Geoscape Ottawa-Gatineau

Grade 7 Lesson Plans to accompany the Geoscape Ottawa-Gatineau poster and website
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Theme Seven: Groundwater

List of Expectations		
Grade	Strand and Topic	Expectations
7	Science: Earth and Space Systems The Earth's Crust	• investigate some of the ways in which humans have altered the landscape to meet their needs and assess the environmental and economic consequences
7	Geography: Natural Resources	• demonstrate an understanding of the concept of sustainable development and its implications for the environment

Overview

The Geoscape "Groundwater" theme consists of lessons which will enable students to understand the complexities of the groundwater system and appreciate the problems of water quality.

At the end of these lessons, students will be able to:

- Understand the importance of groundwater as a renewable resource
- Determine how a water table is formed
- Recognize some of the problems with contaminants affecting groundwater

Suggested Lessons	Brief Description
Students Take Notes	Overhead: Wealth from the Land
Key Word Game	Word Match
Lesson 1	Digging a water well A laboratory activity that allows students to work with a model of an aquifer.
Lesson 2	Contamination: a demonstration of how contamination can reach an aquifer.
Lesson 3	Labelling Water Cycle Diagram
List of related web sites and resources	Environment Canada's website on groundwater, water quality and water conservation http://www.ec.gc.ca/water/en/info/pubs/e_teach.htm USGS http://ga.water.usgs.gov/edu/watercyclegwstorage.html http://ga.water.usgs.gov/edu/watercycle.html Wind Cave National Park's web page on "Getting the Groundwater picture" (U.S. Department of the Interior) http://www.nps.gov/wica/Hydrology_Groundwater_Getting_the_Groundwater_Picture.htm

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Students take notes:

Groundwater: Vital but Vulnerable

Groundwater

- is water under the earth's surface
- is found below a surface called the **water table**
- fills pores in soil, sand and gravel
- also stored in pores and fractures in bedrock
- both quantity and quality are important
- supplies streams, rivers, wells and springs
- provides drinking water in some rural areas
- is used for agricultural purposes (irrigation)

Aquifer

- a layer of porous or fractured material (rock or sediment) beneath the surface that can hold water and through which water can move
- like a huge underground sponge
- water can be pumped out for use
- is recharged by rainwater or snowmelt infiltration
- clay and silt at surface can form a blanket and can stop water from moving down into the ground (AQUITARD). Instead, water will run off into rivers.

In the Ottawa area, precipitation ultimately goes to:

- evapo-transpiration (45%),
- runoff to rivers and lakes (45%), and
- infiltration to groundwater (only 10%).

Students take notes: **Groundwater: Vital but Vulnerable**

Water Quality

The chemical composition of surrounding rocks will affect the quality of the water.

Surrounding Rocks	**Interaction**	**Characteristics of Water**
Rocks containing pyrite	Release of sulphur	Smell of "rotten eggs"
Champlain Sea Sediments	Salt-rich	Salty water
Limestone and Dolostone	Dissolved calcium and magnesium	Hard water. Lime is deposited in pipes, kettles, etc.
Granite and Gneiss	Little or none	Soft water

- Groundwater can be contaminated by human activity.
- Any substance that is placed at the surface may eventually flow down to mix with the groundwater.

Potential Sources of Contamination:

