**. Rainwater stands at 5.5 on the pH scale.
8. **True**. Acid rain falling in Canada comes from Canadian and American industries.
9. **True**. Effluent and greywater mean the same thing.
10. **False**. Oxygen is added to water in a treatment plant during the aeration stage.

Match the Meanings

1.	coagulation	(**3**)	impurities percolate through layers of sand, charcoal and gravel
2.	sedimentation	(**5**)	what is left behind after wastewater is treated
3.	filtration	(**7**)	purifying chemicals are added to water before it goes to your home
4.	aeration	(**1**)	alum is added to the water causing dirt and other particles to stick together
5.	sludge	(**4**)	water is sprayed into the air where it mixes with oxygen
6.	primary treatment	(**2**)	impurities settle to the bottom of the tank
7.	chlorination	(**6**)	stage at which solids are separated from liquids in wastewater treatment

TOPIC 4. WATER WORKS!

Chapter 4(A): One Resource — Many Users



Purpose

To look more closely at the two basic ways we use water (withdrawal and instream use); to compare Canada's use of water with that of other countries; and to provide an overview of the many and competing users of water in Canada.

Subject areas

Social Studies, Language Arts, History/Geography, Math, Environmental Studies, Science

Procedure

1. Conduct an informal survey with the students.

   - Ask them how many ways Canadians use water. Stress here that you mean Canada as a whole, not individual water use around the home.
   - Write their answers on the board and lead them to consider uses they may not have mentioned that are covered in this chapter, for example:

transportation	fisheries	recreation
waste disposal	wildlife	manufacturing
hydroelectricity	thermal power	
agriculture	mining	

2. Discuss with the students how water is used in each of these examples. They will be able to think of lots of ways they use water for recreation, both summer and winter, but they may have trouble with thermal power or mining. Explain some of the more difficult concepts to them — you will find background information in Freshwater Series A-4.

3. Go over the difference between instream water use and withdrawal use and show where each of the above uses belongs. Point out to them that both kinds of use can contribute to pollution if care is not taken.

4. Take some time to discuss municipal water use. Point out to the students that this is where we use water in and around our homes. Ask them how many ways they and their families use water personally. Discuss with them that Canadian homeowners use much more water than people in many other countries. This will be dealt with more extensively in the section on conservation (Topic 6).

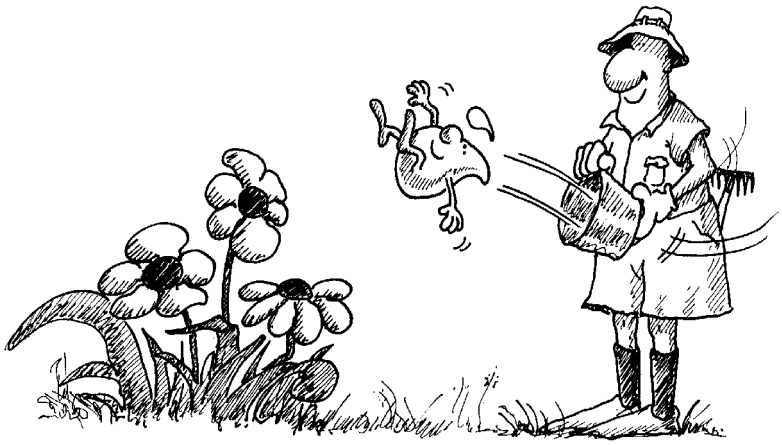
Note:	If they do the survey of water users in their community help them phrase the questions carefully. Some users may not be too environmentally friendly and may resent a blunt question. Ask them to compare results at the end of the survey.

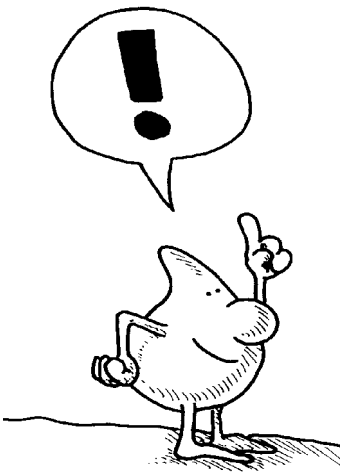
Vocabulary

hydroelectricity *instream*	*withdrawal*

References

- Freshwater Series A-4: "Water Works!"
- *A Primer on Fresh Water*: "Water — How we use it"





TOPIC 4. WATER WORKS!

Chapter 4(A): One Resource — Many Users

How many ways do we use water?

Quick! Take a survey around the room and make a list of the ways we use water in Canada. You can easily think of things such as recreation for swimming, sailing, and skating, but would you have thought of transportation? After all, water transportation is one of the best ways to move goods around the world — it's hard to imagine shipping oil or wheat by air, isn't it?

Did anyone come up with fisheries or irrigation? If you live in the prairie provinces, irrigation may have been one of the first things you thought of, but if you live in other parts of Canada, such as the Atlantic provinces or the west coast, your first thoughts might have been of the fishing industry. Or, if you come from more industrial regions, such as those in Ontario or Quebec, you might have mentioned **hydroelectricity**.

Did You Know?

As early as 5000 B.C., our ancestors used irrigation to increase crop production. And water-flushed toilets have been found dating back to around 2750 B.C.

As you read through this information about the many and varied uses of water, you will see that water has always been essential, not only for our survival, but for providing the quality of life that we enjoy in Canada. And you will also note that some of the ways we use water make it unfit for others to use unless the water receives expensive treatment. What we have to remember is that *everyone lives downstream from everybody else*. We might also take this further to say that, in the long run, we all live downstream from ourselves.

Indian Proverb: *The frog does not drink up the pond in which he lives.*

Canada's use of water

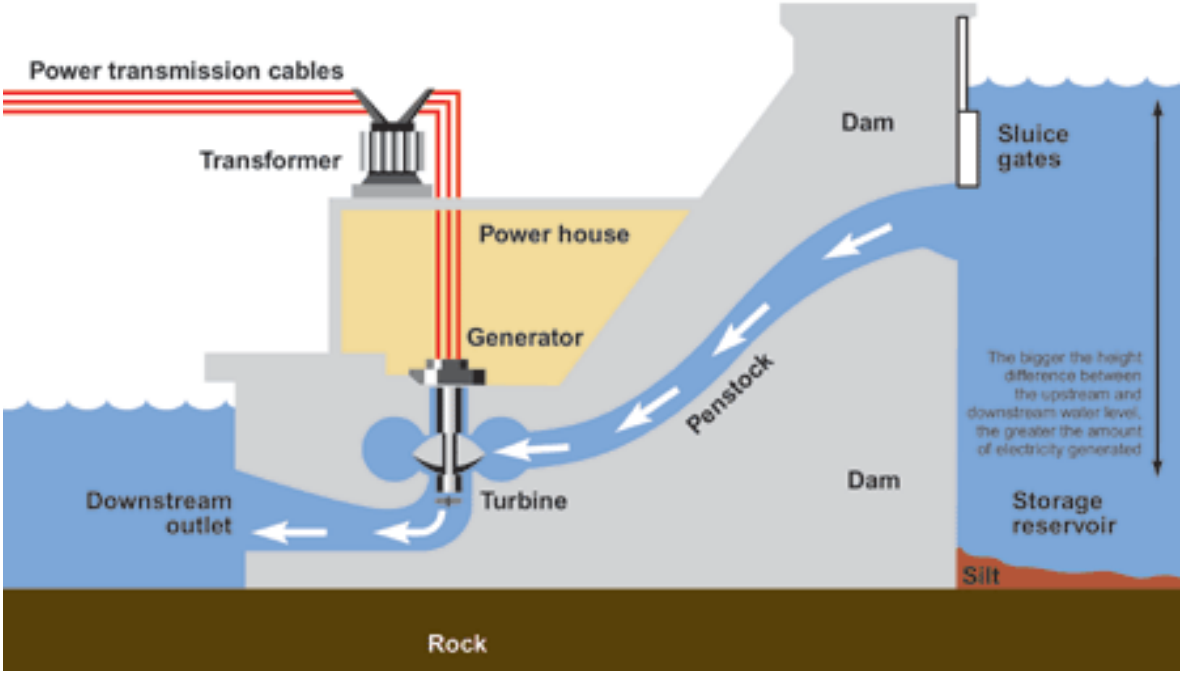
Water has always played a very important role in helping Canada grow as a nation, and today Canadians are among the biggest water users in the world.

Let's take a look at the many uses we make of water, and let's group these uses under the two basic ways: **instream** and **withdrawal** uses.

1. *Instream use* is when water is used in its natural setting "in the stream." These include:

    - Hydroelectric power generation — This is energy produced by the force of falling water. In Canada, hydroelectric plants provide 62% of electricity demands.

Hydrolectric power generation



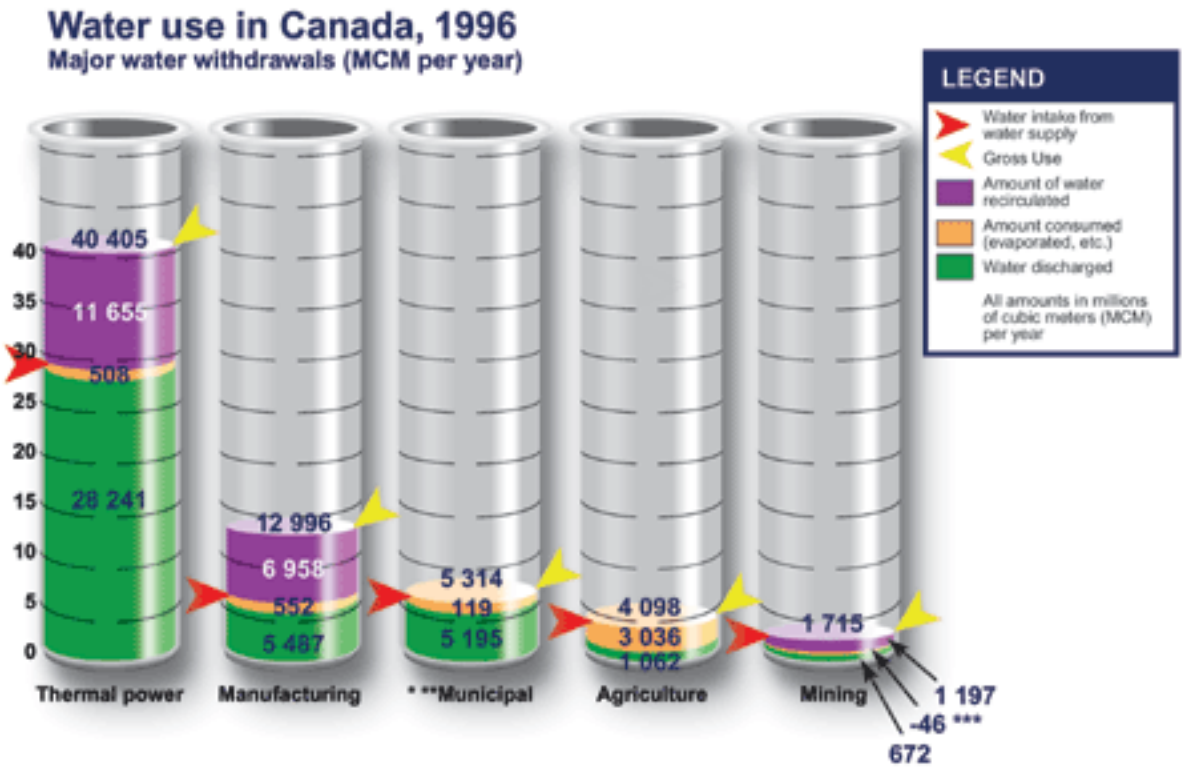
- Transportation — Inland waterways, such as the St. Lawrence River and the Mackenzie River, have played an historic role for getting Canadian goods to market. These same waterways took early European explorers into the interior of our country.

- Freshwater fisheries — We have hundreds of thousands of lakes and rivers, and these water sources provide sport fishing and commercial fishing industries.

- Wildlife — Many wildlife species depend on water, and most Canadians participate in some form of wildlife-related activities such as hunting, photographing, and studying.

- Recreation - Canadians have always enjoyed outdoor recreation, especially around water. Activities include swimming, boating, canoeing, fishing, camping, and skating.

- Waste disposal – For centuries Canadians have used lakes, rivers and oceans as places to dump human and industrial wastes. As we discussed in earlier chapters, water's natural purification process is less and less able to clean these wastes and many of our waterways are becoming overloaded.



2. *Withdrawal use* is when water is taken from the stream and used on land. These uses include:

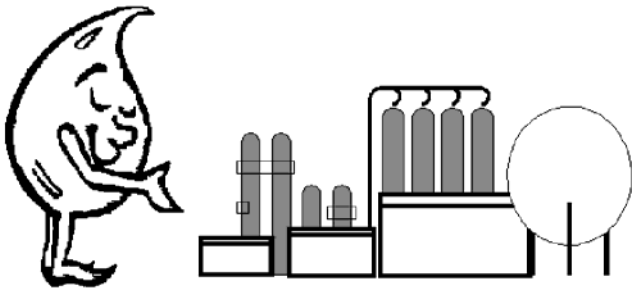
   - Thermal power generation — Next to fuels, water is the most important resource used in large-scale thermal power
   - production.

   - Agriculture — Water is used for irrigation and livestock watering, especially in the south of British Columbia and in the three prairie provinces.

   - Manufacturing — Water is the lifeblood of industry. To manufacture one automobile requires at least 120 000 litres of water.

   - Municipal — This includes all the ways we use water in the communities where we live.

   - Mining — The mining industry uses water to separate ore from the rock, to cool drills, to wash the ore during production, and to carry away unwanted material.



African Proverb: *Water may flow in a thousand channels but it all returns to the sea.*

Water use and water quality

Both instream users and withdrawal users can harm the water supply. Contaminants get into the water supply directly with "instream" use, for example, when spills occur or contaminants leak into the water, or during "withdrawal" when water is withdrawn for use and gets only partial treatment before it is returned to nature. Most water use lowers the quality of the water.

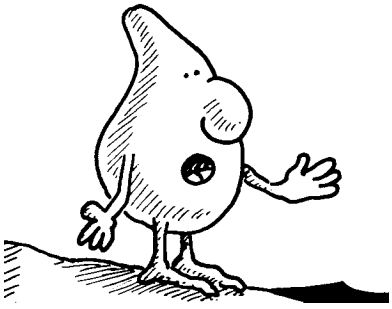
Water Rule: Using water includes the responsibility of cleaning it up after its use, before it passes to the next user downstream. We must do unto others what we would have them do unto us.

Did You Know?

During the summer months, about half of all treated water is sprayed onto lawns.

TOPIC 4. WATER WORKS!

Chapter 4(A): One Resource — Many Users



Activity 1 — Math

Using the chart below, complete the exercises which follow.

Water Withdrawals in Canada, 1996 (MCM per year)

Region	Thermal Power	Manufacturing	Municipal*	Rural*	Agriculture	Mining	Regional Total
Atlantic	2 372	480	285	134	14	206	**3 491**
Quebec	809	1 173	1 351	278	103	38	**3752**
Ontario	23 228	3 011	1 496	291	173	56	**28 255**
Prairies	2 337	368	534	141	3 030	61	**6 471**
British Columbia*	4	1 008	668	135	778	158	**2 751**
National Total	**28 750**	**6 040**	**4 334**	979	**4 098**	**519**	**44 720**
Percent of Total	64.289	13.506	9.691	2.189	9.162	1.161	99.998

*These municipal and rural estimates include: residential, commercial/institutional, and other uses (i.e., not industrial).

** Sectoral data for Yukon, Northwest Territories, and Nunavut are included with British Columbia.

Note: Data for some sections have been extrapolated and rounded.

Source: Environment Canada water use surveys and studies.

1. Which region or province uses the least thermal power? What is the difference between this amount and the amount used by Ontario?

2. The prairie provinces have the most water intake for agriculture. What is the total amount used by the other regions?

3. Use the information from the chart and prepare five math problems for a classmate. Make sure you can answer the questions yourself.

4. Use a pie chart to present clear information at a glance. Take the "percent of total" on the bottom line, round off the numbers to the nearest whole number and show the information on a pie chart.

Activity 2 — History/Geography

Water played an important part in the development of our nation and it continues to play a vital role in the development of Canada.

From the following list, select one of water's major uses, and show how important water is to Canadians.

- transportation
- manufacturing
- power/energy
- trade/shipping
- fisheries
- agriculture
- recreation

Make your presentation more interesting by using illustrations to describe the role that water plays. (Imagine, flying oil and timber to a market, using candles or oil lamps for light, making products by hand or simple machine.)

Activity 3 — Environmental Studies, Research/Interview/ Survey

Research: Find out who the big users of water are in your community. Then find out from them how much water they use and how they use the water.

- Brainstorm with the class and identify all the major users of water in your community, for example, manufacturing/industry, recreation facilities, transportation, agriculture, etc.

- Don't forget to check small businesses like dry-cleaners, hair salons, and car washes; and places like fire stations, hospitals, community centres, etc.

- Work alone or in a small group and select one water user each. Prepare a report for the class.

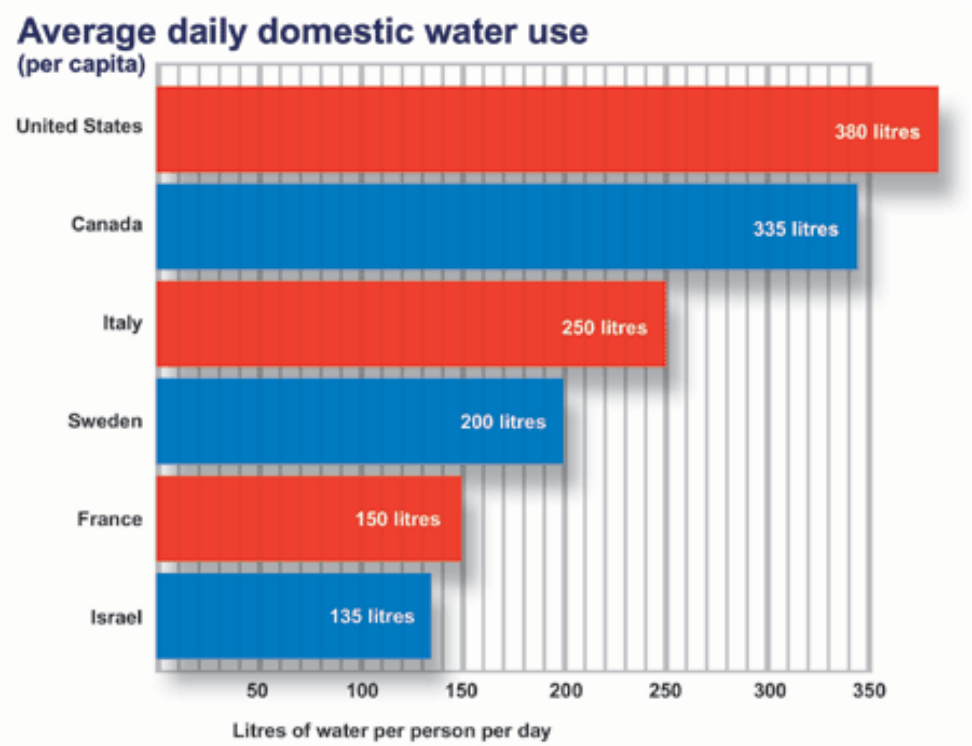
Guidelines for interviewing water users:

- Within your group identify who will do the interview. Make sure only one contact is made with each place.
- Within your class draw up a list of questions to ask. Make sure your teacher approves the list.
- Plan what you want to know. For example:

How much water do they use? How? What is the yearly and monthly cost? Is there any recycling? Do they try to conserve? If so, how? Are they in favour of higher water costs for those who use the most water?

Activity 4 — Social Studies, Math

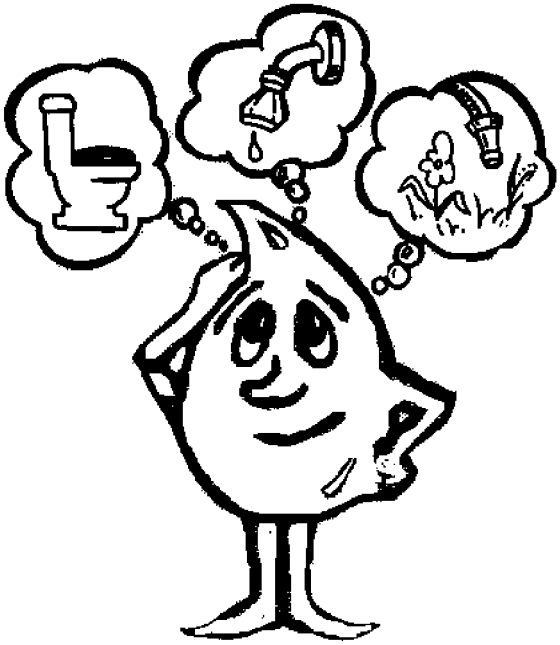
Look at the graph "Average daily household water use (per capita)." What does this graph show? Ask yourself why we use so much water in Canada. Do we need to? Compare your use with other countries — how much more do we use than Sweden? France? Israel? Why are there such differences? Do you really think we are cleaner?



Based on the information from the graph, make up five math questions for your class.

Activity 5 — Social Studies, Language Arts

Look back to the information which outlines some water facts about how we use (and maybe misuse) water in Canada. Do we really need "clean" water in our toilets? Find out more about "greywater." Write a paragraph of about 100 words presenting your views on the uses of treated water.



Read the "Water Rule" from your information sheet again. Work with another person and draw up a list of five other water rules you think people should live by.

Activity 6 — Science

Look back at the diagram "Hydroelectric Power Generation." Study this diagram and research in the library for other diagrams explaining how water provides energy.

- Either using a simple diagram or by building a model, demonstrate how a hydroelectric power dam works.

Activity 7 — Environmental Studies

Different households or families use varying amounts of water. There are different reasons for this. Read through the list of factors below and write at least one sentence to explain how each might affect the use of water. For example, in the category "What the family owns," you might write:

If the Martins did not own a swimming pool they might use less water in the summer months.

