Elementary Teacher's Guide

BOW RIVER BASIN WATERSCAPE POSTER

www.calgary.ca/waterworks call 3-1-1

THE CITY OF CALGARY

Acknowledgements

The activities in this guide were designed to complement the Bow River Basin Waterscape Poster, part of a series of posters developed by the Geological Survey of Canada (part of Natural Resources Canada) in partnership with many different agencies. To learn more about this poster series please visit www.geoscape.nrcan.gc.ca.

The Bow River Basin Waterscape was developed by the Geological Survey of Canada in partnership with the following agencies: the Bow River Basin Council, Alberta Environment, Climate Change Central, Calgary Roman Catholic School District No. 1, the Calgary Board of Education and the City of Calgary with participation of individuals from Parks Canada, the University of Calgary,
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To ensure the poster is accessible as an educational resource, The City of Calgary worked with a group of elementary and junior high teachers from Calgary schools to create these interactive water activities to accompany the poster. The City of Calgary gratefully acknowledges the following individuals for creating, testing and editing these activities:

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Bow River Basin Waterscape

Introduction

We live in the basin of the Bow River, a remarkable tract of land that extends from the Rocky Mountains, across foothills and the rapidly growing City of Calgary, to the broad prairie. This land has been home to First Nations people for thousands of years. Within this basin, all waters flow into the Bow River. We share this water with plants and animals. Without this water, nothing could live. With this water, a great diversity of life, including humans, can thrive. As residents of the Bow River basin, we must protect the land that produces these life-giving waters. There are many challenges. Our rapidly growing population demands much of the land and water. Our climate is changing and the future of our water supplies is uncertain. To act wisely, we need first to understand our basin. The purpose of this poster is to introduce us to the local water cycle, how humans use the basin waters, and how we can live well on the land.

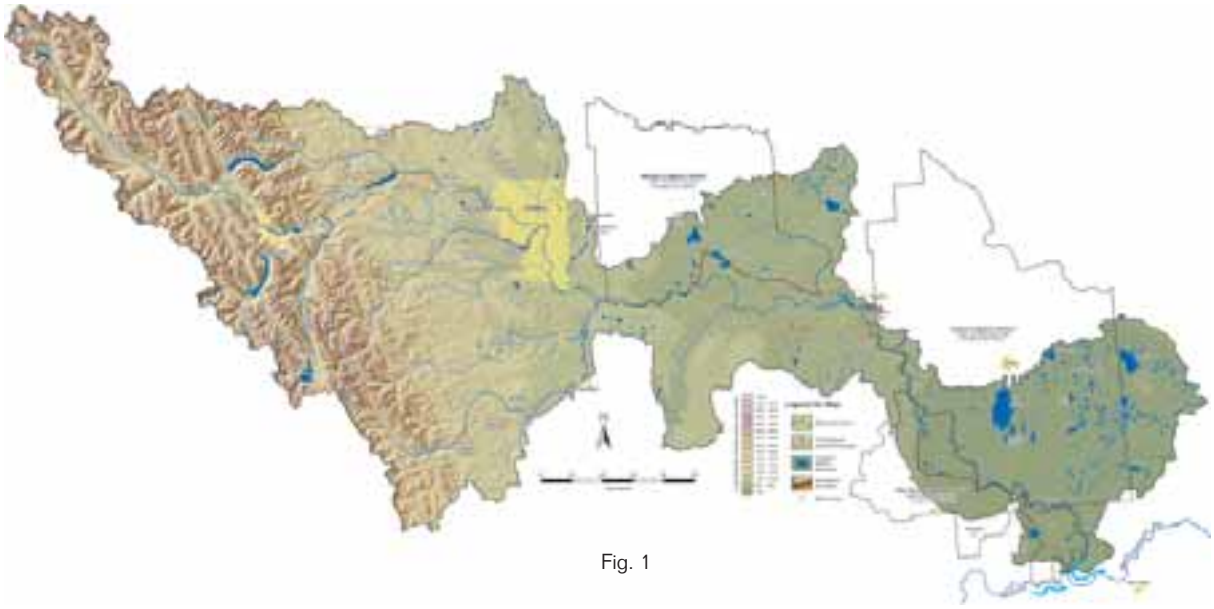


Fig. 1

Fig.2

The Bow, Red Deer, and Oldman rivers are tributaries of the South Saskatchewan River. This family of rivers carries water from the Rocky Mountains across the dry southern prairies of Alberta and Saskatchewan. The Bow River joins the Oldman River near Medicine Hat to form the South Saskatchewan River. Bow River waters flow all the way to Hudson Bay. Downstream communities that use these waters such as Medicine Hat and Saskatoon depend on us to care for the quality of the water as it passes through the Bow River basin.

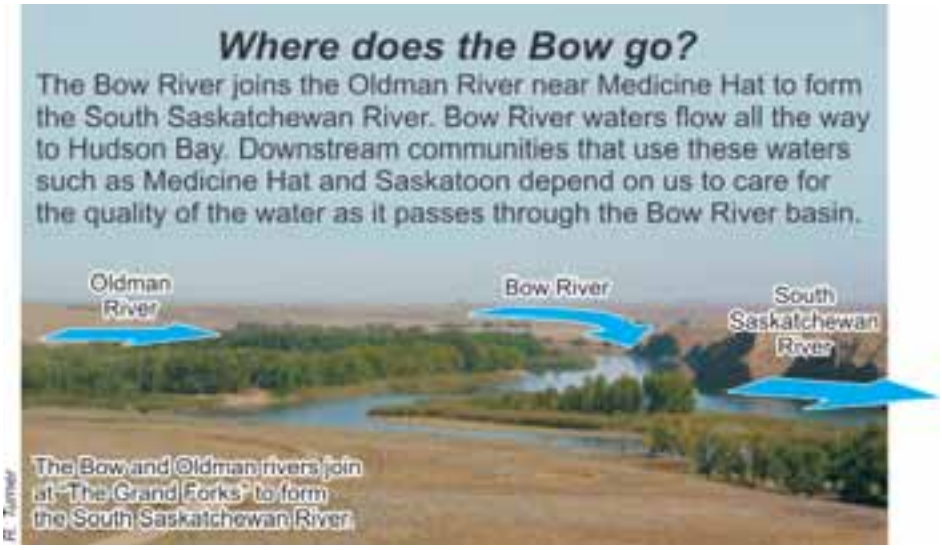


Fig. 3

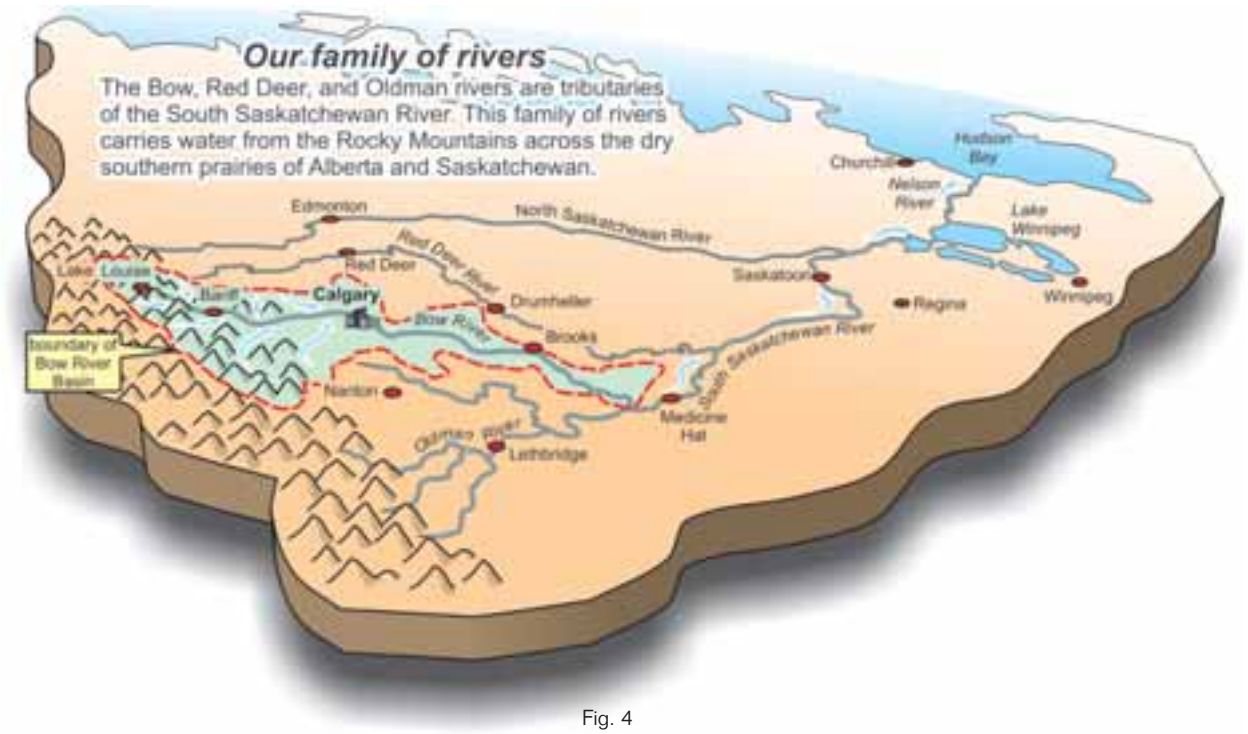


Fig. 4

The Message

The underlying message throughout the poster is the importance of protecting and conserving the shared waters of our Bow River, ensuring a sustainable resource for future generations all along the watershed.

Activities

This guidebook consists of a collection of lessons and activities that support the various panels on the Waterscape poster. Each one is linked to outcomes in the Alberta Learning Program of Studies, relate to the student's local environment and can be applied globally. Activities are designed to provide accessible, hands-on classroom experiences that will help our students gain the appreciation, the knowledge and the understanding necessary to make well-informed decisions concerning the future of the Bow River in order to conserve and protect this precious resource.

Graphics

Graphic files can be accessed online at www.geoscape.nrcan.gc.ca and www.brbc.ab.ca . Teachers are encouraged to find creative ways of integrating these visual aids into their lesson plans.

Fig. 5

Using Bow River Basin Waterscape in the Classroom

Each panel on the Waterscape poster focuses on a different topic as it relates to the Bow River basin. The activities that have been included are meant to support the information in each of the panels on the poster. By posing questions and providing students with interesting activities it is hoped that the students will be intrigued and motivated to investigate further, ask their own questions and strengthen their knowledge and understanding of the significance the Bow River.

The format of the activities includes background information, curriculum connections, materials, activities and extensions. In no way does this guide provide teachers and students with a unit of study for any grade or any curriculum area. It is a starting point for an inquiry of the Bow River that reflects the simplicity, the harmony and the brilliance of the natural world through science, literature and art. Author Katherine Paterson, defines simplicity as an observation and of giving children opportunities really to 'see' by watching something over time and noticing details. Harmony is found when we connect with nature and realize we are part of the experience. Brilliance is in the discovery and appreciation of beauty and in the essence of the object that is viewed." (Chancer and Rester-Zodrow, Moon Journals, p.41, 1997) The river, the poster and the activities provide a common focus but it is the student's interest, natural curiosity and desire to understand that drives this inquiry. Students are encouraged to explore ideas, ask questions, seek answers and express their understandings in a variety of ways, through words, pictures, music, acting, and dance.

Waterscape Poster Alberta Curriculum Ties

Poster Panel	Science Curriculum	Social Studies Curriculum
Watershed	**Grade 5: Wetland Ecosystems** 1. Recognize and describe one or more examples of wetland ecosystems found in the local area; e.g., pond, slough, marsh, bog, fen.	**Grade 4 Alberta: A Sense of the Land** **4.1.2 critically examine the physical geography of Alberta by exploring and reflecting upon the following questions and issues:** 1. What are the major geographical and natural vegetation regions, landforms and bodies of water in Alberta (e.g., prairie region, forests, rivers, hoodoos, Rocky Mountains, oil sands)? 2. What are the factors which determine climate in the diverse regions of Alberta (e.g., latitude, mountains)? 3. What are the significant natural resources in Alberta and where are they located (e.g., mineral deposits, coal, natural gas and oil, forests)?
Water Cycle	**Grade 5: Weather Watch** 4. Describe evidence that air contains moisture and that dew and other forms of precipitation come from moisture in the air.	
Hidden Sea	**Grade 5: Wetland Ecosystems** 11. Recognize that changes in part of an environment have effects on the whole environment.	**Grade 4 Alberta: A Sense of the Land** **4.1.4 analyze how Albertans interact with their environment by exploring and reflecting upon the following questions and issues:** 1. In what ways do the physical geography and natural resources of a region determine the establishment of communities? 2. How are natural resources used by Albertans (i.e., agriculture, oil and natural gas, forests, coal)? 3. How do Albertans deal with competing demands on land use in Alberta (e.g., conservation, solar and wind power, recreation, agriculture, oil exploration, forestry)?

Climate Change	**Grade 5: Weather Watch** 7. Record weather over a period of time. 9. Describe the effects of the Sun's energy on daily and seasonal changes in temperature—24-hour and yearly cycles of change. 10. Recognize that weather systems are generated because different surfaces on the face of Earth retain and release heat at different rates. 11. Understand that climate refers to long term weather trends in a particular region and that climate varies throughout the world. 12. Recognize that human actions can affect climate, and identify human actions that have been linked to the greenhouse effect. **Grade 5: Wetland Ecosystems** 11. Recognize that changes in part of an environment have effects on the whole environment.	**Grade 4 Alberta: Celebrations and Challenges** **4.3.1 appreciate the factors contributing to the quality of life in Alberta:** 1. appreciate the influence of the natural environment and resources on the growth and development of Alberta 2. value and respect their relationships with the environment
Sharing	**Grade 5: Wetland Ecosystems** 11. Recognize that changes in part of an environment have effects on the whole environment.	**Grade 4 Alberta: Celebrations and Challenges** **4.3.1 appreciate the factors contributing to the quality of life in Alberta:** 3. appreciate the influence of the natural environment and resources on the growth and development of Alberta 4. value and respect their relationships with the environment
Water Use (Urban)	**Grade 5: Wetland Ecosystems** 11. Recognize that changes in part of an environment have effects on the whole environment. **Grade 4: Waste in Our World** 2. Identify and classify wastes that result from human activity. 3. Describe alternative methods of disposal, and identify possible advantages and disadvantages of each. 4. Distinguish between wastes that are readily biodegradable and those that are not.	**Grade 4 Alberta: Celebrations and Challenges** **4.3.1 appreciate the factors contributing to the quality of life in Alberta:** 1. appreciate the influence of the natural environment and resources on the growth and development of Alberta 2. value and respect their relationships with the environment

Irrigation (Rural)	**Grade 5: Wetland Ecosystems** 11. Recognize that changes in part of an environment have effects on the whole environment. **Grade 4: Waste in Our World** 2. Identify and classify wastes that result from human activity. 3. Describe alternative methods of disposal, and identify possible advantages and disadvantages of each. 4. Distinguish between wastes that are readily biodegradable and those that are not	**Grade 4 Alberta: Celebrations and Challenges** **4.3.1 appreciate the factors contributing to the quality of life in Alberta:** 3. appreciate the influence of the natural environment and resources on the growth and development of Alberta 4. value and respect their relationships with the environment
Keeping Clean	**Grade 5: Wetland Ecosystems** 9. Identify human actions that can threaten the abundance or survival of living things in wetland ecosystems; e.g., adding pollutants, changing the flow of water, trapping or hunting pond wildlife. 10. Identify individual and group actions that can be taken to preserve and enhance wetland habitats. 11. Recognize that changes in part of an environment have effects on the whole environment. **Grade 4: Waste in Our World** 2. Identify and classify wastes that result from human activity. 3. Describe alternative methods of disposal, and identify possible advantages and disadvantages of each. 4. Distinguish between wastes that are readily biodegradable and those that are not.	**Grade 4 Alberta: Celebrations and Challenges** **4.3.1 appreciate the factors contributing to the quality of life in Alberta:** 5. appreciate the influence of the natural environment and resources on the growth and development of Alberta 6. value and respect their relationships with the environment

Curriculum Connections and Opportunities for Interdisiplinaria Using Waterscape Activities

ACTIVITY	SCIENCE	SOCIAL STUDIES	MATH	LA	FINE ARTS
Getting to Know the Bow				✔	✔
School Yard Model	✔	✔		✔	
Moving Mountains Making Mole Hills	✔	✔	✔	✔	✔
Mapping the Watershed	✔	✔	✔		
What Is the water Cycle	✔				
Water Cycle Model In a Bottle	✔			✔	✔
Water Cycle Keeps On Rolling	✔	✔		✔	
Dance Of the Waterdroplet	✔	✔		✔	✔
Groundwater Model	✔	✔	✔	✔	
Climate Change? So What!	✔	✔	✔	✔	
How Does Climate Change Affect the Watershed?	✔	✔		✔	
Tasty Waste	✔	✔			
How is Our Water Shared?	✔	✔	✔		
Kilolitre Challenge	✔	✔	✔		
Making Wise Decisions	✔	✔		✔	
How is River Water Treated	✔	✔		✔	
Taste Test Challenge	✔	✔	✔	✔	
Catch That Oil Spill	✔	✔		✔	
All Bogged Down	✔	✔		✔	

Activities

Learning Through Art

Background

Today's culture surrounds us in images from the newspapers, magazines, on the web so it is important that we be able to interpret them in a meaningful way. At the end of the unit, students should have become very familiar with the Bow River from social, scientific and personal perspectives.

The goal of this activity is to develop a sense of the river's role through time by linking past, present and future together. This is especially important when considering the current generation's responsibility for ensuring a sustainable water resource for future Albertans, and perhaps even more importantly, for caring for the river that gives us so much.

Time Required

3 hours

Curriculum Connections

Information Literacy, Art, Visual Literacy

Objectives

- Develop the necessary skills to look at an image carefully and critically to gather information, ideas and the intentions or implied meaning of the artist.

Materials

- Various pictures (photographs or paintings/ drawings) of the Bow River in different seasons
- A good resource is "The Bow. Living with a River" (Book or art prints available at the Glenbow Museum Gift Shop)

ACTIVITY

1. Choose a photograph (or piece of artwork) that catches your interest. What colors, lines, patterns, shapes and textures can you see?
2. Examine the picture closely. Describe what you see in the picture to each other. Write any words/ideas that pop into your head.
3. What time of year is it? What time of day? How do you know?
4. Use your imagination and walk into your picture. Use your senses to explore… What do you hear? What do you taste? What do you smell? What do you hear?
5. Using chalk pastels, (or other mediums such as watercolour pencil crayons or paint) have the students very lightly sketch the shapes (triangles, circles, rectangles, squares) they "see" in their picture onto their art paper.
6. Using the pastels blend the colors to create the background colors in the picture.
7. Next have the students add detail in the background, mid ground, and fore ground.
8. Spray the picture lightly with hairspray to set the pastels.
9. Next day have the students use regular pencil crayons to add more vibrant color and shadows
10. Have the students examine the Bow River photograph or artwork
11. Examine the picture closely. Describe what you see in the picture to each other. Write any words/ ideas that pop into your head.