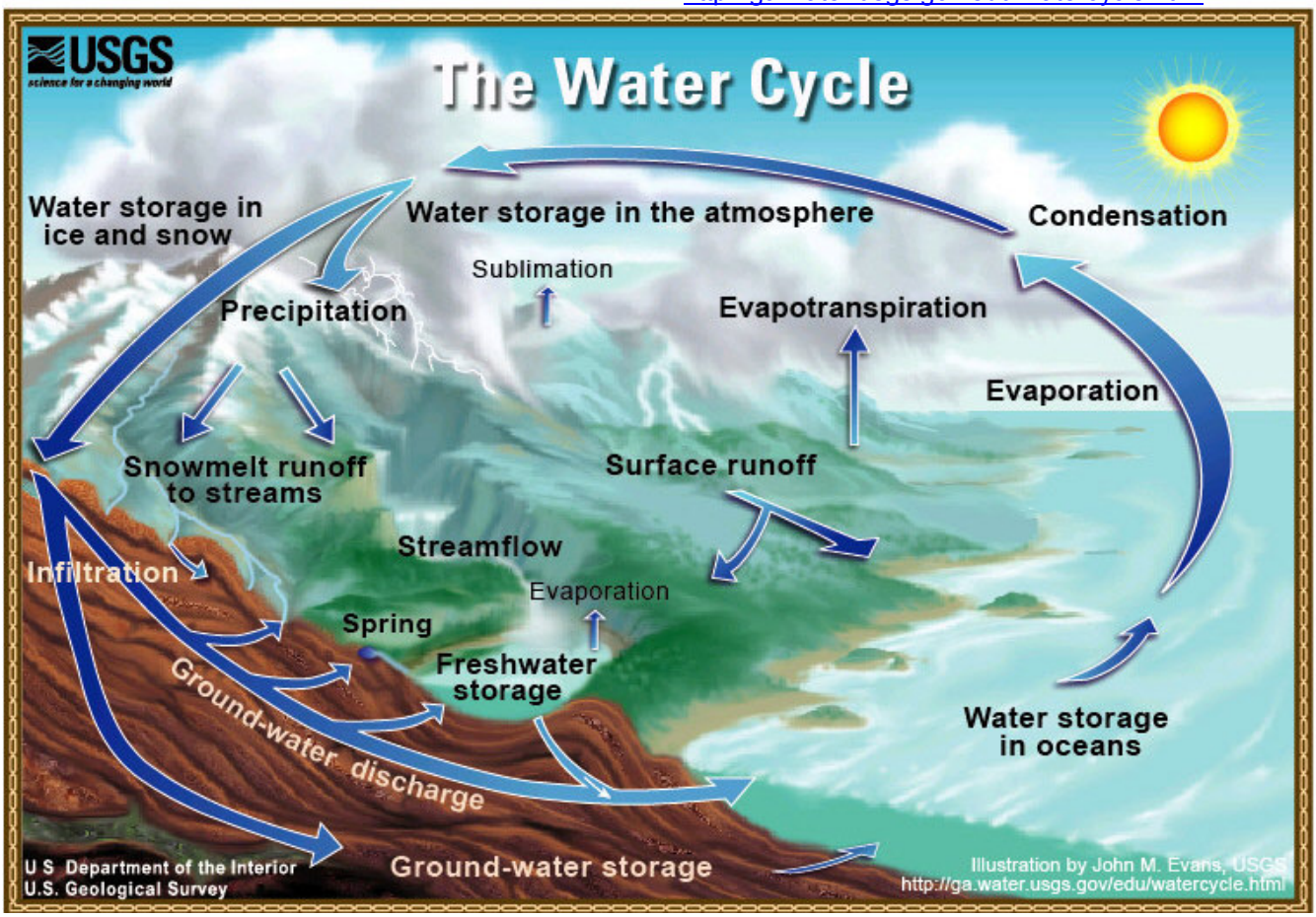
Urban areas: gas station, dry cleaners, garbage dumps, snow disposal dumps, industrial sites

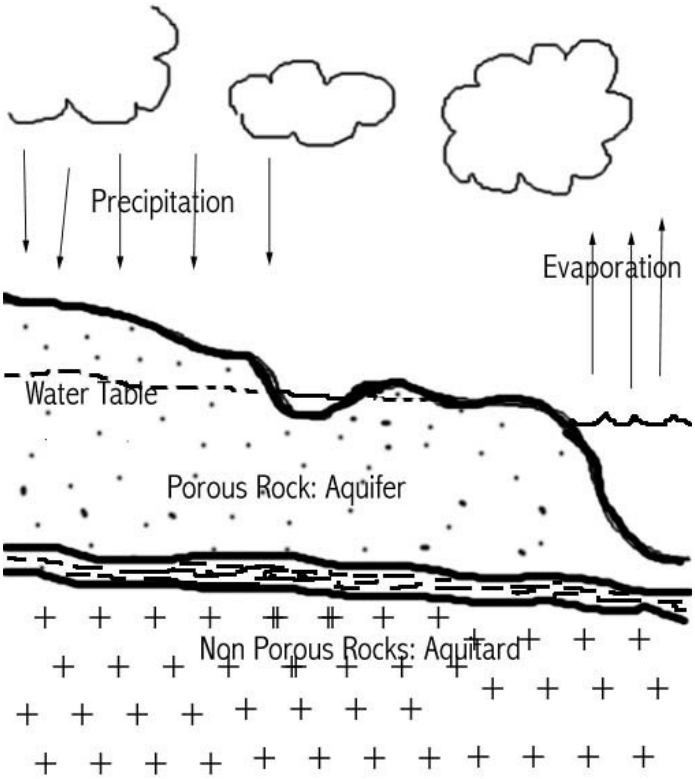
Rural areas: livestock wastes, pesticides, fertilizers