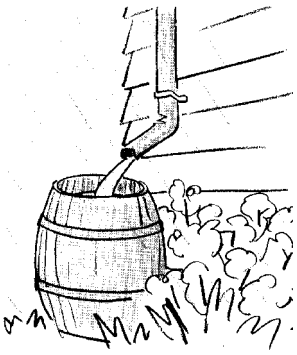
Factors:

- number of family members
- ages
- size of family property/yard
- what the family owns
- some family activities
- time of year

Activity 8 — Environmental Studies

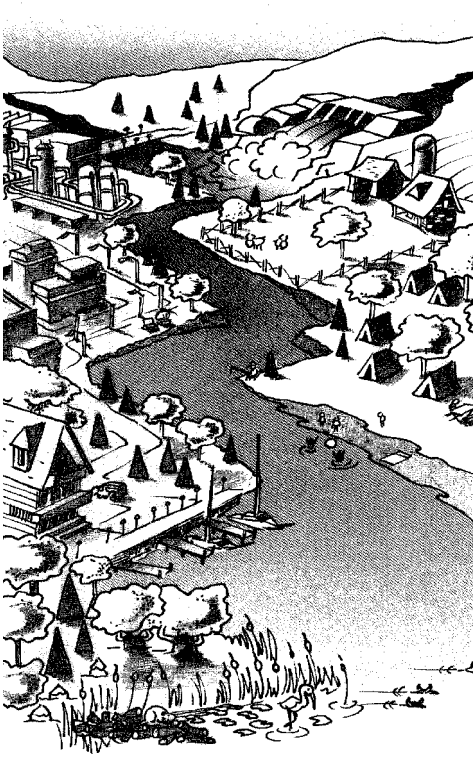
You've heard about harvesting crops and harvesting fish from the sea. What about harvesting water? Some families catch water in a rain barrel or other large container — harvesting water which falls on the roof of their homes during a rainfall. They use this to water their lawns or crops, or to wash their cars and sometimes for their clothes.

Talk to your parents about how you could do this at home and what you could use this water for. Why would you do it?



TOPIC 4. WATER WORKS!

Chapter 4(B): What Will This Cost Me?



Purpose

To have students recognize that Canadians get a real bargain with their water and to explore whether we would use and waste less if we had to pay a more realistic cost.

Subject areas

Math, Social Studies, Language Arts, Geography, Art, Environmental Studies

Procedure

1. Ask the students, "Why do you have to pay for water anyway? After all, water is all around us." Find out if they have any idea how much they pay for water now.

    - Remind them to ask their parents tonight how much water costs for their household.

2. After they have read the Student Information sheets, discuss the different activities together and help them interpret the charts if there are any problems. Each chart can lead to a more in-depth discussion about the ways we use water and the price we pay for water in Canada.

    - Point out to the students that in Canada there is a large gap between the cost of providing water to Canadians and the price we pay for water use. This gap will have to be closed and we will have to pay a more realistic price for the water we use.

3. There are a number of math problems with the activities, but you may want to develop more. The charts will help you do this.

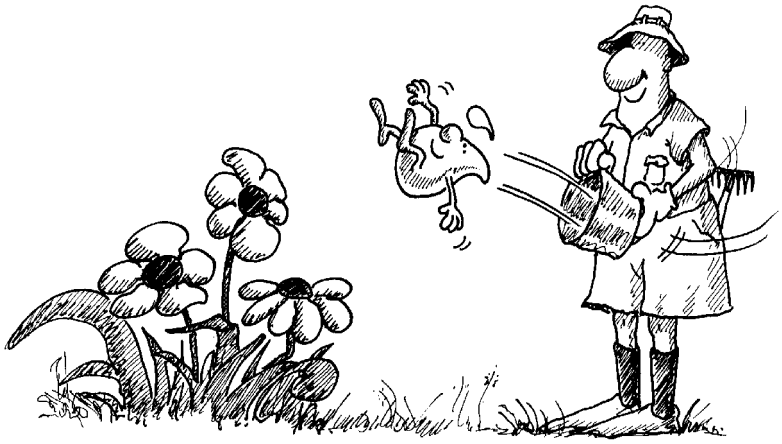
4. If you have research facilities available, you might want to have students try to find out why prices for water are so much higher in countries like Australia.

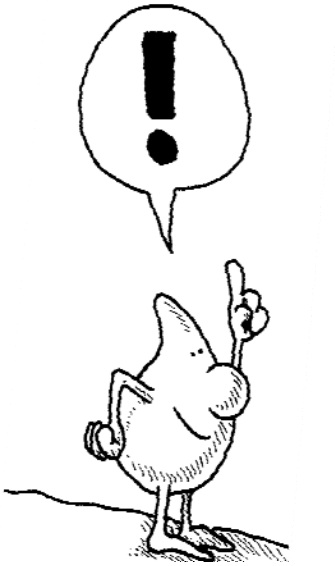
Vocabulary

flat rate	***metered rate***

References

- Freshwater Series A-4: "Water Works!"
- *A Primer on Fresh Water*: "Water — How we use it"
- *Municipal Water Rates in Canada: Current Practices and Prices*





TOPIC 4. WATER WORKS!

Chapter 4(B): What Will This Cost Me?

Pay to use water? You're kidding!

Can this happen to you? It's ten o'clock — still early morning as far as you are concerned and you are on your way from gym to math. You stop to get a drink from the water fountain in the hall. What's this? The fountain has a coin slot! You must be kidding! Who pays for water around here?

How come no one told you about this before?

Your good friend reminds you what the announcements over the past two weeks have been telling you. From now on if you want a drink of water at school, you have three choices: you can bring your own, pay at the fountain, or buy bottled water. Seems you haven't been paying attention. You haven't felt the need until now— when you're really thirsty.

You probably think, “What do you mean, pay for water? It's all around us. Nobody in Canada should have to pay for water.”

It's time to pay for the pipes

Well, somebody has to pay for water. The water you drink and use in school and at home has to come from somewhere that guarantees it is safe for human use. And that costs money. It costs a lot of money to pump, store, move, and treat water, and then to take away the waste. Check at home. You will probably find that there is a monthly water and sewage bill to cover some of these costs. But is it enough?

Several studies show that what Canadians pay for water is not enough to cover costs of operating, repairing, upgrading, or expanding. Right now, across Canada, the water-related infrastructure in many cities and towns is in need of major repairs.

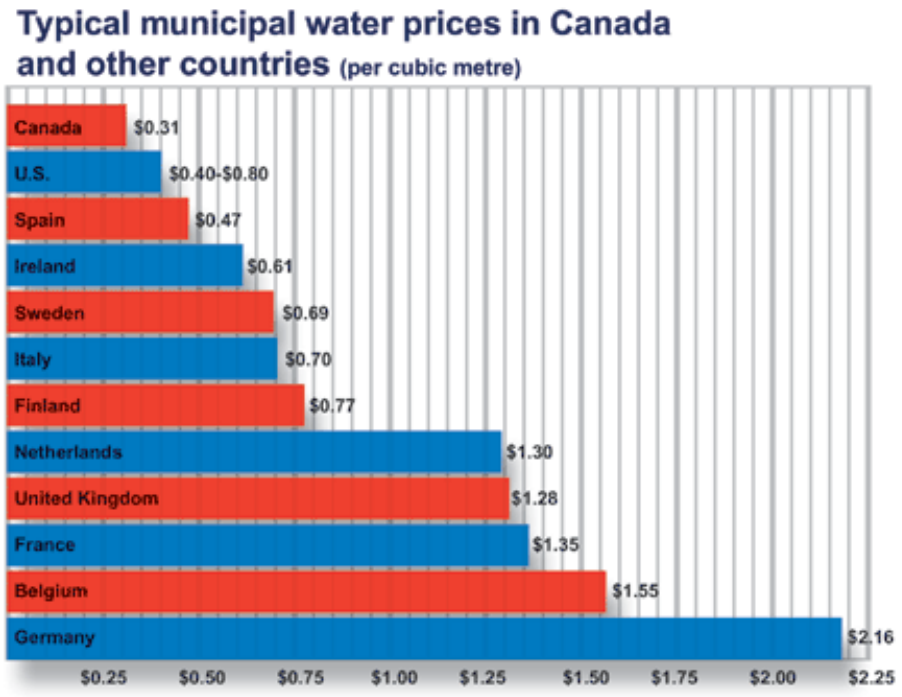
What is infrastructure, you ask?

By infrastructure we mean:

- water and wastewater treatment plants
- water mains and pipes that carry water
- towers and reservoirs that store water
- sewer pipes that carry away wastewater

Somebody has to pay for the upkeep of these utilities; they don't get looked after by magic.

Right now you do pay for water, one way or another. Your household may receive a regular bill charging you for the use of water and all parts of the infrastructure. Or, if you live in a condominium or an apartment, the water and wastewater charge may be part of your monthly fee. In some provinces it is included with taxes. And in rural areas where people own their own wells and septic systems, each individual is responsible for the upkeep of the infrastructure.



How much does this cost?

Water prices across Canada are generally low. The average householder in Canada pays about $33 per month for water delivered to the residence. Monthly bills range between $19 and $52, the lowest being in areas of the west and east coasts, and the highest in the prairie provinces. As you can see from the diagram “Typical municipal water prices,” Canadians pay less than many other countries for their water.

There are four basic ways that Canadians pay for water use:

1. Flat Rate — all customers pay the same amount whether they use the same amount of water or not. This does not encourage conservation because the careful water watcher pays the same amount as the water waster. Doesn't seem fair, does it? In 2001, 32% of people in Canada are charged the flat rate.

2. Constant Rate (commonly called the metered rate) — here you pay for each unit of water that you use. With this system, you are more likely to monitor water use. In 2001, 40% of Canadians pay a metered rate.

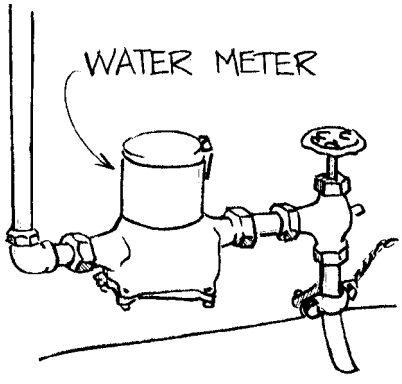
3. Declining Block Rate — this method does not encourage water conservation. It means that if you are a big user of water, you pay less per "block" (or specific volume) as you get beyond the first blocks. Eight percent of people in Canada pay a declining block rate in 2001.

4. Increasing Block Rate — this method is just the opposite of the declining block rate. It means that if you are a large consumer of water, for example, some industry, then you will pay increasing rates as you use more volumes of water. Twenty percent of Canadians payed this rate in 2001.

The two most common ways of charging for water use are constant or **metered rates** and **flat rates**. Which rate scheme would you encourage?

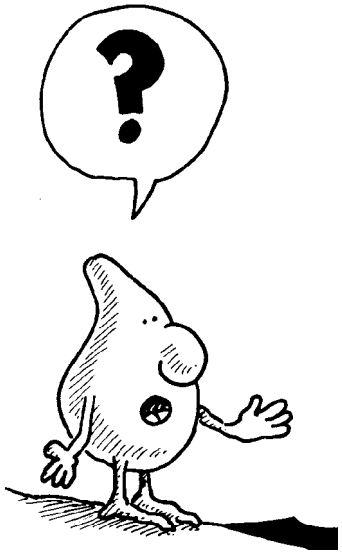
What is a fair price?

Think about how important water is to our lives. We rely on a good supply of water, and our health depends on safe water — yet even now we do not pay the true cost of water. On average, we in Canada pay $1.14 for 1000 litres (which includes the cost of waste treatment) — a bargain at twice the price. If you don't think so, compare the price of good water from your tap with what people pay for bottled water: approximately $1500 for 1000 litres. Over a thousand times as much!



So what do we do to close gap between what we do pay and what we should pay to cover the cost? One clear way to with the problem is to pay a realistic price for the we use. This means that those who use more should pay more — also means that our use should be metered because comparisons show those with metered use less water than households with flat rates.

A lot of the water we use this in our households is wasted by such things as leaky faucets, faulty plumbing, and overuse of deal water for watering the lawn and washing the car. water Much of this waste could be reduced if we had to water pay a fair price for water. which You would tend to think water twice about leaving the hose running if you knew it was valuable water going rates down the drain.



TOPIC 4. WATER WORKS!

Chapter 4(B): What Will This Cost Me?

Activity 1 — Social Studies

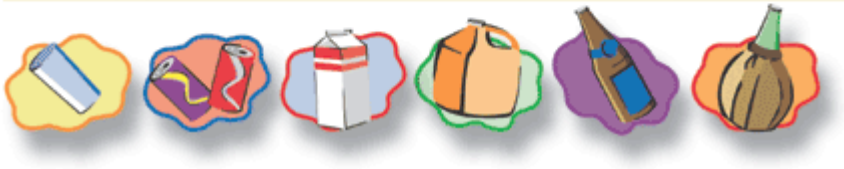
Some cities and municipalities have meters which tell exactly how much water you use. And this is what you are charged for. Others have a flat rate, which means that no matter how much you use, you still pay the same amount. Which do you think is the better system? Why?

In Alberta, Edmonton households are metered, while most Calgary households pay a flat rate. A study which compared use in both cities showed that the unmetered houses used 50% more water. The study also showed that metered users in both cities used about the same amount.

- Why do you think the unmetered houses used more water?
- Do you pay a metered or a flat rate?
- Find out what your monthly water and sewage bill is.
- Do you think we should pay enough for our water use to cover the full costs of water delivered to the tap and taken away as waste?
- Even at twice the price, water is still the best bargain around compared to other liquids we drink. (Look at the table on the following page.) Would your family be willing to pay more for water?

Typical prices for popular beverages
($/1000 litres)

Beverage	Cost *
Tap water **	1.14
Cola	850.00
Milk	985.00
Bottled water/Mineral water	1 500.00
Beer	2 500.00
Wine	9 000.00
Whiskey, gin…	26 700.00



* All amounts are in 1992 Canadian dollars.
** Only tap water includes automatic delivery to the user. This figure includes the cost of waste treatment.

Activity 2 — Math

Champagne bath anyone?

Back in the grand old days of Hollywood, people used to talk about celebrating by taking a bath in champagne.

- Look back at the table in Activity 1 showing typical prices for popular beverages. (Champagne is a type of wine, only generally more expensive.)
- Figure out how many litres of liquid bathtub holds. Brainstorm with your group or class for ideas of how to do this.
- Then estimate how much it would cost for a champagne bath, a bath in milk, or a sticky bath in cola.
- Compare this cost with a good old water bath.
- Using the chart, make up two math problems for other students to solve.
- Look at the cost of bottled water. your How much would it cost to take a bath in bottled water? (Talk about really taking a bath!)

Activity 3 — Math

1. Study the diagram from the Student Information sheets which shows water prices in different countries and make up 10 math problems. For example:

   - True or False: Canada and the United States together pay less than France.
   - How many times does Canada's price divide into Australia's?

2. Using another type of graph or diagram, show the same information from the bar graph.

Activity 4 — Geography, Research

Ask your teacher for a blank map of the world. Using an atlas, find each of the countries from the diagram used in Activity 3 and on your blank map enter the price each country pays for water.

Find out why the prices are higher in three of these other countries.

Activity 5 — Environmental Studies, Art

A fair price for water!

Prepare a bumper sticker or a poster to convince people about the importance of paying a fair price for water used. Some of the themes you can use are listed below, but try to create a really catchy slogan.

- Paying a fair price will encourage us to avoid waste and to use water efficiently — and we will conserve water.
- By conserving water we will produce less waste and this will reduce infrastructure costs.
- The reduced demand will put less pressure on water resources in the environment.
- Fair pricing will bring in money to cover the cost of water supply and waste disposal
- The costs will be shared equally by those who benefit most.

Activity 6 — Art

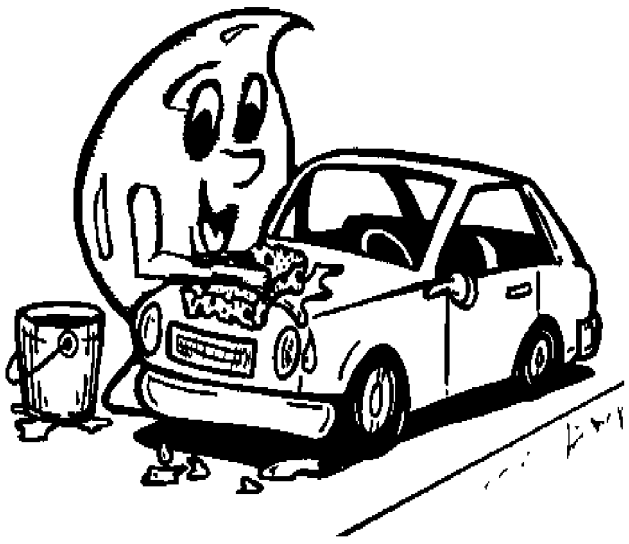
Working alone or with a friend, use pictures from magazines to make a collage of all the ways we use water.

Activity 7 — Environmental Studies, Language Arts

How do you use water?

Make a list of all the ways you have used water during the past twenty-four hours.

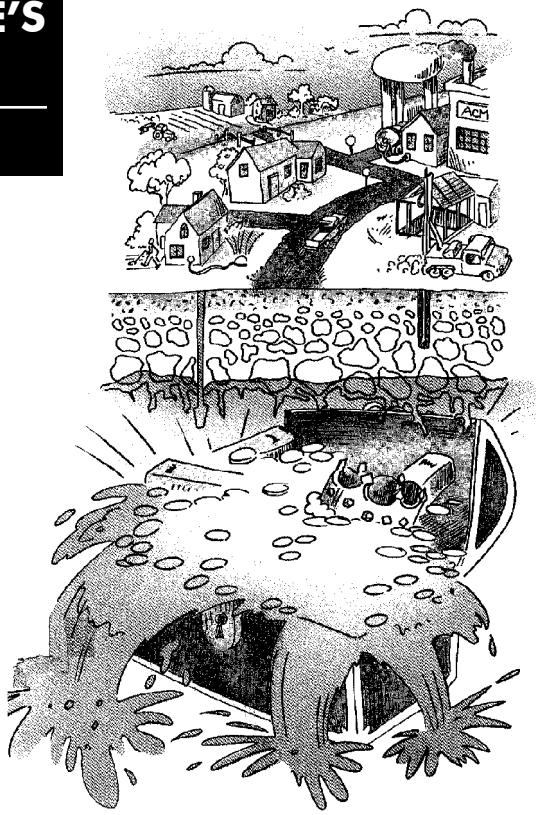
- Write down everything you and your family have done that involved the use of water around your home and at school.
- Divide these uses into two groups: those that are necessary or essential, and those that are nice but you could survive without.
- Write down those uses where you think water was wasted — or where less could have been used.



- Summarize what water means to you by completing the following statement: "Water is . . . ". Compare your statement with those of others in the class.
- Art: Suppose you were trying to tell what water means to you to someone who did not understand your language. Make a drawing to illustrate your "Water is . . ." statement.

TOPIC 5. GROUNDWATER — NATURE'S HIDDEN TREASURE

Chapter 5(A): Groundwater — I Dig It!



Purpose

To help students see the extent and importance of groundwater in Canada.

Subject areas

History, Environmental Studies, Math, Language Arts, Science

Procedure

Review: Remind the students that groundwater is a large part of the hydrologic cycle and the world's water supply. Because we can't see groundwater, we tend to forget about it.

- Groundwater is an essential and vital resource for about a third of all Canadians, yet few of us understand or appreciate its value. Our knowledge about groundwater seems to depend on where we live in Canada.
- Ask the students if they have ever drunk water from a well. Try to find out how much they know about groundwater before distributing the information sheets.

Vocabulary

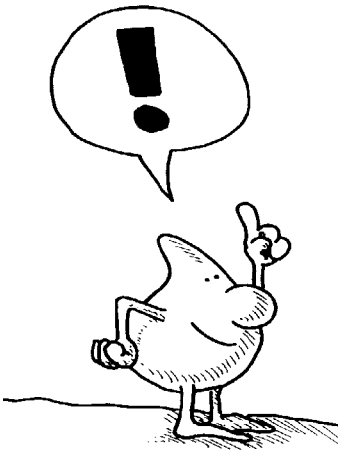
aquifer *confined* *crevice*	*impermeable* *unconfined* *unsaturated*

References

- Freshwater Series A-5: "Groundwater — Nature's Hidden Treasure"
- *A Primer on Fresh Water*: "Water — Underground"

TOPIC 5. GROUNDWATER — NATURE'S HIDDEN TREASURE

Chapter 5(A): Groundwater — I Dig It!

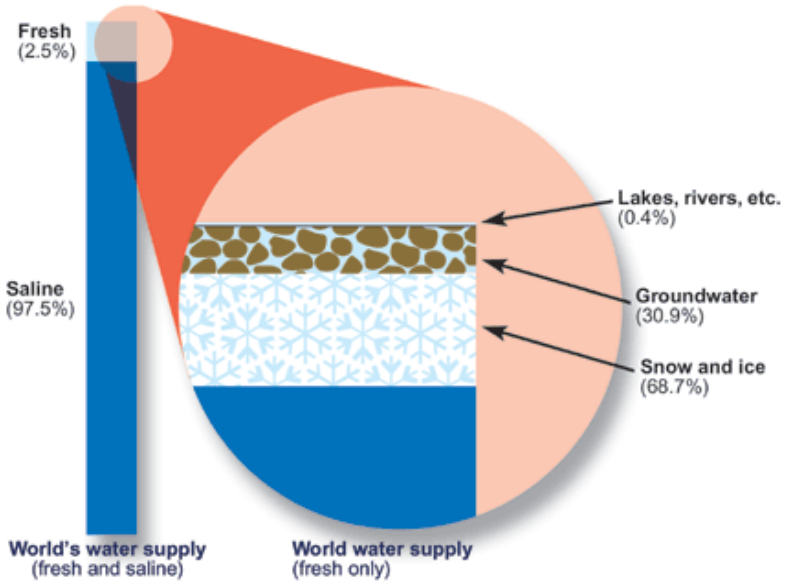


Picture the postcard view of Canada. What do you see? Sparkling blue lakes, long meandering rivers, and glistening white glaciers. Groundwater, which exists everywhere under the surface of the land, is not part of this picture. And because it is "hidden" from view, we tend not to think of it too much, instead we concentrate on the quality of our beautiful lakes and rivers. The question is, should we be concerned about groundwater quality since there is so much of it and since it is protected by ground cover? What do you think?

