Water Systems: How Important is Water to our Lives?

Lesson Title: How Important is Water to our Lives?
Unit: Science-Water Systems
Grade: 8
Time: 110 minutes (total)

- 25 minutes for the Introductory Activity (Schema Activation) – Water Trivia Game
- 60 minutes for the Enhancing Activity (Hook – Water Chemistry, Erosion and Deposition, Turbidity, and Filtration Analysis)
- 40 minutes for the Culminating Activity (Group Presentations and Recommendations)

The Big Eco Idea: **Water is crucial to life on Earth and it is an important resource that needs to be managed sustainably.**

Description Of the Task:

Students work in small cooperative learning groups as Hydrologists to investigate and research Siena Island, an uninhabited island in the 1000 Islands region. Their task involves teamwork to determine drinking water quality on the island through various tests that measure pH, turbidity, bacteria count and erosion and deposition analysis. Final recommendations are done by each student.

Curriculum Expectations:

SCIENCE & TECHNOLOGY-*Understanding Earth and Space Systems: Water Systems*

2.1 Follow established safety procedures for the use of apparatus and chemicals.
2.3 Test water samples for a variety of chemical characteristics.
2.5 Use technological problem-solving skills to design, build, and test a water system device that performs a practical function or meets a need.
2.6 Use appropriate science and technology vocabulary in oral and written communication.
2.7 Use a variety of forms to communicate with different audiences and for a variety of purposes.
3.2 Demonstrate an understanding of the watershed as a fundamental geographic unit, and explain how it it relates to water management and planning.
3.3 Explain how human and natural factors cause changes in the water table.

LANGUAGE
Oral Communications

2.3 Communicate orally in a clear, coherent manner, using a structure and style appropriate to the topic and the intended audience.
2.4 Use appropriate words, phrases, and terminology from the full range of their vocabulary, including inclusive and non-discriminatory language and a range of stylistic devices, to communicate their meaning accurately and engage the interest of their intended audience.
2.5 Identify a range of vocal effects, including tone, pace, pitch, volume, and a variety of sound effects, and use them appropriately, with sensitivity towards cultural differences, to communicate their meaning.
2.6 Identify a variety of non-verbal cues, including facial expression, gestures and eye contact, and use them in oral communications, appropriately and with sensitivity towards cultural differences, to help convey their meaning.

Groupings

- Students working in small, cooperative learning groups
- Students working individually
- Students working as a whole class

Teaching / Learning Strategies

- Inquiry
- Discussion
- Measurement
- Science learning log/journal
- Brainstorming
- Performance task

Assessment Strategies

- Science learning log/journal
- Observation
- Peer/self assessment
- Group presentation

Assessment Recording Devices

- Rubric
- Checklists
- Anecdotal record

Resources Required:

Materials

Introductory Activity--Water Trivia Game

- Chart paper/chalkboard
- Chalk/markers
- Science learning log/journal
- Pencils
- Noise makers
- **BLM 1.1.a**--Map of Siena Island
- **BLM 1.1.b**--Scenario Task Card
- **BLM 1.1.c**--Water Trivia Game Questions
- **BLM 1.1.d--**Water Trivia Game Answers

Water Chemistry Activity--pH Testing and Water Quality Guidelines

- 2 types of pH paper (1-14 ph range, orange colour-6/group and 4.5-8.5 ph range, green colour-3/group)
- Plastic bottles with lids (6-50 ml) (**test substance #1** = lemon juice, **test substance #2** = washing soda, **test substance # 3** = distilled water, **test substance # 4** = Pine Lake, **test substance # 5** = Tulip River, **test substance #6** = Cedar Bog)
- Measuring cups/spoons (50 ml)
- Washing soda (2 tsp)
- Distilled water
- Tap water
- Baking soda
- White grape sparkling water (1 bottle of PC brand with aspartame)
- Paper towels (1 roll)
- Scotch tape
- White labels (for each of the test substances)
- Permanent marker
- Pencils
- Science learning log/journal
- Test substances – (**test substance #1** = lemon juice, enough to fill the bottle; **test substance #2** = 1 cup water, 2 tsp washing soda; **test substance #3** = distilled water, enough to fill bottle; **test substance #4** = 1 tsp baking soda in 1 L of distilled water; **test substance #5** = tap water,