Overhead:

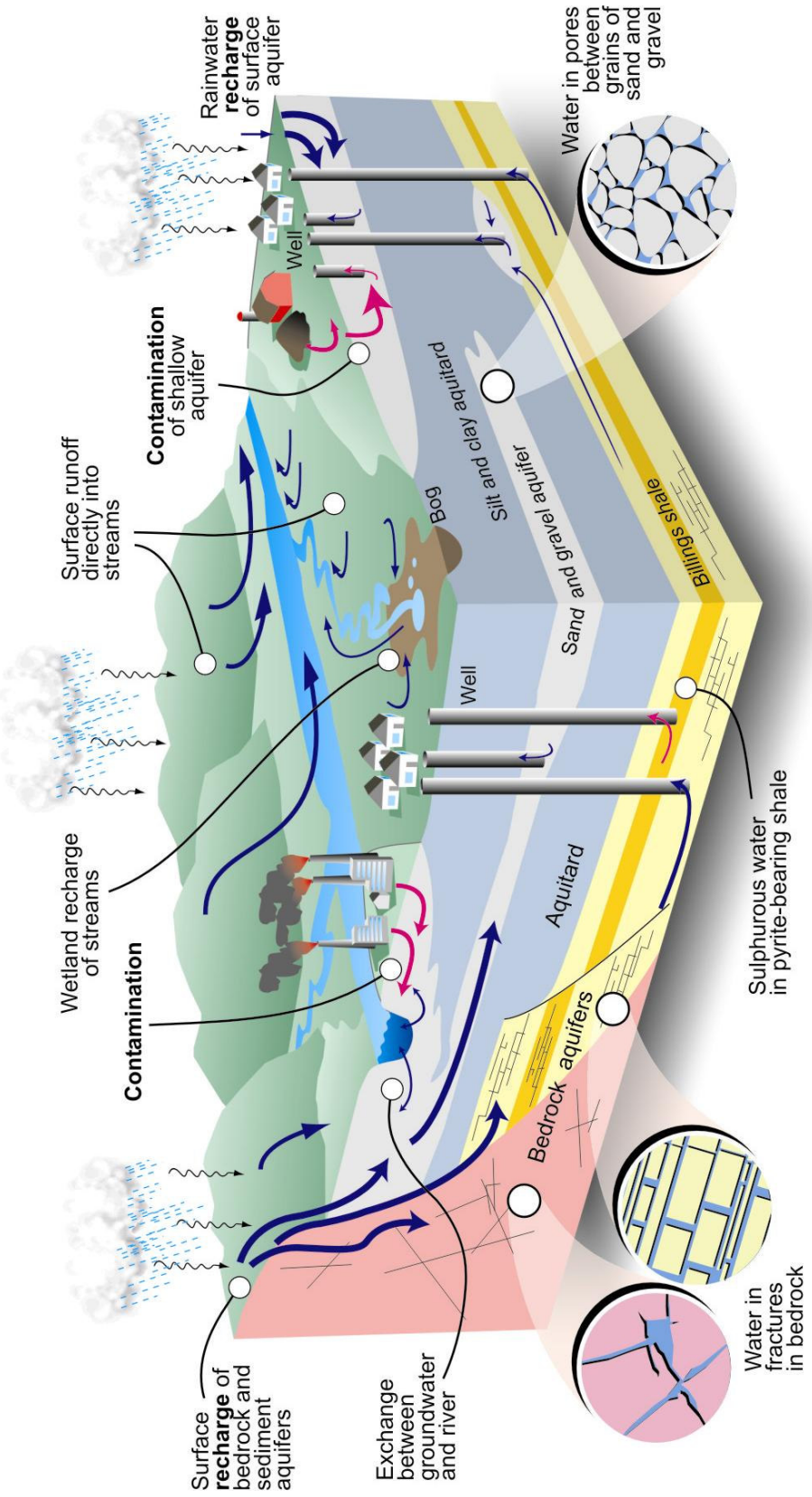
The Water Cycle

http://ga.water.usgs.gov/edu/watercycle.html