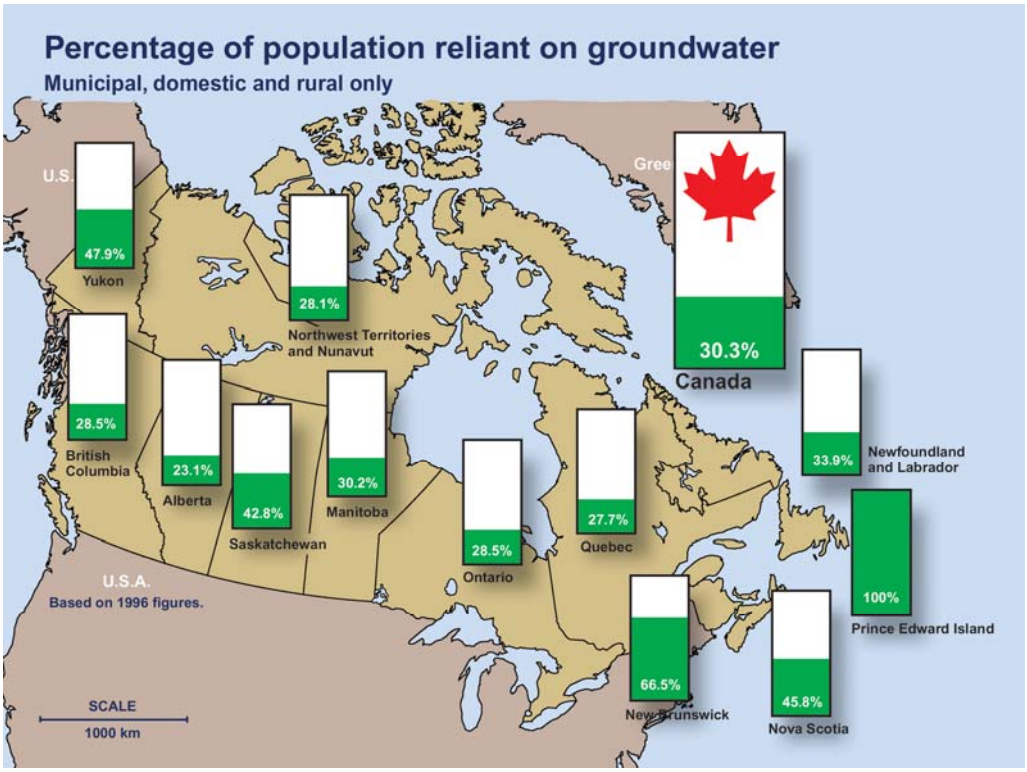
What's going on down there?

About one third of all the fresh water in the world is found underground! Just think, that's twice as much as we can see on the surface. Look at the diagram "Groundwater and the world's freshwater supply" to get an idea of the amounts.

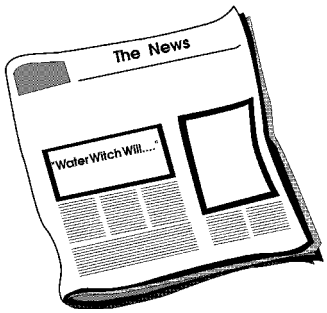
Groundwater and the world's freshwater supply



Over one quarter (30.3%) of Canadians rely on groundwater for all their daily needs. If you look at the diagram of Canada below you can see which areas depend entirely on groundwater and which regions hardly use it.



Water witches??



Your Current Events class this afternoon has set off a special spark of interest in you. As you thumb through the newspaper looking for headlines of noteworthy events in the world, your eyes light on the following:

> **Water Witch Will Find Water For You**
>
> Using the latest "divining rod," this water witch will point out the best place to dig a well on your property!

Come on now, water witch? Divining rod? Pointing to water in the ground? Sounds like one of these headlines you read at the grocery checkout.

Believe it or not, many people will not start to dig a well until they have called in a water witch, or diviner, to locate the spot where they are likely to find water. A water witch will use a steel divining rod or a forked stick (or even a clothes hanger!) and walk back and forth over the property. When the rod twitches or vibrates over a certain spot, this means there is groundwater below. Fact or fiction? Check it out with older people in your area. You may be surprised by some of the stories you hear.

Whether water witches can locate the best spot to dig for groundwater or not, the fact is that there is lots of groundwater beneath us. Even under deserts!

Did You Know?

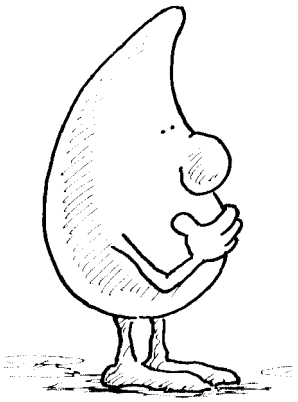
Groundwater provides nearly all the water used to raise livestock in Canada.

Groundwater flow

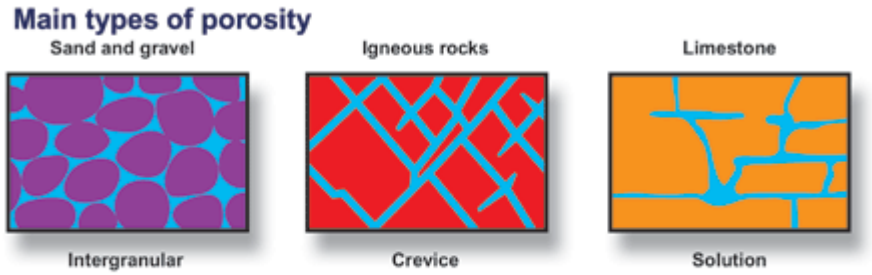
We know that groundwater moves underneath the soil because it is part of the hydrologic cycle, but just how fast does it flow?

Groundwater flows through the soil at different rates: it may move quickly, depending on the kind of soil it is in, but fast flow is unlikely; it can move as slowly as 10 centimetres a day and travel only 1 to 2 kilometres a year; or, one water molecule can be in the ground thousands of years before being discharged.

When you think of groundwater flowing you should know that it does not flow as our rivers above ground do, nor does it collect in underground lakes.

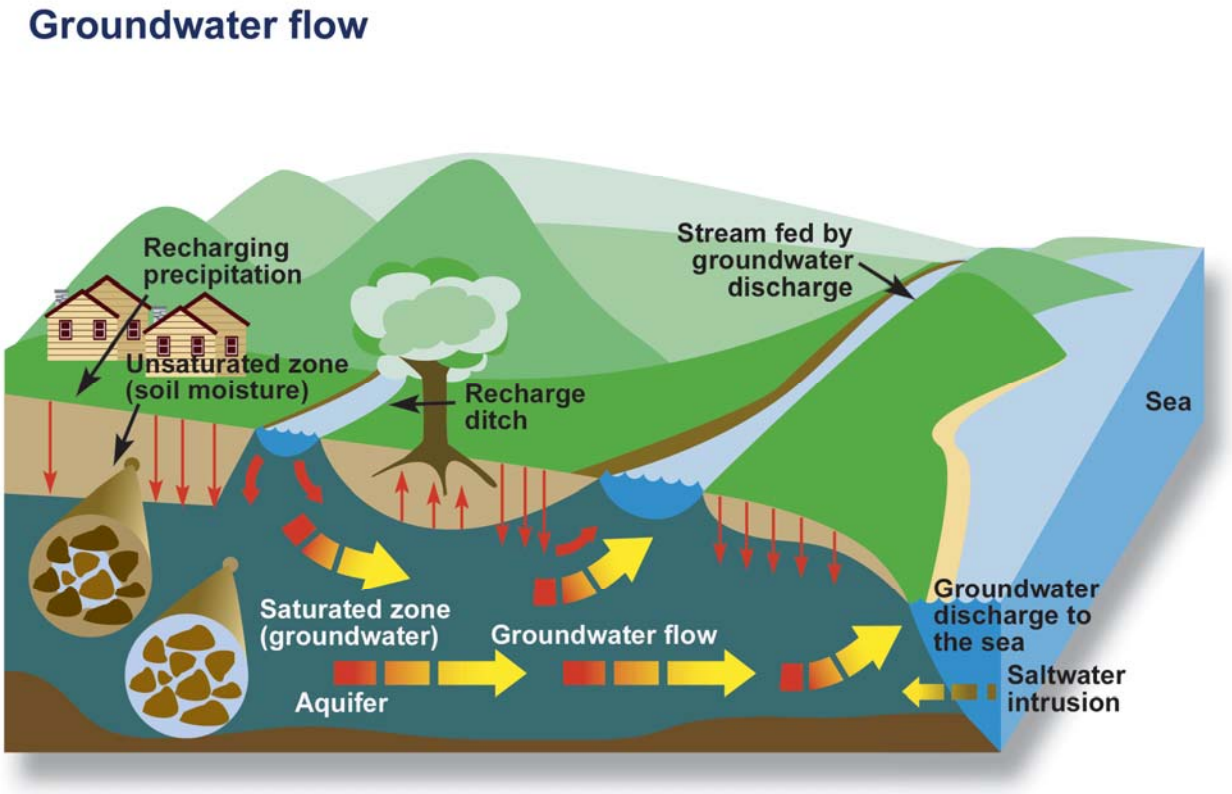


Rather, it is found almost everywhere underground — in the spaces between particles of rock and soil, or in **crevices** and cracks in rock — as you can see in the following diagram.



Where groundwater can be found. It fills the spaces between sand grains, in rock crevices, and in limestone openings.

Look at the diagram "Groundwater flow." In it you can see the **unsaturated** zone, where the spaces in the rock and soil contain air as well as water; and the saturated zone, where the water is called groundwater and it is always on the move.

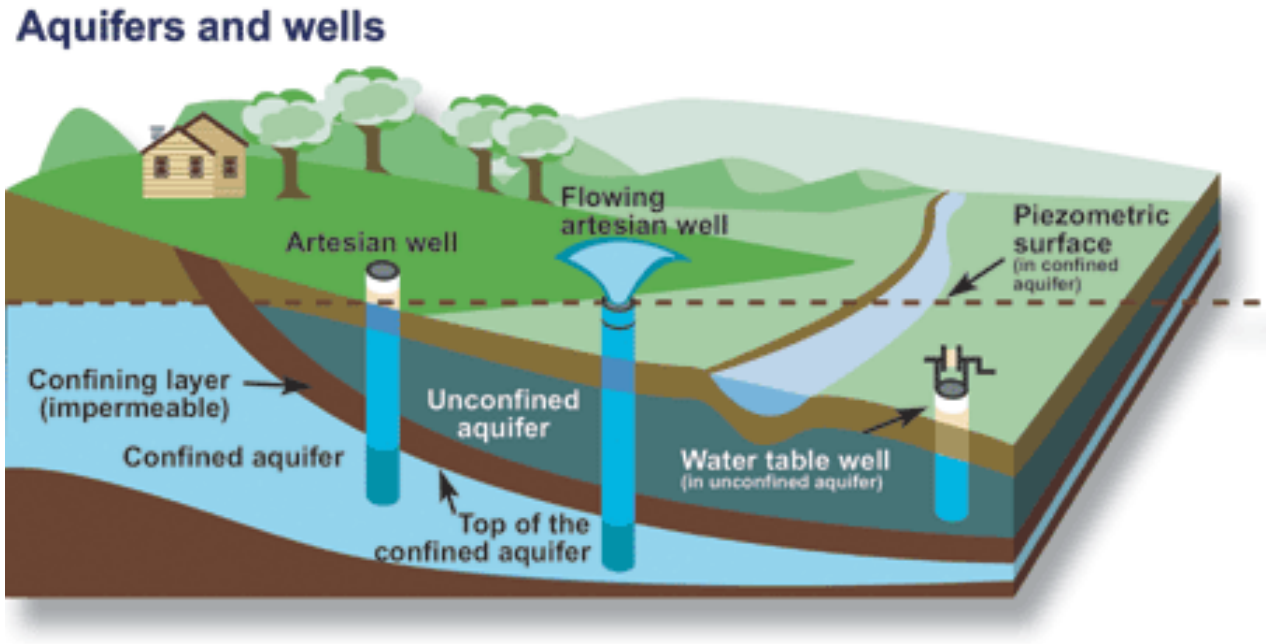


Remember: Although groundwater may move very slowly through the system, it is a very important part of the hydrologic cycle. Eventually it finds its way back to the lakes, rivers, and oceans.

Aquifers

The underground areas of soil or rock where quantities of water are found are called **aquifers**. These aquifers are the sources of wells and springs.

Look at the diagram "Aquifers and wells" and see if you can tell the difference between **confined** and **unconfined** aquifers.



Did You Know?

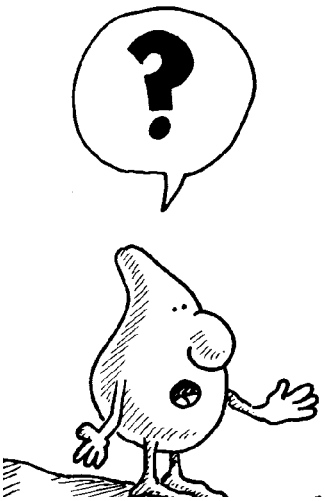
Water can be hard or soft. Groundwater tends to be harder than surface water because it has been filtered through soil and rock, picking up some minerals from the process. Which do you think would make it easier to work up a good lather in the shower or bath — hard or soft water?

What is a water table?

That's what we call the top or surface of the groundwater supply. Water progresses slowly down through the sand and gravel until it comes to **impermeable** rock where it can't go any further down because the rock is watertight. Above this rock is the groundwater supply or the saturated zone, and the top part of that supply is the water table.

TOPIC 5. GROUNDWATER — NATURE'S HIDDEN TREASURE

Chapter 5(A): Groundwater — I Dig It!



Activity 1 — Math and Research

Check back to the diagram "Percentage of population reliant on groundwater."

- Show these percentages on a graph.
- Research: Find out how many people live in Canada. How people live in each and territory? Based on the percentages of groundwater users provided, calculate how many people from each province rely on bar groundwater supplies.
- If there is an average of four persons per household, how many many households rely on province groundwater?
- Make up five math problems based on your research.

Research: Why do so few people in the Northwest Territories use groundwater? Why is this so different from the Yukon? Why does everyone in Prince Edward Island use groundwater?

Explain the use of groundwater in your own province or territory. Do you have lots of other sources of supply?

Activity 2 — Local Research

Which witch is the water witch?

As mentioned earlier, it might be interesting to find out if people in your area have ever used "witches," or "diviners," to locate good places to dig wells — especially if you live in a rural area, or if your parents and grandparents have come from a rural area.

You may find out other beliefs or superstitions which have some truth in them.

Interview people from the community. Ask them about water witches, or diviners, and find out if they have heard about them. Come back and report to the class what you have learned.

If you can find someone to give you instructions, try your own hand at being a water witch.

Activity 3 — Science

Groundwater occurs in the tiny spaces between soil particles (silt, sand, and gravel) or in cracks in bedrock, much like a sponge holds water. The underground areas of soil or rock where abundant quantities of water are found are called "aquifers," and this is where we find the sources of wells and springs which provide water for 30% of Canadians.

1. Demonstrate how much water can be held between grains of sand:

    - Fill a container with sand and gradually pour in water. You will be surprised at the amount of water a "full" container can hold.

2. Test to find out which soil is the most absorbent: sand, gravel, potting soil, or clay. This will also show you which soil is easier for water to travel through quickly. (Just for review, *absorbent* means that something will hold water.)

What you will need:

- 4 beakers the same size (or you can use funnels with cloth covering the hole)
- 1 beaker to hold 500 mL of water
- four kinds of soil: sand, gravel, clay, potting soil
- water

What to do:

- Fill each of your beakers three quarters full with sand.
- Put 500 mL water in the water-beaker.
- Pour water into the sand until the soil is saturated. Record the exact amount of water the sand absorbed.
- Top up the water beaker to 500 mL three more times and repeat the same step with the clay, the gravel, and the potting soil.
- Show the results on a bar graph.

Which type of soil is the most absorbent?

- Do you think the results will be the same each time you do the experiment?
- Report your findings. Write a sentence for each of the different kinds of soil. Find out what kinds of soil can be found in the area where you live.

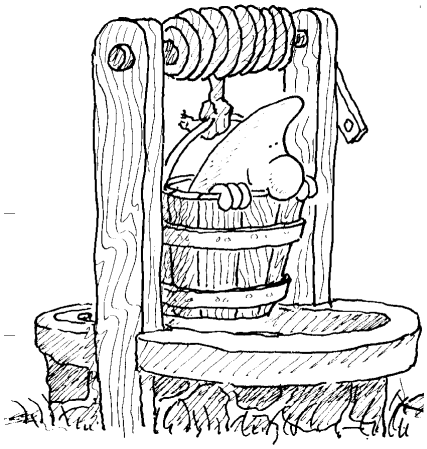
Activity 4 — General

Look at the diagram "Aquifers and wells." Explain the difference between confined and unconfined aquifers. What is an artesian well?

Activity 5 — Historical Review

You have just met a very befuddled water molecule who has recently been discharged from an underground source. The water molecule is having trouble understanding all the changes that have occurred in Canada during the past 300 years.

- Your assignment is to review what the water molecule has missed. Explain the changes and events clearly so that they can be easily understood.



- Brainstorm together. What areas need to be covered in your review? For example:
  - Who lives in Canada? Where people come from?
  - What historical events have happened in 300 years. Make a time line.
  - What has happened in science? Technology?
  - What are recreational uses of water?
  - What about living accommodations? Cities? Transportation? Boats? Water did ways? Roads? Water contraptions like taps, showers, pipes, toilets, dishwashers?
  - Explain new sources of water pollution and the need for water treatment plants
  - Identify other areas that need to be explained.

Activity 6 — Environmental Studies

Contact your local Department of Health to find out the regulations controlling the drilling of water wells in your area. Write a report, create a chart, or make a presentation to the class.

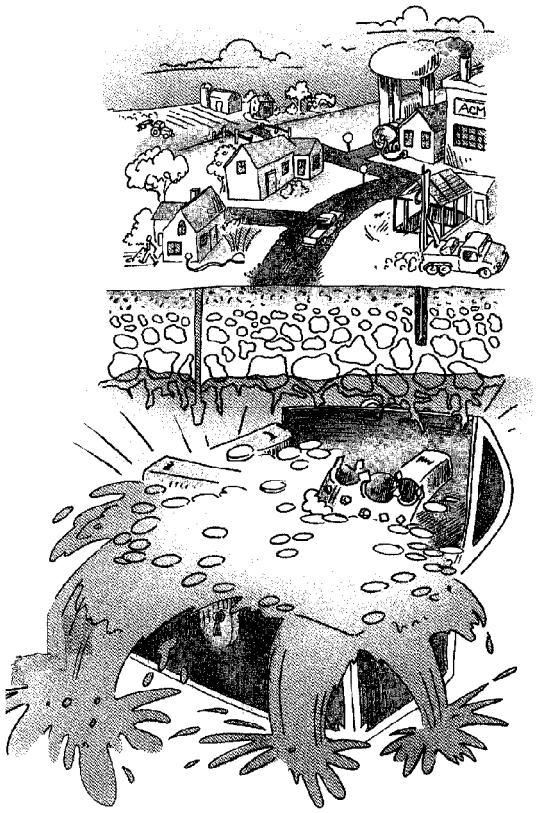
Activity 7 — Research

Do you know what a "sink hole" is? If you lived in parts of the United States like Texas or Florida, you might be familiar with one. Sink holes occur where there is not enough water on the surface to support the people who live there, so they keep pumping up the underground supply. Unfortunately, the underground supply only contains so much water; the groundwater supply is depleted (or mined) and the ground sinks.

Find out more about sink holes. Have there been any around where you live? Explain. What can be done to prevent sink holes?

TOPIC 5. GROUNDWATER — NATURE'S HIDDEN TREASURE

Chapter 5(B): Groundwater — Why We Should Be Concerned



Purpose

To help students grow aware of how we threaten our supply of groundwater and to consider ways we can lessen the stress on this resource.

Subject areas

Science, Environmental Studies, Art

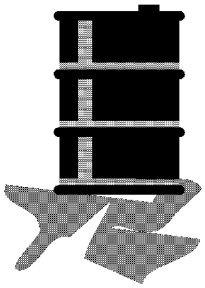
Procedure

1. Review groundwater with the students. Point out that it's easy to believe our groundwater supply is safe from the pollution which affects surface water, but this is not the case. Just because we can't see groundwater, doesn't mean we aren't affecting its quality.

- We need to take precautions to protect groundwater because there are many threats to its purity — some of these threats are from people and some from natural causes.

2. Brainstorm with the students for possible threats to the groundwater supply. Ask how their own households contribute. Depending on where they live, some of the following topics may be discussed:

- leaky sewer lines
- septic systems
- leaky oil tanks or pipelines
- spills/leaks from industrial chemicals



- landfills
- mill tailings in mining areas
- chemicals for preserving wood

Understanding the quality of groundwater and how it becomes polluted is important because:

- it is difficult to identify the sources of groundwater pollution and when we do find pollution, it is difficult to clean up. Why? It is not easily accessible and it travels slowly
- it is easier to prevent pollution than to clean it up
- we need to understand that what we do now will help ensure that our children and grandchildren will not have a problem.

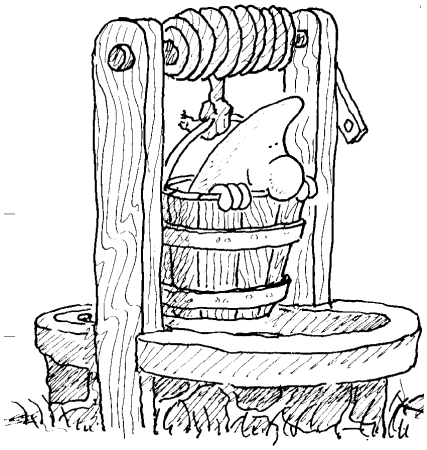
3. Discuss "orphan" wells. There are thousands of these across Canada where the wells have run dry and they have been left open — to become a source of contamination.

Vocabulary

Anthropogenic	***Potable***
corroded	***saltwater intrusion***

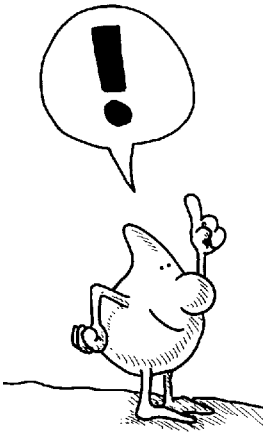
References

- Freshwater Series A-5: "Groundwater — Nature's Hidden Treasure"
- *A Primer on Fresh Water*: "Water — Underground"



TOPIC 5. GROUNDWATER — NATURE'S HIDDEN TREASURE

Chapter 5(B): Groundwater — Why We Should Be Concerned



There's so much groundwater, why worry?

Suppose you are researching groundwater pollution and you come across this sentence: "Groundwater becomes contaminated when anthropogenic substances find their way to the groundwater zone." Huh? What in the world does that mean? It helps when you know that "anthropogenic" means "people-created." The question is, what are the people-created substances that contaminate groundwater?

Read the following story about a small town in Ontario, which could just as easily be a community anywhere.

> Residents of Manotick, a town near Ottawa, can tell you about a groundwater supply that has been polluted by toxic chemicals from an anthropogenic source. The polluted water in some of their households is so bad that they have been told not to shower with the water, let alone drink it. What is the source? Some people are speculating that the chemicals are coming from an old dry-cleaning plant.

Did You Know?