Turbidity Activity

- Secchi disks (6)
- Wooden spoons (3)
- Ruler (1/group)
- Sand (1 small bag)
- Topsoil (1 small bag)
- Peat moss (1 small bag)
- Tap water
- Labels (Pine Lake, Tulip River, Cedar Bog)
- Permanent marker
- Paper towels (1 roll)
- Measuring cup (50 ml)
- Plastic containers (3 – Pine Lake, Tulip River, and Cedar Bog water test samples)
- Water test samples (Pine Lake = 1 tbsp topsoil; Tulip River = 1 tbsp sand; and Cedar Bog = 1 tbsp sand, 1 tbsp topsoil, and 1 tbsp peat)
- Science learning log/journal
- Pencils
- **BLM 1.2.b** – Student Worksheet
- **BLM 1.2.g** – Science Learning Log/Journal Page
- **BLM 1.2.h** – Student Criteria for Science Learning Log/Journal
- **BLM 1.2.k** – Anecdotal Record Sheet
- **BLM 1.2.l** – Rubric for Science Learning Log/Journal
- **BLM 1.2.m** – Peer/Self Assessment
- **BLM 1.3.a** – Turbidity Task Card
- **BLM 1.3.e** – Rubric for Turbidity Analysis

Erosion and Deposition Activity

- Science learning log/journal
- Pencils
- **BLM 1.2.b** – Student Worksheet
- **BLM 1.2.g** – Science Learning Log/Journal Page
- **BLM 1.2.h** – Student Criteria for Science Learning Log/Journal
- **BLM 1.2.k** – Anecdotal Record Sheet
- **BLM 1.2.l** – Rubric for Science Learning

enough to fill bottle; **test substance #6** = white grape, low calorie sparkling water with aspartame, enough to fill the bottle)

- **BLM 1.2.a** – pH Testing Task Card
- **BLM 1.2.b** – Student Worksheet
- **BLM 1.2.c** – pH Wide Range Scale
- **BLM 1.2.d** – pH Narrow Range Scale
- **BLM 1.2.e** – Guidelines for Canadian Drinking Water Quality
- **BLM 1.2.f** – Water Quality Task Card
- **BLM 1.2.g** – Science Learning Log/Journal Page
- **BLM 1.2.h** – Student Criteria for Science Learning Log/Journal
- **BLM 1.2.i** – Rubric for Water Chemistry Analysis
- **BLM 1.2.k** – Anecdotal Record Sheet
- **BLM 1.2.l** – Rubric for Science Learning Log/Journal
- **BLM 1.2.m** – Peer/Self Assessment Form

Culminating Activity-Group Presentations and Group Discussion

- Science learning log/journal
- Pencils
- **BLM 1.2.g** – Science Learning Log/Journal Page
- **BLM 1.2.h** – Student Criteria for Science Learning Log/Journal
- **BLM 1.2.k** – Anecdotal Record Sheet
- **BLM 1.2.j** – Criteria for Good Oral Presentations
- **BLM 1.2.l** – Rubric for Science Learning Log/Journal
- **BLM 1.2.m** – Peer/Self Assessment Form
- **BLM 1.5.a** – Group Presentations Checklist
- **BLM 1.5.b** – Rubric for Group Presentations

Log/Journal

- **BLM 1.3.b** – Erosion and Deposition Task Card
- **BLM 1.3.c** – Erosion and Deposition Task Card 2
- **BLM 1.3.d** – Checklist for Erosion and Deposition

Filtration Activity:

- Measuring cup (50 ml)
- Wooden spoons (3)
- Filter paper (1 bag)
- Sand (1 small bag)
- Topsoil (1 small bag)
- Peat moss (1 small bag)
- Cotton balls (1 bag)
- Small gravel (1 small bag)
- Tap water
- Screen door fabric (mesh for filter device)
- Elastics (to secure filters)
- Filtration sample (use the mixture for Cedar Bog – 1 tbsp of sand, 1 tbsp topsoil, and 1 tbsp of peat)
- Filtration bottles (5 clear water bottles)
- Science learning log/journal
- Pencils
- **BLM 1.2.b** – Student Worksheet
- **BLM 1.2.g** – Science Learning Log/Journal Page
- **BLM 1.2.h** – Student Criteria for Science Learning Log/Journal
- **BLM 1.2.k** – Anecdotal Record Sheet
- **BLM 1.2.l** – Rubric for Science Learning Log/Journal
- **BLM 1.4.a** – Filtration Task Card
- **BLM 1.4.b** – Rubric for Filtration

Black Line Masters (BLM)

- **BLM 1.1.a** – Map of Siena Island
- **BLM 1.1.b** – Scenario Task Card
- **BLM 1.1.c** – Water Trivia Game Questions
- **BLM 1.1.d** – Water Trivia Game Answers
- **BLM 1.2.a** – pH Testing Task Card
- **BLM 1.2.b** – Student Worksheet

Print and Websites

Canada. Environment Canada. *The pH Scale*. http://www.ec.gc/water/en/manage/quale/e_ph.htm.

Canada. Environment Canada. *Acid Rain and the Facts*. http://www.ec.gc.ca/acidrain/acidfact.html.

- **BLM 1.2.c** – pH Wide Range Scale
- **BLM 1.2.d** – pH Narrow Range Scale
- **BLM 1.2.e** – Guidelines for Canadian Drinking Water Quality
- **BLM 1.2.f** – Water Quality Task Card
- **BLM 1.2.g** – Science Learning Log/Journal Page
- **BLM 1.2.h** – Student Criteria for Science Learning Log/Journal
- **BLM 1.2.i** – Rubric for Water Chemistry Analysis
- **BLM 1.2.k** – Anecdotal Record Sheet
- **BLM 1.2.j** – Criteria for Good Oral Presentations
- **BLM 1.2.l** – Rubric for Science Learning Log/Journal
- **BLM 1.2.m** – Peer/Self Assessment
- **BLM 1.3.a** – Turbidity Task Card
- **BLM 1.3.b** – Erosion and Deposition Task Card
- **BLM 1.3.c** – Erosion and Deposition Task Card 2
- **BLM 1.3.d** – Checklist for Erosion and Deposition
- **BLM 1.3.e** – Rubric for Turbidity Analysis
- **BLM 1.4.a** – Filtration Task Card
- **BLM 1.4.b** – Rubric for Filtration
- **BLM 1.5.a** – Group Presentations Checklist
- **BLM 1.5.b** – Rubric for Group Presentations

Canada. Environment Canada. *Acid Rain and Water*. http://www.ec.gc/ca/acidrain/acidwater.html.

Canada. Environment Canada. *What is Canada Doing?* http://www.ec.gc.ca/acidrain/done-canada.html.

Canada. Health Canada. Reprinted 1995. *pH.* http:www.hc-sc.gc.ca/waterquality

Ertco Precision. http://www.ertco.com/hydrometers.html

Gralla, Preston. (1994). How the Environment Works. Emeryville: Ziff-Davis Press.

Upper Midwest Aerospace Consortium. Environmental Effects of Acid Rain. http://www.umac.org/ocp/acid/environmental.htm

Water Environment Federation. (1998). Water Sourcebook. Alabama: University of South Alabama.

Preparation:

1. Inform students the day before the water investigation activity to dress appropriately in case something is accidentally spilled on them.
2. Organize all of the materials required for the water investigation prior to the experiment.
3. When conducting the experiment in the classroom, remember that access to water and a sink/lab is necessary for the turbidity, filtration and pH tests.
4. Review with students the appropriate school safety procedures when conducting experiments. Have paper towels and a mop/bucket in case of a floor spill.
5. Photocopy all required Black Line Master sheets (**BLM 1.1.a**, **BLM 1.1.b**, **BLM 1.1.c**, **BLM 1.1d**, **BLM 1.2.a**, **BLM 1.2.b**, **BLM 1.2.c**, **BLM 1.2.d**, **BLM 1.2.e**, **BLM 1.2.f**, **BLM 1.2.g**, **BLM 1.2.h**, **BLM 1.2.i**, **BLM 1.2.j**, **BLM 1.2.k**, **BLM 1.2.l**, **BLM 1.2.m**, **BLM 1.3.a, BLM 1.3.b, BLM 1.3.c, BLM 1.3.d, BLM 1.3.e, BLM 1.4.a, BLM 1.4.b, BLM 1.5.a, BLM 1.5.b**).
6. Laminate appropriate activity Task Cards (**BLM 1.1.b**, **BLM 1.2.a**, **BLM 1.2.f**, **BLM 1.3.a**, **BLM 1.3.b**, **BLM 1.3.c**, **BLM 1.4.a**), Map of Siena Island (**BLM 1.1. a**), Water Trivia Game Questions (**BLM 1.1.c**), pH Wide Range Scale (**BLM 1.2.c**), pH Narrow Range Scale (**BLM 1.2.d**), and Guidelines for Canadian Drinking Water Quality (**BLM 1.2.e**).
7. Pre-cut the two types of pH paper (1-14 ph range, orange colour and 4.5-8.5 ph range, green colour) for each group.
8. Make the six test substances (test substance #1 = lemon juice, test substance #2 = washing soda, test substance # 3 = distilled water, test substance # 4 = Pine Lake, test substance # 5 = Tulip River, test substance #6 = Cedar Bog) prior to the pH testing.
9. Construct six Secchi disks and the three water test substances (Pine Lake, Tulip River, and Cedar Bog) prior to the turbidity analysis.

10. Purchase the material for the filters and make the filtration mixture (Cedar Bog--1 tbsp of sand, 1 tbsp topsoil, and 1 tbsp of peat) prior to the filtration analysis.
11. Review with students the Criteria for a Good Oral Presentation (**BLM 1.2.j**) and Criteria for Science Journal (**BLM 1.2.h**).
12. Divide students into small cooperative learning groups of 4-5 to allow for heterogeneous grouping.

Vocabulary:

- Acid/acidic
- Acidity
- Acid rain
- Algal bloom
- Alkalinity
- Base/basic
- Bioremediation
- Bog
- Chlorination
- Contamination
- Coliforms
- Corrosion
- Dehydration
- Deionized water
- Deposition
- Distillation
- Distilled water
- Erosion
- Fecal matter
- Fertilizer run-off
- Filtration
- Fluoride
- Groundwater
- Hydration
- Methemoglobinemia
- Natural rain
- Nitrates
- Organic matter
- Ozonization
- pH
- Pollutants
- Pollution
- Potable
- Reverse osmosis
- River
- Seawater
- Secchi disk
- Sewage
- Surface water
- Turbidity
- Ultra violet radiation
- Watershed/drainage basin
- Water treatment
- Water quality

Teaching / Learning:

Lesson Plan Progression

A) Introductory Activity (Schema Activation)	Time	Assessment Techniques	Key Questions
Activate Prior Knowledge: Whole class discussion-Introduce the concept of water. Questioning led by teacher: • Why is water crucial to life on Earth? • What do we use water for? ***Recreation, cleaning, power generation, growing food, etc*** • What is your personal water consumption at home? At school? **1.** Students brainstorm their ideas with a partner and record responses on a white board. Divide students into small, cooperative learning groups of 4-5 students to play the **Water Trivia Game** (activating prior knowledge). Each group is given a different noise maker for the answer period. **2.** **Play the Water Trivia Game:** A series of questions will be read to the class. Students are to discuss each question as a group and then use their noisemaker to signal that they have the answer. The first group to sound their noisemaker with the correct answer will receive a point. Either the teacher or selected students can read the questions. If students are reading the question, make sure that you indicate to the class that they can't begin discussing their answers	**25 minutes**	**Observations:** Observation notes will be made during discussion. **Questions and Answers:** Questions led by the teacher or student. Ask students to recognize and recall specific facts and ideas. Ask students to retell and summarize	**a)** Why is water crucial to life on Earth? **b)** What do we use water for? **c)** What is your personal water consumption at home? At school? **d)** What is pH? **e)** Where is the term used? **f)** Why do we