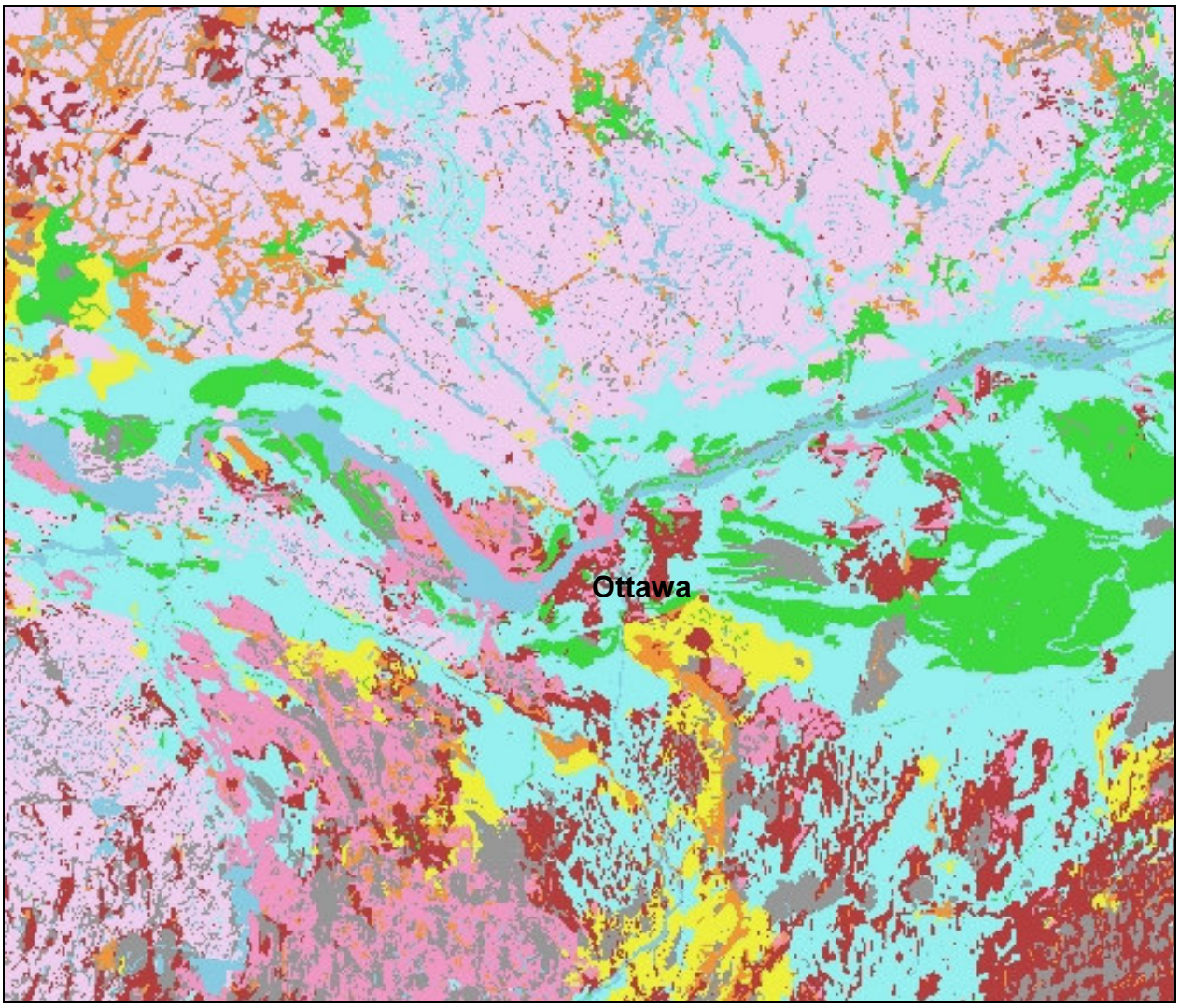




Overhead: **Geoscape groundwater diagram**