12. What time of year is it? What time of day? How do you know?

13. Use your imagination and walk into your picture. Use your senses to explore…What do you hear? What do you taste? What do you smell? What do you hear?

14. What emotions are you feeling? Happy, relaxed, angry, sad, frightened, peaceful, anxious, serene? What in the picture makes you feel this way? The shapes? The colors?

15. What is the artist trying to communicate through this work?

16. Do you like this picture? Why or why not?

17. Have the students follow the same exercise with another picture.

Extension

Have the students create an "image folder" using the internet to find images of rivers and river life around the world. (www.dogpile.com images)

Have students revisit the same picture later in the year and record their observations in their journals.

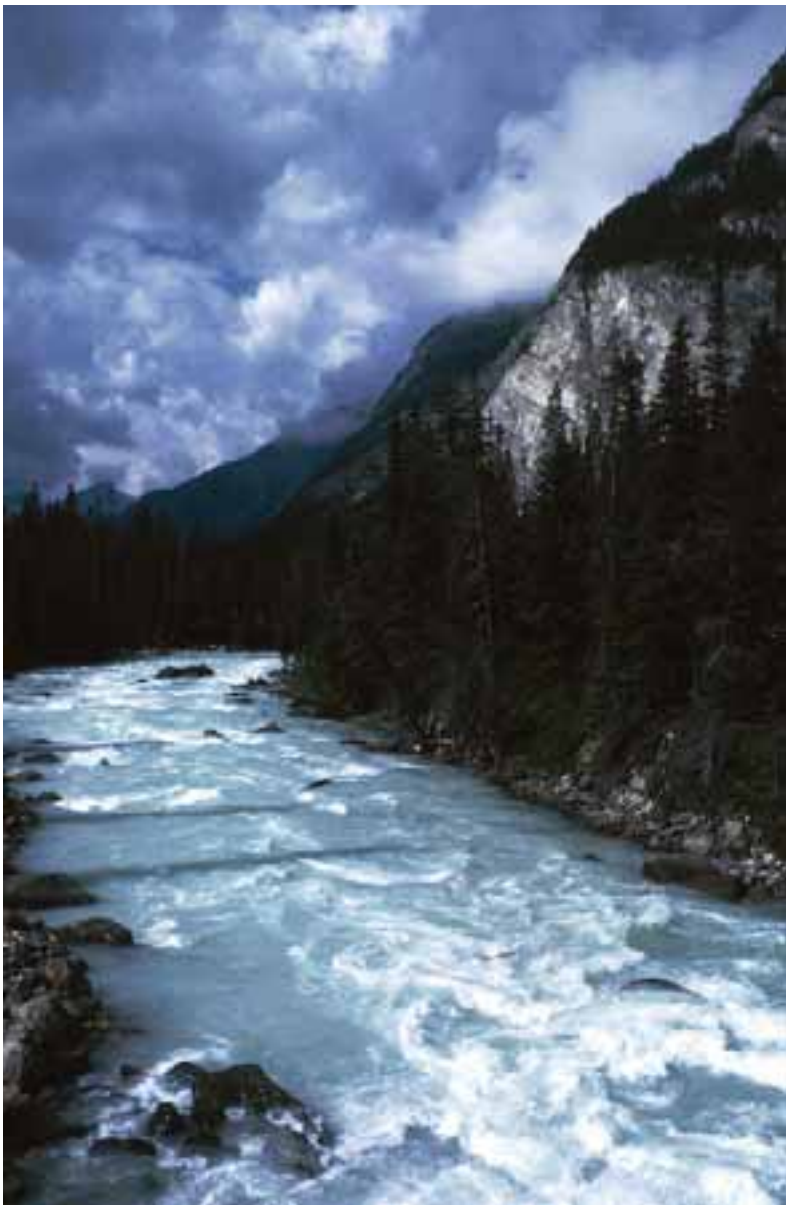


Fig. 9

Bow River Basin Panel Activities

BACKGROUND INFORMATION

What is the Bow River basin?

A river basin or watershed is high at its edge, and low in the centre where the river flows. The Bow River basin or watershed includes all the land that feeds water to the Bow River and its tributaries.

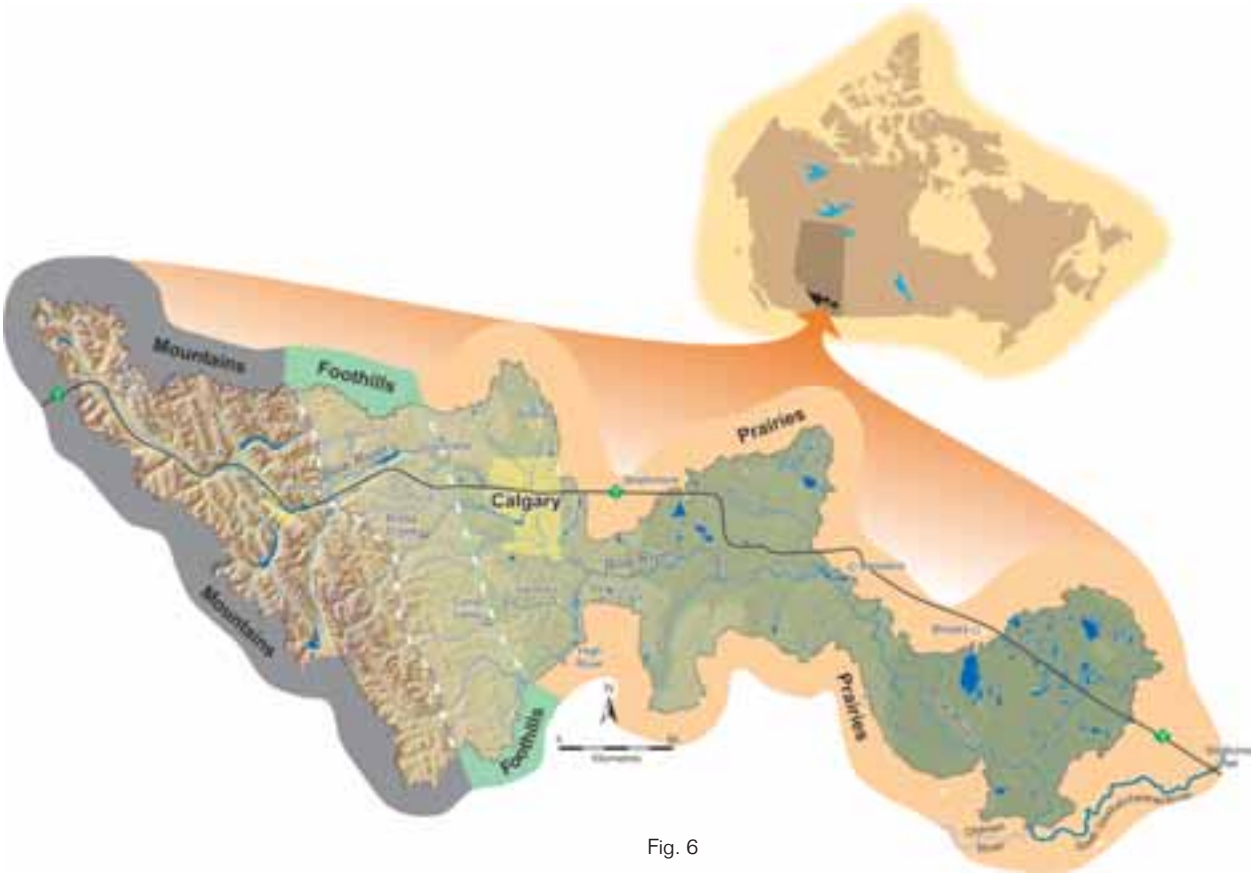


Fig. 6

Mountains, foothills, and prairies

Most Bow River waters come from the Rocky Mountains, an area largely protected within parks. East of the mountains, the Bow River flows through foothills, and then to most of the basin's human residents.

Who lives here? Over a million people...and growing fast!

The Bow River basin is the most densely populated river basin in Alberta. There is less water available per person here than any other river basin in the province. And yet, in the last ten years, the population of the basin has grown by over a quarter of a million people. So we have a challenge!

An ancient homeland

The lands of the Bow River basin have been home to First Nations people for thousands of years. Today, the Stoney Nakoda Nation has reserve lands throughout the foothills of the Bow River basin. Tsuu T'ina Nation reserve lands extend west from Calgary to Bragg Creek, and the Siksika Nation reserve lands straddle the Bow River valley near Bassano.

Fig. 7

Fig. 8

The area of land that is drained by streams and rivers is called a watershed. The boundaries of the watershed move the water from one place to another.

The Bow River's headwaters are high in the Rocky Mountains. They begin at the Bow Glacier. The river flows from this point down the mountains through the foothills to Calgary. At this point it is joined by the Elbow River. It continues to flow south until it joins the South Saskatchewan River near Taber, Alberta eventually emptying into the Hudson Bay. The Bow River Watershed includes all the land that contains tributaries that flow into the Bow River. The bow river is about 7800 square kilometres.

Essential Understandings

- Watersheds include both water and land components.
- Streams and other tributaries form rivers
- Hills and mountains form the boundaries between watersheds and direct the path and speed of rivers
- Low-lying areas create pooling
- Water quality is affected by what is upstream
- Each watershed has a unique mixture of habitats, rivers, lakes, forests, farms and cities.
- Topographic maps identify the shape of the earth's surface.

Schoolyard Model

Time Required
2-3 hours.

Curriculum Connections
Science, Social Studies

Key Vocabulary
- drainage basin
- riparian zone
- watershed
- reservoir
- tributary
- pollutants
- head-waters
- non-point source pollutants

Fig. 10

Outcomes
- Construct a 3 dimensional model of a watershed and use it to explore drainage basins, water pathways
- Define the concept of a drainage basin and watershed
- Manipulate the model to illustrate how a watershed can change
- Give examples of how their model relates to the real world

Materials
- Large sheets of strong plastic (12' X 6')
- Assortment of rocks, sticks, crumpled paper, crushed cans
- Coloured drink crystals or food coloring
- Water source (hose or buckets of water)
- Golf tees
- Spray bottle
- Sponge

ACTIVITY

1. Divide students into groups of 3-4
2. Give each group a sheet of plastic, a plastic pail and a handful of golf tees.
3. In the schoolyard (preferably in an area close to a water source and with a slope) have each group collect rocks, sticks, crumpled paper etc…(this can be collected before the class by the students)
4. Have students arrange the objects to create an uneven landscape. The tall objects will become the mountains, shorter objects may become lakes, hills etc. Cover the entire area with the plastic sheet and tack down the outside edges with golf tees.
5. Gently mould the plastic around the objects.
6. Predict what will happen when it 'rains' on their model.

7. Using the spray bottle have the students spray water, starting at the top of the landscape. Continue raining until streams, rivers and lakes begin to form.

8. Have students choose a site in the watershed to build their home school etc.

9. Have students experiment with their river by rearranging the landforms, building dams and changing the rate of water flow.

   a) Have students plant a 'forest' (place the large flat sponge for the forest , it will soak up water like soil and vegetation) What happens if you remove the forest?

   b) What happens if your river water is diverted for irrigation (makes canals to take the water away from the river)

   c) Have students sprinkle colored drink crystals (pollutants) along the river, then spray (rain) water over the crystals. What happens along the river?

10. Have students observe, discuss and record their observations.

11. Have students share and discuss the activity in a large group.

12. Record all questions generated from discussion and observations.

Guiding Questions

1. Where would the source or headwater of the river be?

2. Where does the water flow?

3. Why does it follow that path?

4. Where does the water pool? What things on the landscape determine the river basin?

5. What determines the boundaries of the watershed?

6. Who might use your river and how?

7. How can nature or people change a river?

8. How might pollutants enter a river?

Fig. 11

Moving Mountains, Making Molehills

Time Required

2–3 class periods

Curriculum Connections

Science, Social Studies

Key Vocabulary

- drainage basin
- watershed
- tributary
- head-waters
- riparian zone
- reservoir
- pollutants
- non-point source pollutants

Outcomes

- Build a 3-D model that demonstrates how small streams flow together to form a river that runs through steep sided V shaped valleys
- Identify and learn about he unique shape of the Bow River Watershed

Materials

- Plastercine, paper maché or clay for each pair of students.
- Piece of card board large enough to build the model on (12”X 18”)
- Popsicle sticks
- Miniature plastic animals, people, etc.
- Spray bottle

Fig. 12

ACTIVITY

1. To build the model start from the lowest point of elevation , the prairie grasslands. The land should begin to gradually role into the foothills and then into the mountains, with deep valleys, to the highest points of elevation.

2. Starting at the source of the river form its pathway down to the prairie. Remember to include tributaries and lakes along the way.

3. Paper maché and clay models need time to dry before they can be painted with acrylic paint and allowed to dry before the next step.

4. Using a spray bottle, spray water across the top of the mountains. Observe how the water flows from its source to the prairie.

5. Add miniature animals, plants, buildings, dams, people etc.

Guiding Questions

1. What are the geographical/physical features of your watershed?

2. How might people use your river?

3. How might wildlife use your river?

4. Do the geographical features of your watershed influence how it is used? How?

5. How do people change rivers? Why do they change them?

6. Where would be the best place to build a dam?

7. Where might there be a farm, a town or city, a golf course?

Mapping the Watershed

Fig. 13

Time Required

1 class period

Curriculum Connections

Science, Math, Social Studies, Language Arts

Key Vocabulary

- contour lines
- elevation
- interval
- concentric circles

Outcomes

Students will:

- Create a topographic map of their 3-D watershed.
- Identify the highest points of elevation that define the Bow River Watershed.
- Have a better understanding of how topographic maps show the shape of the earth's surface.

Materials

- Handout of topographic map

ACTIVITY

1. Look at your 3-D model of the watershed. Mark with a pencil intervals up the side of your mountain.
2. On a piece of paper draw circles (contour lines) to represent the base of the hills and mountains. Add smaller circles inside the larger ones (concentric circles) to represent the height (elevation) of the hills and mountains.
3. Draw the river and tributaries on to the map
4. Put an X on the highest points (elevations). They look like small circles on the map but they are mountains and hilltops.
5. Draw a line connecting the X's. This is where the river starts. It is the source or headwaters of the river.
6. Draw a line from the hilltops with the lowest elevation to the mouth of the river. Everything within the lines is the watershed for this river. All the water flows down through the watershed to the ocean.

Fig. 14

7. Examine a topographic map of the Bow Glacier region of the watershed. Find the highest and lowest points of elevation. Locate the valleys. How do the contour lines relate to the contour intervals?

Guiding Questions

1. What do the circles and lines on the map represent?
2. How are the geographical/physical features of the watershed determined?
3. What are the geographical/physical features of the watershed?
4. How do the geographical features of the watershed influence how it flows (flow rate, path, width, volume,…)
5. Where would be the best place to build a dam?

Extension

Have several topographic maps of the Bow River basin for the students to investigate. Have the students find the highest and lowest elevations along the Calgary-Jasper highways.

The Water Cycle in Bow River Basin Panel Activities

BACKGROUND INFORMATION

Our mountain cloud catchers

Almost all the water in the Bow River comes from the Rocky Mountains. This mountain chain forces air to rise and cool, causing moisture to condense and fall as rain or snow. This precipitation, together with the meltwaters from glaciers that release ancient snowfalls, feed the Bow River through its many mountain tributaries. Even groundwater that feeds the Bow River begins its life as rain or snow.

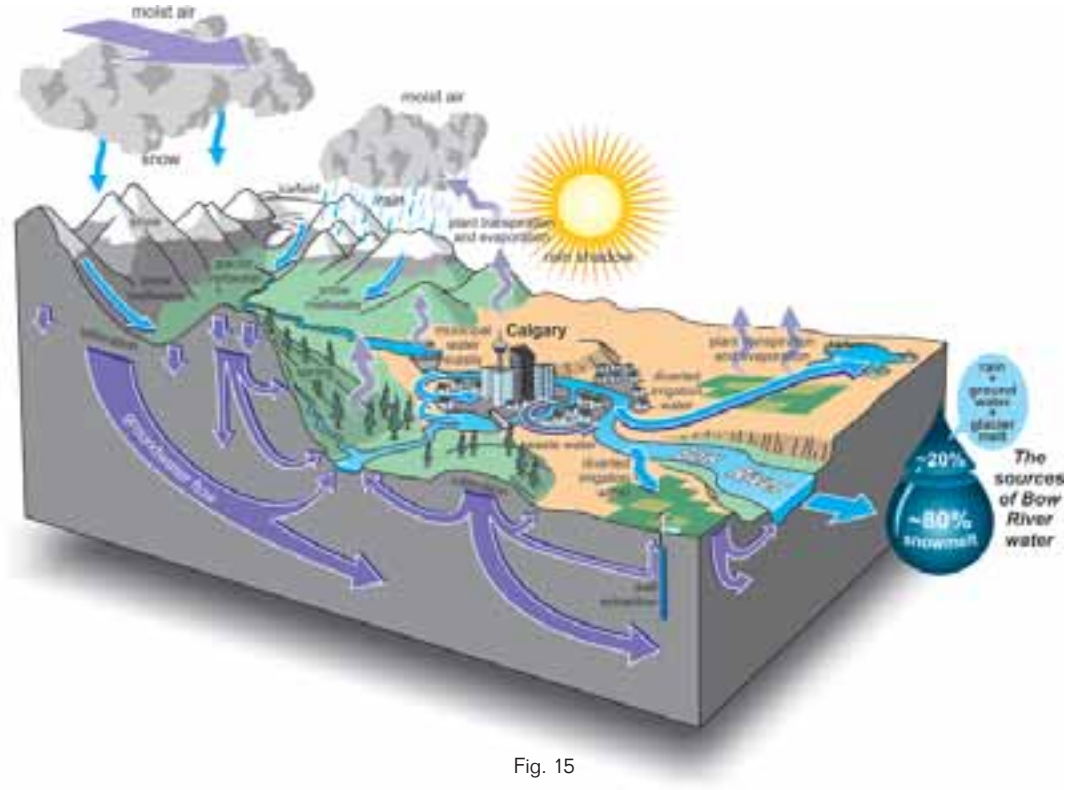


Fig. 15

Prairie lands: living in the rain shadow

So effective are the Rocky Mountains at stripping moisture from eastward moving air masses that little is left for the prairie areas, creating a "rain shadow." This is why irrigation is vital to agriculture; the Bow River is the most dependable source of water.

Fig. 16

Storing our water: nature's water towers and cisterns

Water flows the entire length of the Bow River in less than two weeks. Why then doesn't the Bow River dry up between rainstorms? Because nature stores and slowly releases water throughout the basin. Water is stored in snow packs, glaciers, wetlands, lakes and groundwater.