Leaks of petroleum products have been increasing over the past two decades because underground steel tanks installed in the 1950s and 1960s have become **corroded**. This causes about half of them to leak by the time they are 15 years old. Often you will see your local garage closed for repairs as old tanks are dug up and replaced with newer fibreglass ones.

How we contaminate groundwater

Other sources of groundwater contamination include leaky septic systems, landfills, industrial wastes, livestock wastes, mill tailings in mining areas, sludge disposal, graveyards, runoff of salt and other chemicals on roadways, coal tar, pesticides/fertilizers, and atmospheric fallout found in rain and snow.

Groundwater pollution from natural causes

Don't think that people are the only causes of groundwater contamination. Nature adds contaminants too. Some of these are too much iron, manganese, and arsenic; uraninium in bedrock; and **saltwater intrusion**, which occurs when seawater seeps into groundwater near coastal areas.

The good news and the not-so-good news

The good news is that groundwater is generally safer than surface water for drinking because soil and rocks provide natural processes that filter and purify the water. The bad news is that these processes don't work when anthropogenic substances reach the water supply. Other bad news is that since groundwater moves so slowly, once it becomes contaminated, the pollutants take a very long time to leave the system.

The news media often come up with stories about underground pollution which may have started years ago — it's very hard to trace the cause of some pollution (ask the people from Manotick, Ontario). And even if the polluter is identified, the business may have closed long ago, so we can't get the guilty party to pay. Guess who ends up paying?

Cause for concern

So, the message is — we should be concerned about our groundwater supply. Consider the following:

- The health of a million or more Canadians may be affected by drinking contaminated well water.
- It is often impossible to restore polluted groundwater to **potable** quality because it is difficult to reach and it moves so slowly through the soil.
- Since 1979, over 500 wells in New Brunswick have been contaminated by leaking petroleum tanks.
- Organic herbicides sprayed along transmission corridors for power lines have contaminated bedrock wells in Quebec.

Groundwater and deep wells can be contaminated by waste disposal sites as the following diagram shows.

And don't forget "orphan wells"

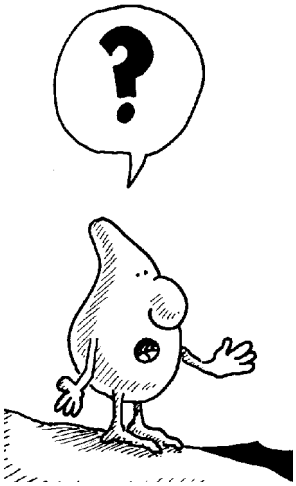
In some parts of the country, people overuse the groundwater supply (or there may be a drought) and this causes the water table to drop. Wells run dry because they cannot reach the water. Some of these wells which run dry permanently are abandoned and are known as "orphan wells." Sometimes, instead of being boarded over, these wells are left open and, unfortunately, some people use them to dump wastes in so they become contaminated. Many of the contaminants find their way back into the groundwater supply.

Are we doing anything about cleaning up the groundwater we have polluted?

All levels of government in Canada are starting to take some actions to protect our water supply, but there is still a long way to go. Although groundwater is hidden, it is just as important as the sparkling lakes and rivers in our postcard image of Canada. Instead of concentrating on cleaning up, we must prevent contamination in the first place. For example:

- leaking underground storage tanks should be replaced by tanks that will not corrode
- landfills should be located where they will not contaminate underlying groundwater

- hazardous materials should not be stored where they can spill into recharge areas
- orphan wells should be boarded up so they do not become handy disposal sites
- what do you think?



TOPIC 5. GROUNDWATER — NATURE'S HIDDEN TREASURE

Chapter 5(B): Groundwater — Why We Should Be Concerned

Activity 1 — Environmental Studies

Your information sheets talk about ways we can prevent pollution of our groundwater. The suggestions are aimed mostly at industries. What can we do in our households? (Some municipalities have already begun helping householders take care of waste materials.)

- Draw up a list of things we can do, such as taking hazardous household substances to the waste disposal area.
- Prepare a report or a speech.

Activity 2 — Science

Take another look at natural causes of groundwater pollution:

- arsenic
- iron
- manganese
- uranium
- saltwater intrusion

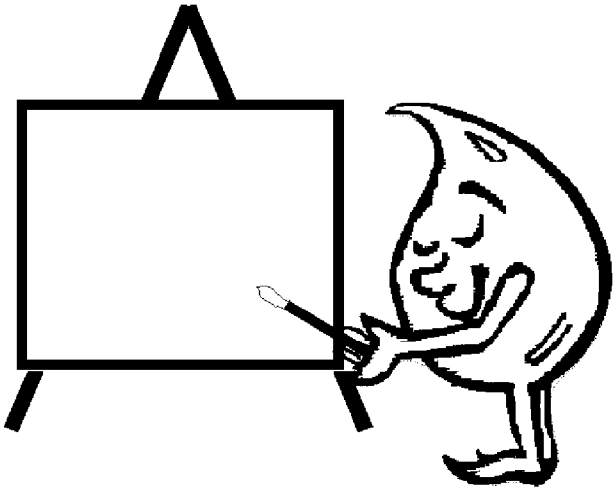
Take one natural cause and research to find out about it. For example, what is arsenic? What effects does arsenic have on people? Or, how can saltwater intrude on groundwater? What's the problem, it's all water, isn't it?

Activity 3 — Art

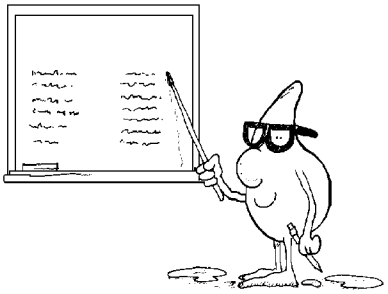
Create your own comic strip character to give tips for protecting our groundwater supply. Use your character in a poster.

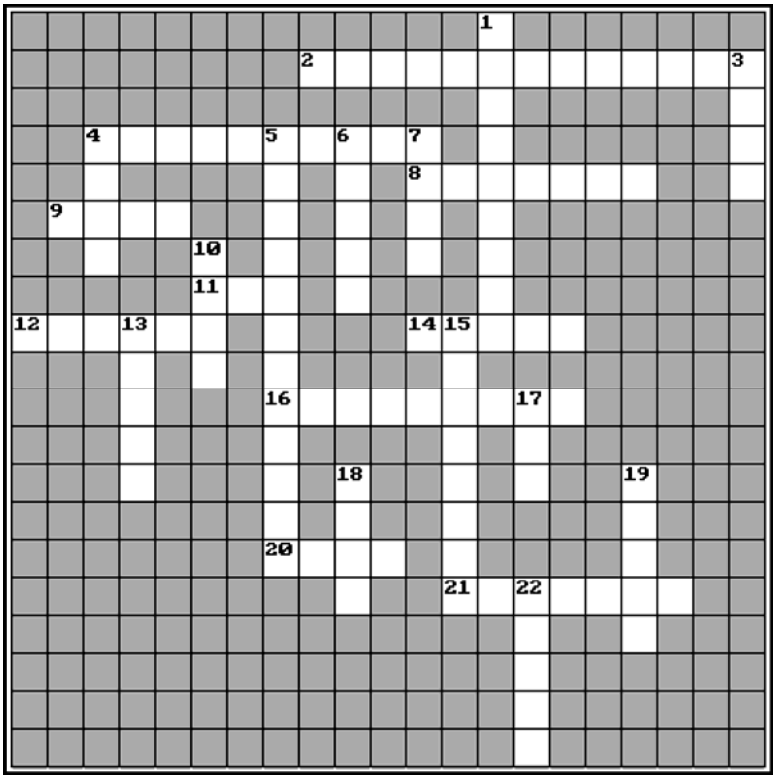
Activity 4 — Environmental Studies, Art

- Look back at the different ways that groundwater becomes polluted and how this affects people.
- Get poster board and markers from your teacher and design posters to inform people about the dangers of pollution to groundwater.
- On your poster show ways that this pollution can be avoided.



TEST 3
Crossword Puzzle





Across

2. Pollution caused by people is called _____ pollution.
4. When water is taken from a stream, lake, etc., and used on land, it is called _____ use.
8. Where water collects underground.
9. The rate at which water moves.
11. Everyone must _____ water wisely.
12. Filtration occurs in a _____ tank.
14. When you use water to get rid of soap, you _____.
16. Saltwater _____ is one source of natural pollution.
20. Pollution can get into groundwater from a _____ in an underground tank.
21. If you pay for the amount of water you use, you are paying a _____ rate.

Down

1. Another word for contamination.
3. The amount we pay for water should cover the of supply.
4. What you dig to find water.
5. When water is used for swimming and sailing, we this use _____.
6. Leftover matter that we consider useless and try dispose of.
7. Sludge is sometimes taken to a _____ fill site for
10. Free from pollution.
13. We _____ water and wastewater to get rid of
15. When water is used in its natural setting, it is this kind of use.
17. The mining industry uses water to separate rocks _____.
18. Charging a _____ rate for water used does not water conservation.
19. Most of our electricity comes from hydroelectric _____.
22. Another word for poisonous.

Fill in the blanks

1. A "water witch" is said to locate water underground with the use of a _____.

2. Groundwater is found in wells and springs which have their sources in _____.

3. The water rate structures which encourage people to conserve water are the _____rate and the _____ rate.

4. Water seeps into the ground through the process of _____.

5. The two basic ways we use water are in its natural setting or _____; and taking it from the stream and using it on land — _____use.

True or False

T F 1. Approximately 75% of Canadians rely on groundwater for their water supply.

T F 2. Groundwater spends about one year underground.

T F 3. If pollution is "anthropogenic," this means it was caused by people.

T F 4. During the summer months about half of all treated water is sprayed onto lawns.

T F 5. Most Canadians who pay for their water, pay a flat rate.

T F 6. Both instream water users and withdrawal users can contaminate the water supply.

T F 7. On average, Canadians pay $500 per 1000 litres of tap water.

T F 8. People who live on the prairies pay the highest costs in Canada for their water.

T F 9. Two-thirds of all the fresh water in the world is found underground.

T F 10. Impermeable rock is rock which lets water filter through.

Question Time

List five causes of groundwater pollution:

1. _____
2. _____
3. _____
4. _____
5. _____

What are two examples of withdrawal use?

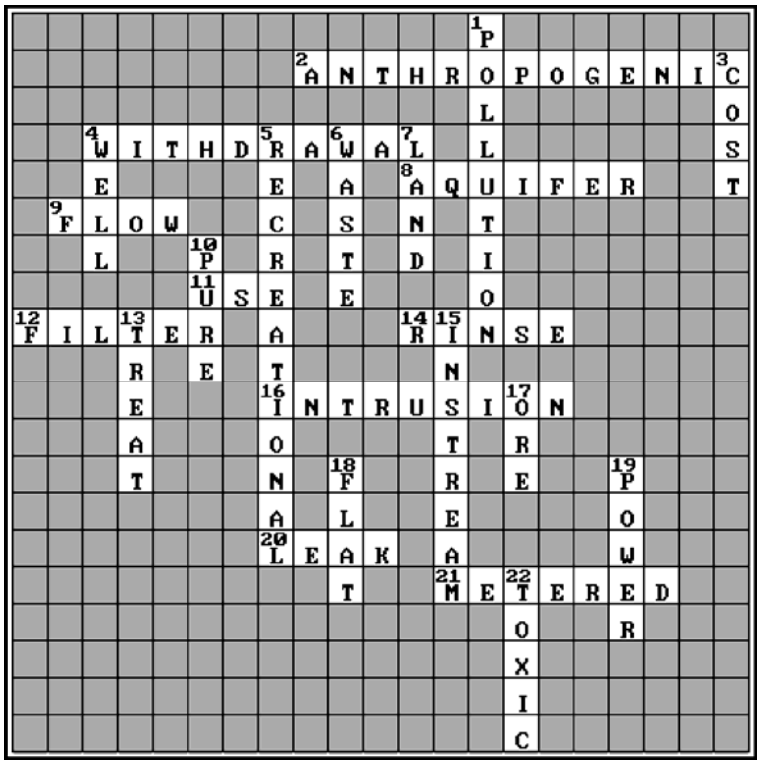
1. _____
2. _____

What are two examples of instream use?

1. _____
2. _____

Describe one simple way to prevent groundwater pollution.

TEST 3
Crossword Puzzle



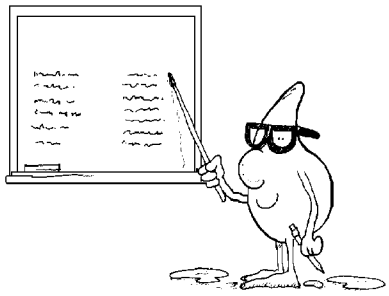


Figure 1

Fill in the blanks

1. A "water witch" is said to locate water underground with the use of a **divining rod**.
2. Groundwater is found in wells and springs which have their sources in **aquifers**.
3. The water rate structures which encourage people to conserve water are the **constant** or the **metered** rate and the **increasing block** rate.
4. Water seeps into the ground through the process of **percolation**.
5. The two basic ways we use water are in its natural setting or **instream**; and taking it from the stream and using it on land — **withdrawal** use.

True or False

1. **False**. Approximately 26% of Canadians rely on groundwater for their water supply.
2. **False**. Groundwater can spend days, months or hundreds of years in the ground.
3. **True**. If pollution is "anthropogenic," this means it was caused by people.
4. **True**. During the summer months about half of all treated water is sprayed onto lawns.
5. **True**. Most Canadians who pay for their water, pay a flat rate.
6. **True**. Both instream water users and withdrawal users can contaminate the water supply.
7. **False**. On average, Canadians pay $1.14 per 1000 litres of tap water.
8. **True**. People who live on the Prairies pay the highest costs in Canada for their water.
9. **True**. Two-thirds of all the fresh water in the world is found underground.
10. **False**. Impermeable rock is rock which keeps water from filtering through.

Question Time

Possible responses:

List five causes of groundwater pollution:

- leaky sewer lines
- septic systems
- leaky oil tanks or pipelines
- spills/leaks from industrial chemicals
- landfills
- mill tailings in mining areas
- chemicals for preserving wood
- pesticides/herbicide use

What are two examples of withdrawal use?

- thermal power generation
- agriculture
- manufacturing
- mining

What are two examples of instream use?

- hydroelectric power generation
- transportation
- freshwater fisheries
- wildlife
- recreation
- waste disposal

Describe one simple way to prevent groundwater pollution.

You be the judge!

TOPIC 6. WATER CONSERVATION — EVERY DROP COUNTS!

Chapter 6

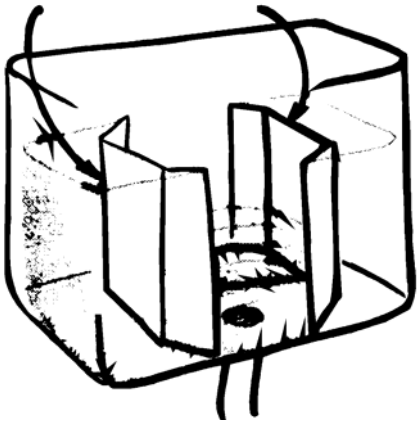
Purpose

To reinforce with students that water is a resource which needs to be used wisely — and this wise use begins with each individual.

Subject areas

Environmental Studies, Language Arts, Math, Art, Science, Social Studies

TOILET DAM



Procedure

The students should finish this chapter with the understanding that water conservation and wise water use begin with each and every one of us. Emphasize with them that we really don't need to use all the water we do. Reducing the amounts of water we use will not change our lifestyles — we just learn to do more with less. We won't even notice reductions which come from water dams in toilets or low-flow shower heads.

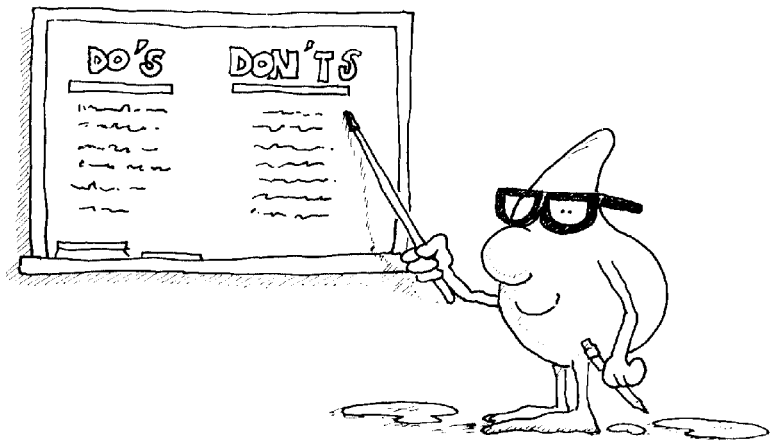
- Stress the importance of water and the ways we take it for granted. Try a variation on the simple experiment outlined in the information sheets. Arrange to have the students carry pails of water over a certain distance without spilling any. So that the water is not wasted, make sure it is used to water a tree or the classroom plants.

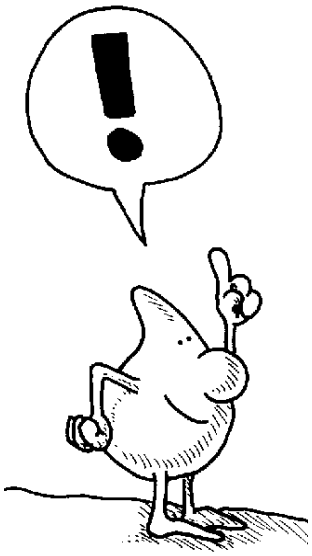
Vocabulary

xeriscaping

References

- Freshwater Series A-6: "Water Conservation — Every Drop Counts!"
- *A Primer on Fresh Water*: "Water — DOs and DON'Ts"
- *Water: No Time To Waste — A Consumer's Guide to Water Conservation*





TOPIC 6. WATER CONSERVATION — EVERY DROP COUNTS!

Chapter 6

Try this

If you want to demonstrate how much we take water for granted, do this simple experiment:

Bring an empty bucket or pail to school or to a friend's house about a kilometre away from your home.

Fill the bucket with water and measure how many litres the bucket contains. Carry it back to your house and be very careful not to spill any water because that's all you get for one day.

Water is heavy, isn't it? And if you lived in some parts of the world you would spend a large part of each day carrying water to your home. These water trips might make you think twice about the way we waste water. We use on average about 335 litres of water per person per day in Canada — more than twice as much as Europeans — and much of this water we use is wasted.

Now, about the water you carried home — don't allow yourself to touch any other liquid for one day. Keep a record of everything you use water for during that day. (Don't forget to include water used for cooking — whether you do the cooking or not.)

How important is water?

Just as our bodies need blood (which is 82% water) to live, so does the planet need water. As we learned earlier, we could not exist without water:

- our bodies are about two-thirds water
- all living creatures and all fruit and vegetables need water
- water is home to all kinds of life forms

Yet we take it so much for granted.

We are lucky in Canada. We have lots of water, but even our supply is not endless! It seems that as our population grows, we develop more and more ways to use and pollute our water supply. But our population does not have to grow by much to use a lot more water — in the decade between 1972 and 1981, the population grew by only 5%, but our water use grew by 50%!

As Canadians, we can usually depend on a safe steady supply of water gushing into our homes every time we turn on a tap. This simple fact makes us the envy of many nations in the world where limited water supply and polluted water often make the difference between life and death.

Conservation or wise water use.

Most people hear the word "conservation" and they immediately think of major changes in their lifestyles, especially in the area of water. Not so. Simply stated, conservation means doing more with less. With very few changes in the way we live our lives, we can reduce the water we use in our households by 40%. Think about it. If your family paid $200 for water use last year, that would mean a saving of $80!

A review of why we pay for water

Remember (if you live in a municipality with water purification and wastewater treatment plants) that every drop of water coming from your tap has been treated to keep it safe for drinking. That's expensive.

And also remember that every drop of water going down the drain, whether you actually used it or wasted it, has to be treated again. Unfortunately, water molecules can't say, "Hey, I'm clean. Don't waste your money giving me the treatment!" They get whooshed to the treatment plant along with the dirty water molecules. And that costs money.

Think About This

Much less than 1% of the water produced at a large municipal water treatment plant is used for drinking purposes. You don't have to be a rocket scientist to figure out that a lot of money is wasted purifying water that we just flush away.

How do we use water in our homes?

This is not a classroom survey, but in all likelihood, you probably shower or bathe regularly. However, if you had grown up during your great-grandparents' time, you might have had a weekly scrub on Saturday whether you needed it or not. And, if you lived in some countries, even today, you would be very lucky to get enough clean water to drink, let alone having the luxury of standing in a shower and letting all that water run down the drain.

Think about all the ways water is used in your home. For example:

- cleaning the house
- washing clothes
- flushing the toilet

- cooking
- showering and bathing
- watering the lawn
- washing the car

Facts on Water Use In and Around Our Homes

- Canadians use an average of 335 litres of water each day for household and gardening purposes. The United States uses 380 litres; Israel uses 135 litres.
- Only 10% of our home water supply is used for drinking and cooking.
- About 65% of indoor home use occurs in the bathrooms.
- Toilets use 40% more water than needed.
- The greatest water use occurs in the summer when about half to three quarters of treated water is sprayed on lawns.

How do we change our habits and lifestyles?

It's very simple. Let's start with the bathroom — the room in the house where, on average, each of us flushes 175 litres of water a day down the drain. And, combined with baths and showers, it is the room where about 65% of our indoor water use occurs. While you are looking at water use in the house, check out the kitchen and the laundry room. You can probably see lots of ways where you can conserve water in these rooms
too.

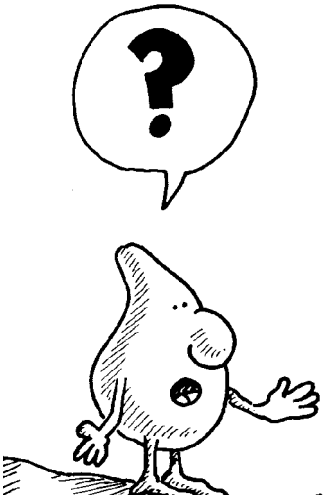
And, what about your lawns and gardens? We read earlier about the waste of water on our lawns. Did you know there are lots of plants and shrubs, as well as landscape design, that don't need lots of water? Find out about the use of sprinklers — for example, "oscillating" sprinklers lose a lot of water to evaporation, especially on a hot day.

Do you water your driveway? Lots of people use a hose to wash off dirt in the driveway. It's hard to think of a more wasteful use of water around the home! Just think, good clean water, fit to drink, is flowing down the driveway straight into the storm sewer.

Give your car a sponge bath. Don't wash your car with a running hose, using about 400 litres of water a car wash. Use a bucket of soapy water and then hose the car off quickly with a trigger nozzle on your hose. Save yourself 300 litres of clean water.