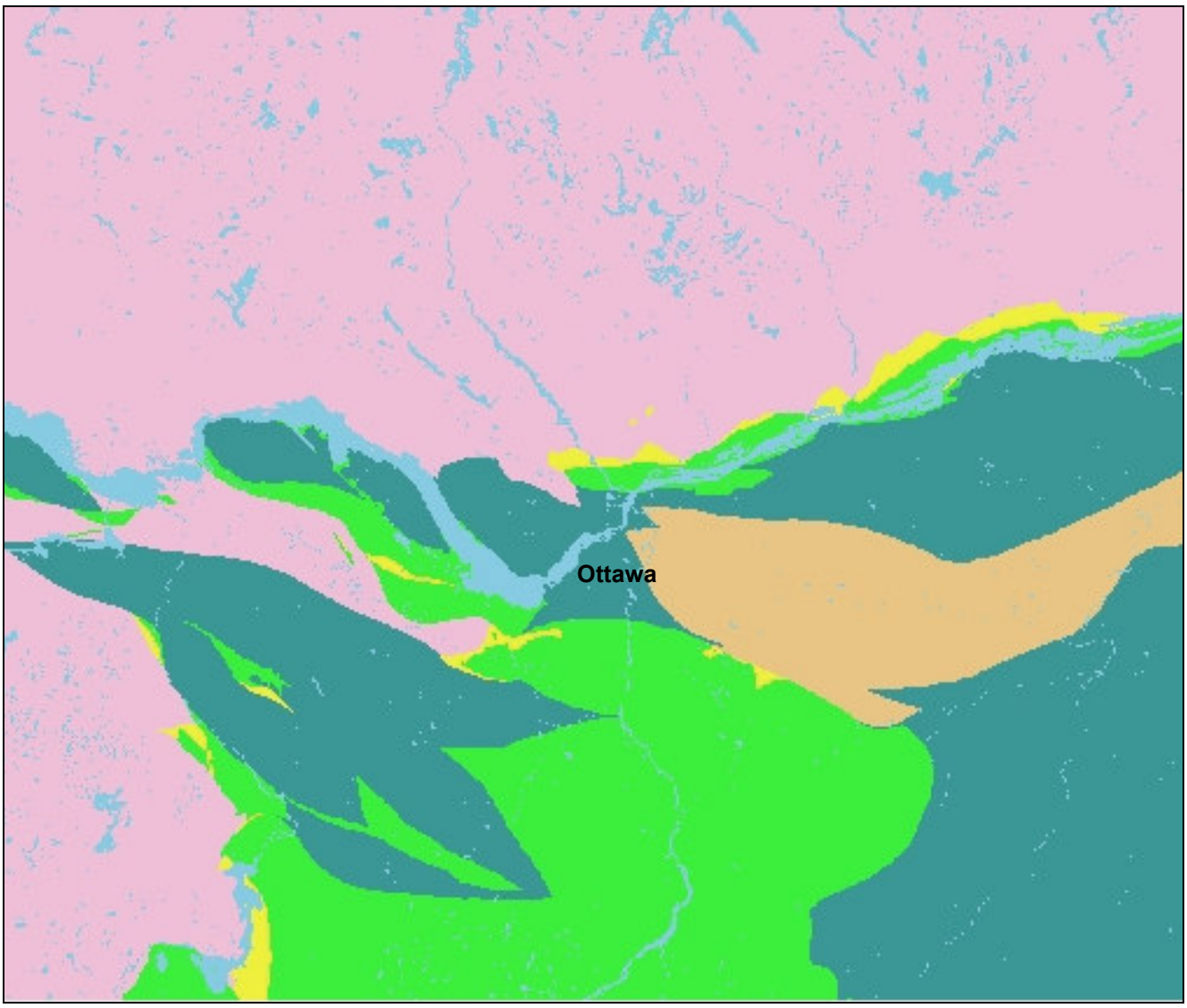
Hydrogeology of surficial materials / Hydrogéologie des dépôts meubles