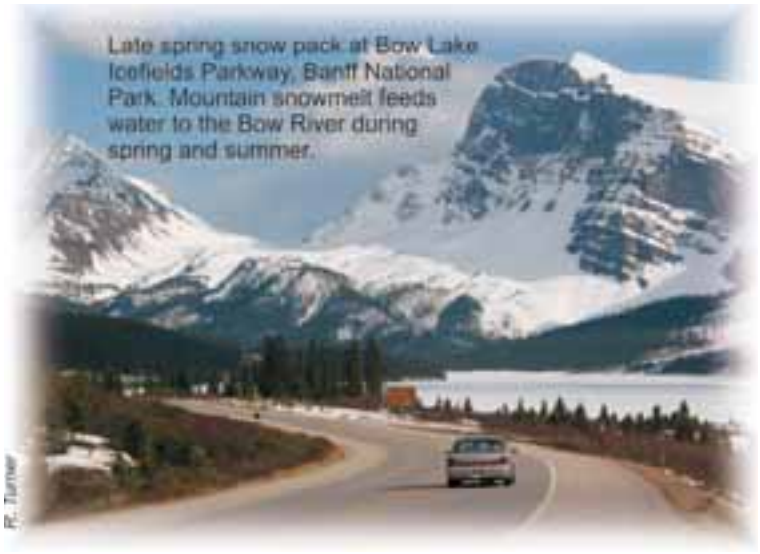


Fig. 17

No glaciers? What then?

Many people wonder what will happen to the river if the glaciers melt away? In fact, glacier meltwaters contribute less than 1% of the total annual flow to the Bow River so their overall contribution is small. However, the portion of Bow River derived from glaciers rises during the summer as snowmelt wanes. During a drought year with reduced snowfall and rain, the relative contribution of glacier melt water to the Bow River is higher. Without glaciers in the Bow River basin, water supply during drought years would be much more challenging. However, as long as it snows and rains every year, we can expect the river to keep moving.

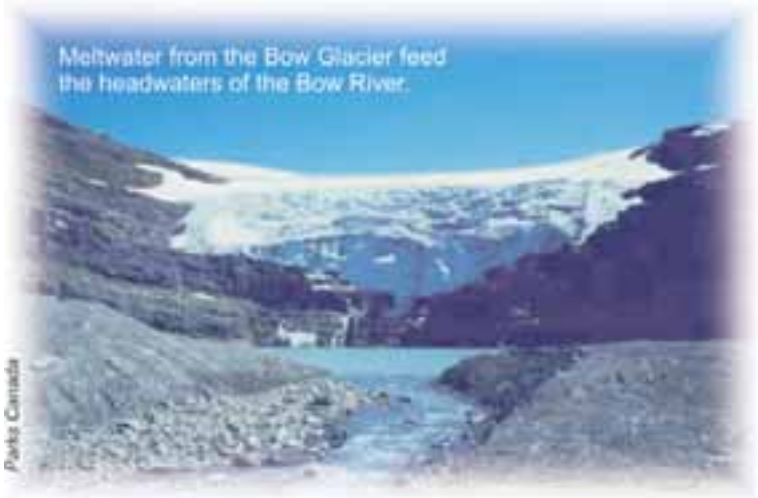


Fig. 18

What is the Water Cycle?

Time Required
1 hour

Curriculum Connections
Science, Math

Key Vocabulary
- evaporation
- condensation
- evapo-transpiration
- infiltration
- precipitation
- transpiration

Outcomes
- Identify how the water moves through the environment
- Illustrate the water cycle

Materials
- Fish tank
- Cookie sheet
- Bag of ice
- Kettle

ACTIVITY
1. Where does the water come from? How does the river form? What creates the rain?

2 Show the Water Cycle drawing and introduce the vocabulary

3. Boil water

4. Place the fish tank on an slant so that one end of the fish tank is higher than the other.

5. Place cookie sheet on top of the fish tank.

6. At the higher end of the cookie sheet, place bag of ice.

7. Pour boiling water into the fish tank so that water pools at lower end of fish tank

8. Observe the water droplets form on the sides of the fish tank and on the underside of the cookie sheet.

9. Explain how most of the evaporation in Alberta come from evapo-transpiration

Guiding Questions
1. What causes the water to evaporate?

2. What causes the water to form clouds?

3. How do the changing seasons and temperatures affect the water cycle?

Extension
1. Have the students draw their own diagram of the water cycle

2. Discuss the difference between the water cycle in Alberta and in other places such as coastal areas.

Water Cycle in a Bottle

Time Required

- 2 hours to build
- Several days for observation

Curriculum Connections

Science, Language Arts

Key Vocabulary

- atmospheric water
- surface water
- condensation
- water cycle
- groundwater
- evaporation
- transpiration

Outcomes

- Understanding of the interrelatedness between atmospheric water, groundwater and surface water.
- Understand the roles of evaporation, condensation and transpiration in the water cycle.

Materials

Enough for one water cycle model. If students are working in groups, each group can make their own model from which to make observations.

- Three 2-L clear plastic bottles
- Three bottle caps
- Marker
- Scissors
- Awl or nail
- 1 meter cotton string
- Masking tape
- 500 mL (2 cups) water
- 250 mL (1 cup) slightly moist potting soil
- Several fast-growing plant seeds (grass, beans or radishes work well)
- 10 ice cubes

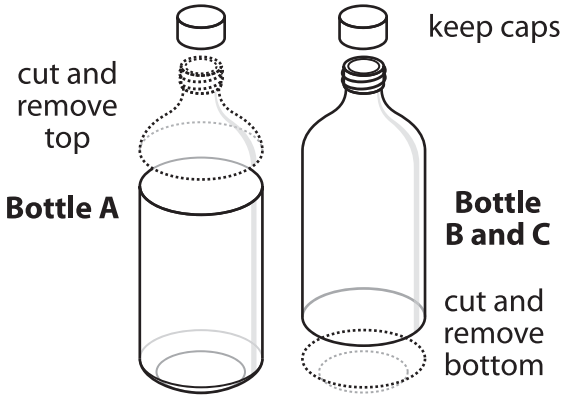


Fig. 19

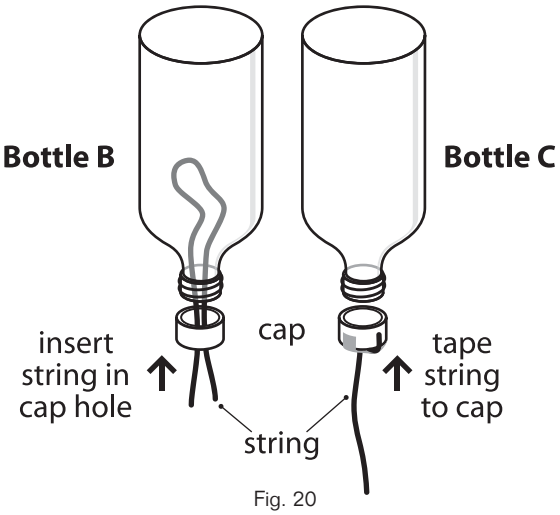


Fig. 20

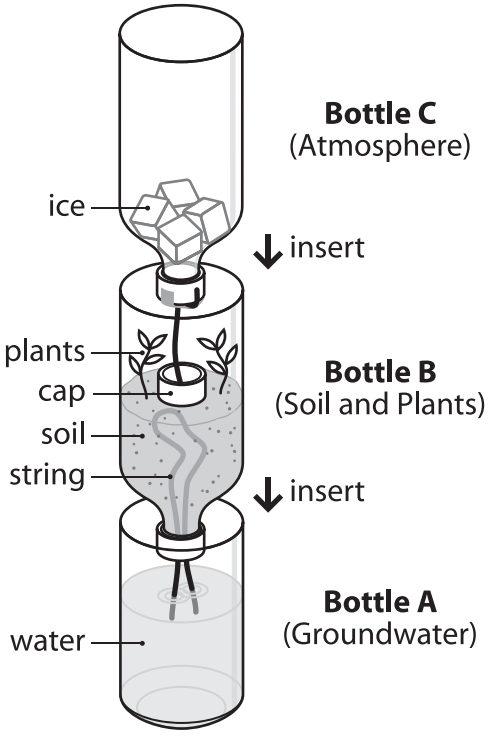


Fig. 21

ACTIVITY

Building the Water Cycle Model:

1. Remove labels from three 2-L clear plastic pop bottles. Save the lids.

2. Draw a line around the top ridge of Bottle A. Cut around the line so that you have the "body" portion of the bottle.

3. For Bottle B and Bottle C, draw the line on the lower ridge. Cut around the lines so you have the "head, shoulders and body" portion of the bottle (upper 2/3 of bottle).

4. Bottle B:
   - Poke a hole in a cap using the awl or nail.
   - Cut 50 cm of cotton string
   - Fold string in half and thread loop through the hole in the cap, leaving at least 5 cm of string from each end hanging down.

5. Bottle C:
   - Place a cap with no hole on Bottle C.
   - Tie 30 cm of string around the bottle neck. Trim short end close to knot.
   - Tape string onto cap so that the end drops down from the centre of the cap. You will probably need to trim this so that it sits neatly in the collector cap in Bottle B.

6. Assemble the bottles as shown in the diagram. These sections will be referred to as groundwater, surface water and atmospheric water.

Atmospheric water (Bottle C) with ice cubes (such as the cold layer of air above the Rockies). Only use ice cubes when demonstrating. Layer C will still provide greenhouse effect for Layer B.

Surface water (Bottle B) with 250 mL potting soil and plants started from seed. Soil should just cover the top of the loop. Place an upside down cap on the surface of the soil. The string from the atmospheric water chamber sits in the upside down cap on the soil surface and acts as a "rain" collector.

Groundwater (Bottle A) filled with 500 mL of water. This may need to be recharged.

Observation

1. Referring to the drawing of the water cycle model predict what will happen within the model.
2. It will take a few weeks for the seeds to germinate and become an active part of the water cycle. Students record observations on a regular basis.
3. When the seeds have sprouted, place the ice in the atmospheric chamber (Bottle C). Students should write about what this represents in terms of the Rocky Mountains.
4. Replace the ice daily and continue to make regular observations over the next few days. They should be looking for signs of evaporation, transpiration, condensation and precipitation.
5. As a final journal entry, have students predict how this water cycle will change over time if the predictions of global warming come true?
6. Using the notes from their observations, students write a summary of what they have learned about their water cycle. They must include the words water cycle, evaporation, transpiration, condensation and precipitation correctly in their creation.

Guiding Questions

1. How does the temperature affect the water cycle?
2. How does climate change affect the water cycle over time?
3. What is the role of vegetation in the water cycle?

Extensions

- How might you improve on this model? Suggest possible problems and ways that it could better represent the actual processes involved in the Earth's water cycle.

Water Cycle Keeps on Rolling

Time Required

1- 2 hours

Curriculum Connections

Science

Key Vocabulary

- evaporation
- condensation
- evapo-transpiration
- infiltration
- precipitation
- transpiration

Outcomes

- To have the students simulate moving through the water cycle as a water droplet.

Materials

- Game cards
- Station cards

ACTIVITY

1. Photocopy and enlarge 2 sets of the water cycle game cards. Cut apart and place cards into labelled envelopes.

   A. Ocean B. Atmosphere
   C. Icepack D. Groundwater
   E. Rivers and lakes (surface water)
   F. Plants G. Animals

2. Set up 7 stations around the perimeter of the classroom. Label each station A. Ocean, B. Atmosphere, C. Icepack, D. Groundwater, E. Rivers and lakes (surface water), F. Plants G. Animals.

3. Place game cards for each category at the corresponding station.

4. To begin the cycle (game) have all the students start at the animal station. Give each student a card from that station. In turn, each student moves to the next station by following the instructions on the card.

5. Have students record the name of each station as they move to it. If a student chooses a card that tells them to remain at the same station, they must write the name of that station down a second time and then choose another card.

6. Stop the game after 5 minutes. Have the students note how many students are at each station. Continue the game stopping every 5 minutes and noting how many students.

7. Game is over when all the students reach the ocean at least once.

Guiding Questions

1. How quickly does a water droplet move through the water cycle?

2. Why is the water cycle not a direct path?

3. How does pollution accumulate in various places in the water cycle?

Extension

- Add 2 pollution cards to each station. If a student draws a pollution card they must keep it with them. They must write pollution beside each station name as they move through it.

- Have the student sketch the path they followed through the cycle.

*Adapted from Evergreen Theatre “We’re All Wet” Teachers Resource Guide 1997

Station Labels

OCEAN

ATMOSPHERE

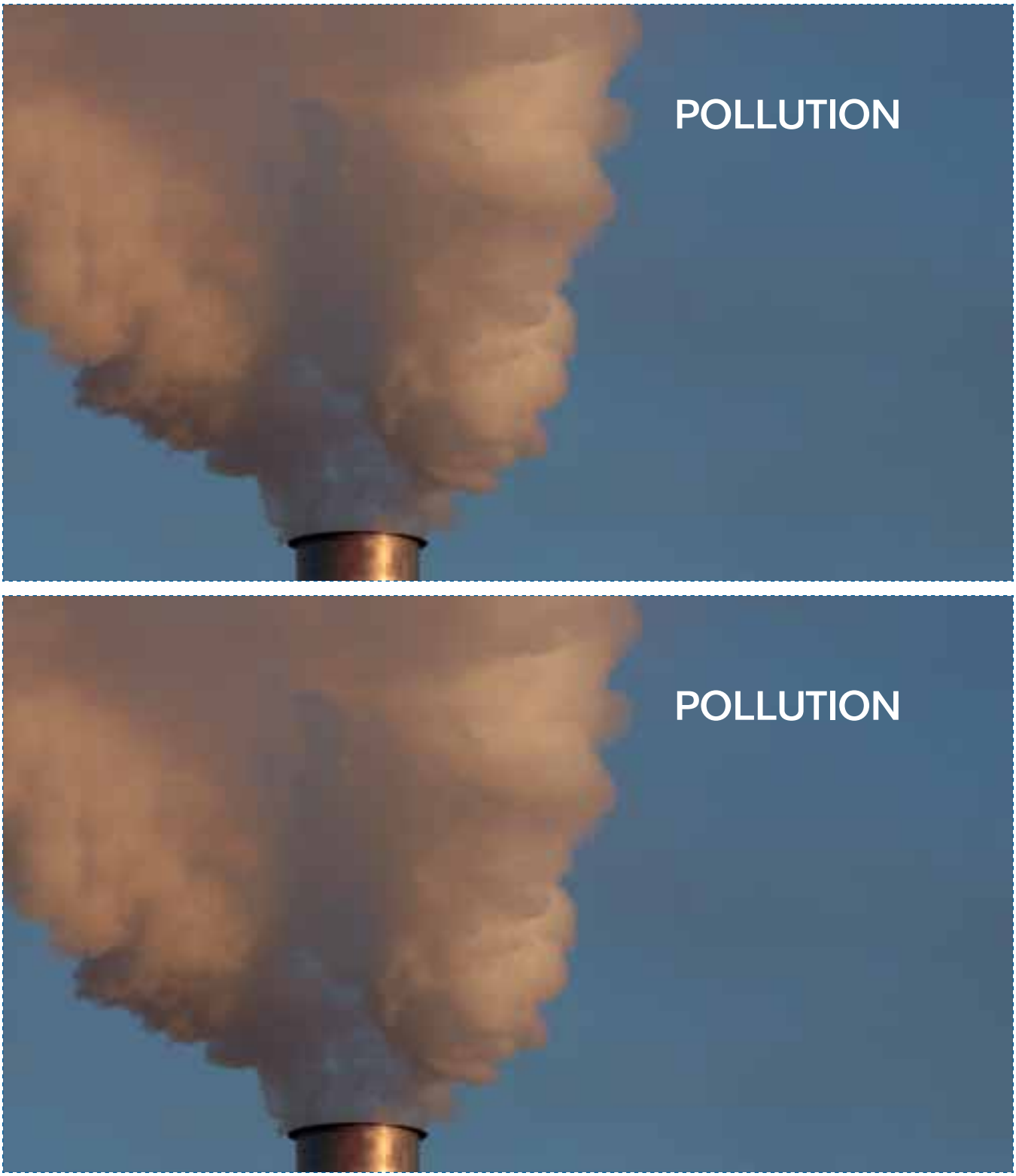
ICE PACK

GROUNDWATER

RIVERS/LAKES

PLANT

ANIMAL


POLLUTION
POLLUTION

OCEAN
Go to end
of line and
select again

OCEAN
Go to end
of line and
select again

OCEAN
Go to end
of line and
select again

OCEAN
Go to end
of line and
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OCEAN
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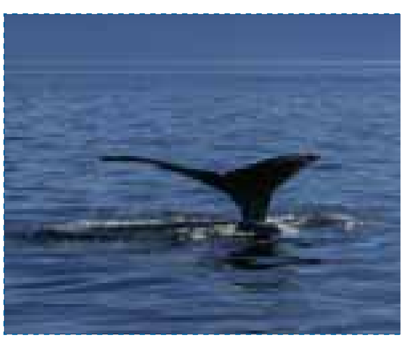


OCEAN
Go to end
of line and
select again

OCEAN
Go to end
of line and
select again

ATMOSPHERE
Go to end of line and select again

ATMOSPHERE
Go to Ocean

ATMOSPHERE
Go to Ocean

ATMOSPHERE
Go to Ocean

ATMOSPHERE
Go to Ocean

ATMOSPHERE
Go to Ocean

ATMOSPHERE
Go to Ocean

ATMOSPHERE
Go to Ice Pack

ATMOSPHERE
Go to Groundwater

ATMOSPHERE
Go to Surface Water

ICE PACK
Go to
Groundwater

ICE PACK
Go to
Groundwater

ICE PACK
Go to
Surface
Water

ICE PACK
Go to
Surface
Water

ICE PACK
Go to
Atmosphere

ICE PACK
Go to
Atmosphere

ICE PACK
Go to end
of line and
select again

ICE PACK
Go to end
of line and
select again

ICE PACK
Go to end
of line and
select again

ICE PACK
Go to end
of line and
select again

GROUNDWATER
Go to end of line and select again

GROUNDWATER
Go to end of line and select again

GROUNDWATER
Go to end of line and select again

GROUNDWATER
Go to end of line and select again

GROUNDWATER
Go to end of line and select again

GROUNDWATER
Go to
Surface Water

GROUNDWATER
Go to
Surface Water

GROUNDWATER
Go to Ocean

GROUNDWATER
Go to Ocean

GROUNDWATER
Go to Plant

RIVERS/
LAKES
Go to Ocean

RIVERS/
LAKES
Go to Ocean

RIVERS/
LAKES
Go to Ocean

RIVERS/
LAKES
Go to Ocean

RIVERS/
LAKES
Go to Plant

RIVERS/
LAKES
Go to Plant

RIVERS/
LAKES
Go to
Atmosphere

RIVERS/
LAKES
Go to
Atmosphere

RIVERS/
LAKES
Go to
Atmosphere

RIVERS/
LAKES
Go to Animal

PLANT
Go to
Atmosphere

PLANT
Go to
Atmosphere

PLANT
Go to
Atmosphere

PLANT
Go to
Atmosphere

PLANT
Go to
Atmosphere

PLANT
Go to
Atmosphere

PLANT
Go to
Atmosphere

PLANT
Go to Animal

PLANT
Go to Animal

PLANT
Go to Animal

ANIMAL
Go to Atmosphere

ANIMAL
Go to Atmosphere

ANIMAL
Go to Atmosphere

ANIMAL
Go to Atmosphere

ANIMAL
Go to end of line

ANIMAL
Go to end of line

ANIMAL
Go to Surface Water

ANIMAL
Go to Surface Water

ANIMAL
Go to Groundwater

ANIMAL
Go to Groundwater

Water Cycle: Dance of the Water Droplet

Time Required

1–2 hours

Key Vocabulary

- evaporation
- condensation
- evapo-transpiration
- infiltration
- precipitation
- transpiration

Outcomes

- Create and perform a dance that demonstrates the movement of a water droplet through the water cycle.
- Understand the water cycle as continuous.