There are many, many ways we can conserve water. And these ways can all be started at home. Water conservation benefits us all in the long run. It lowers our water costs, reduces health risks, extends the useful life of our infrastructure, and protects our water resources, now and in the future.

> "*Anyone who has gained any pleasure at all from nature should try to put something back.*" — Gerald Durrell



TOPIC 6. WATER CONSERVATION — EVERY DROP COUNTS!

Chapter 6

Activity 1 — Math

Of the water used in an average Canadian household, approximately 30% is flushed down the toilet. Another 35% is used in showers and baths. Clothes washing takes about 20%. Another 10% is used in the kitchen for drinking, food preparation and dish washing. And, 5% goes for general cleaning around the house.

- If the average Canadian uses just over 335 litres per day, calculate how much water your family uses for each of the above.

- Check your family's water bills for the past year. What was the total volume of water used? How much was used per month? Calculate how much was used per day? How does this compare with your answers above? What is the daily consumption per person in your family?

- The average seven-member family in the Third World uses about 58 litres of water per day. Calculate how much the average four-member family in Canada uses. What is the difference per person?

- Calculate how much water each person in a Third World country would get to use each day. What would you be able to do with this much water? How might your lifestyle have to change?

Activity 2 — Social Studies

1. Brainstorm how many ways your city/community uses water.

    - Make a list. Now, take this list and make two columns, a NEEDS column, and a WANTS column. If you have trouble deciding between the two, consider the following:

      Your town water supply has been mysteriously contaminated. You have to buy water from a truck at $0.25 a litre. Now make your lists. What can you do without or really cut back on?

2. Make the same kind of list for your family's water uses. To help you decide what is most important to you, think about the following:

    There has been a drought and you have to carry your water from a supply area half a kilometre away. Sometimes you have to walk carrying a couple of buckets of water. Think about the ways your family uses water every morning. What water uses would you be able to give up? What habits would you change? (Try carrying two buckets filled with water.)

Activity 3 — Art

Design a bumper sticker, a button, a t-shirt or a poster using a water-wise slogan. For example, "Let's keep it on tap for the future."

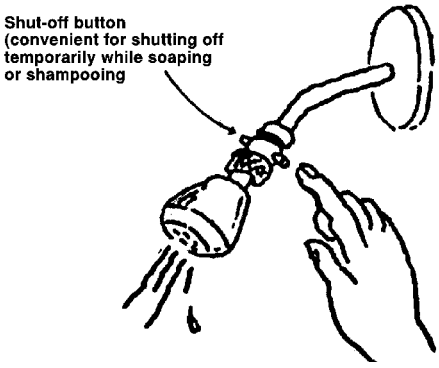
Activity 4 — Environmental Studies

Water conservation comes down to four simple R's: reduce, repair, recycle, and retrofit.

- Take each of the R's and write out one rule you and your family can create to use water wisely and save water, money, and energy.

Look at the following list and check off the water-saving measures you already take in your house:

- replace your toilet with a low-flush toilet using about 50% to 80% less water per flush
- put "toilet dams" (or other "displacement devices") in your toilet — but don't use a clay brick, it can dissolve
- don't use the toilet as an ashtray or a garbage disposal
- take a 5-minute shower
- don't waste water in an overfilled bathtub



- replace your shower head with a low-flow model
- install aerators on your faucets
- repair drips in the taps
- don't keep the water running while you are brushing your teeth
- check your toilet tank for leaks. A leak of only one drop per second wastes about 10 000 litres of water per year. Put food colouring in the tank — if without flushing the colour appears in the bowl, you have a leak that should be repaired promptly.

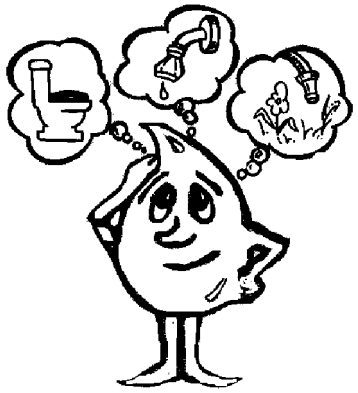
What about your kitchens? When you go home tonight, ask your parents to sit down with you and look at ways the whole family can cut down on water waste in the kitchen. For example, instead of letting the water run to get cold water for a drink, keep a bottle in the fridge. Prepare a checklist like the one above for the kitchen or other parts of your household.

Activity 5 — Language Arts

Write a book for younger children

- Write a book about a water character who spreads a "wise water use" message. Use a catchy title, for example, "Squeaky Clean Fights the Grunges."

- To get started: look at children's books in the library and ask teachers of kindergarten and grade one about the kinds of books younger children like best.



- Hints for your book:

  - Be colourful. Remember how you used to like bright pictures.
  - Don't make your story too long.
  - Plan a simple story line and keep the message simple.
  - "A picture is worth a thousand words." Keep that old saying in mind — don't use too much text.

When you have finished

- Ask a teacher if you can read your book to a kindergarten or grade one/two class.
- Ask the librarian to display your book.

Other ideas

- Have a book-writing contest in your class.
- Do you have a computer? Perhaps you could input your text and lay out your own book.

Activity 6 — Math

A five-minute shower with a standard shower head uses 100 litres of water. A five-minute shower with a low-flow shower head uses 35 litres of water. Make up five math problems using this information. Here are a few to get you started:

- If your family has four members, how much water can you save in one day using a low-flow shower head? In one month? In one year?
- If the cost of water (including water treatment) is $1.14 for 1000 litres, how much money will a low-flow shower head save your family?

Activity 7 — Social Studies

What If?

Choose one of the following situations and explain what you would or could do:

- Your neighbours are washing their car and keep the hose on while water is running down the street.
- You are at a restaurant and the waiter brings you a glass of water you do not want.
- You are going out with the group. Your jeans need washing. There are no other dirty clothes to wash them with.
- You pass by a building which waters its lawns regularly. Even after a heavy rainfall, the sprinkler is on.
- Your friend likes to "fix" the school water fountain so it is continually running.
- You are alloted 10 litres of water a week. How do you use it?
- Many people on your street water their lawns with sprinklers in the middle of the day when the sun is shining. You know that water droplets magnify the sun's rays, and this causes the grass to burn. And these same people water the lawns on windy days when the drops blow away.

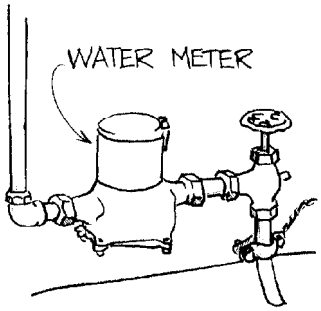
Activity 8 — Science, Environmental Studies

This class activity should be carried out with the help of your teacher.

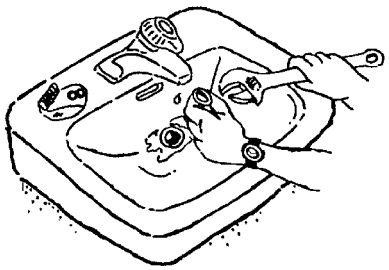
Simulation: You own a large company which has been to come up with solutions to conserve water. You have broken down the major tasks into the "Solution topics" listed below. Each person (or small group) is preparing a report and/or demonstration to show how people can save water and consulting money. (Remember, sometimes we hired have to spend money now to save money later. For example, a California study found that for every $1 spent in leak detection programs, $2 was saved.)

Solution topics:

- water metering or ways to price water use (what about tax credits or rebates for wise water use? Or fines for waste and misuse?)



- water recycling other systems (some industries are now recycling all water they use so it does not go back to the hydrologic cycle untreated)
- wastewater reuse (some places take greywater and use it to water lawns)
- flow-control devices and/or water saving devices (think about your bathroom use)
- drought-resistant landscaping (**xeriscaping**)
- efficient sprinkling/irrigation technology
- leak detection and repair (10 - 30% waste through leaks)
- water use restrictions
- elimination of combined sanitary/storm sewers
- repair and replace old water mains and sewer lines (infrastructure)
- rural septic systems



Activity 9 — Environmental Science

What on earth is "xeriscaping?"

Xeriscaping is also known as "nature-scaping," that is replacing thirsty grass with native ground covers and flowers that require little upkeep and are drought-resistant. ("Xeros" is the Greek word for dry.)

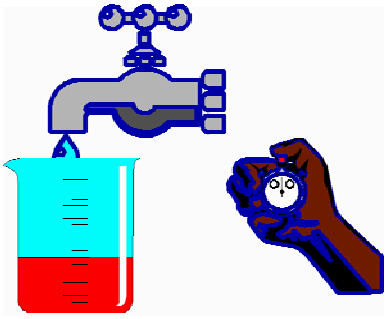
You know that a lot of water is used to keep our lawns and gardens fresh. Why not plan a garden that doesn't need much water to be healthy? Consult with local gardeners and research from books. Start your own water-wise garden. Talk to your parents about doing the same.

Activity 10 — Math, Science

Check the waste from a leaky tap. Try this experiment to find out how much water a leaking tap wastes.

You will need:

- a 500-mL beaker
- a stopwatch



What to do:

- Arrange the tap to drip one drop every second (use the stopwatch here).
- Catch the drips in a beaker.
- Allow your experiment to run for 20 minutes.
- Measure the amount of water you have caught.

Follow-up:

- Calculate how much water is wasted per hour, per day, per month, and per year.
- If a family in an underdeveloped country uses 2 litres of water a day for cooking, how long would they be able to get along with what is wasted by a leaky tap in one month?

Activity 11 — Math

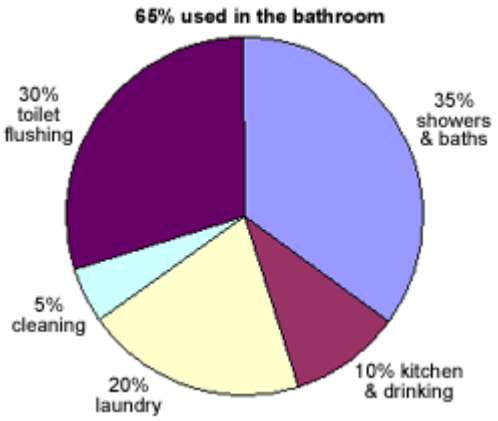
Conduct a water audit and find out how much water you use at home.

If you have a meter:

- Find your water meter at home. Monitor it for one week and chart how much water your family used. Are some days higher than others? Why?

- Find out if you have a leak. Check the meter before going to bed, or ask your parents to help you. (You have to make sure no one flushes the toilet or runs water overnight.) Check the meter first thing in the morning. If the meter shows a change in water use this probably means you have a leak somewhere in the system. It could be the toilet, a dripping faucet, or a pipe that you can't see.

- Don't flush your money down the drain. Find out how much money you could save by buying a low-flush toilet. Compare the number of litres a low-flush toilet uses with the number of litres a traditional toilet uses. Make an estimate. Count the number of times your toilet is flushed during the day. Multiply this by 365. How many litres do you use? What could you save?



Remember: Toilets account for30% of water used.

Activity 12 — Language Arts

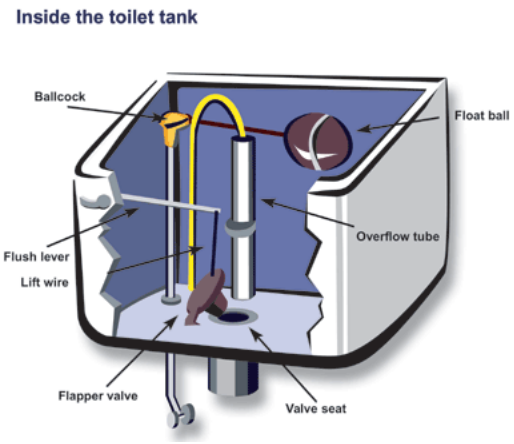
Make up slogans for wise water use and conservation. Brainstorm with your class and come up with some old sayings that you have heard your parents or grandparents use. Change these into sayings that have something to do with water. Here are some to help you get started:

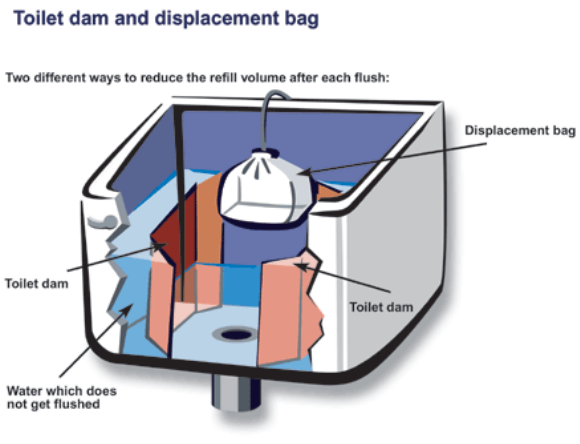
- A penny saved is a penny earned = A drop saved is a drop earned
- Never put off till tomorrow what you can do today = Never pollute today what you may need to drink tomorrow
- A stitch in time saves nine = Wise use this time saves many a thin dime

Make a poster of your water wise saying.

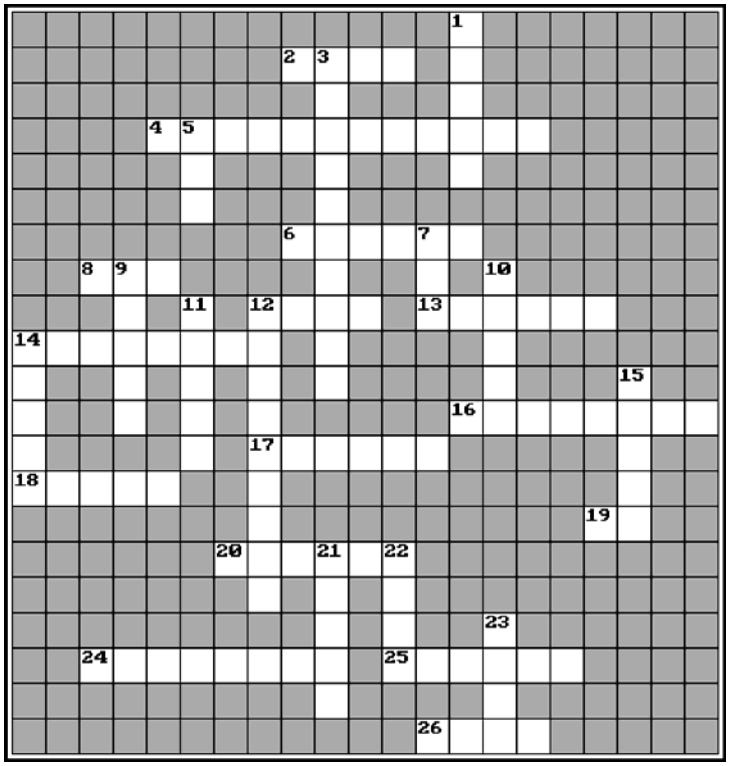
Activity 13 — Environmental Studies

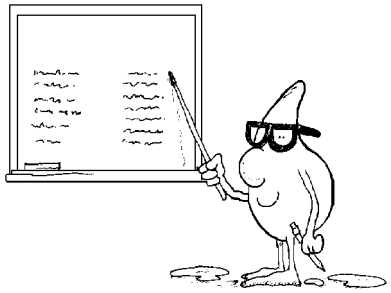
- Most people have no idea how a toilet works. You turn a handle and whoosh, it's gone! Show your demonstration skills and explain to the class how a toilet works. Use a diagram.
- Explain how toilet dams conserve water.





TEST 4
Crossword Puzzle





Across

2. Device used to transport water to your home.
4. Preservation and protection of our resources.
6. Gas formed by heating water.
8. A barrier to hold back water.
12. Container used to carry water.
13. The sun's ____ heats water molecules.
14. Chemical used to purify water.
16. A living person, animal, or plant.
17. Water is made up of hydrogen and ____.
18. Most of Canada's rivers drain ____.
19. The scale on which level of acidity is measured.
20. A small, flowing body of water.
24. Treated waste discharged from a wastewater treatment plant.
25. Countries with less water than Canada would like us to ____ water to them.
26. Do you ____ about water quality?

Down

1. The treatment of water and wastewater helps keep _____ substances from our water supply.
3. To supply water to farms, for example, by ditches and canals.
5. Mining companies use water to separate _____ from rocks.
7. Everyone must ____ water wisely!
9. Water contains two ____ of hydrogen.
10. A device used to measure how much water has been used.
11. A measure of liquid capacity.
12. To filter down, as through soil.
14. We are all links in the food ____.
15. A water _____ or diviner might help you locate underground water.
21. We inhabit the planet ____.
22. Other countries think Canada has _____ water than it needs.
23. Water has been around for over ____ billion years.

Word Puzzle

Find the water-related words in this puzzle. They may be spelled-out backwards, forwards, or Diagonally.

air	household	retrofit
bath	infrastructure	save
conservation	lead	shower
conserve	litre	sponge
drain	money	toilet
drop	pollution	transportation
greywater	purify	treat
habit	rain	water
health	reduce	wise
		xeriscaping

T X E R H T L A E H H A B I T
A R G T R N K A P N E X N N R
C V E P Q A I O I S T F O R A
H I R A E R R A I G R I E E N
G E A L T D R W V A T C X W S
N R E G N O P S S A T O N O P
I E M H R H X T V E I N O H O
P T O T S O R R R C F S I S R
A A N A T U E S E U O E T G T
C W E B C S T A T D R R U Y A
S Y Y T N E O V A E T V L F T
I E U O C H I E W R E E L I I
R R C D G O L L I T R E O R O
E G B E H L E D R A I N P U N
X A F J I D T N A E L C U P I

Word Scramble

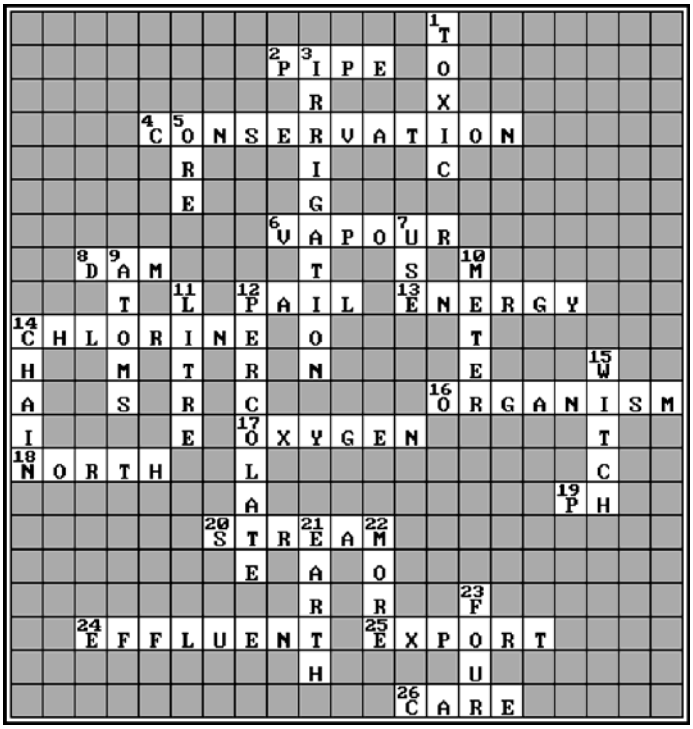
See if you can unscramble each of the words below and then write in the correct definition from those given below:

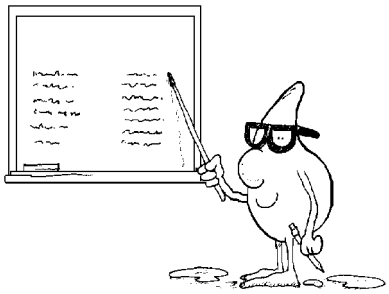
Scrambled word	Correct spelling	Definition
elryecc	_____	( )
coitx	_____	( )
egatriri	_____	( )
werse	_____	( )
hecnoril	_____	( )
mosat	_____	( )
upraov	_____	( )
chogiloryd	_____	( )
tgpanrocineoh	_____	( )
nogyex	_____	( )

Definitions

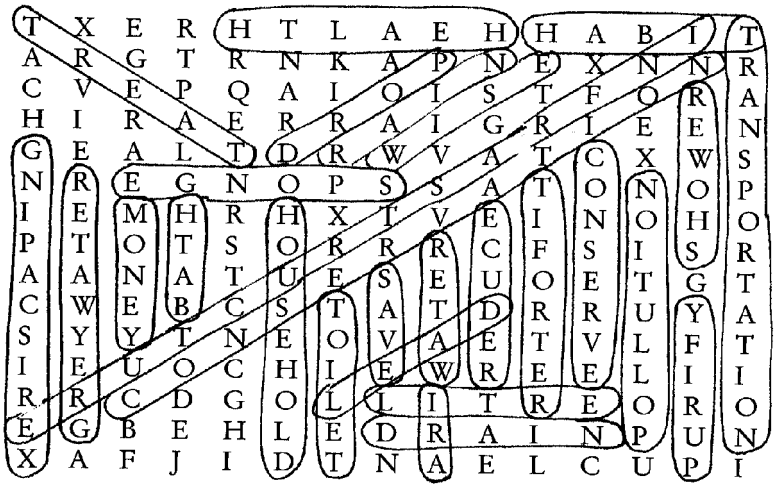
1. caused by people
2. water has one atom of this
3. pipe that takes water away from your house
4. to supply water to farms by ditches or canals
5. poisonous
6. to use again
7. another name for the water cycle
8. water changes to this when it is heated
9. water has three of these
10. added to water for purifying

TEST 4
Crossword Puzzle





Word Puzzle

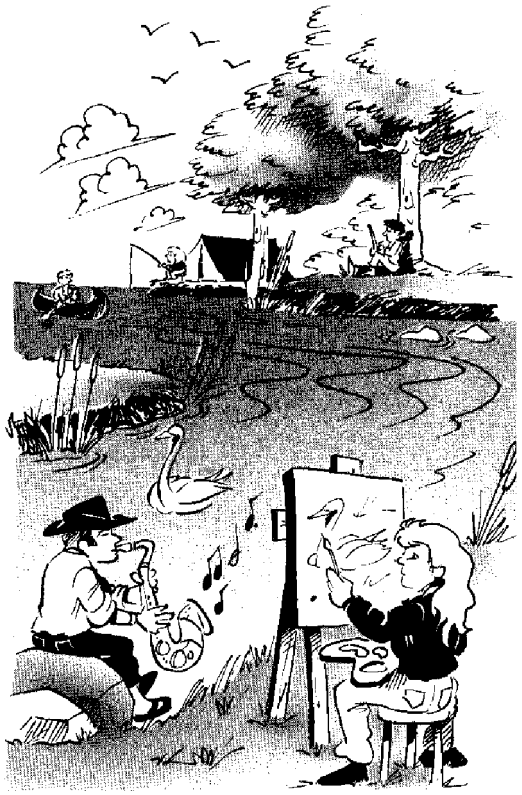


Word Scramble

Scrambled word	Correct spelling	Definition
elryecc	recycle	(6)
coitx	toxic	(5)
egatriri	irrigate	(4)
werse	sewer	(3)
hecnoril	chlorine	(10)
mosat	atoms	(9)
upraov	vapour	(8)
chogiloryd	hydrologic	(7)
tgpanrocineoh	anthropogenic	(1)
nogyex	oxygen	(2)

TOPIC 7. WATER, ART, AND THE CANADIAN IDENTITY

Chapter 7: At the Water's Edge



Purpose

To help students gain a keen appreciation for water's role in shaping the identity of Canadian society. This will be accomplished through the study of Canadian art and tradition using a historical perspective.