Hydrogéologie des dépôts meubles		Hydrogeology of surficial materials
Roche en place paléozoïque		Bedrock Paleozoic
Roche en place précambrienne		Bedrock Precambrian
Marais et tourbières		Bogs and swamps
Aquifère fluvioglaciaire		Glaciofluvial aquifers
Aquitard de silt et d'argile marin		Marine clay and silt aquitard
Aquifère de till et de fluvioglaciaire remanies		Reworked glaciofluvial and till aquifers
Aquifère de sable de surface		Surficial sand aquifers
Aquifère de till		Till aquifers

Urban Geology of the National Capital Area : Online data http://gsc.nrcan.gc.ca/urbgeo/natcap/index_e.php
Géologie urbaine de la région de la capitale nationale: Données en ligne http://gsc.nrcan.gc.ca/urbgeo/natcap/index_f.php

Bedrock Aquifers / Aquifères dans le roc



Good quality, high yield
Bonnes qualités et quantité

Variable yield, variable quality
Qualité et quantité variables

Good quality, medium to high yield
Bonne qualité, quantité moyenne a bonne

Poor quality and poor yield, mineral content above MOE standards
Qualité et quantité médiocres, contenu en minéraux supérieur aux normes du MOE (Ontario)

Sufficient supply for domestic use, variable quality, often sulphurous and saline in eastern regions
Quantité suffisante pour usage domestique, qualité variable

Urban Geology of the National Capital Area : Online data http://gsc.nrcan.gc.ca/urbgeo/natcap/index_e.php
Géologie urbaine de la région de la capitale nationale: Données en ligne http://gsc.nrcan.gc.ca/urbgeo/natcap/index_f.php

Key word game: **Match the word with it's definition** **name:**

Groundwater

1. Aquifer ____
2. Aquitard ____
3. Bedrock ____
4. Dolostone ____
5. Flow rate ____
6. Impervious ____
7. Infiltrate ____
8. Infiltration ____
9. Limestone ____
10. Porous ____
11. Pyrite ____
12. Recharge ____
13. Runoff ____
14. Silt ____
15. Sulphurous Water ____
16. Wetlands ____

a) the discharge of water from the land through streams

b) having small spaces (voids) that may be filled with liquid or air

c) land which is commonly wet (bog, fen, marsh, swamp)

d) fine grain size (1/256 to 1/16 mm) mid-way between sand and clay

e) not allowing liquid to pass through

f) a hard sedimentary rock primarily made up of calcium carbonate

g) the process of passing through something

h) to slowly pass through or into something

i) layer or zone below the earth's surface that can contain water

j) a layer of rock or sediment that will prevent infiltration or movement of water

k) a sedimentary rock composed mainly of dolomite

l) a yellowish-gold metallic coloured mineral made up of iron and sulphur

m) water that contains sulphur which is harsh or corrosive

n) the speed at which water moves

o) the process of adding water to ground water, usually by precipitation.

p) solid rock exposed at the surface or underneath soil and loose sediments

Key word game Solutions

Groundwater

1.	Aquifer	**i**
2.	Aquitard	**j**
3.	Bedrock	**p**
4.	Dolostone	**k**
5.	Flow rate	**n**
6.	Impervious	**e**
7.	Infiltrate	**h**
8.	Infiltration	**g**
9.	Limestone	**f**
10.	Porous	**b**
11.	Pyrite	**l**
12.	Recharge	**o**
13.	Runoff	**a**
14.	Silt	**d**
15.	Sulphurous Water	**m**
16.	Wetlands	**c**

7.1 Lesson 1: Digging a water well

Brief Description
Students will create a model of an aquifer and a water table and drill a well using a straw.

Suggested Materials
Large glass jar or clear plastic container
Sand
Water
Drinking straw
Student worksheet
Overheads: “Geoscape groundwater diagram”, “Water cycle”

Duration 40 minutes

Preparation
Teacher may ask students to bring in their own jars and sand for the activity

Lesson Instructions

1. Start with a discussion about water wells. Ask students if they know anyone who draws their drinking water from a well.

2. Use the overheads “Water cycle” and “Geoscape groundwater diagram” to explain the water cycle and how it relates to groundwater and the water table.

3. Distribute the materials and have students follow the procedures on their worksheet.

Extended activity
This activity can be continued by discussing wetlands (swamps, marshes, bogs) and having students manipulate the sand to form ponds and swamps etc.