Materials

- Balloon
- Music
- Role cards (cloud, mountain, stream, river, ocean)

ACTIVITY

1. Divide the students into groups of 5.
2. Have each student choose a role card to identify their part in the dance.
3. Have each group spread out in a large space.
4. Review with students that a water droplet has a very long, difficult and continuous journey — one that never ends.
5. Fill the balloon with water.
6. Starting with the cloud person have the cloud hold the water droplet and float gently around until it reaches the mountains where it freezes into a snow flake (hand off water drop to mountain) and remains there until the warm weather arrives with spring.
7. The snow melts (mountain gives droplet to stream) and the water drop begins its journey rushing, cascading, tumbling down the mountainside forming streams that join into rivers (stream gives droplet to river).
8. The river twists and turns and winds its way through the hills and forests slowing as it crosses the prairies and out to the ocean (river gives droplet to ocean).
9. Where it moves back and forth with tides.
10. Slowly the sun warms the water droplet changing it to vapour and it rises back to the sky forming a cloud that floats across the sky. (Ocean gives droplet back to cloud).

This dance demonstrates the water cycle. It could be performed in small groups or in a large group with many water droplets following the journey accompanied by classical music (perhaps something from Tchaikovsky's "The Nutcracker Suite"). This dance could be a powerful expression of learning.

Guiding Question

Not necessary

Extension

Perform the dance for the school and families.


RIVER


OCEAN


SUN

The Hidden Sea Panel Activities

BACKGROUND INFORMATION

What is groundwater?

Rain and snowmelt infiltrate into the ground. Soil and rock act as giant sponges full of tiny pores and cracks usually less than millimetres in size. Below the water table, these holes are full of water. This is groundwater. Groundwater slowly travels through connected pores and cracks, just centimetres to hundreds of metres per year. Any rock or sediment that yields useful amounts of water is an aquifer. The volume of groundwater below us dwarfs the volume of water stored in glaciers, lakes, wetlands, and rivers.

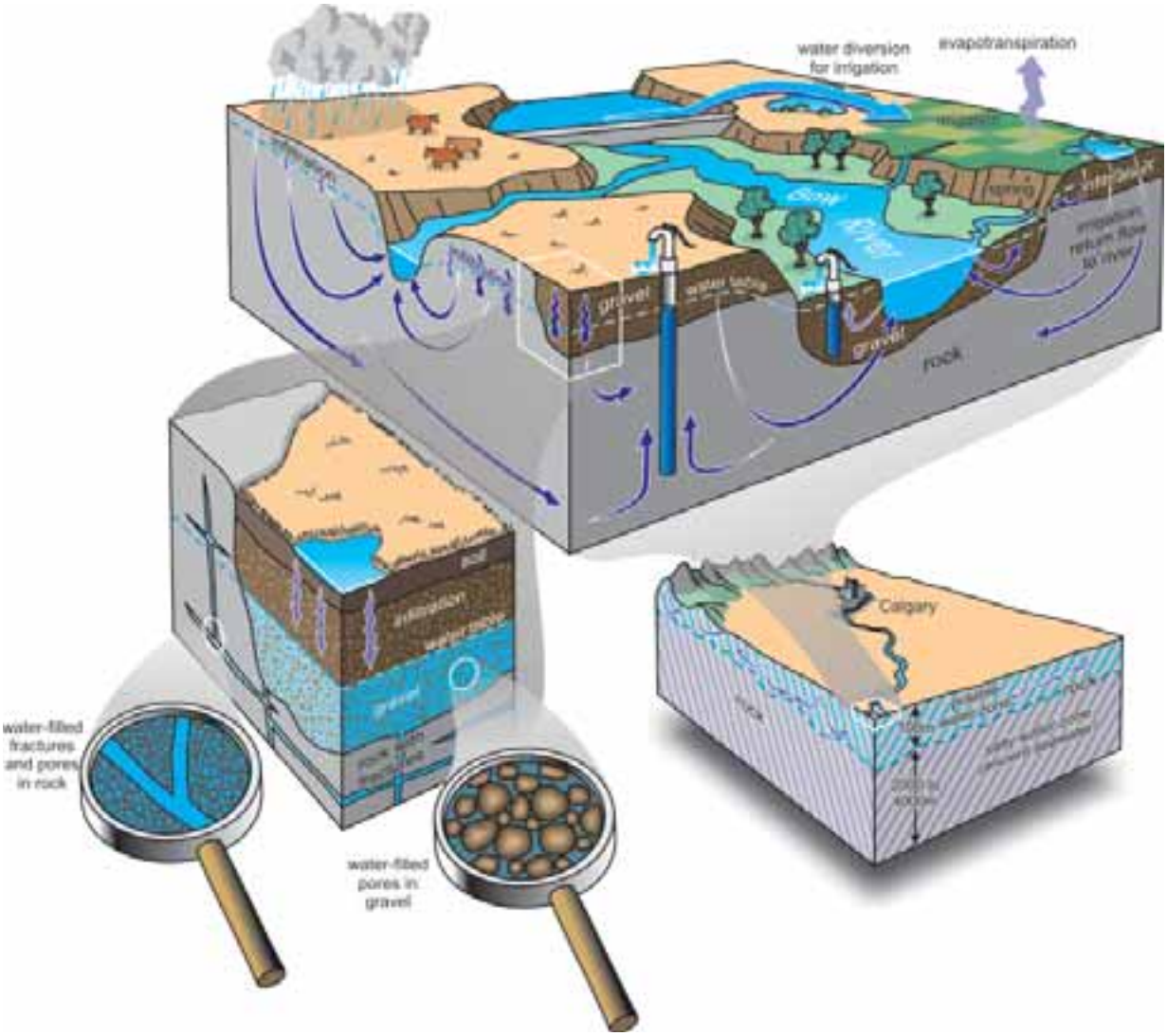


Fig.22

Groundwater feeds the river

Groundwater and surface water are one connected water system. Water wells intercept groundwater that may be on its way to springs that feed streams and rivers.

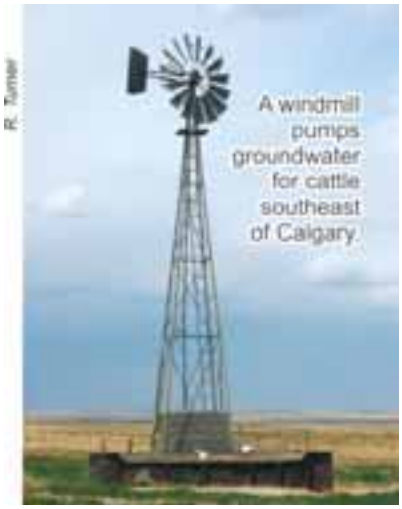


Fig. 23

Shallow groundwater: the precious drinkable part

In southern Alberta, oil and gas drilling has shown that groundwater is found to depths of four kilometres or more. However, most of this groundwater is very salty. Only shallow groundwater is potable or fit to drink.

Fig. 24 – A hand pump provides groundwater for drinking at Big Hill Springs Provincial Park near Cochrane.

Build a Groundwater Model

Time Required
1 hour

Curriculum Connections
Science, Math

Key Vocabulary
- groundwater
- aquifer
- plume
- surface water
- contaminant
- water table

Outcomes
- Demonstrate the concept of groundwater and how water moves through an aquifer to the river.
- Show the movement of a contaminant through an aquifer to the river.

Materials per group
- One 1.89 litre rectangular plastic cranberry juice bottle with cap
- ½ ice cream pail fine gravel (use white aquarium gravel for demo)
- Nylon stocking and an elastic
- Water and blue food colouring
- Clear plastic glass to catch the overflow water
- Cocoa and water as a contaminant
- 2 litre pop bottle for pouring water
- Film canister with holes punched in bottom
- 1 rubber band

ACTIVITY

1. Cut away one of the narrow sides of the bottle.
2. Put the nylon over the neck of the bottle using the elastic to hold it in place.
3. Put the lid on the bottle, lay it on its side and fill it 2/3 full of gravel.

Fig. 25

Fig. 26

Groundwater demo instructions

Pour the coloured water into the container and fill it until it is half way up the gravel.

The groundwater model represents a cross-section of ground with gravelly soil underfoot. The nylon/ rubber band represents the root structure preventing the gravelly soil from flowing freely into the "river". This setup demonstrates an aquifer, the groundwater in the aquifer and the water table.

Fig. 27

Flow of groundwater

Remove the cap on the bottle and catch the liquid in the cup. Simultaneously pour water from the pop bottle into the opposite end of the groundwater model.

Groundwater is always moving slowly to the river. Discussion about downhill direction of water flow fits here.

Fig. 28

Pollution Plumes!!

Place the film canister (which has holes punched through the bottom) on top of the gravel bed at the far end from the mouth of the bottle, and close to one side of the model. This represents a tank or any container from which a contaminant may leak onto the surface of the ground. With the lid screwed on the plastic groundwater model, fill the film canister with the cocoa water "contaminant". (This could represent excess fertilizer, sewage from cattle etc) Allow the canister to empty into the aquifer, watching the contaminant "plume" form.

Fig. 29

Demonstrate the movement of this plume by carrying out the same procedure as was used for the groundwater flow. Collect the water in the plastic container, and then compare to the water entering the groundwater model.

Guiding Questions

1. How does the water flow underground?
2. How does the hidden sea relate to well water and aquifers?
3. How do pollutants enter the hidden sea?
4. What is the difference between point source pollutants and non-point source?

Fig. 30

Fig. 31 – Comparison of groundwater before contamination and after

Climate Change: What is the Future For Our Water? Panel Activities

BACKGROUND INFORMATION

Climate change: what is the future for our water?

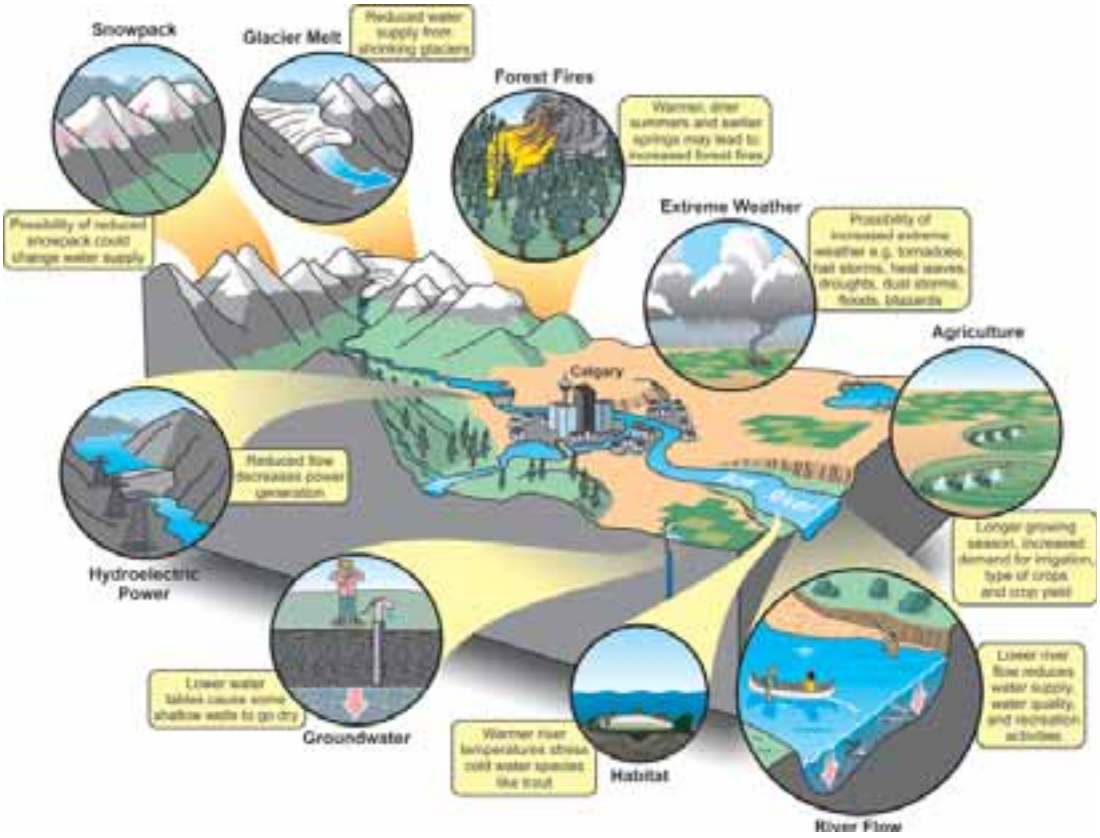


Fig. 32

This topic should be taught using an additional poster called **The Winds of Change: Climate Change in the Prairie Provinces** (GSC, 2001). This poster is an invaluable resource for teaching about climate change in Alberta. The poster is available from the Geological Survey of Canada, 3303 – 33rd St. NW in Calgary, Phone 403 292-7030. Visit their educational website at www.nrcan.gc.ca/gsc/education_e.html.

Climate is different from weather. Weather is what might be happening outside (raining, snowing, sunny, cloudy, hot, cold) on a particular day, time and place. Climate is the pattern of weather over a longer period of time over a greater area, like all of Western Canada. Global climate refers the patterns of temperature and precipitation over the whole planet. Warm or cold climate regions are generally determined by: how much solar energy enters the Earth system, how solar energy circulates within the Earth system and how heat energy leaves the Earth system.

Climate Change? So What!

Time Required

1 hour

Curriculum Connections

Social Studies, Language Arts, Science

Outcomes

- Be able to identify several positive and negative aspects of climate change and the impact it will have on them personally, on the local community and the global community

Materials

- Student Chart

ACTIVITY

1. In small groups or partners have the students discuss and record how different climate might affect them personally affect things around them (locally , globally) living (biotic)? (humans, wildlife, plants) non-living (abiotic)? (buildings, roads, economics etc.)

2. Discuss the responses in larger groups. Are the affects always negative or positive?

3. Follow up by asking What adaptations would humans have to make if the climate changed? Other living things?

Extensions

1. Have students contact a local climatologist to find out about the current climate trends and future predictions for Calgary and surrounding area.

2. Research the recent affects of the spring rains had in the Bow River Watershed.

   - What was the impact on:
     Humans? Wildlife ? Plants? The landscape? The river?

3. Research recent global natural disasters. (tsunami's, hurricanes, flooding)

   - Are the weather patterns changing globally? Are they becoming more extreme? Support your answers.

4. Research different regions of the world to determine how living things have adapted to live in certain climates. (polar, desert, mountains, rainforest etc).

Adapted activity from " Is Climate Change Good For Us ?" p.17-19
New Society Publishing , GreenTeacher 2001

SEASON_____ Climate Change	How would it affect me?	How would it affect things around me?
1. More sunny days		
2. Less Sunny days		
3. Higher daytime temperatures		
4. Lower daytime temperatures		
5. More rain		
6. Less rain		
7. More snow		
8. Less snow		
9. More wind		

How Does Climate Change Impact the Waterscape?

Time Required

Setting the stage: 20 min
Activity: 2 x 60 minute lessons

Curriculum Connections

Science, Math, Social Studies

Key Vocabulary

- glacial melt
- snowpack
- hydroelectric power
- groundwater
- habitat
- irrigation

Outcomes

- Identify how changes in climate have an impact on nine key topics
- Determine how each area impacts other areas

Materials

- Climate Change Cards
- Internet connection or related resources

ACTIVITY

1. Ask the students what they know about climate change? What is the difference between climate and weather? Information can be found at:
   - http://www.climatechange.gc.ca/english/climate_change/

2. Show the students climate change data:
   - http://www.climatechange.gc.ca/english/climate_change/maps.asp

3. Divide students into 9 groups.

4. Assign each group an area from the climate change section of the poster and distribute a Climate Change Card to each group.

5. Students collect information using the resources available (internet or otherwise)

6. The students must collect information to support their opinions about the impact that climate change would have on their topic and how this will impact other areas.

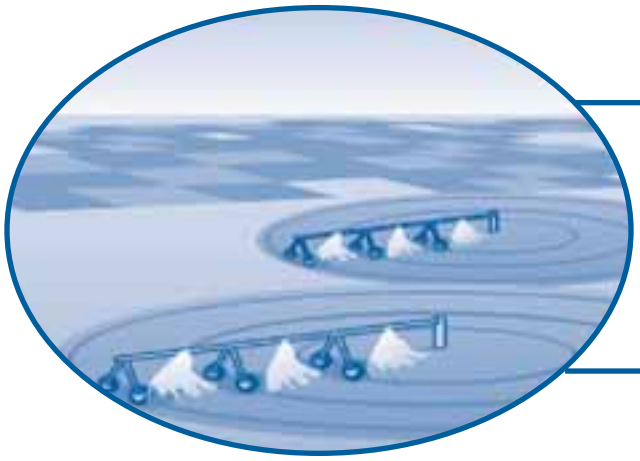
7. Following the research, students conduct a discussion on their topic with the other groups.

Extension

1. Have the students create their own impact web diagram

2. Discuss the difference between the climate change and weather

3. Follow up inquiry on how does climate change impact other parts of Canada or the World differently from or similarly to Alberta.



Agriculture

Longer growing season, increased demand for irrigation, type of crops and crop yield

What impact will the increased growing season, demand for irrigation, and the types of crops have on the water supply? How does it impact other areas?