Subject areas

Art, Language Arts, Environmental Studies, History, Geography, Music

Procedure

> **Note:** Because art and tradition span all facets of our system of learning, this is an appropriate section to link as many subject areas as possible while encouraging students' own creativity and independent study.

1. Generate class participation with the following ideas:

   - Discuss what art means to different individuals in the class. This discussion will establish the diversity of meaning and feeling that art has for a large group of people.

   - Display a particular piece of art and generate discussion. Or, ask students about a specific piece of art that may be hanging in their homes or one they might have seen. Or, ask students about a poem or story that depicts feelings about water.

   - Ask students why so many artists, poets, writers, and musicians focus on water and its "meaning." Beside water's many uses, what does water mean to them?

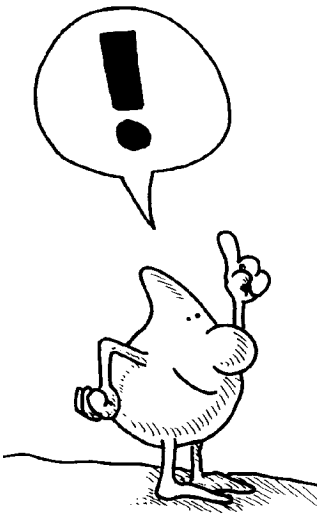
2. Concentrate on activity, creativity, and independent study throughout this section. A focus on each student's initiative is important from the beginning. This can be done in a number of ways:

    - For example, in the first class have the students choose a medium such as drawing a picture, making a collage, writing a poem or a story. Using their chosen medium, they are to describe a personal experience that they relate to water. This could include everything from a rainstorm to tears running down a cheek.

3. Music provides a good opportunity for group activity and learning. Bring music into the classroom for the students to listen to; for example, Gordon Lightfoot's "The Wreck of the Edmund Fitzgerald." Use a wide variety of songs to gain a representative cross section of Canadian society.

References

- Freshwater Series A-7: "Water, Art, and the Canadian Identity: At the Water's Edge"



TOPIC 7. WATER, ART, AND THE CANADIAN IDENTITY

Chapter 7: At the Water's Edge

How do you feel about being by the water? If you had a choice of taking your vacation near a river or lake, or in a setting where no water was present, which would you choose?

The majority of Canadians would take the waterfront, hands down. We have so many beautiful lakes and rivers to choose from in all provinces and territories that we are the envy of many other countries.

Could you imagine your life without water?

Picture your daily routines without taps and a shower, without water in the summer, ice in the winter, puddles in the spring. Water is one of the most precious riches that the earth provides. But water gives us more than life; it also gives meaning to our lives, and this meaning cannot always be measured in scientific terms or in numerical data.

However, this meaning can be expressed in art. Writers, artists, musicians, dancers, and actors have all been inspired by water, and these artists express things we all feel about water but may not be able to communicate as well. This celebration of the Canadian landscape and water through art began with the first Canadians.

Water Canada's Aboriginal peoples

For thousands of years the Aboriginal peoples of Canada selected sites for villages because they were close to water.

Before Europeans crisscrossed North America, Canada's Aboriginal population had depended on water for their physical and spiritual health. From the magnificent totems and legends of the West coast to the stone cuts and stencils of the Inuit in Canada's North, Aboriginal art records how much they depended upon water and all it provided, and it also shows how Aboriginal history is tied to these waters.

Art and Canada's history

When English and French explorers and settlers first came to Canada, rivers were the main transportation system. Follow the path of streams and rivers flowing into Hudson Bay, and the Mackenzie and the St. Lawrence rivers. You can see how these waterways, which had long been the Aboriginal peoples' route of travel, now became the guide to European exploration, trade, and settlement.

Some of the first European explorers, such as Alexander Mackenzie, Simon Fraser, and David Thompson, recorded their trips in journals — writings which were rich in accounts of the waters they saw, as well as in their respect for the force of the mighty rivers.

Water in words

We can feel the danger of the waters and the respect early writers felt for them by reading David Thompson's account of travelling the Black River:

> *The dashing of the water against the rocks, the deep roar of the torrent, the hollow sound of the fall, with the surrounding high dark frowning hills. . . .*

or by reading the lines of Simon Fraser about the river that bears his name:

> *The struggle which the men on this trial experienced between the whirlpools and rocks almost exhausted their strength; the canoes were in perpetual danger of sinking or being broken to pieces.*

But other writers and poets saw Canada's waters as romantic, and their writings were filled with the grandness and majesty of the lakes and rivers. Poets like Charles Sangster and the four "Confederation poets," Charles G.D. Roberts, Bliss Carman, Archibald Lampman, and Duncan C. Scott found inspiration in the lakes and streams they came to know.

One of Canada's most popular poets, Pauline Johnson, also captures the force of nature and energy in her poetry. Born of an English mother and a Mohawk father, her poetry celebrated her Aboriginal heritage and the Canadian landscape, especially its lakes and rivers. Lines from her poem "The Song My Paddle Sings" are familiar to most Canadian students:

And up on the hills against the sky,
A fir tree rocking its lullaby,
Swings, swings,
Its emerald wings,
Swelling the song that my paddle sings.

Other writers and poets were inspired by Canadian waters and landscape. For example:

- Frances Brooke, who wrote *The History of Emily Montague*, one of Canada's first novels
- Thomas Cary, poet
- Adam Allan and J. Mackay, two poets who focused on eastern Canada
- William Francis Butler, whose novel, *The Great Lone Land*, tells of his journey from
- Fort Gary to the Rocky Mountains

The artist's view of water

When you visit any of Canada's art galleries, you will see paintings of Canada's beautiful scenery from coast to coast — scenery that includes all kinds of landscapes, especially our rivers, lakes, and streams. Paintings you will find include the following:

- Canadian landscape paintings from the late 1700s, which began with the works of such artists as Thomas Davies, whose watercolours sparkled with brilliant colour
- Artists such as Joseph Légaré in Quebec and William Armstrong in Ontario and western Canada, whose paintings featured rivers and streams
- Paul Kane, one of the most celebrated painters of the Canadian West, who recorded the lives of Aboriginal peoples through his sketches of rivers, waterfalls, portages and life along the waterways, as he travelled along the routes of the fur traders of the Hudson's Bay Company in the mid-1800s
- Tom Thomson and the Group of Seven, artists whose works celebrated Canada's wilderness
- Robert Bateman, whose paintings highlight natural settings and the wildlife that inhabit them

Water and music

The gurgling of a stream, the thunderous crashing of waterfalls, and the quick dripping of a spring thaw — these are all sounds of nature's music. All sounds that are reflected in the music and songs of Canada's history. From the ballads of the voyageurs to the modern songs of musicians such as Gordon Lightfoot and Stan Rogers, water has inspired artists. Indeed, it is often through stories told in music that we learn about our past.

R. Murray Schafer, one of Canada's foremost composers, returns often to the lakes and streams of his native land. He writes, "A mountain stream is a chord of many notes strung out stereophonically across the path of the attentive listener."

How things change

The rivers, lakes, and streams celebrated by early artists were from a clean and pure environment, one which knew little about pollution and water diversion. What happened?

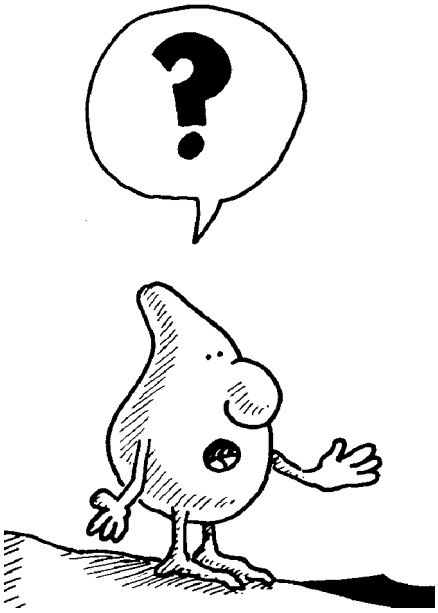
After World War II, Canada began to develop as an industrialized society. And this industrialization began to reduce the quality of our natural environment, especially our rivers, lakes, and streams. In *Rivers of Canada*, published in 1974, Hugh MacLennan identifies the modern uses of Canada's water systems with a sense of loss:

> *...the rivers of Canada are still there, and their appearance and character have changed little or not at all in the last century and a half. It is only our use of them that has altered. Now we fly over them, build dams on them, fish in them for sport, use them for municipal water supplies, and some of them we have poisoned with sewage and industrial effluents. . . . But the rivers are as worth knowing as they ever were, though none of us will know them as the voyageurs did.*

In recent years, Canada's Aboriginal peoples have seen the quality of their lives changed and lowered by development, pressures from oil exploration, large hydroelectric developments, and other sources.

Many natives feel that when their land deteriorates, so too does their health and way of life. As Grand Chief B.G. Cheechoo of the Nishnawbe-Aski Nation explains:

> *Our history is tied to these waters. Our continued reliance on fishing, trapping and hunting and our desire to do so is dependent on these waters. Our future is based on these waters. . . . Any threat to such waters poses a direct threat to our survival.*



TOPIC 7. WATER, ART, AND THE CANADIAN IDENTITY

Chapter 7: At the Water's Edge

Activity 1 — Language Arts, Poetic Expression

Make your writing come alive!

Canadian Roderick Haig-Brown writes, "rivers are **veins of the earth** through which the lifeblood returns to the heart."

Another Canadian writer, Hugh MacLennan, in *The Watch That Ends the Night*, writes:

> *In the early October of that year, in the cathedral hush of a Quebec Indian summer with* ***the lake drawing into its mirror the fire of the maples****, it came to me that to be able to love the mystery surrounding us is the final and only sanction of human existence.*

Both Haig-Brown and MacLennan are using metaphors to compare rivers and lakes to veins and mirrors. Figures of speech, such as metaphors and similes, are used by writers to add description to their writings. (A simile resembles a metaphor except that it uses *like* or *as* to make a comparison, for example, "rivers are like veins of the earth.")

We all know that rivers are not really veins, nor are lakes mirrors. But we also see the connections and comparisons when someone makes them.

- Try to make your own comparisons. Think of an original way to describe some part of water and write your own metaphors and similes. Think about how water tastes, looks, feels, smells, etc. Write your comparison so that you can make people look at water in a new way.

- Describe what water means to you, and/or what it means to people all around the world. Be creative. Paint a picture, make a model, write a poem or a song.

Activity 2 — History

Although early writers recognized the beauty and value of our waterways, they were also very aware of the dangers involved in navigating lakes and rivers. Those who were not careful often paid for their mistakes with their lives, and even those who were careful often were caught in nature's fury.

- Find out about disasters in Canadian history where people and water came into conflict — maybe a water-related disaster occurred in your region, or affected someone close to you. Describe this disaster in a poem, a story, a picture, or a song.

Activity 3 — Art, Writing

In Freshwater Series A-7, "Water, Art, and the Canadian Identity: At the Water's Edge," you will find pictures of famous Canadian paintings. Pretend you can afford to buy one of these works of art to hang in your home. But in order to buy it, you must explain in writing why you have chosen a particular painting.

- Tell why you made your choice
- Explain what mood or feeling you think the painter was trying to express

Activity 4 — Art and Writing, Research

In your reading, you saw a reference to Tom Thomson and the Group of Seven. These painters all painted the wilderness of Canada, especially scenes in Ontario's Algonquin Park. Research one of these painters and prepare a short report about his work.

The Group of Seven included:

- Lawren Harris
- A.Y. Jackson
- J.E.H. MacDonald
- Frederick Varley
- Arthur Lismer
- Frank Johnson
- Franklin Carmichael

Activity 5 — History, Environmental Studies

Canada's Aboriginal peoples, rely on water for physical and spiritual health. But in recent years they have seen the quality of their lives degraded by pressures of human development, pressures from oil exploration, large hydroelectric developments, and other sources.

- Compare past and present lifestyles of Canada's Aboriginal peoples.
- Research a large hydroelectric development, such as James Bay. Show what effect this development has had on Canada's Aboriginal peoples.

Activity 6 — Literature, Research, Writing

Research one of the Confederation poets. Find examples of poetry using water themes. Prepare your analysis of these works.

Note:	It can be difficult to read, look at, or listen to a piece of artistic expression and decide for yourself what the artist is trying to say. What you need to look at is how you feel about the piece.

Here are some questions to ask yourself when analysing art:

- How does this piece make me feel? For example, does it make me sad, excited, happy, or otherwise?
- Does it remind me of anything in my own life? For example, something else I may have seen or heard.
- How much importance does the artist seem to place on water in the piece?
- Do I feel that this piece shows respect for the water which it depicts?

Activity 7 — Research, Writing

Pauline Johnson toured throughout Canada, England, and the United States, giving recitals of her poetry. She became very popular and led a very interesting life — so much so that books have been written about her. Research and prepare a report about a part of Pauline Johnson's life and her poetry.

Activity 8 — Art

Create your own rain pictures

You know how water can land on your homework project or favourite water colour and smudge the ink or paint. Why not use the rain to help you create your own watercolour?

- Use water based paints or poster paint to make some shapes on a sheet of drawing paper.
- Place the paper outdoors for a short while in the rain.
- Bring it in and let it dry.
- Frame it.

Activity 9 — Language Arts, History

Research a Aboriginal legend

Check with your librarian and learn about some of our communities and water systems that were named by Canada's Aboriginal peoples. Find out if there are legends or stories that go with the names. One example is found in the following lines:

> On a height of land in northern Manitoba is a pond from which water flows east into the Hayes River, and west into the Nelson. This is the Echimamish, "the-river-that-flows-both-ways." Each time they crossed the divide, Native Canadians left offerings in tribute to the mystical reversal of flow that made portaging between the rivers so easy.

A few other examples of place names are:

- *Yukon* comes from the Athapascan language and means "clear water."
- The Restigouche River, which flows through New Brunswick, was called "good river" by the Micmacs.
- The Hurons called Niagara Falls the "thunder of waters."
- Winnipeg is named after its river, which the Cree knew as "muddy water."

See how many others you can find.

Note: One of many books to help you in your research is *Indian Giver: A Legacy of North American Native Peoples,* by Warren Lowes. Canadian Association in Support of the Native Peoples, 1986.

Activity 10 — Language Arts, Creative Writing

Using water as the central theme, write a short story or poem. Be creative. You are not allowed to use topics such as lakes or rivers; you have to use less obvious subjects such as tears, perspiration, fog, or puddles.

Ask your teacher and classmates for examples of poems or suggestions you may gain ideas from. And remember, poems do not necessarily have to rhyme. You may use a specific type of poetry such as haiku or diamante (your teacher will explain what these types of poetry are).

Activity 11 — Music

Make your own kind of music!

- Music can be made using water. Fill a set of glasses with different levels of water. When the rim of the glass is rubbed with a wet finger the different levels of water will produce different sounds. See if you can find the levels of water that will produce a recognizable tune.

- Or, in a similar activity, fill bottles with different levels of water and blow into the mouths of these bottles to produce different sounds and pitches.

- Work with your teacher and class to make a symphony of water sounds by recording audio images of water such as waterfalls, a tap, a shower, rivers, rain, a bubbling brook. Play these tapes together or in series to make different compositions. You can also test the hearing of your classmates by having them listen to the tapes to try to identify the sounds properly.

- Study modern poetry or song lyrics that deal with water. Choose material that will be fun for you. Write your own poem and put it to music.

Activity 12 — Art, History

Canada's history has been well documented through Canadian art. The original waterways are pictured by artists such as Cornelius Krieghoff, Paul Kane, Joseph Légaré, and Thomas Davies.

Study and prepare a report on a work of art that directly relates to a topic in Canadian history.

Some examples are:

- Aboriginal use of waterways
- arrival of the first European immigrants
- use of Canadian rivers in the Fur Trade
- present use of water in transportation, for example, the Great Lakes

Activity 13 — Aboriginal Art, Research

Examples of Aboriginal art can be found that show the respect and closeness Canada's Aboriginal peoples feel with nature. Modern Aboriginal artists continue this tradition, for example, Morriseau, Chee Chee, and countless others.

Take an example of Aboriginal art, such as a drawing, painting, or carving, and tell the class about the artist and the art.

Activity 14 — Geography, Research

Water and architecture

Many of our cities and towns were located next to waterways because they provided food, a water supply, and a "road" for transportation. Often our architecture is also influenced by location and closeness to water.

Study an example of architecture from a particular Canadian city that has been influenced by water and prepare a report about it. Some examples to get you thinking are:

- the Expo 1986 site constructed in Vancouver, British Columbia. Buildings were designed to resemble ships in the Vancouver harbour.

- Toronto's Ontario Place, focused on the Toronto harbour shoreline. If you have visited the site you may be familiar with its setup.

- the Parliament Buildings, designed and built to present an attractive view from the Quebec side of the Ottawa river, as well as the Ontario side. This is a good example of the influence that rivers have.

- you may have a local mill in your area which is located on a river. Mills have historic importance in the development of original Canadian settlements.

- you may also wish to include bridges in this study of Canadian architecture.

TOPIC 8. WATER — THE TRANSPORTER

Chapter 8

Purpose

To help students gain an awareness about another of water's cyclical roles — as a transporter of sediment — and to have students see that the movement of sediments in water affects the environment.

Subject areas

Science, Geography, Language Arts, Math, Environmental Studies, Art

Procedure

1. Focus students' attention on this topic by asking them if they have noticed how water in rivers and streams can change colour in spring when it is moving faster. Find out if they know why water changes colour, and if they are aware that water can carry away valuable topsoil and transport toxics.

2. Draw their attention to another of nature's cycles: that of erosion, transportation, and deposition.

3. Lead a discussion about how human activities add sediment to the water systems through forestry, agriculture, and construction, for example. Ask how sediment might harm the environment.

Vocabulary

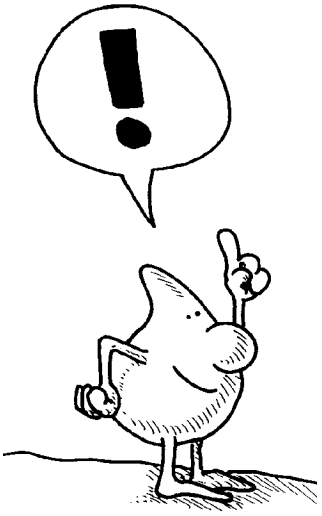
deposition *erosion*	*navigation* *suspended solids*	*sediment*

References

- Freshwater Series A-8: “Water — The Transporter“

TOPIC 8. WATER — THE TRANSPORTER

Chapter 8



What does water transport?

If someone asked you how water carries things from one place to another, you would probably think of the ships, barges, and canoes that travel on water and carry goods and people around. You might even think of your water skis that let you skim over the lake. But these aren't the only things that water transports.

Take a good look at your favourite beach. Notice how sandbars or other deposits of sand grow larger or smaller from one year to the next. This is because water transports soil from one place to another in the form of **sediment**. First, water erodes soil from the land and then, by its river systems and currents, moves this soil to other areas, and deposits it there.

This is another of nature's cycles.

The cycle of **erosion**, transportation, and **deposition** is called the sediment cycle.

- The cycle starts with erosion, the weathering of small particles from rocks by water, wind, glaciers, plants, and animals. But this does not happen overnight; it takes place slowly, over centuries or millennia (thousands of years), unless, of course, humans become involved, when erosion can take place much faster.

- When the eroded material is small enough, it is ready to be moved into streams and rivers and carried downstream by the flow of the water. This is the transportation part of the cycle.

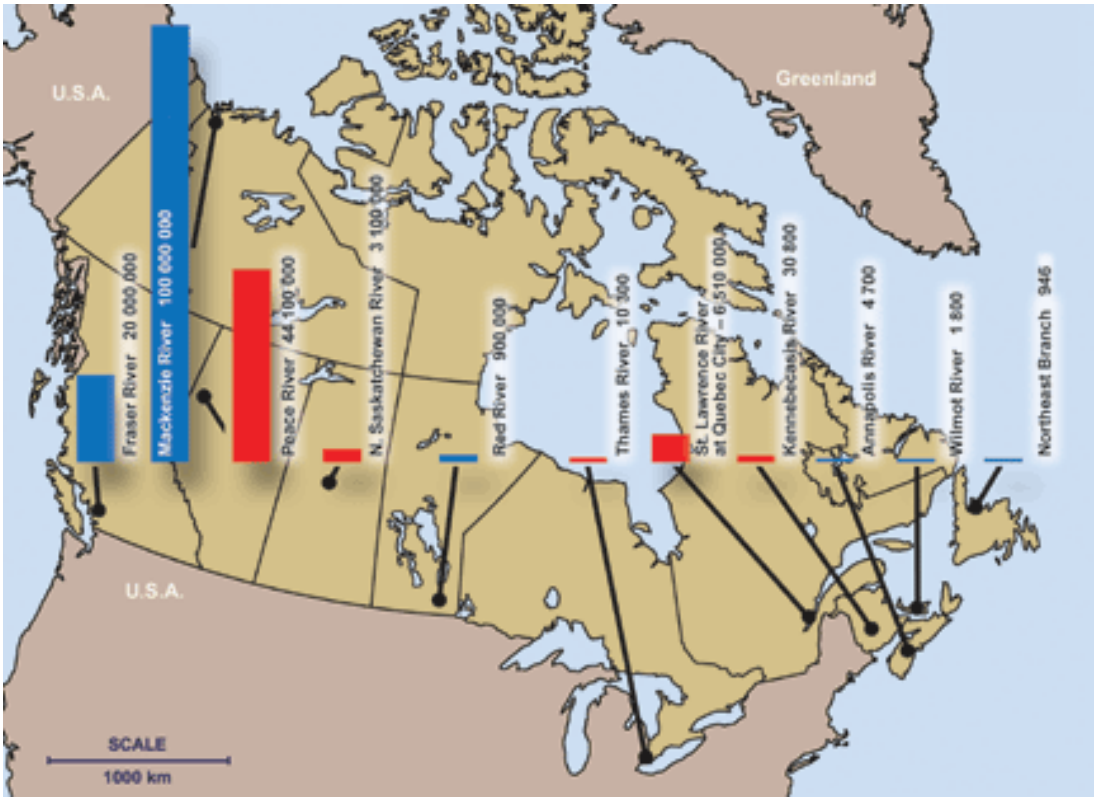
- The final process in the cycle is deposition: meaning that when there is not enough movement in the water to continue carrying the sediment, it comes to rest, or is deposited — on floodplains, on sandbars, on islands, and in deltas.