Student worksheet: **Digging a water well**

Lab: Digging a water well

Problem: How do we find water in a well?

Hypothesis:

Materials:
Large glass jar or clear plastic container
Sand
Water
Drinking straw

Procedure:
1. Fill the jar with sand up to about 2 cm from the top.
2. Slowly pour water on the sand.
3. Observe what happens to the water as it sinks to the bottom.
4. Continue adding water until the water level is about 3 cm from the top of the sand.
5. Holding the drinking straw upright, wiggle it into the sand in the centre of the jar.
6. As you wiggle the straw, you will be "drilling" a hole into the sand.
7. Remove any sand that gets trapped in the straw and continue wiggling it in until the straw reaches about 1 cm from the bottom of the jar.
8. Remove the straw and observe what you see in the hole.

Observations:
Quantitative Observations:

	Description
Dry Sand	
Wet Sand	
Drilled Hole	

Questions:

1. Why is the sand porous?

2. Why does the water stop descending when it meets the glass bottom of the jar? What does this represent in nature?

3. How would you describe the water table in your model?

4. When you drilled your hole into the sand, what happened when the straw was removed?

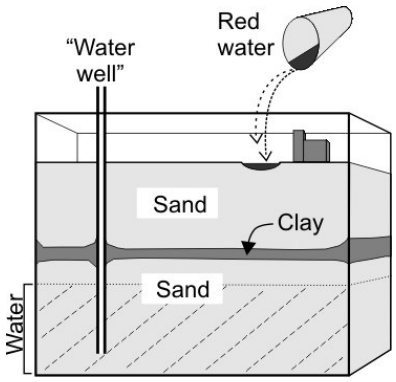
5. Explain how this model represents how groundwater is used in rural areas.

6. Would you drink the water from a well? Explain.

7.2 Lesson 2: Contamination Demonstration

Brief Description
A lab demonstration by the teacher to show how pollution can contaminate an aquifer.

Suggested Materials
Large glass bowl or small aquarium
Sand
Plasticine or modelling clay
Water
Red food dye
Drinking straw or metal rod
Clear glass tube



Duration 15 minutes

Preparation

Teacher assembles the model in advance.

a. Fill half full of sand. Flatten. This is the lower aquifer.

b. Add water to 1-2 cm from top of sand.

c. Place a flat sheet of plasticine or modelling clay on top of the sand, carefully sealing the edges to the class. This is the Aquitard.

d. Insert a clear glass tube through the aquitard and into the lower aquifer. Carefully make a seal. This is the water well.

e. Carefully add rest of sand, taking care not to move tube or break seals. This is the upper aquifer.

f. Set a toy building or block on the surface near one end to represent the source of contamination.

g. Prepare a beaker of very red water.

Lesson Instructions

1. Identify the aquifer and aquitard layers and well.

2. Explain that the lower aquifer is recharged with water at some distance away, where the layer comes to the surface or the aquitard is missing. The upper aquifer is temporarily dry.

3. What is in the well? Ask a student to identify the water table.

4. Slowly pour red water on the surface at the contamination site and watch it disperse through the upper aquifer. See how the aquitard saves the lower aquifer.

5. What happens if the aquitard is not continuous or is broken by fractures, old wells, etc.? Pierce the aquitard layer with the rod. Watch the contaminant move into the lower aquifer and towards the well.

6. Discuss with class how water wells could be contaminated. Point out to class that contaminants move sideways as well as downward, and the impact of pollution may be felt far away from the contamination source.

7.3 Lesson 3: Water Cycle Diagram

Brief Description
This simple activity involves the labelling of the Water Cycle Diagram found on the Ottawa-Gatineau Geoscape Poster

Suggested Materials
Overhead Projector or LCD Projector
Overhead of Geoscape Groundwater diagram or Geoscape web page
Student worksheets