Web links:

http://www.gcrio.org/CONSEQUENCES/summer95/agriculture.html

http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl9706/$FILE/aafrdadaptationfinalreport.pdf

Habitat

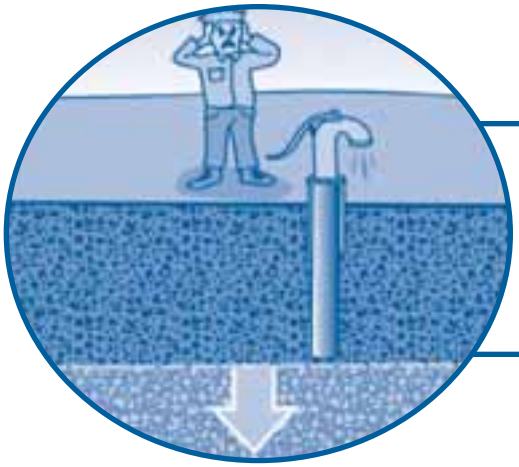
Warmer river temperatures stress cold water species like trout

What impact will the increased river temperatures have on aquatic plants and animals? How does it impact other areas

Web links:

http://www.defenders.org/wildlife/globalwarming/wildlife.html

http://www.ec.gc.ca/climate/overview_science-e.html



Groundwater

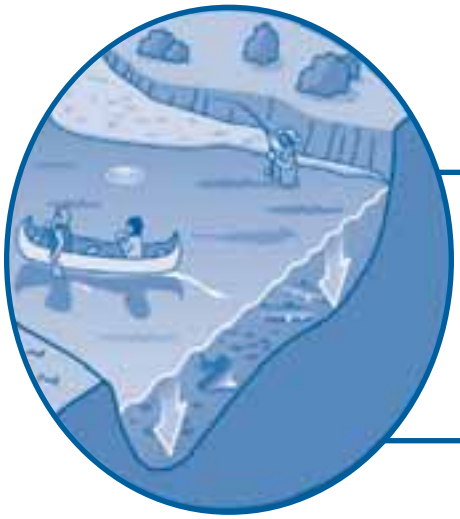
Lower water tables cause some shallow wells to go dry

What impact will climate change have on the water table? How does it impact other areas?

Web links:

http://www.gcrio.org/CONSEQUENCES/summer95/agriculture.html

http://adaptation.nrcan.gc.ca/posters/articles/pr_05_en.asp?Region=pr&Language=en



River Flow

Lower river flow reduces water supply, water quality and recreation activities

What impact will climate change have on river flow, quality and recreation? How will this impact other areas?

Web links:

http://adaptation.nrcan.gc.ca/posters/articles/pr_11_en.asp?Region=pr&Language=en

http://www.grida.no/climate/ipcc_tar/wg2/167.htm

Hydroelectric Power

Reduce flow decreases power generation

What impact will climate change have on power generation?
How will this impact other areas?

Web links:

http://www.newscientist.com/article.ns?id=dn7046
http://adaptation.nrcan.gc.ca/posters/articles/ac_05_en.asp

Extreme Weather

Possibility of increased extreme weather e.g. tornadoes, hail storms, heat waves, droughts, dust storms, floods, blizzards

What impact will climate change have on extreme weather conditions?
How does it impact other areas?

Web links:

http://adaptation.nrcan.gc.ca/posters/articles/pr_07_en.asp
http://www.atl.ec.gc.ca/weather/severe/climatechange_e.html

Forest Fires

Warmer, drier summers and earlier springs may lead to increased forest fires

What impact will climate change have on the number and severity of forest fires? How will this impact other areas?

Web links:

http://adaptation.nrcan.gc.ca/posters/articles/bc_09_en.asp
http://adaptation.nrcan.gc.ca/posters/articles/pr_06_en.asp
http://www.nofc.forestry.ca/climate/en/factsheets/factsheet9_e.html

Glacier Meltwater

Reduced water supply from shrinking glaciers

What impact will climate change have on glacial melt? How will this impact other areas?

Web links:

http://adaptation.nrcan.gc.ca/posters/articles/pr_04_en.asp
http://adaptation.nrcan.gc.ca/posters/articles/nu_05_en.asp

Snowpack

Possibility of reduced snowpack could change water supply

What impact will climate change have on snowpack? How will this impact other areas?

Web links:

http://www.msc.ec.gc.ca/crysys/education/snow/snow_edu_e.cfm
http://www.socc.ca/snow/variability/index.cfm

Sharing Our Waters Panel Activities

BACKGROUND INFORMATION

There are many ways we depend on the Bow River

There are many, many users of the Bow River water and all are dependent on this shared water supply. These many users - wildlife, industry, municipalities, hydropower, agriculture, and recreation - commonly have no other source of water. So, we must protect and share this water.

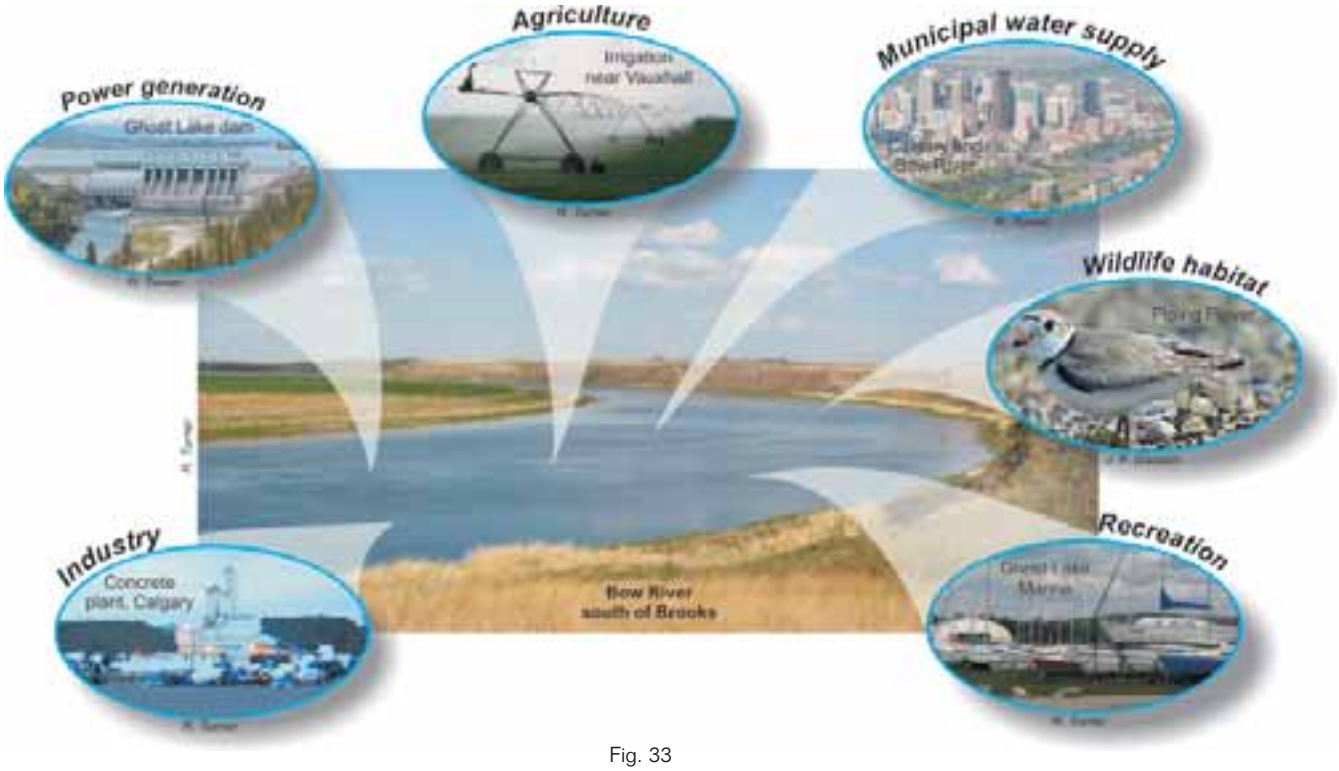


Fig. 33

Not all water use is the same!

Some water use occurs in the river, such as by wildlife, fisheries, and recreation. Some water is withdrawn from the river, used and returned (non-consumptive use). Municipalities return over 90% of the water they use as treated sewage. Some water is withdrawn from the river and not returned (consumptive use). In dry years, irrigation returns about 20% of what it withdraws. Most of the rest is used by plants, while some evaporates and a small amount sinks into the ground. Withdrawal of water from the river reduces river flow, and can have an impact on wildlife habitat in and along the river.

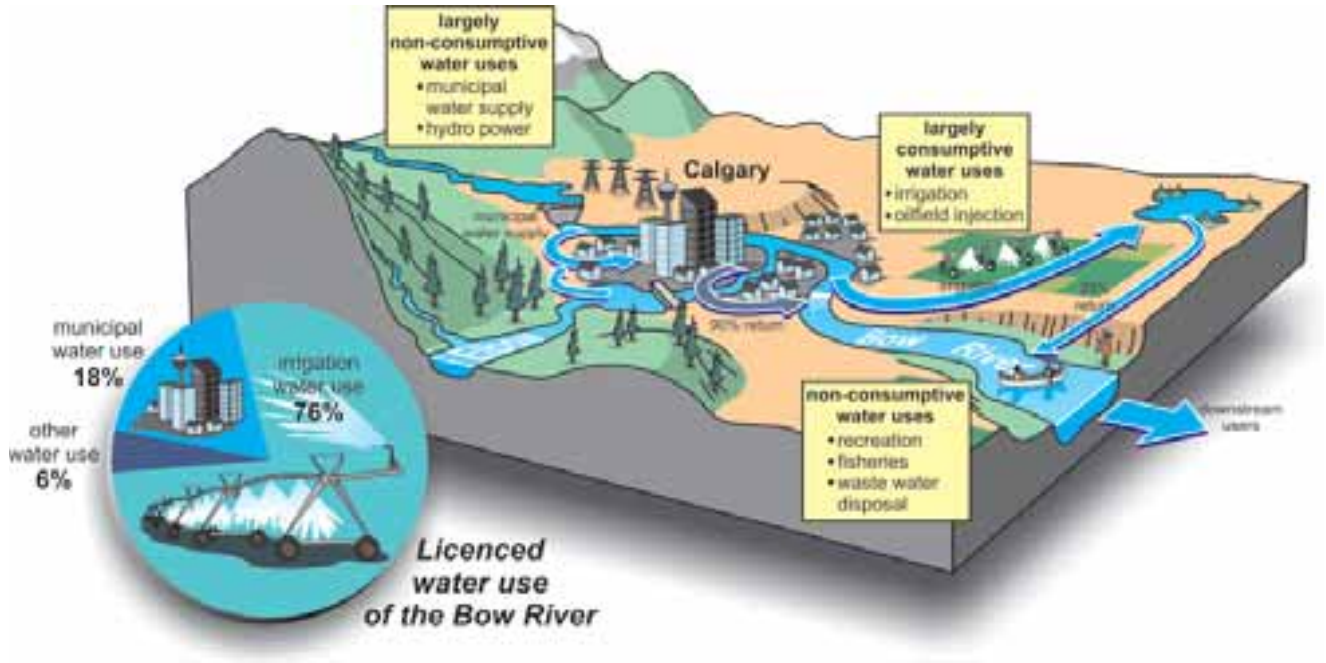


Fig. 34

How is Our Water Supply Shared?

Time Required

Setting the stage: 20 min
Activity: 2 x 60 min lessons

Curriculum Connections

Science, Social Studies

Key Vocabulary

- recreation
- industry
- hydroelectric power
- habitat
- irrigation
- municipal water supply

Objectives

- Identify what groups are the largest consumers of out water supply
- Determine the impact over consumption can have on others

Materials

- Large sponge
- Ice cream size bucket
- 2 L of water
- 6 tin pie plates.

ACTIVITY

1. Ask the students where does our water get used. Generate a list or web of the ideas. Elicit from the students the six categories of water users.

2. Brainstorm ways in which each group uses or overuses water.

3. Create a circle with the students

4. Assign students from the circle roles from the water consumer categories and the rough percentages (i.e. Irrigation should have 75% of the students, recreation 1 student, Industry 2 students, …)

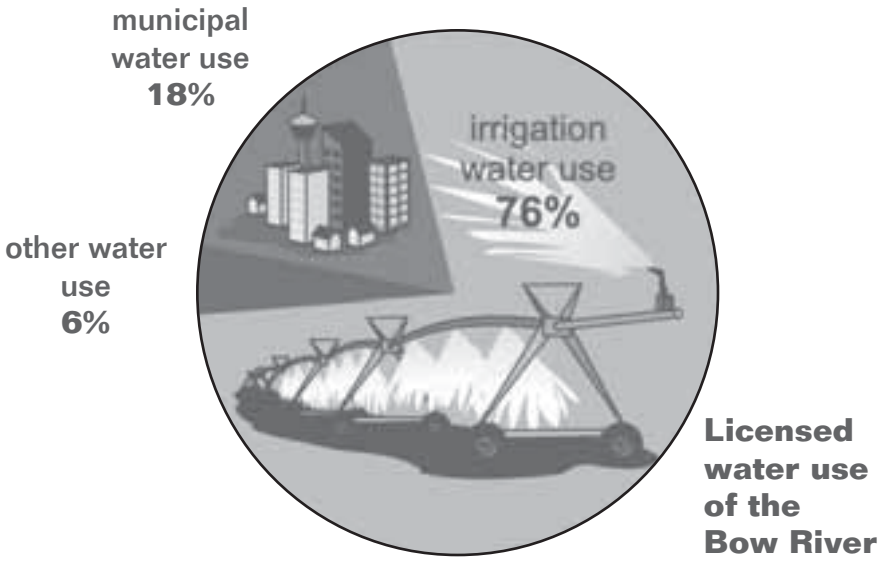


Fig. 35

Fig. 36

5. Teacher starts with the bucket and the sponge and 2 L of water in the bucket. Mark the level of the water.

6. Soak up as much of the water as you can and then pass the sponge to the first consumer, irrigation.

7. Each person in that consumer group gets to squeeze the sponge once into the pie plate that represents their water share (one pie plate for each consumer group)

8. After each of the consumer groups have had an opportunity to squeeze the sponge, attempt to squeeze more water from the sponge into the original bucket

9. Pass the sponge back along the consumers and have them attempt to recover as much of the water as they can.

10. Once the sponge has traversed the circle, measure how much water has been recovered

GUIDING QUESTIONS

1. What happens to the water consumption during times of draught?

2. What happens to the water consumption when there is flooding?

3. Why does irrigation take most of the water supply in Alberta?

4. How would it be different in other provinces or countries?

EXTENSION

1. Have the students create their own consumer pie graph

2. Discuss how each consumer group is over-using water supply

3. Brainstorm ways in which each consumer could reduce the wastage

Tasty Waste

Time Required
1 – 2 hours

Curriculum Connections
Science

Key Vocabulary
- contaminant
- potable water
- surface water
- groundwater
- pollution plumes
- porous rock or
- sediment rock
- permeable rock

Objectives
There are many different users depending on the Bow River as their only source of potable water. Even though users may be tens or hundreds of kilometres apart, their actions can have a direct impact on each other. In this activity, students gain an understanding of possible connections between groundwater and surface water (through wells, leaching, etc.), how can spread, and how contaminants that are hidden can suddenly appear in someone's drinking water!

Materials
- Bag of miniature white marshmallows (20 per student)
- Ice cream – enough for class (individual, plastic ice cream cups which are available by the bag in any grocer are ideal for this activity since no one gets more than anyone else and there is less mess)
- Clear plastic drinking cups (enough for everyone in class)
- Straws – enough for 2 per student
- Masking tape·
- Green food colouring
- Dropper
- Red sprinkles
- Plastic spoons (enough for everyone in class)

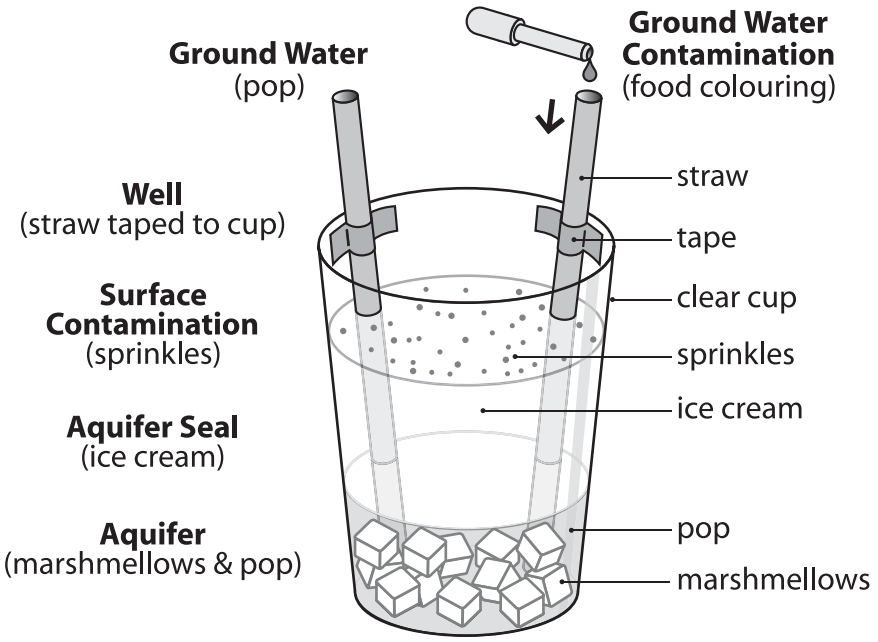


Fig. 37

ACTIVITY

1. Have students brainstorm about how pollution plumes might move from groundwater to surface water or visa versa (groundwater flow, leaching, well contamination, etc.).

2. Tell students that they are going to create an edible aquifer to demonstrate how areas that are far apart can still contaminate each other.

3. Demonstrate the building and subsequent contamination of the aquifer using the following steps:

   - Tape 2 straws to opposite insides of clear plastic cup. The bottom of the straw should be about 1 cm from the bottom of the cup.
   - Place marshmallows (20 is plenty) in bottom of cup. The marshmallows represent porous and permeable rock or sediment.
   - "Charge" the aquifer by adding just enough clear pop (water) to almost cover marshmallows. If you put in too much, the marshmallows may float; just push them back down with the spoon. Aquifers are charged from rainwater percolating down through overlying sediment.
   - Take a spoon and remove the ice cream from its holder, carefully placing it in the cup on top of the marshmallows. It should be just about a perfect fit but you may have to push it down slightly with the spoon. This represents a less porous and permeable layer above the water table.
   - It is now time to start contaminating this pristine environment. To represent contamination on the surface (fertilizer, pesticide, herbicide, etc.) distribute red sprinkles on top of the ice cream.
   - To represent contamination from the abandoned oil well, place ONE drop of green food colouring into the straw. It is recommended that this step be done by the teacher when students are making their models since food colouring can be an invitation to disaster in the wrong hands. GENTLY blow on the straw to move the contaminant down into the aquifer. Have students describe their observations of the aquifer.