How much sediment is transported in Canada?

As you know, Canada is a huge country. The amount of sediment being transported depends on the area where you live. If you look at the map showing the average

sediment loads for rivers in Canada, you will see that western and northern Canadian waterways carry much more sediment than those in other regions. There are reasons for this.

**Average annual suspended–sediment load (in tonnes)
for selected rivers in Canada**



Canada's glacial history

Ten thousand years ago glaciers covered much of Canada. When the climate became warmer, the glaciers melted and left a great deal of erodible material across western Canada. In the mountains, where rivers such as the Fraser, Peace, and upper Mackenzie flow, steep slopes and plentiful water carry away large amounts of sediment.

In contrast, the flat and dry Prairies have lower sediment loads; and in eastern Canada, much of the land is bedrock and therefore provides smaller loads.

If a river or stream has a great rate of flow, it can carry many tonnes of sediment a year.One good example of this is the Fraser River, which carries an average of twenty million tonnes of sediment a year. The St. Lawrence River transports approximately 2.3 million tonnes of sediment past Montreal each year; this is equal to 230 000 truckloads of soil. Other rivers carry much less.

Why is sediment important?

You probably know that water moves particles of soil along with it because you have seen that rivers become muddy in spring when they are rushing downstream. But you may be surprised to learn:

- how much sediment water can carry
- what may be contained in the sediment
- what serious effects sediment can have on the environment

What are some of these effects?

- Pollution — Sediment sometimes carries toxic chemicals from sources such as agriculture and industries. These toxics pollute our water supplies.
- Obstruction of navigation — Sediment can also make navigation difficult or impossible. If sediment from fast-moving rivers is deposited downstream, it eventually builds up and may make the water too shallow for boats or ships to go through. Sediment in navigation channels may be a problem in your area, as it is in the Fraser River (British Columbia), the Mackenzie River (Northwest Territories), and the Great Lakes and St. Lawrence River system (Ontario and Quebec).
- Damage to fish/aquatic habitat — Sediment in streams directly affects fish in several ways:
  - Suspended sediment can irritate fish gills and lead to death. It can also destroy the protective mucous covering the eyes and scales of fish, making infection and disease more likely.
  - It cuts down on the light penetrating the water. This affects fish feeding and can reduce fish survival.
  - Settling sediments can bury and suffocate fish eggs.
  - Sediment particles absorb warmth from the sun and thus increase water temperature. This can stress some species of fish.

- Damage to water supply plants — Sediment in the water can wear out pumps and turbines which in turn can increase the cost of keeping things in good repair. And this can increase the costs of water supplied to households in Canada.

- Interference with energy production — Sediment affects the size and life expectancy of reservoirs that were created for power generation. A dam traps sediment that would normally be carried downstream, and that sediment builds up and decreases the size of the reservoir.

- Erosion — Some farming practices increase soil erosion. This affects Canadians in three ways:

    - Productive soil is lost to farms.
    - Sediments and pollutants are added to streams.
    - Costs of maintaining irrigation systems rise.

- Negative effects from construction — Sediment from construction sites can find its way to sewers and streams and increase the cost of water treatment or affect aquatic life.

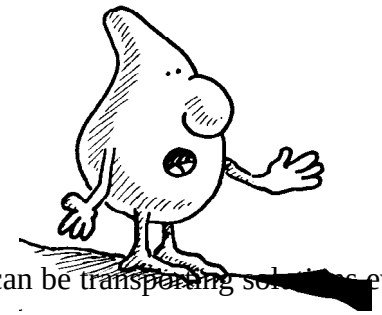
Canada's waterways move many millions of tonnes of sediment each year in this never- ending cycle. The sediment is measured and classified in three different ways:

- as suspended load (**suspended solids** in the water)
- as bed load (rolling or bouncing along the bottom)
- as bed material (stationary on the bed)

Once this sediment is measured and classified, it is analysed to determine just what is being transported in our waterways. The data from this research are then used to address environmental and engineering concerns.

TOPIC 8. WATER — THE TRANSPORTER

Chapter 8



Activity 1 — Science

Conduct a simple experiment to demonstrate how water can be transporting solutions even though we cannot see them.

- Take three water glasses and fill them with water.
- Ask a classmate to put a spoonful of salt in one glass and a spoonful of sugar in another. Stir both glasses.
- When the solutions have settled, challenge other students to identify which glass of water is the "pure" one.
- What conclusions would you draw from this simple experiment?
- What message would you deliver to others?

Activity 2 — Geography, Math

Check back to the map of Canada that shows the average annual suspended- sediment load for selected rivers in Canada.

- Make up ten math questions based on the information contained in the diagram.
- Explain why there are such differences between the load of the Mackenzie River and the load of the Thames River.

- Over 750 stations across Canada collect and analyze sediment data. Find out where the stations are in your province or territory. What are the loads of rivers in your region?

- Does sediment movement cause a problem in your province or territory? Explain why or why not.

Activity 3 — Art, Environmental Studies

Prepare a diagram or model to illustrate the stages in the sediment cycle.

Activity 4 — Environmental Studies, Research

Read the following case study, then find out whether your province or territory takes measures to protect the environment during construction as was done in St. John's.

When people in St. John's, Newfoundland began to build the Institute for Marine Dynamics in 1982, they also built a desedimentation plant to keep sediment from reaching the water supply.

They used a settling pond and added alum to the water. Alum is the short name for aluminum sulphate, a com- pound that acts as a magnet, attracting dirt particles, which may colour the water. As the sediment particles come together, or coagulate, they become heavier and settle to the bottom of the tanks. (The water purification plant in your community may use alum in its process; if so, you might want to learn more about how it works.)

Over three years, 1250 tonnes of sediment were kept from entering the nearby water of Rennie's River. The cost of the desedimentation was less than one tenth of the construction costs, and a trout habitat was protected from contamination.

Activity 5 — Science, Environmental Studies

As you read in the Student Information sheets, sediment can harm fish populations.

Take one or two of the harmful effects mentioned and find out how and why these things happen. For example:

- how does sediment change the way light penetrates water?
- how does this light change affect the feeding and survival of fish?
- how does sediment irritate fish gills and how can it cause death?
- what kinds of infection and disease do fish get from sediment?
- how do sediment particles absorb warmth from the sun and increase water temperature?
- what can happen when fish are stressed?

If you can, find examples of some of these events and when they happened. Include diagrams to explain your research.

Activity 6 — Environmental Studies, Research

Many sediment problems are caused by human activity.

Deforestation and sediment problems

Sediment problems caused by deforestation occur in several Canadian provinces for example, British Columbia, Ontario, Quebec, New Brunswick, and Newfoundland:

- Tree cutting can increase water runoff and soil erosion, thus adding to the sediment transported by river systems.
- Tree cutting can also release chemical substances that occur naturally in forest soils.

Take either of these topics and find out the relationship between forestry practices and sediment in the water system in your area.

Agriculture and sediment problems

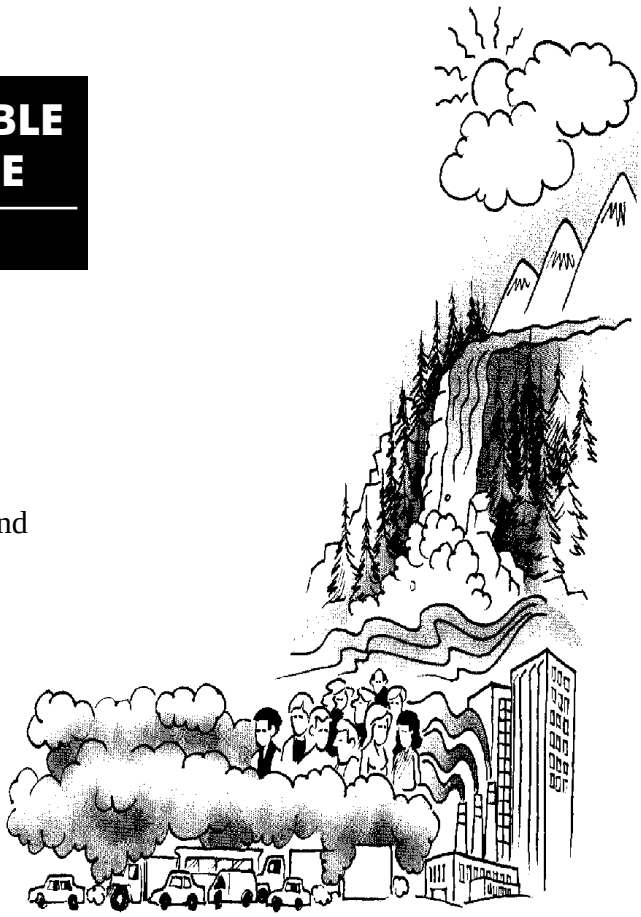
Sediment-related problems associated with agriculture occur across Canada. For example:

- toxic chemicals are added to the environment
- soil is eroded and thus lost to farmlands
- costs of maintaining irrigation systems are increased

Take one of these topics and find out what is happening in the area of agriculture in your region or province.

TOPIC 9. WATER — VULNERABLE TO CLIMATE CHANGE

Chapter 9



Purpose

To help students understand how changes in their lives might occur because of changes in climate; and to help them see that some climate changes are caused by people and could be prevented.

Subject areas

Science, Geography, Language Arts, Art, Current Events, Environmental Studies, Social Studies

Procedure

1. Focus the attention of students on climate and changes in weather patterns with the following quote from K. Hubbard, an American humourist: "Don't knock the weather. Nine-tenths of the people couldn't start a conversation if it didn't change once in awhile."

   Point out to students the differences between weather and climate as discussed in their Student Information sheets.

2. Ask students for other examples of conversation about the weather, if not from real life certainly from old movies or TV shows. For example:

   - "Can't remember when it was this hot (cold, wet . . .)."
   - "Hot for May, what?"
   - "We had snow like this back in . . ."
   - "Cold enough for you?"
   - "You think this is hot! This is nothing . . ."

3. Stress that changes in weather patterns are normal. We have all experienced a green Christmas or a cool summer. Ask students for examples of natural weather phenomenon they have experienced, such as extreme heat, cold, snow, rain, thunderstorms, floods, and drought.

4. Guide their discussion to the greenhouse effect and the more serious change of global warming — which is caused by people. Point out to students that although scientists may differ about the extent of global warming, they generally agree that it is occurring and will probably continue.

5. Ask students what effect they think climate change could have on water, and ask them how it could affect their lives. Point out that some changes could be good, and some not so good.

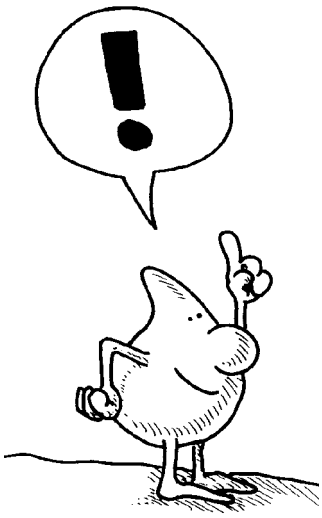
6. One activity asks students to look at population growth and scarce water resources. This activity may be for more mature students but it could be used as a discussion topic for the class.

Vocabulary

aquatic	***drought***
climate	***permafrost***

References

- Freshwater Series A-9: "Water — Vulnerable to Climate Change"
- *A Primer on Fresh Water:* "Water — Forever on the Move"
- "Did You Know We Live in a Greenhouse?" Atmospheric Environment Service, Environment Canada



TOPIC 9. WATER — VULNERABLE TO CLIMATE CHANGE

Chapter 9

What makes climate?

If a person from another country were to ask you about the **climate** of Canada, you might answer that it really depends on where you live in Canada. For example, if you live in parts of British Columbia such as Vancouver or Victoria, you may see a bit of snow during the winter months, but not a whole lot. However, if you come from many other parts of Canada, you will likely see lots of snow — often more than you really want.

The odds are strong in this country of ours that you will shovel some of the white stuff between November and March. But usually between May and September you will have no snow and lots of hot weather. Usually. So, on average, you would be able to tell a stranger what to expect from Canada's climate.

How do you know this? It's simple. Since weather conditions have been pretty much the same for centuries, you can usually forecast climate conditions for winter and summer.

What is the difference between weather and climate?

When you combine the average weather conditions and weather patterns over a long period of time, you find out what the climate of an area is. And this knowledge helps you decide where you will take a winter vacation; you know where to find snow for skiing and warm sunshine for swimming.

But climates can change.

We know that weather conditions can vary from year to year because we have experienced or read about **droughts**, floods, bad storms, and the like. But what about long-term climate change? What about things like global warming where scientists expect serious changes in climate?

The climate of any region can be altered from causes such as changes in the gaseous content of the atmosphere or changes in the amount of sunlight reaching the earth's surface. These are natural causes. Unfortunately, climate can also change because of human activity.

Why is everyone so concerned about climate change?

If you have been paying attention for the past few years, you will have heard about climate change, global warming, and the greenhouse effect. Many people are quite concerned about these possible changes and how they will affect humans, animals, and plant life. They are also concerned about the ways people have caused (and continue to cause) the problems that bring the changes.

Isn't climate change natural?

Another question you might be tempted to ask is: what's the big deal about climate change? After all, in your lifetime you have seen winters where there hasn't been enough snow for skiing in February; you have been frustrated by a green Christmas where you couldn't try out your new toboggan; and you have sloshed your way through summers that have been miserably wet, cold, and depressing.

Aren't these events part of living in Canada? Don't they give people something to talk about?

- "In the winter of '79 we wore shoes all winter."
- "Yep. We had snow in June that year."
- "Didn't see one drop of rain from May till October."
- "If you don't like the weather, wait a minute."

Yes, changes in some climate patterns are natural. Variations occur in every climate, and as human beings we have learned to accept these shifts and to adapt to them when they occur.

But what about the changes in climate patterns that are unnatural — changes that people cause? Even though some changes seem to bring short–term improvements, are there other changes that are harmful?

Many scientists predict there will be global warming and related climate changes within the next four or five decades. Human activities that are increasing greenhouse gases and reducing natural vegetation will cause these changes. And the changes in our climate may be both harmful and helpful.

Just what is meant by global warming?

Global warming is the term scientists use to describe what happens to the earth's climate when people and industries add greenhouse gases to the atmosphere. These scientists estimate that temperatures, as a global annual average, will likely increase from 1 C to 5 C.

While the scientists may disagree about how much global warming will occur or how much the climate will change in different parts of the world, they do agree that there has already been some global warming and there will likely be more.

What are greenhouse gases and how do they affect the climate?

Some greenhouse gases are normal in the atmosphere. They trap the sun's heat in a blanket of air around the earth and keep it from escaping into space. This keeps the earth's temperatures just right for people, animals, and plants to live and grow — something like the way a greenhouse helps plants grow.

But, problems occur when we use more and more of the world's energy, adding large amounts of gases to the atmosphere by burning fossil fuels in our industries, cars, and homes. These gases trap heat near the earth's surface and add to global warming.

The main greenhouse gases are:

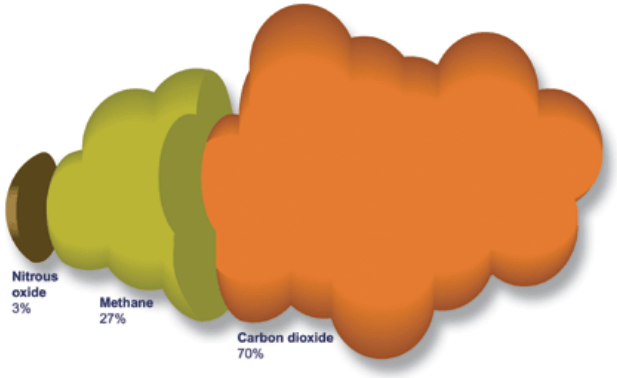
Carbon dioxide (CO_2)
Human source: Comes mostly from burning fossil fuels (oil, gas, and coal) for electricity and in cars and factories. Also from burning forests.
Annual increase: 0.5%
Life span: 50-200 years

Methane (CH_4)
Human source: Bacterial decomposition of organic matter (without oxygen) in rice paddies, swamps, garbage dumps, and intestines of ruminants like cows and sheep. Also from burning wood, mining coal.
Annual increase: 1%
Life span: 10-12 years

Chlorofluorocarbons (CFCs)
Source: Chemically synthesized for use as coolants in refrigerators and air conditioners. Also used in foam insulation, aerosol sprays.
Annual increase: 4%
Life span: up to 10 000 years

Nitrous oxide (N_2O)
Human source: Bacterial reactions in soil and water and from the breakdown of nitrogen-based chemical fertilizers. Also from burning fossil fuels and wood (deforestation).
Annual increase: 0.4%
Life span: 150 years

Current greenhouse gas emissions



As well as the warmer temperatures mentioned above, scientists are predicting some of the following changes because of global warming:

- more precipitation in winter and less in summer for some areas of Canada
- melting polar ice caps, causing a rise in sea level and possible flooding of coastlines or even the disappearance of small islands

What might this global warming mean for Canada?

So, what's it all about, you ask. Should I, in Canada, be upset if the climate is going to change and get warmer? After all, think about some of the benefits:

- fewer trips to Florida in the winter because we will have the perfect climate here. As well, more tourists will come here because of our warmer temperatures
- a longer growing season in parts of Canada where the summer is currently too short to grow many crops, and a longer shipping season in the north and Great Lakes because of less ice
- more precipitation in the north, which would increase the water supply in northern watersheds and thus increase hydroelectric power
- warmer weather, which would mean less demand for electric power for heating (however, it could increase demand for electric fans and air conditioners)

There may be no doubt in your mind that some of these changes could be very good for Canadians.

What about changes that may not be as welcome?

As well as some of the "beneficial" changes mentioned above, such as warmer weather and longer growing seasons, scientists predict some of the following changes, which might not be too welcome, in the different regions of Canada:

Pacific Coast

- A rise in sea level would threaten low-lying coastal lands, such as the Fraser River delta, with possible flooding and erosion
- More precipitation could promote landslides and flooding

- Warmer river temperatures could cause fish to die; however, warmer ocean temperatures could encourage species such as tuna, hake, and squid to migrate from the south

- A warmer climate could allow insects, pests, and disease to migrate northward and stress the forests, while the same forests would become drier and more vulnerable to fire

- Prairie Provinces

- Higher temperatures and increased transpiration and evaporation could bring more drought to the Prairies. This would likely lead to increased irrigation, which would bring salts to the surface of the soil and thus degrade it

- Agriculture could move northward where the climate is more humid but the soils are not as good

- Great Lakes and St. Lawrence Basin

- Higher temperatures would mean more evaporation and drier soils. Water levels in the Great Lakes could fall by between half a metre and a metre. The St. Lawrence outflow could be reduced by 20 percent

- Lower water levels could reduce the amount of cargo that ships could carry per trip

- Industries in this region relying heavily on water are:
  - electric power
  - primary metals
  - chemicals
  - food processing
  - timber products
  - shipping (particularly of grain and metal products)

These could all be affected by changes in water levels.

- Higher temperatures could affect the health of forests in the region and dry out marshes, thus reducing wildlife habitat

- Some fish species could disappear from the lakes while other species could move northward

- Less snow could shorten the ski season for southern Quebec and Ontario

Atlantic Coast

- A rise in sea level could bring flooding, thus affecting residences, transportation, and industrial facilities in low-lying areas, as well as regions along rivers such as the Saint John

- Saltwater intrusion could contaminate groundwater aquifers (the main source of regional water supplies), disturb sensitive ecosystems, and displace freshwater fish populations

- A rise in ocean temperatures could affect the distribution and makeup of the fish population, limiting some species, encouraging others

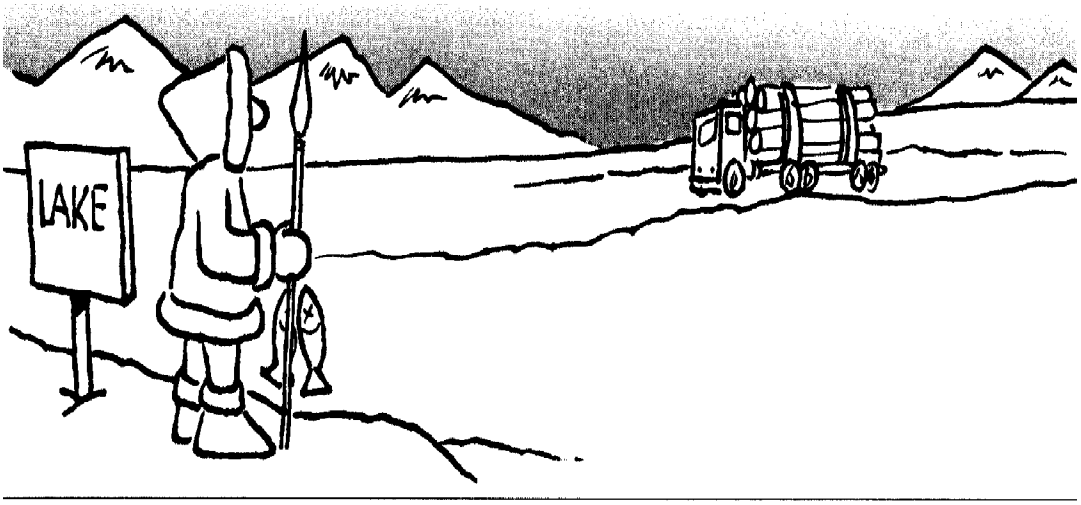
The North

- A rise in sea level would also flood low-lying areas in northern Canada, for example, the Mackenzie River delta. It could also erode shorelines and change near-shore ecosystems

- Milder winters and longer summers would shorten the season for ice roads and thus reduce access to remote settlements and timber stands

- Gradual melting of the **permafrost** would change water drainage patterns and destabilize the land, thus affecting roads, pipelines, and buildings

- Greater precipitation would result in a greater buildup of snow, which could mean extensive and earlier flooding in spring



Did You Know?

An increase of 3°C may not seem like much. However, around 1000 A.D. a climate slightly warmer than today's allowed the Vikings to settle Iceland and Greenland. About 500 years later their colonies had disappeared, partly because of a temperature drop of about 1°C.

What can we do?

Different people give different answers.