Duration 30 minutes

Lesson Instructions

1. Using either the overhead or the projected web page, explain each step of the Geoscape water cycle.

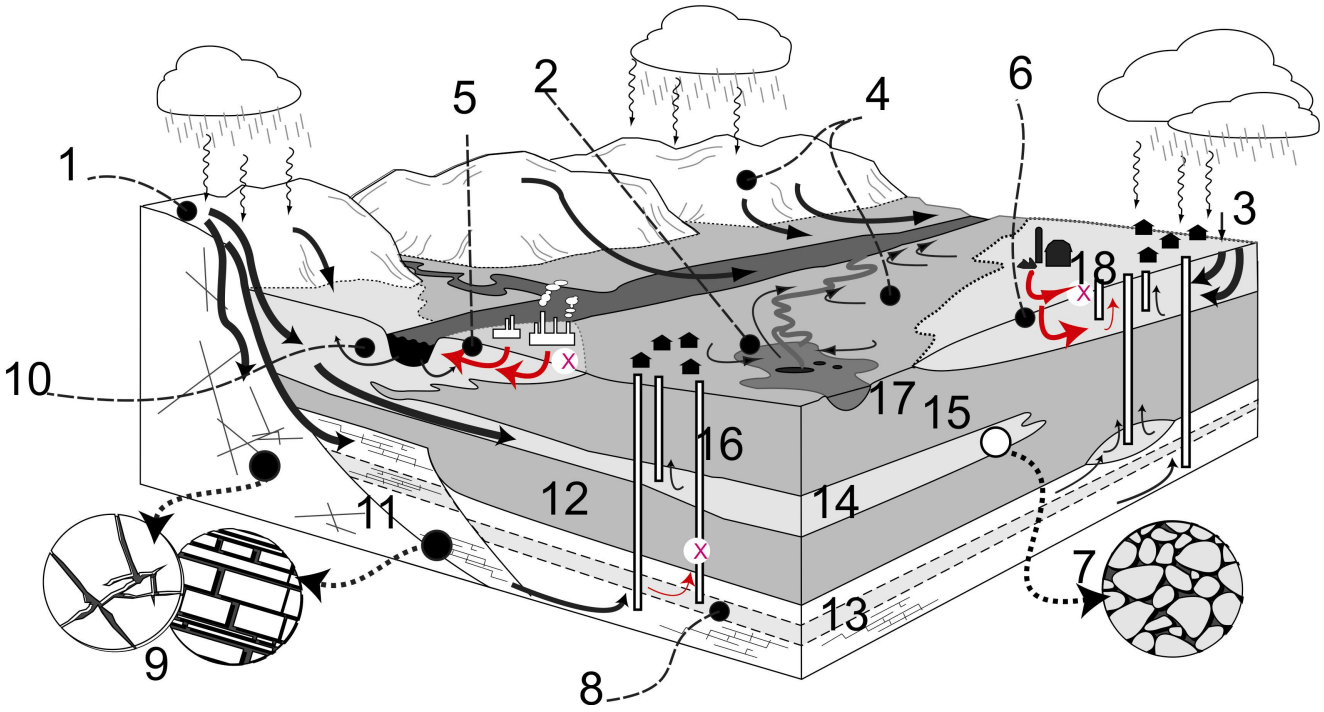
2. Remind class that in Ottawa area, about 45% of precipitation evapo-transpirates back into atmosphere, 45% runs off the surface into streams, and only 10% infiltrates the ground and becomes groundwater.

3. It would be useful here to have the following rock samples for demonstration
    - Sandstone, sand, gravel: porous, good aquifer
    - Shale, clay: non porous, aquitard
    - Pyrite: mineral that contains sulphur that could contaminate groundwater

4. Have students complete the worksheet.

Student Worksheet: **Geoscape Groundwater diagram**

Match the letter with the number



A. Surface recharge of bedrock and sediment aquifers
B. Wetland recharge of streams
C. Bedrock aquifers
D. Aquitard
E. Well
F. Water in fractures in bedrock
G. Water in pores between grains of sand and gravel
H. Billings shale
I. Silt and clay aquitard
J. Well
K. Rainwater recharge of surface aquifer
L. Contamination of shallow aquifer
M. Sulphurous water in pyrite-bearing shale
N. Contamination
O. Sand and gravel aquifer
P. Bog
Q. Surface runoff directly into streams
R. Exchange between groundwater and river

1. _____ **2.** _____ **3..** _____ **4.** _____ **5.** _____ **6.** _____

7. _____ **8.** _____ **9.** _____ **10.** _____ **11.** _____ **12.** _____

13. _____ **14.** _____ **15.** _____ **16.** _____ **17.** _____ **18.** _____