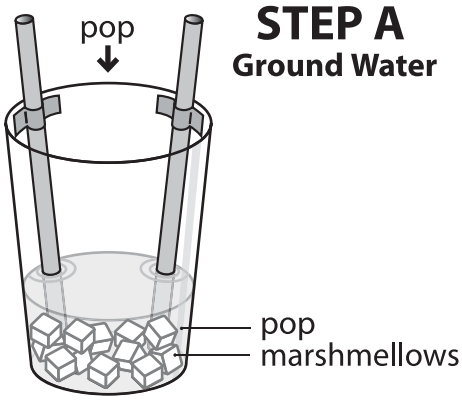


Fig. 38

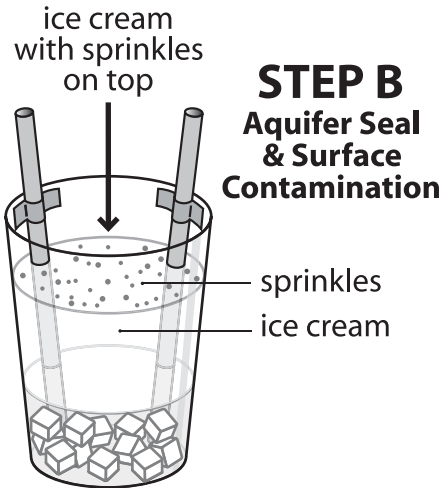


Fig. 39

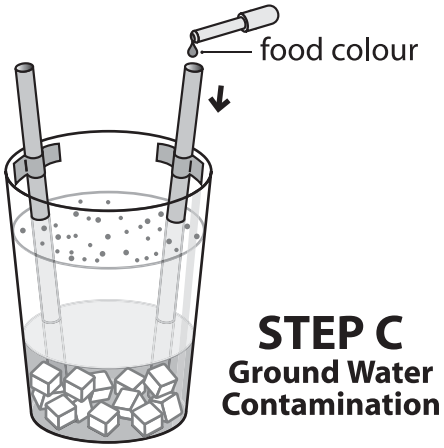


Fig. 40

- To represent rain, sprinkle some pop over the surface of the model. Have students observe as red contaminant is leached from the surface and begins to percolate down through the soil toward the aquifer.

- The farmer is going to need to get some water from his well. Have students predict what will happen when he sucks some liquid up through the well. Suck some of the pop up as students watch what happens to both the oil contaminant and the surface contaminant.

4. Students are now ready to make their own models. Management suggestion – have packages made ahead of time for students (cup, 2 straws, 20 marshmallows, plastic spoon). Because the ice cream melts fairly quickly, you may want to do ½ of students at a time while others work on a related task.

5. Lead them through building the basic model. You may want to have three stations set up – one for adding rainwater (pop), one for adding ground contaminant (sprinkles) and one for adding oil contaminant (food colour). Two dependable students can deal with rain and surface contaminant stations while the teacher does the food colouring. This is also a great day to have a parent volunteer, if you can round one up.

6. Students go through the same steps as the demonstration, adding straws, marshmallows, pop, ice cream, sprinkles, more pop and food colouring. All along, they make visual observations. However, because this process needs to be done quickly in order for the ice cream not to melt, they do not make written observations until the end.

7. When done, students draw a before and after picture of their aquifer. They should label the aquifer, groundwater, water table, sediment and soil, sources of contaminant and paths of contaminant. They then infer reasons for contaminant paths and connect their observations to a real life situation where this might occur.

Guiding Questions

1. How do the contaminants get into the water table?

2. What happens to the aquifers when the contaminants percolate into the groundwater?

3. What sources of contaminants are commonly found in urban areas?

Extensions

- Describe your own ecological footprint by keeping a diary of a typical day's water use (including how you use water to dispose of different kinds of waste material). For each entry, think about how this might affect someone else sharing your water and describe how you could lighten your footprint by changing your habits.

- A field trip to the Inglewood Wildlands is a wonderful experience for the class and an excellent example of how a site can be reclaimed after water has been polluted by an oil spill. Go to www.inglewoodwildlands.ca for information on how to take a class there.

- Design a way to remove or at least contain the contaminant from the polluted environment in the model aquifer. Of course, eating it will get rid of it but that is cheating.

Urban Water Panel Activities

BACKGROUND INFORMATION

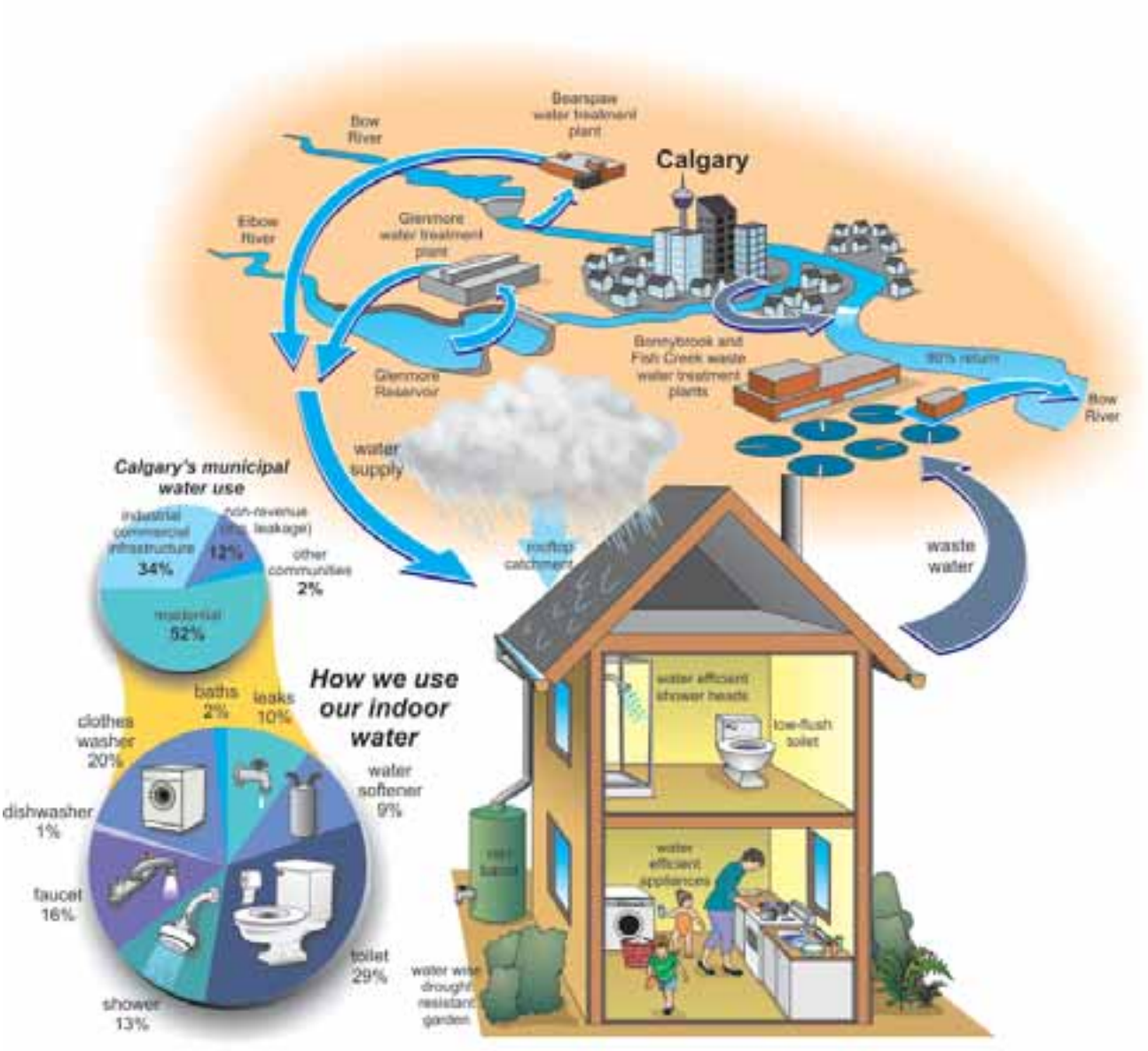


Fig. 41

Much of Calgary's sewage is treated at the Bonnybrook wastewater treatment plant (foreground) before discharge into the Bow River.

Fig. 42

Calgary: a big city on a small river

Calgary is a big, rapidly growing city on a relatively small river. The Bow River, a world class trout stream, has a limited capacity to assimilate waste water without reducing its water quality. Because of this, the standard of Calgary's wastewater treatment is among the very highest in Canada.

Bow River water enters our lives in many ways.

Experiments show that your body's water is completely replaced every four weeks. If you live in the Bow River basin, you are largely made up of Bow River water. So, when you turn on the tap, drink a pop, or eat bread, locally-grown vegetables, or beef, think "Bow River."

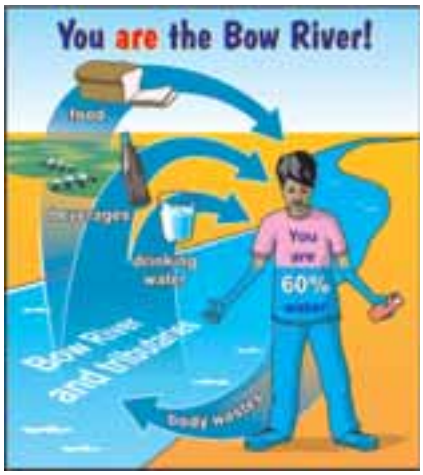


Fig. 43

Fig. 44

Fig. 45

Urban Water

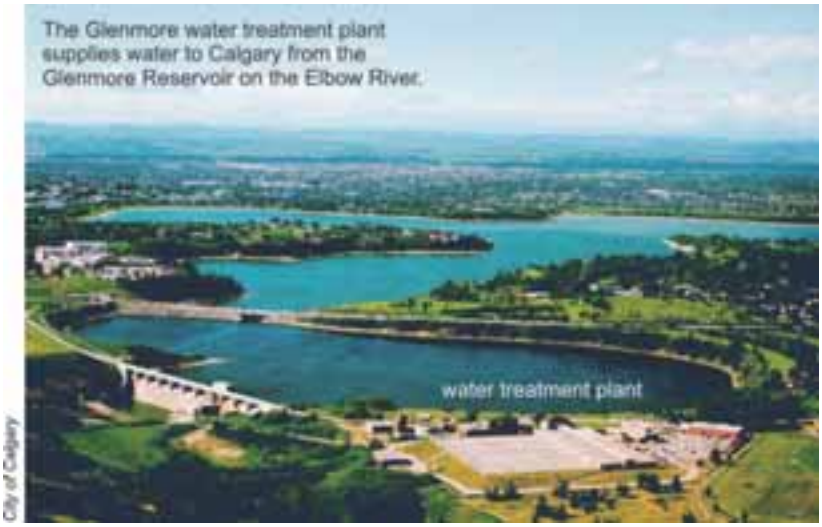


Fig. 46

Background

When river water arrives at the water treatment plant it is referred to as raw water. The runoff water from snowfall and rainwater runs across the ground into the river carrying dirt and other contaminants. The water may also contain bacteria and other harmful microorganisms. This water must be treated before it is potable (safe to drink).

People often don't recognize a good thing when they see it as is the case for Calgary's drinking water. The trendy thing to do is complain about the bad taste of our water and go out and buy bottled water instead. It must be better because everybody is drinking it.

Environmental Costs of Bottled Water:

- Every year, 1.5 million tons of plastic are used to make bottled water. Toxic chemicals are released during the manufacturing and disposal of the plastic bottles.
- There are 90 billion litres of water bottled annually and the majority is shipped. The fuel used for transporting water contributes to acid rain and enhanced greenhouse effect.
- A tremendous amount of water is used in the manufacturing process. For every litre of bottled water produced, it is estimated that approximately 1000 litres of water are used. When you are talking about 90 billion litres of bottled water, this takes a very large bite (or gulp) of water resources.
- Drinking distilled water, which many bottled waters are, actually drains your body of minerals whereas tap water provides many essential minerals.

Economic Costs of Bottled Water:

- The bottled water industry is the fastest growing drink industry in the world despite the fact that in most countries, including Canada, tap water is as high or higher quality as bottled water.
- There are more standards regulating tap water than bottled water in Canada.
- Many bottled water labels are actually tap water so the only difference is one comes from pipes and one comes from plastic
- The average cost for 1 L of bottled water is 80. The cost for 1 L of tap water for residential customers in Calgary is just slightly over 1/10 of it. In fact, it would be less than that since that cost includes sewer charges as well. Talk about a deal!
- If you really don't care for the taste of tap water, put some in an uncovered pitcher in the fridge for a few hours. It will be delightfully cold and the chlorine which offends some people's taste buds will have evaporated off.

Fig. 47

How is River Water Treated?

Time Required

1 – 2 hours

Curriculum Connections

Science, Math

Key Vocabulary

- aeration
- coagulation
- sedimentation
- filtration
- disinfection
- potable water

Objectives

- Demonstrate the processes used to purify water for drinking

Materials per group

- 1 four litre ice cream bucket of dirty water add 500 ml of dirt to 4 litres of water)
- 1 two litre plastic pop bottle with cap
- 2 two litre plastic pop bottles, one with bottom cut off and one with top cut off
- 1 two litre plastic pop bottle with bottom cut off to hold inverted pop bottle
- 2 tbsp alum
- 1 ½ cups fine sand
- 1 ½ cups coarse sand
- 1 cup small pebbles
- 1 coffee filter
- 1 rubber band
- spoon for stirring

Fig. 48

ACTIVITY

1. Pour the dirty water into the pop bottle with a cap and note the appearance and smell of the water. Place the cap on the bottle and shake for 30 seconds.

2. Pour the water back and forth 10 X between the two pop bottles with their tops cut off. Aeration adds air to the water and allows gases to escape.

3. Add two tbsp. alum to the aerated water. Slowly stir for 5 minutes. Coagulation is the process where alum is used to make dirt and other solid particles stick together to form floc.

4. Allow the water to sit for 20 minutes. Sedimentation is when gravity pulls the particles of floc to the bottom of the container.

Fig. 49

Fig. 50

5. Make observations every 5 minutes.
6. Construct a filter using the bottle with its bottom cut off. Filtration removes suspended particles that were not heavy enough to settle:
   - Attach the coffee filter to the outside neck of the bottle.
   - Pour one cup of pebbles in the bottle
   - Pour 1½ cup coarse sand on top of the pebbles
   - Pour 1½cup fine sand on top of the sand
   - N.B Clean the filter by pouring clean tap water through the filter until the water runs clear.
7. Carefully, without disturbing the sediment pour 2/3 of the water through the filter, catching the filtered water in one of the cut off pop bottles.
8. Compare the treated water with the untreated water. Note: Disinfectants have not been added to kill any organisms that might be harmful. This water is not safe to drink!

Guiding Questions

1. What is the purpose of aerating the water?
2. What gases are present in the water before treatment?
3. What particles are being filtered out of the water?
4. Why are there so many layers of filtration?

Extension

1. Have the students research the water treatment process in their own community.
2. Investigate what determines the quality of drinking water.
3. What effect do flood conditions have on water treatment plants?
4. Why are people asked to limit their water consumption during a flood?

Taste Test Challenge

Time Required
1 hour

Curriculum Connections
Science, Social Studies

Outcomes
- To develop an understanding of the real cost of bottled water in terms of environmental damage and financial impact

Materials (for each group)
- Tap water (approximately 4 L)
- Pitcher
- 2 brands of bottled water (2 L each)
- Dixie cups (enough for everyone in class). If you can find a very cheap source of cups (i.e. Wendy's catsup containers) then you can use 4 cups for each student.

ACTIVITY

1. Take four unlabelled water bottles. Fill one with Calgary tap water, one with tap water that has been left in an open container for several hours, allowing the chlorine to evaporate, and the other two with any of the bottled water brands currently on the market - lots to choose from. Make sure they are all the same, cold temperature.

2. Students will take turns coming up to do the taste test. Students will be asked to rate the taste by ranking the bottles from 1 (best taste) to 4 (worst taste).

3. When done, tally up the results to see which one is the winner. The water with the lowest score will be the victor.

4. Lead the class in a discussion about bottled versus tap water. Everyone talks about the ills of tap water and how much better bottled water is but students need to ask themselves if they are just being taken in by the bottled water "spin doctors".

Fig 51 - Bottle A

Fig 52 - Bottle B

Fig 53 - Bottle C

Fig 54 - Bottle D

Guiding Questions

1. Why do people buy bottled water?
2. When does it make sense to have bottled water?
3. How do they companies influence your decision to buy bottled water?
4. What taste differences did you observe?

Extensions

1. Design and conduct a survey for the students in the school in order to collect data to determine which type of water (bottled or tap). Graph the data.
2. From the data, make recommendations to the school administrators about the need to encourage the use of reusable bottles and tap water by students and teachers.
3. Write an editorial for the school newsletter where you inform people awareness of the economic and environmental consequences associated with bottled water.

Reducing Water Consumption

Time Required
1 - 2 weeks

Curriculum Connections
Science, Math, Social Studies

Key Vocabulary
- consumption
- municipal water supply

Objectives
- Identify ways in which we are over consuming water
- Determine ways in which our water consumption can be reduced by 1000 litres as a class.

Materials
- Milk jugs (as many as students can bring in)
- Tape measures

ACTIVITY

1. Discuss the statistic on the number of litres the average person consumes in a day.
2. Represent the approximate number using 4 litre milk jugs.
3. Give students fact sheet on the consumption of water in home. This can be found at: http://www.sawater.com.au/NR/rdonlyres/9E796BFF-7A3D-46A7-8E90-DF9F054AB4F4/0/WWHouse.pdf
4. Create a chart showing the amount of water that the class would use on an average day.
5. For several days, have students keep track of water consumption activities such as how many times they wash their hands and for how long.
6. Create graphs of the water consumption over those set days.
7. Challenge students in small groups to determine a way of reducing the amount of water that the class uses in a week by 1000 litres. Students will need to determine the amount of water consumed in an average week.