Some argue that since we cannot predict how climate will react to changes in the atmosphere and biosphere, we should not worry because global warming may not happen.

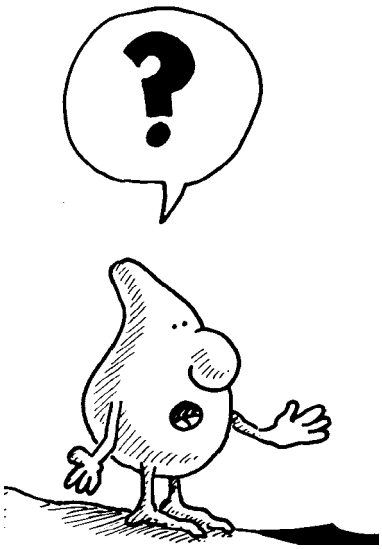
Others say that because we do not know how water supply will be affected, there's no point in spending time and resources on what may not happen.

But scientific experts recommend two general strategies:

1. Prevent or limit the cause of climate change by cutting back on production of greenhouse gases and planting more forests.

2. Expect the change and adapt to it as it comes, for example, by moving from low- lying coasts, or planting the kinds of crops suited to a warmer, drier climate.

It would make sense to follow both of these strategies. Both involve conservation methods and more efficient use of our resources.



TOPIC 9. WATER — VULNERABLE TO CLIMATE CHANGE

Chapter 9

Activity 1 — Geography, Current Events, Atlas Use

Variations from normal weather happen frequently and news bulletins are always reporting on natural disasters such as floods and droughts.

Check your newspapers or listen to the news on television or radio. Prepare a report using the following questions as a guide:

- What's in the news about flooding and/or droughts?
- Where is this happening? In Canada or in other countries?
- What are the effects of massive flooding? How are people affected when there is a severe drought?
- Why does it concern us if there is drought in Ethiopia? What other countries around Ethiopia are affected?
- Are these droughts similar to the droughts on the Canadian prairies?
- What can we learn from flooding in Bangladesh?

Activity 2 — Environmental Studies, Research

Read other literature from Environment Canada about global warming and the greenhouse effect. Find out what could happen if temperatures rise around the world. How could it affect water flow, the melting of ice caps, **aquatic** life, human life, etc.?

Recommend what we can do to deal with the problem of global warming.

Look back at the two recommendations made by scientists (to adapt, or to limit and prevent). Write your point of view about these recommendations. Explain which would make you a better environmental citizen.

Activity 3 — Language Arts, Environmental Studies

Weather, climate change, and you

1. Fact or fiction? Check this out:

   Many teachers can tell there is going to be a change in the weather because of student behaviour. Some students become "unsettled" during low pressure times.

   - What is the difference between high pressure and low pressure? When are you likely to get rain?

2. Your great grandparents were very aware of the weather. They studied it carefully and tried to predict, through signs, what was going to happen. They had old sayings or beliefs (some people would call them superstitions) that described the occurrence. Some of these related to water are:

   - When the dew is on the grass, rain will never come to pass.
   - If it rains on the last Friday of the month, the next month will be rainy.
   - The bigger the beaver dams are built, the drier the season will be (certainly downstream from the beaver dam).
   - It is a sign of rain when cattle bunch together, or when cattle lie down.
   - Cats will not want to go outdoors when they feel it is going to rain.
   - You all know about the groundhog. . . .
   - People with arthritis know that when their knees ache it is going to rain.

- Try to find other old sayings related to water and the weather. Ask older people if they can remember any of these.

- Look at the list above. Some of these you know right away are superstitions, but are there any that might be based on fact?

- Do you have any "internal barometers" that tell you when it is going to rain? Make your own weather prediction; for example, if you plan a picnic it will probably rain, or if you wash the car or water the lawn, it is certain to rain.

- Take one of the weather predictions or superstitions above and draw a picture to illustrate it.

Activity 4 — Geography, Science

- Regions that do not have much water but have growing populations are always needing to find new sources of fresh water. Some of their schemes sound a bit far-fetched right now but with changes in technology, there is no telling what might happen in the future.

- One such plan focuses on Canada's glaciers, which contain more water than the Great Lakes. This plan involves towing parts of the glaciers, or giant icebergs, south to the United States.

- Look at a map of North America. How far would such a block of ice have to be towed to get from northern British Columbia to California? What problems can you see? What could happen to climate patterns along the way if such a massive project could be carried out? What do you think about the idea? If not that particular idea, can you think of a plan which might work? Sell your idea to the class.

Activity 5 — Research, Environmental Studies

Select one or more of the following topics to research and prepare a presentation on:

- Find out how farms contribute to global warming. Use the following vocabulary to guide you in your research: methane, nitrous oxide, fertilizers.

- Explain how car and factory emissions contribute to global warming.

- Explain how deforestation and land-fill sites contribute to greenhouse gases.

- How can saving energy reduce emissions of greenhouse gases?

- Prepare explanations showing how you and your family contribute to greenhouse gases.

For whichever topic you choose, draw up a short list of things that good environmental citizens can do to cut down on the greenhouse gases we add to the atmosphere.

Activity 6 — Art

You can have an impact on the way human beings treat our environment. Create a visual message to make a strong point about global warming and the greenhouse effect.

Design posters, buttons, T-shirts, bumper stickers. Tell people what to do to help.

Activity 7 — Social Studies

Why should you care about climate change?

Climate affects almost everything you do.

Take a moment and think about climate and you. Because of the climate you live in you wear certain kinds of clothing, live in a special kind of house, and take part in specific kinds of recreation.

Prepare a profile of yourself, your climate, and your life, and pretend you are sending it to someone who lives in a completely different environment.

How could your life change if world climates became warmer through global warming?

Activity 8 — Environmental Studies

We have made a lot of references to the "greenhouse effect" without talking much about what a greenhouse is.

Conduct some research. Find out what exactly a greenhouse is and prepare some kind of presentation to show the class how a greenhouse works. This could be a scientific experiment, an oral report with illustrations, or a more dramatic presentation.

Activity 9 — Research, Geography, Environmental Studies

Permafrost is the term used to describe permanently frozen ground, which is said to be beneath one fifth to one quarter of the world's land. Permafrost underlies much of the Mackenzie Basin in Canada's north.

Find out more about this large area of Canada's north and prepare a research project examining some of the following topics:

- the geographic area of permafrost
- people who live on permafrost
- how the unique features of permafrost affect the lives of people in the north the provinces, territories, and governments involved with permafrost
- industries on permafrost
- how climate change could affect permafrost
- how the effects of climate change on permafrost could affect greenhouse gases and further climate change
- how changes in permafrost could affect the supply, quality, and levels of water.

Activity 10 — Social Studies

People who study the world population predict that if it continues to increase at the same rate, it will double by 2050. How old will you be then?

Research

- Approximately how many people currently live in the world? What might this population be by 2050?

- Already there are stresses on the world's water supply. What do you think are some of these stresses? (Think about less developed countries, where there are few water treatment facilities, or places where they do not have the supply of water we have).

- What extra stresses do you predict by 2050? What are problems that can be caused by these stresses?

- What solutions do you recommend? (Should we look for ways to share our resources? Should we be giving more money to poorer countries to help them take care of scarce water supplies? Should we charge more for our own water and wastewater treatment?)

Prepare a paper to be presented to the United Nations committee on conserving our resources.

Activity 11 — Environmental Studies, Research

> "Wetlands are the only ecosystem selected for conservation by agreement around the world."

Find out more about wetlands by researching and answering the following questions.

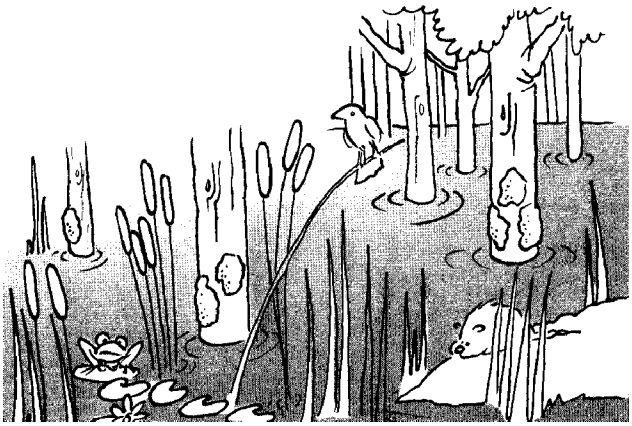


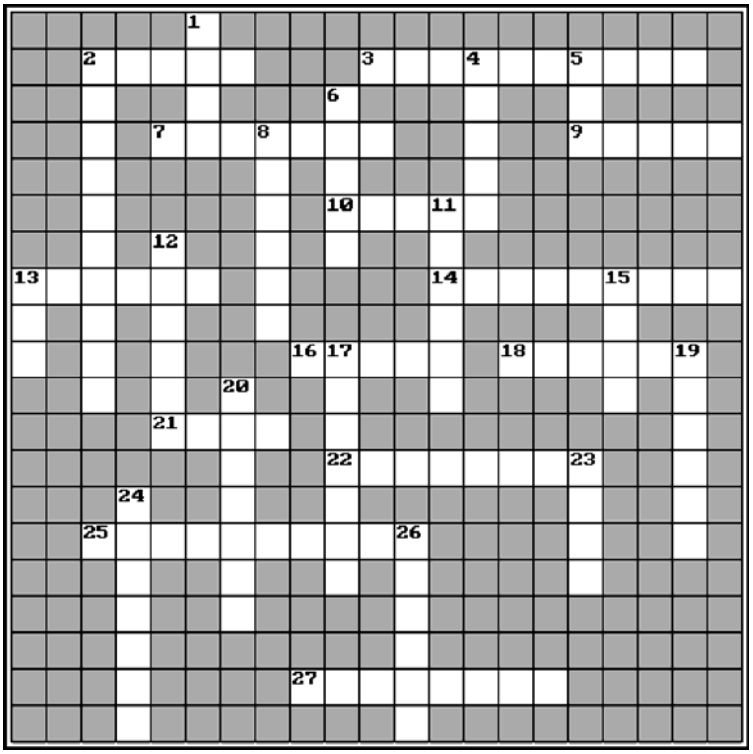
Figure 1

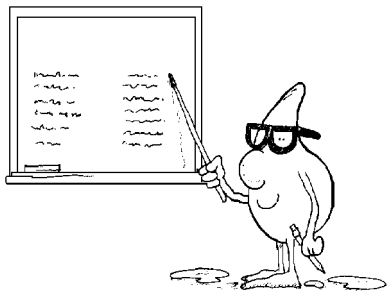
- What is a wetland? There are different kinds: how many can you name?
- What kinds of animals and plants live in wetlands?
- Wetlands are considered valuable for a number of reasons. How many reasons can you find?
- In what ways are wetlands being threatened?
- What ways are being used to conserve wetlands?
- Are there wetlands in or near your community? How do people use them?

Activity 12 — Science, Environmental Studies

Check back in the Student Information sheets where they discuss the changes that could occur in different areas of Canada if the climate got warmer. Prepare a report outlining what might happen in your part of the world; how could these changes affect your way of life?

TEST 5
Crossword Puzzle





Across

2. The ____ of Seven.
3. This slows down when rivers are blocked by sediment.
7. He painted nature in Algonquin Park.
9. Confederation ____.
10. Without water we cannot ____.
13. ____ arming may increase world temperatures by 1 to 5 degrees.
14. He wrote "The Wreck of the Edmund Fitzgerald."
16. The Rocky Mountains have high ____.
18. A large river in Western Canada.
21. Canada is a good source of fresh and ____ water.
22. Rivers can deposit sediment and create ____.
25. Permanently frozen ground.
27. Thousands of years ago, these covered much of Canada.

Down

1. Fast flowing water is said to ____ downstream.
2. A layer of air traps heat around the earth and acts as a____ for people, animals, and plants.
4. A native of Northern Canada.
5. Water in our homes comes out of a ____.
6. Aboriginal art form from Canada's West Coast.
8. Pauline Johnson was born of a ____ father.
11. "Splish, ____, I was taking a bath..."
12. Canada has beautiful, high mountain ____.
13. Fossil fuels create a greenhouse ____.
15. A creature that breathes through its gills.
17. The first stage of the sediment cycle.
19. A fast moving part of a river.
20. Weather patterns make up our ____.
23. A form of frozen precipitation.
24. A river will eventually drop, or ____, its sediment.
26. Chemical pollutants.

Fill in Blanks

1. The first stage in the sediment cycle is _____.

2. Water transports soil from one place to another in the form of _____.

3. _____is the term used to describe the phase of the sediment cycle in which water drops its load downstream.

4. Glaciers, wind, and water wear away small particles of rock through a process called _____.

5. The term that means thousands of years is _____.

True or False

T F 1. The poem “The Song My Paddle Sings” was written by Tom Thomson.

T F 2. When early explorers and settlers first came to Canada, rivers were the main transportation system.

T F 3. Alexander Mackenzie was a painter of Canada's waterways.

T F 4. The Fraser River is named after Fraser Thompson.

T F 5. Poets such as Charles G.D. Roberts, Bliss Carman, Archibald Lampman, and Duncan C. Scott were members of the Group of Seven.

T F 6. Native people of Canada selected sites for villages because they were close to water.

T F 7. Rivers in mountainous regions carry greater loads of sediment than rivers in the Prairies.

T F 8. The St. Lawrence River transports more sediment than the Fraser River.

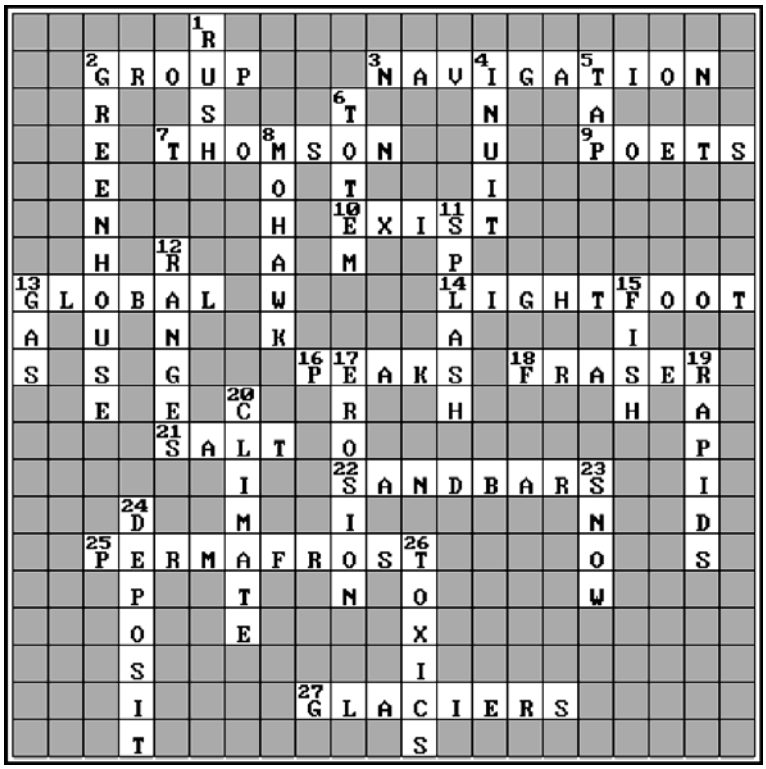
T F 9. Glaciers covered much of North America over 10 000 years ago.

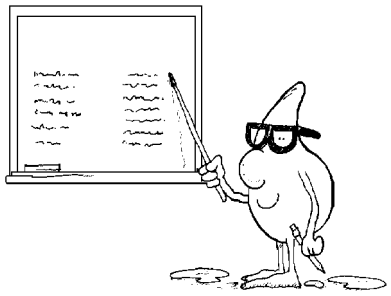
Question Time

How would you answer the following questions in one or two sentences?

1. Why is there less river-deposited sediment in eastern Canada than in western Canada?
2. What are two sources of toxic chemicals carried by sediment?
3. Why is sediment a problem for navigation?
4. How can sediment affect fish eggs?
5. What bad effects does sediment have on water supply?
6. How does construction of roads and buildings affect the environment?
7. What is the difference between weather and climate?
8. What "natural causes" can lead to changes in the climate of a region?
9. What is meant by "global warming"?
10. How do some greenhouse gases help us?
11. What problems are associated with greenhouse gases?

TEST 5
Crossword Puzzle





Fill in Blanks

1. The first stage in the sediment cycle is **erosion**.
2. Water transports soil from one place to another in the form of **sediment**.
3. **Deposition** is the term used to describe the phase of the sediment cycle in which water drops its load downstream.
4. Glaciers, wind, and water wear away small particles of rock through a process called **weathering**.
5. The term that means thousands of years is **millennia**.

True or False

1. **False.** The poem "The Song My Paddle Sings" was written by Pauline Johnson.
2. **True.** When early explorers and settlers first came to Canada, rivers were the main transportation system.
3. **False.** Alexander Mackenzie was an early explorer.
4. **False.** The Fraser River is named after Simon Fraser.
5. **False.** Poets such as Charles G.D. Roberts, Bliss Carman, Archibald Lampman, and Duncan C. Scott were members of a group referred to as the Confederation poets.
6. **True.** Native people of Canada selected sites for villages because they were close to water.
7. **True.** Rivers in mountainous regions carry greater loads of sediment than rivers in the Prairies.
8. **False.** The Fraser River transports almost ten times as much sediment as the St. Lawrence River.
9. **True.** Glaciers covered much of North America over 10 000 years ago.

Question Time

1. Why is there less river-deposited sediment in eastern Canada than in western Canada?
   - **Much of the land is bedrock.**

2. What are two sources of toxic chemicals carried by sediment?
   - **Agriculture and industry**.

3. Why is sediment a problem for navigation?
   - **If sediment from fast moving rivers is deposited downstream, eventually it builds up and makes the water shallow.**

4. How can sediment affect fish eggs?
   - **Settling sediment can bury and suffocate fish eggs.**

5. What bad effects does sediment have on water supply?
   - **Sediment in the water can wear out pumps and turbines, which can increase the cost of keeping things in good repair.**

6. How does construction of roads and buildings affect the environment?
   - **Sediment from construction sites can find its way to sewers and streams and can increase the costs of water treatment or affect aquatic life.**

7. What is the difference between weather and climate?
   - **Climate is determined from the average of weather conditions and patterns over a long period of time (more than 30 years).**

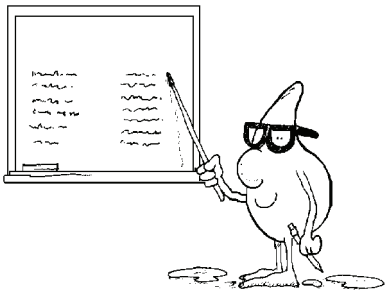
8. What "natural causes" can lead to changes in the climate of a region?
   - **Changes in the gaseous content of the atmosphere and changes in the amount of sunlight reaching the earth's surface can both affect climate.**

9. What is meant by "global warming"?
   - **This is the term scientists use to describe what happens to the earth's climate when people and industries add greenhouse gases to the atmosphere.**

10. How do some greenhouse gases help us?
    - **They trap the sun's heat in a blanket of air around the earth and keep it from escaping into space. This keeps the earth's temperatures just right for people, animals, and plants to live.**

11. What problems are associated with greenhouse gases?
    - **Problems occur when we add large amounts of gases to the atmosphere by burning fossil fuels in our industries, cars, and homes. These gases trap heat near the earth's surface and add to global warming.**

VOCABULARY



acid rain	precipitation that contains acid and damages the environment
aeration	process by which air is combined with something
alum	astringent salt; added to water during treatment to help particles coagulate or cling together
anthropogenic	caused by people
aquatic	growing, living in, or frequenting water
aquifer	underground formation of rocks and soils where water collects
atmosphere	layer of gases and air surrounding the earth
atom	particle of matter smaller than a molecule
basin	area drained by rivers and tributaries
chlorine	chemical used to purify water
climate	average weather conditions and patterns of a region over a long period of time
coagulation	process by which particles are drawn together by forces of attraction
condensation	process by which water vapour cools and changes to water droplets as in the formation of clouds
confined	held in
contaminate	make dirty, pollute
corroded	worn away gradually, for example, by acid
crevice	a split or crack

degradable	can be eroded, or broken down to simpler structure
deposition	process of something being laid or thrown down
desalinization	the removal of salt from water
desertification	land becomes like a desert
disperse	to distribute in different directions
dissolve	to become a fluid, by melting into a liquid, for example drought long period without significant precipitation
effluent	treated waste discharged from wastewater treatment plant erosion wearing down or washing away of soil by water, wind, or ice
eutrophication	process by which lakes and ponds become enriched with dissolved nutrients
evaporation	process by which a liquid changes into vapour
evapotranspiration	*see* transpiration
filtration	process by which solids are filtered out of liquids, a stage in water treatment
flat rate	a rate charged for water use that is the same for everyone no matter how much water is used
fluoride	chemical added at some water treatment plants to purify the water
groundwater	water that is underground
herbicides	chemicals used to kill plants, especially weeds hydroelectricity electricity produced by flowing water used to turn turbine generators
hydrogen	one of the elements making up water
hydrologic cycle	continual exchange of water between the earth and the atmosphere
impermeable	does not permit passage of liquids

infrastructure	all water pipes, storage areas, and treatment plants needed to supply water to a municipality
instream	water used in its natural setting, for example, for fisheries irrigate to supply with water by means of ditches, canals, etc. metered rate a charge per unit of water used, as measured by a meter
molecule	the smallest particle of a substance that retains all the properties of the substance
monitor	to watch closely
navigation	ship traffic
nutrients	food
oxygen	the most common chemical element of the earth's crust, an element making up water
percolate	to filter down, as through soil
permafrost	permanently frozen layer of soil
pesticides	chemicals for killing insects and weeds
potable	safe to drink
precipitation	water falling as rain, hail, sleet, snow, etc.
prehistoric	the period before written history
purify	to clean
recycling	using again
renewable	capable of being replaced by natural ecological cycles
reservoir	a place where water is stored
saltwater intrusion	the seepage of seawater into groundwater near coastal areas
sanitation	the process of making something clean, healthy
saturated	thoroughly wet, unable to hold any more liquid

sediment	matter that settles to bottom of liquid
sedimentation	process of settling particles out of a liquid in a treatment plant
sewer	pipe that carries away wastewater
solvent	a liquid capable of dissolving one or more other substances stringent very strict
suspended solids	small particles of solid matter floating in a liquid
toxic	poisonous
transpiration	process by which water from plants is evaporated into the air, usually through the leaves
unconfined	free to move around
unsaturated	able to hold more moisture
vital	necessary for life
vapour	gas formed by heating a liquid such as water
withdrawal	process whereby water is removed from its natural setting
Xeriscaping	a method of landscaping that uses plants that don't need much water