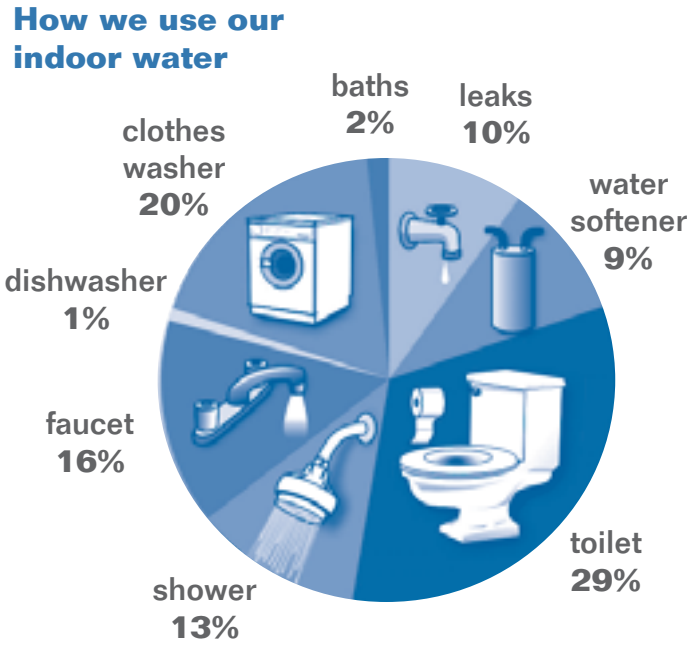


Fig. 55

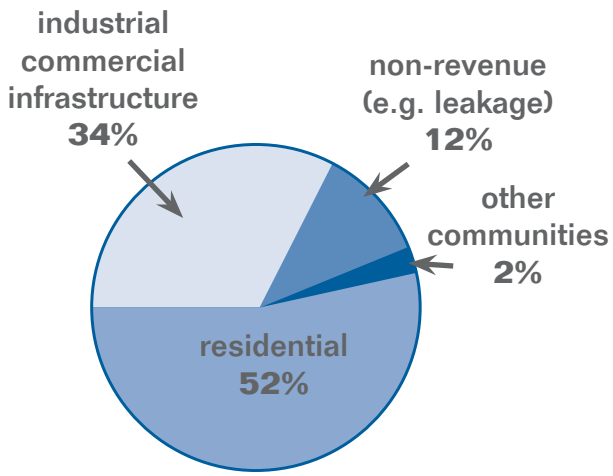


Fig. 56

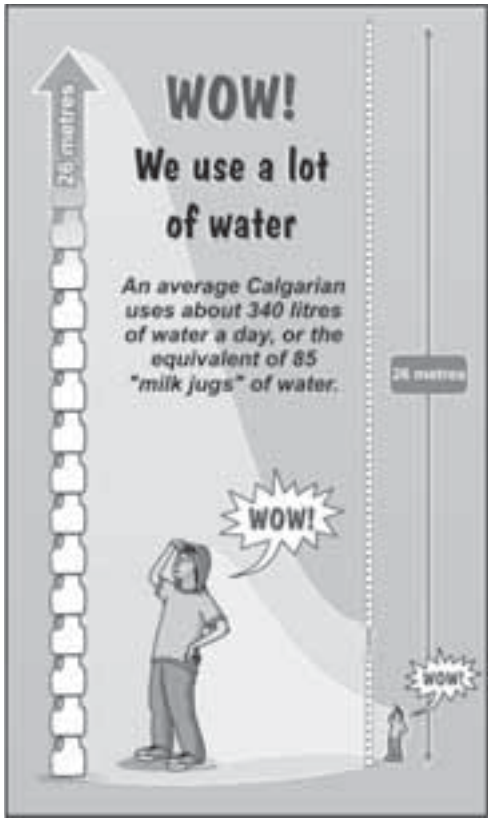


Fig. 57

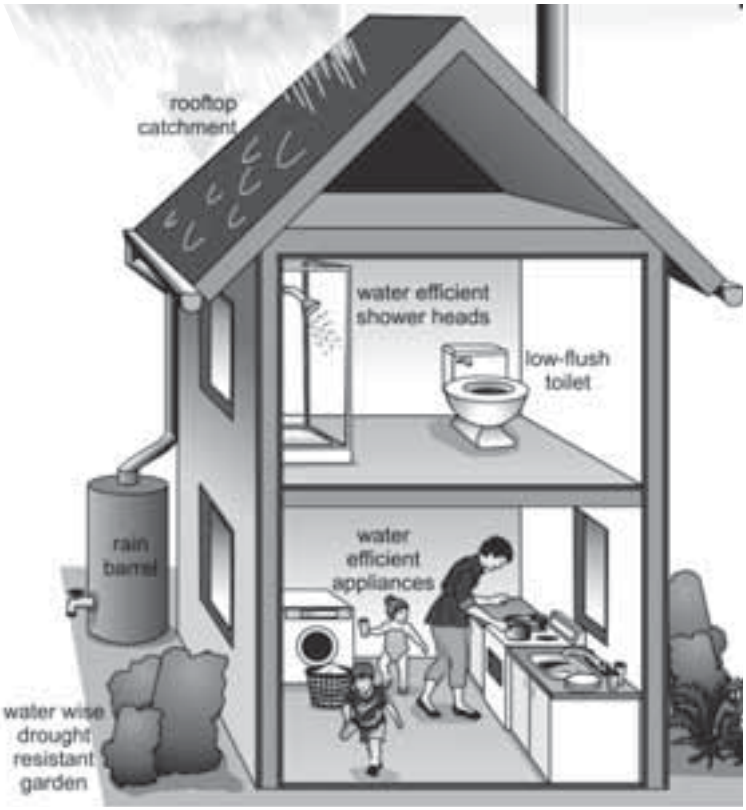


Fig. 58

Guiding Questions

1. Where do we use the most water?
2. How have opinions about water use changed over the past 10 – 20 years?
3. How have appliances and home fixtures changed to improve water conservation?

Extension

1. Have the students create their own consumption pie graph
2. Compare appliance water use for dishwashers, washing machines, or water heaters
3. Examine how pools and hot tubs use water

Drinking water: 1/4 litre

Flushing toilet: 19 litres

Brushing teeth: 7 litres

Dish washer: 75 litres [divided by # of people in house who contributed to what is inside]

Dish washing by hand: 87 litres [divide by # of people in house who contributed to what is inside]

Load of laundry: 152 litres [divide by # of people in house who contributed to what is inside]

Shower/bath: 19 litres per minute the water is running

Irrigation: Watering the Prairies For Food Panel Activities

BACKGROUND INFORMATION

Transforming the prairie: dry grasslands to watered prairie

When European settlers first came to the prairie country of the Bow River basin, they found First Nations peoples living in a vast grassland with few lakes and streams. Early in the last century, irrigation districts were established to move Bow River water out onto the prairie. Through a system of canals and storage reservoirs, water was supplied to farmers. Over time, communities and industries also grew on the prairie, and the irrigation system supplied water for their needs.

Fig. 59

Fig. 60

Fig. 61

Fig. 62

Fig. 63

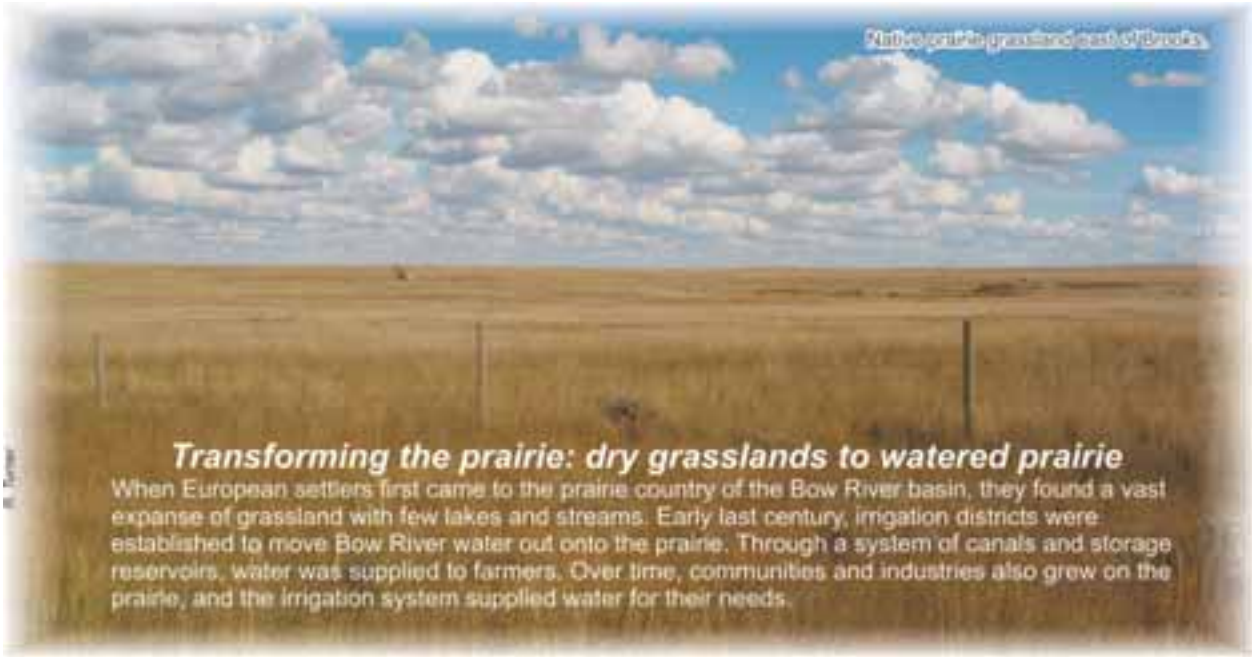


Fig. 64

How irrigation works

Irrigation starts in May and continues until October. Irrigation water is diverted from the river into a system of canals and reservoirs. These provide important wetland habitat for waterfowl and fish. Improved irrigation techniques have greatly reduced the water required to grow crops, allowing more crop production while using the same amount of water.

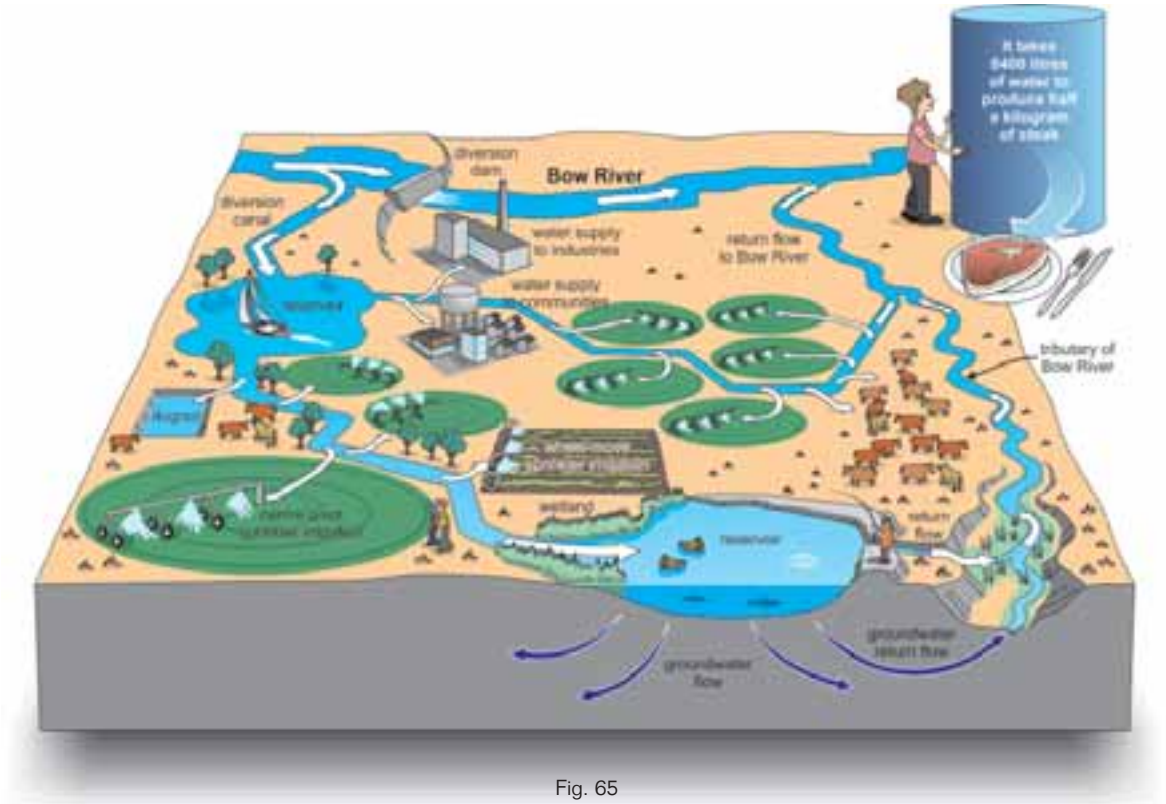


Fig. 65

Making Wise Decisions – Research

Time Required

1 hour

Curriculum Connections

Science, Math

Key Vocabulary

- irrigation
- transpiration
- evaporation
- furrow

Outcomes

- Understand that irrigation (for agricultural use) is essential in order to grow food for the world's population.
- Appreciate that water for irrigation comes from rivers, lakes, reservoirs and wells and is applied through man-made systems.
- Describe the various methods of irrigation used globally and locally.

ACTIVITY

1. Using the Internet, have students research the various types of irrigation used around the world and which method is most effective.
2. Have the students determine the methods of irrigation used locally.

Guiding Questions

1. How does current irrigation practice contribute to excess water consumption?
2. Why is Alberta dependent on irrigation?
3. What different types of irrigation practice are being employed in Alberta? Other countries?

Extension

- Invite an expert from Alberta Agriculture to visit the classroom.

Keeping the River Clean Panel Activities

BACKGROUND INFORMATION

Out on the range: Managing range land for both cows and healthy streams.

Riparian areas occur along streams and wetlands where moist soils and shallow water tables allow water-loving plant communities to establish. These "green zones" are vital ecosystems in the prairie and foothills that provide habitat for wildlife, stabilize stream banks, and protect water quality. Cattle grazing in riparian areas must be managed carefully so that these delicate landscapes are not degraded.

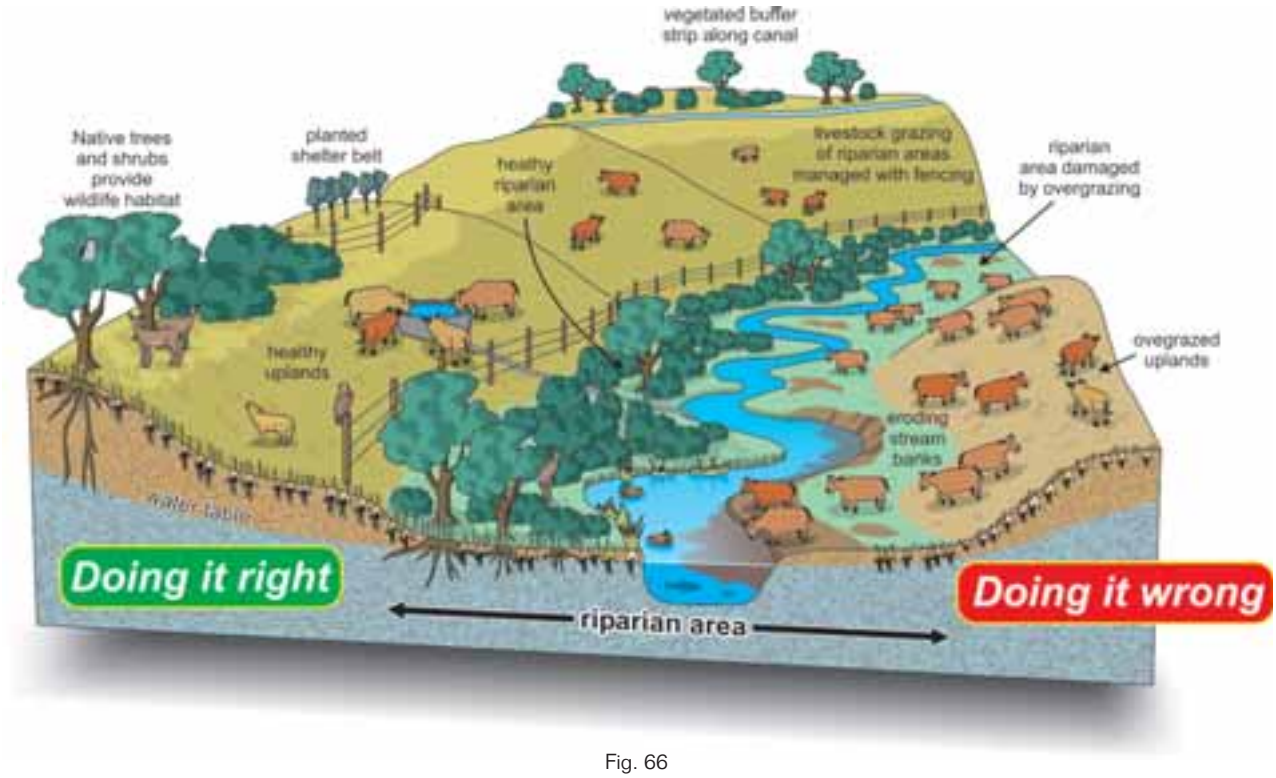


Fig. 66

In the city – stormwater: How bad stuff can get into the river

There is a widespread myth that water that goes down storm drains flows to water treatment plants. This is not true. Storm drains are only meant for rainwater and snowmelt. Many street drains flow through pipes straight to the river.

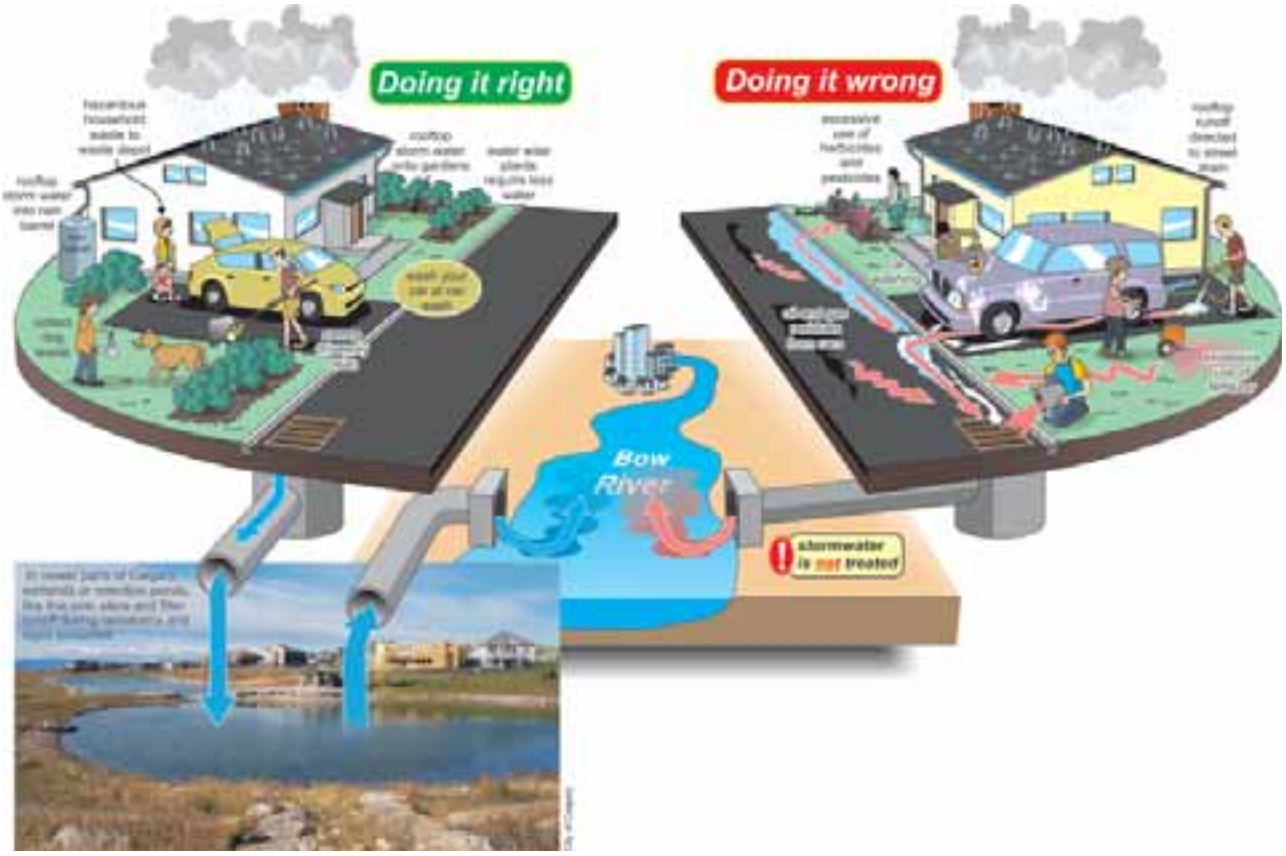


Fig. 67

Catch That Oil Spill

Time Required
1 hour

Curriculum Connections
Science, Math, Social Studies

Key Vocabulary
- groundwater
- surface water
- aquafir
- contaminant
- plume
- water table

Outcomes
- Understand effect of an oil spill as it moves through the groundwater to the river
- Explore the use of different materials to clean up an oil spill.

Materials
- Groundwater model (for modified model using juice bottles see Build Groundwater Model)
- Aluminum pan to act as a river
- Water and blue food colouring
- 2 litre pop bottle for pouring water
- 75 ml water mixed with 15 ml cocoa powder
- or 125 ml of cooking oil
- Though cooking oil is a more accurate representation of oil contamination, cooking oil tends to make the groundwater model difficult to use for any other experiments. It is recommended that oil be used only with groundwater models that will not be reused.
- Items to clean up oil spill: cotton balls, eyedroppers, paper towel, pieces of Styrofoam and foil to make a boom
- Margarine containers to hold recovered oil

ACTIVITY
1. Fill the groundwater model half full of dark blue coloured water.
2. Fill the aluminum pan with water. The groundwater model represents a location near the river where a possible oil spill could take place. The aluminum pan is the river.
3. With the cap on, pour the cocoa mixture representing the oil into the back end of the model and watch where the oil goes.
4. In order to show how the groundwater moves over time remove the cap and allow the water to flow into the river. At the same time continue to add the coloured water to maintain the water table.
5. As the groundwater flows through, observe the oil slick form on the river.
6. Give students small margarine containers and challenge them to use different materials to clean up the oil spill.

Guiding Questions
1. What are the possible sources of oil contamination in the water table?
2. Why does the oil stay on the surface of the water?
3. What material is most effective for collecting the water?

Extensions
1. Research methods of cleaning up after oil spills
2. Bring in a guest speaker to talk about how contaminants are cleaned up when they are discovered going into the Bow.
3. Conduct experiments on the separation of water and oil.

All Bogged Down

Time Required
1 – 2 hours

Curriculum Connections
Science

Key Vocabulary
- wetland
- watershed
- aquifer
- groundwater

Outcome
- Understand the effectiveness of wetlands in cleansing our water before it enters the groundwater.

Materials
- Plastic groundwater model
- Sphagnum moss dampened
- Approximately 1 L of water coloured with blue food colouring to represent groundwater
- 15 ml Cocoa mixed with 75 ml water for contaminant
- Film canister with holes punched through bottom (translucent is best)
- Clear container to catch groundwater flow
- Pop bottle to hold extra blue colored water

Fig. 68

Fig. 69

ACTIVITY

1. Using the plastic groundwater model from Go with the Flow, make a depression and place soaking wet sphagnum moss into the depression to simulate a wetland.

2. Add blue colored water to create a visible water table, and groundwater.

3. Place the film canister on the wetland.

4. Pour cocoa water contaminant into the film canister or “leaky tank”.

5. Observe the contaminant in the film canister, and watch for a plume in the aquifer. (There should be no or very little trickling of the contaminant through the moss.)

6. Remove the cap on the plastic groundwater model, and simultaneously pour blue colored water into the model as the water flows through. Try to maintain the same water table level.

7. Compare the quality of water flowing out of the model to that flowing in.

8. Remove the sphagnum moss, and squeeze it out into a clear container. Compare the color of this water to that of the groundwater.

Fig. 70

Guiding Questions

1. How does the moss impact the water table?
2. Why does the contaminant get caught in the bog (moss)?
3. How are wetland areas important in the watershed?

Extensions

1. This wetland appears to successfully "clean" the water as it passes through. Why does it work? Would there be other mechanisms at work in a real wetland situation
2. Research and map the wetland areas in Calgary – both constructed and natural.
3. Discuss the pros and cons of developing natural wetland areas for residential or other use. Try to include a current local example.

Resources

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  http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr4451/$file/ib001-2000.pdf?OpenElement
- **Alberta Environment: Alberta's River Basins** – Detailed information on Alberta's river basins
  http://www3.gov.ab.ca/env/water/basins/basinform.cfm
- **Atlas of Alberta Lakes** – Includes information on drainage basin, water quality, and biological characteristics.
  http://sunsite.ualberta.ca/Projects/Alberta-Lakes/
- **American Water Works Association** – Provides water from the global perspective "water for People"
  http://www.awwa.org
- **The Bow River Basin Council (BRBC)** – a charitable organization dedicated to conducting activities for the improvement and protection of the waters of the Bow River Basin. Excellent source of maps, data and other information. http://www.brbc.ab.ca/index.asp
- **BrainPop** – an educational website that provides animated movies that are related to curriculum topics
  http://www.brainpop.com
- **City of Calgary Waterworks** – information on a variety of water conservation and quality issues, activities, links. http://content.calgary.ca/CCA/City+Hall/Business+Units/Waterworks/index.htm\
- **Environment Canada Freshwater** – links, information and more.
  http://www.ec.gc.ca/water/e_main.html
- **Environmental Protection Agency** – a site dedicated to the protection of human health and the environment. Has a great many areas related to the study of water systems including resuorce links for educators and a kids page. http://epa.gov/
- **Franklin Institute Online** –Science activities and background information based on how water is used in cities. http://www.fi.edu/city/water
- **Global Change Master Directory** – an site that provides many science resources and links for hands-on science activities and experiments. http://gcmd.nasa.gov/Resources/Learning/madscientist
- **Geologcial Survey of Canada** – Creators of the Bow River Basin Waterscapes poster. Visit their educational website at http://gsc.nrcan.gc.ca/edumat_e.php
- **Geoscape Posters** – posters by the Geological Survey of Canada describing the geological landscapes of many cities and regions of Canada. http://www.geoscape.nrcan.gc.ca
- **Global Learning and Observations to Benefit the Earth** – a world wide hands on primary and secondary school based education and science program that collects data locally and reports globally.
  http://www.globe.gov
- **Great Canadian Rivers** – provides information about the history, ecosystems, culture, recreation and economy of Canada's rivers including the Bow. This site also includes video clips of the rivers.
  http://www.greatcanadianrivers.com

- **Green Teacher –** A Canadian published magazine by and for educators to enhance environmental and global education across the curriculum at all grade levels. http://www.greenteacher.com
- **The Groundwater Foundation –** a site dedicated to educating and motivating people to care and about ground water. Has a student activities and information site. http://www.groundwater.org/kc
- How Stuff Works http://www.howstuffworks.com
- **NASA –** http://www.nasa.gov/audience/forkids
- **National Geographic –** www.nationalgeographic.com/geographyaction/rivers
- **Project Wet –** Water Education for Teachers and students that promotes awareness, appreciation, knowledge and stewardship of water resources. www.projectwet.org
- **Trout Unlimited Canada –** source of information for conservation and restoration of Canadian freshwater ecosystems. Home of Yellow Fish Road which is a nation-wide environmental education initiative. In-class materials for educators including lesson plans and activity booklets. The Yellow Fish Road Kit is also available. http://www.tucanada.org/
- **United States Geological Survey Water Science for Schools –** information on a variety of water conservation and quality issues, activities, links. http://ga.water.usgs.gov/edu/
- **Water for life –** Alberta government strategy for sustainability (document is downloadable), information on water conservation. http://www.waterforlife.gov.ab.ca/
- **WaterQuest –** Alberta Agriculture, Food and Rural Development interactive web site http://www.waterquest.ca

Field Trips

- **Bow Habitat Station (at the Sam Livingston Fish Hatchery) –** Investigate water conservation and find out how each part of a water treatment plant works in the Dripper in the Liquid Lesson school program. Located along the Bow River, the Bow Habitat Station features a freshwater and fish interpretive centre, a trout hatchery, and a unique collection of wetlands, interpretive trails, and school programs. Grades: 4-9. http://www3.gov.ab.ca/srd/regions/southeast/bowhabitat/ Contact: (403) 297-6561

- **Inglewood Wildlands –** The Wildlands is a special place created by a community as a response to a technological problem—oil from the refinery has percolated through the gravelly soils and accumulated on the water table about 5 metres below ground surface. It is an environment where students can contemplate human impact on the landscape, appreciate the results of a community vision, understand recovery and reclamation processes, explore nature, and embrace a sense of stewardship for the environment. Calgary teachers have the opportunity to use this unique site as a catalyst for learning, which will augment on-going studies at their own school. Application forms and further information are available on the website http://www.inglewoodwildlands.ca

- **Calgary Bridges Field Trip –** This is a trip that stops at the many interesting bridges that span the Bow River in Calgary. It allows students to get a close up view of the various bridge structures, the culture of the downtown communities as well as some beautiful and unusual views of the river. The Calgary Bridges Book published by the Calgary Board of Education is most helpful for designing this self guided tour. Professional Development opportunities are offered by Calgary Science Network Teacher Workshop Program. www.calgarysciencenetwork.ca/pdworkshops.html

Professional Development

- **Calgary Science Network Teacher Workshop Program –** workshops and fieldtrips presented on topics integral to the Alberta Learning Science Curriculum, as well as general sessions that combine emphases on social studies or language arts with science topics. Each workshop has two leaders: a scientist to ensure relevant content and in-depth subject knowledge, and an experienced educator to guarantee that activities and materials are grade appropriate and practical in a classroom or field trip setting. http://www.calgarysciencenetwork.ca/pdworkshops.html

- **Inside Education –** sponsored institutes for teachers including Bow River Ecotour and Water Education Institute. http://www.insideeducation.ca/html/proDevApp.html

Guest Scientists

- **Calgary Science Network Scientist in the Classroom –** brings science to life for thousands of Calgary area school children through an array of programs, including Scientist in the classroom, Science Fair judging, guidance for scientific field trips, science career awareness and mentoring, enrichment ideas, science questions answered and science speakers. http://www.calgarysciencenetwork.ca/scivisit.html

Glossary

agriculture: the occupation, business, or science of cultivating the land, producing crops, and raising livestock.

aquifer: any rock or sediment that yields a useful amount of water through wells and springs.

atmospheric water: the water that exists in the atmosphere (air), either as water vapour or precipitation before reaching the earth's surface.

Bow River Basin: this is the land that drains all precipitation received as runoff or groundwater into the Bow River and its tributaries. The Bow River basin drains eventually into the Hudson Bay.

canal: an artificial waterway constructed for use for irrigation, or for recreational use; also known as a diversion canal.

chlorine (Cl): a gaseous, poisonous, corrosive, greenish-yellow chemical element that combines with nearly every other element. It is widely used to purify water and as a disinfectant.

cistern: an underground tank for storing rainwater.

condensation: tiny drops of water that form on a cold surface such as a window when warmer air comes into contact with it. The process where a vapour loses heat and changes into a liquid.

contaminant: a substance, such as a toxin or chemical, that leaches into the ground, polluting it and possibly the groundwater and drinking water.

continental divide: a massive area of high ground in the interior of a continent, from either side of which a continent's river systems flow in different directions.

contour interval: the interval between contour lines on a map, or the altitude the interval represents.

contour line: a line on a map connecting points on a land surface that are the same elevation above sea level.

dam: a barrier that is built across a river or stream to block, control, or redirect the flow of water (diversion dam), especially in order to create a reservoir.

desalinization: the process of removing salt from water, usually seawater, to produce potable water.

dissolved oxygen: the amount of oxygen dissolved in water, in parts per million (ppm) by weight, or in milligrams per litre (mg/l). Low levels of dissolved oxygen can be disastrous for local fish and ecosystems.

drought: a long period of extremely dry weather when there is not enough rain for the successful growing of crops or the replenishment of water supplies.

dugout: a depression excavated to collect rainwater and/or water from a neighbouring stream as a water supply for livestock; a common practice amongst farmers in the prairies.

effluent: liquid waste discharged from a sewage system.

evaporation: a process where water is changed from a liquid to a vapour.

evapotranspiration: the return of moisture to the air through both evaporation from the soil and transpiration by plants.

fecal coliform: rod-shaped bacteria normally found in the colons of humans and animals and can become a serious contaminant when found in the food or water supply (e.g. E. coli).

flow rate: the volume of water that flows in a given amount of time, for example: m^3/s (cubic metres per second).

foothills: low lying hills extending from a mountain range. The local foothills are a result of a series of thrust faults that also formed the Rocky Mountains.

freshwater: inland waters, such as, rivers, ponds, wetlands, and lakes, with little or no salt content.

glacier: a large mass of ice formed on land by the compaction and recrystallization of snow, creeping downwards due to the stress of its own weight, and surviving from year to year.

global warming: an increase in the world's temperatures, believed to be caused in part by the greenhouse effect and depletion of the ozone layer.

groundwater: the water (rain and snow) that infiltrates the ground, filling the cracks and pores within the underlying rock and sediment. This 'under ground' water completely fills the spaces within the rock and soil below the water table.

headwaters: the streams that make up the beginnings of a river.

habitat: the natural environment in which a plant or animal lives; such as a forest, prairies or wetlands.

hydroelectric (hydro) power: electrical energy generated by means of a power generator coupled to a turbine through which water passes.

icefield: an extensive area of interconnected glaciers in a mountain region; for example, Columbia Icefield.

infiltration: the movement of water, into soil or porous rock.

irrigation: when the land is too dry to sustain an agricultural industry, water is moved from local rivers (i.e. Bow River and tributaries), through a system of canals and storage reservoirs, to supply water to farmers.

lake: a large body of water, in a depression, surrounded by land.

leaching: when water dissolves soluble, potentially hazardous, material and transports it into the ground and risking water supply contamination.

mountains: any part of the Earth's crust higher than a hill, generally projecting at least 300 m (1000 ft) above the surrounding land; for example, the Rocky Mountains.

nitrate: a compound used as fertilizer that may consist of sodium nitrate, potassium nitrate or ammonium nitrate. Nitrate levels can be measured in soil and water.

oil well: a shaft drilled into the earth through which petroleum (crude oil) is extracted.

oilfield injection: the practice of injecting water (steam) into oil wells to increase oil recovery.

pH: a measure of the acidity($pH<7$) or alkalinity ($pH>7$) of a solution, such as vinegar, or a damp substance, such as soil.

phosphate: any salt formed by the reaction of a metal with phosphoric acid. Once found in detergents, but phosphates are now more regulated due to the negative impact on water ecosystems.

plant transpiration: loss of water vapour through a plant's surface, especially through minute surface pores (stomata).

plume: referring to a pipe-like body of contaminant that has leached into the earth, possibly reaching the water table and contaminating the groundwater and potable water supply.

potable water: water that is safe and palatable for human use.

prairie: an extensive tract of level to rolling grassland, generally treeless, in the temperate latitudes of N. America, characterized by a deep, fertile soil and by a covering of tall, coarse grass and herbaceous plants.

precipitation: rain, snow, or hail formed by condensation of moisture in the atmosphere that falls to the ground.

rain shadow: a very dry region on the side of a mountain range facing away from the wind (leeward side), where rainfall is noticeably less than on the windward side. The rain shadow falls just east of the Rocky Mountains onto the prairies, leaving the prairies relatively dry.

raw sewage: human and domestic waste matter from buildings, especially houses, that is carried away through sewers to be treated at special treatment facilities.

reservoirs: a large natural or artificial lake used for collecting and storing water for human consumption or agricultural use, such as the Glenmore Reservoir, Calgary.

retention pond: a wetland created to store and filter runoff during rainstorms and rapid snowmelt.

riparian area (green zones): parts of the landscape strongly influenced by water, flood plains adjacent to streams and rivers, where water-loving plants grow. Riparian areas are sensitive ecosystems that need to be managed carefully to prevent erosion.

river: a natural formation in which fresh water forms a wide stream that runs across the land until it reaches the sea or another area of water, such as, another river or lake.

saltwater: ocean or sea water with noticeable levels of salt (non-potable).

sewage (waste) treatment plant: a facility where sewage or waste water is collected, and cleaned before returning to a river and heading downstream. Calgary has two sewage treatment plants: Bonnybrook and Fishcreek. Calgary's sewage/ wastewater undergoes a number of processes, including:

- **Headworks:** screens that remove large material from wastewater
- **Primary clarifiers:** used for settling and skimming
- **Bioreactors:** good bugs that use sewage for nutrients
- **Secondary clarifiers:** removal of good bugs
- **Digesters:** anaerobic decomposition of sewage (i.e. bacteria)
- **Disinfection UV:** makes any remaining micro-organisms sterile so they cannot reproduce and phases out chlorine
- **Treated effluent:** cleaned water returned to the Bow River
- **Sludge:** biosolids in a slurry sent to Shepard lagoons to settle
- **CALGRO:** takes treated biosolids to farms to be used as fertilizer

snowmelt: runoff produced when snow melts. Most of the Bow River's water supply comes from snowmelt.

snowpack: The fresh snow deposited yearly that contributes to the melt waters leading to streams and rivers.

soil porosity: referring to the minute spaces within soil that enables it to absorb water.

South Saskatchewan River Family: the tributaries leading into the South Saskatchewan River, namely: the Bow, Red Deer and Oldman rivers.

stormwater: refers to all forms of precipitation (rain, snow, sleet) which becomes runoff or enters the earth as groundwater. People are encouraged to make better use of rooftop stormwater by collecting it in rain barrels or redirecting it directly onto gardens.

surface water: the part of precipitation appearing on the surface as runoff.

transpiration: the loss of water vapour from a plant's surface through minute surface pores called stomata.

treated sewage: raw sewage treated at special treatment facilities. Experimental use of treated sewage to fertilize farmland is currently underway.

tributary: any stream that contributes water to another stream.

water conservation: the practice of protecting the current water supply by reduction of water consumption within the home, at work, in agriculture, or in industry (e.g. water-efficient appliances, toilets, irrigation systems, water-wise gardens).

water cycle: the constant circulation of water between atmosphere, land, and sea by evaporation, condensation, precipitation, and percolation through soils and rocks as groundwater.

water quality: The fitness of water for use, being affected by physical, chemical and biological factors. Calgary's tap water rates high in water quality when compared to other urban centres.

water table: the surface between the zone of water saturation or groundwater (below) and the zone of aeration (above).

water tower: a tower for water storage.

water treatment plant: a facility where water is collected, cleaned and made potable by a municipality for human consumption. Calgary has two water treatment plants: Bearspaw and Glenmore.

water well: a well that extracts groundwater for surface use, either for irrigation, industrial use or as a potable water source.

watershed: another name for a drainage basin where water drains and collects into a series of tributaries feeding into a common river.

wetland: a marsh, swamp or other area of land where the soil near the surface is saturated or covered with water, especially one that forms a habitat for wildlife.