until that particular student returns to his/her group. **3.** After each question, discuss student responses. Another option is to give a question card to each group, having them spend a few minutes discussing their answer and then sharing their response with the class. **4.** What is pH? Where is the term used? ***pH is a scale used to measure how acidic substances are. It is used in chemistry.*** **5.** Why do we care about the pH of water? ***The Canadian guideline for the pH of potable water is 6.5 – 8.5. Our body can tolerate different levels of acidity. We can drink fruit juices and pop which have a pH between 2.5 and 4.0, but it is easier on our bodies if it is in the guideline's range.*** .		information **Anecdotal Record** **Science Learning Log/Journal** **Rubric**	care about the pH of water?
B) Enhancing Activity: Hook **Water Investigation Activity**	**Time**	**Assessment Techniques**	**Key Questions**
1. Introduce the water investigation scenario to students. Read the following: ***As Hydrologists (people who study water), you have been given the role of investigating the water quality of Siena Island, a newly discovered island in the 1000 Islands. It has an active and healthy ecosystem that has never been disturbed. As the best water scientists in Canada, you have been selected to carry out this assignment by testing and using natural water resources in a sustainable manner. Your surrey will include an analysis of Pine Lake, Tulip River and Cedar Bog, which are three different bodies of water on the island. The task involves conducting various tests, such as a pH, turbidity, bacterial count, filtration, and erosion and deposition analysis to determine how safe the water is for drinking. As a team, you will be recording your findings in a data report that includes final recommendations, presented to the class, on the future use of the island.*** **2.** Ask students what the following terms mean: acid, acidity, alkalinity, base, bog, chlorination, contamination, coliforms, corrosion, dehydration, deionized water, deposition, distillation, distilled water, erosion, fecal matter, fertilizer run-off, filtration, fluoride, ground water, hydration, methemoglobinemia, natural rain, nitrates, organic matter, ozonization, pH, pollutants, pollution, potable, reverse osmosis, river, seawater, Secchi disk, sewage, surface water, turbidity, ultra violet radiation, watershed/drainage basin, water treatment, water quality. Discuss definitions with the whole class prior to beginning the experiment. **3.** Review safety procedures, cooperative learning criteria and group presentation criteria before starting the learning task. **4.** Within their groups, students will assign a role of recorder, material organizer, scientist, clarifier, observer etc. Teachers can decide which roles to assign to groups, or students can have the choice of several roles. **5.** Each group will begin at a different water investigation station and will spend approximately 15 minutes completing the learning task. **6.** Explain each activity to the class prior to them beginning the centres. **Station #1 – Water Chemistry Activity-pH Testing and Water Quality Guidelines** In this activity, students will perform a pH test on various samples, including the three water samples from	**60 minutes** 15 minutes	**Observations:** Observation notes will be made during discussion. **Anecdotal Record** **Peer/Self Assessment** **Rubric** **Science Learning Log/Journal**	**a)** What is the pH of test substance # 1 (lemon

Siena Island. As well, they will analyse other water quality factors, such as bacteria count, nitrate levels, and fluoride levels related to the **Guidelines for Canadian Drinking Water (BLM 1.2.e).** **Prior Knowledge and Skills:** • Students know what an acid and a base are. • Students know what the term pH means. • Students can follow a step-by-step procedure. **What to do:** **1.** Each group is given six strips of orange pH paper (1-14) and three strips of green pH paper (4.5-8.5) to analyze the test substances. **2.** They take one strip of pH paper (1-14) and place one drop of test substance #1 (lemon juice) on the end of the strip of pH paper. **3.** They compare the new colour of the pH paper to the **Wide Range Colour Scale (BLM 1.2.c)** and decide the pH of the test substance. **4.** They tape and label their test strip with the name of the substance and its pH to their worksheet **(BLM 1.2.b)**. **5.** Students repeat this process for the other five test substances (test substance #2 = washing soda, test substance # 3 = distilled water, test substance # 4 = Pine Lake, test substance # 5 = Tulip River, test substance #6 = Cedar Bog). **6.** In Part B of the learning task, students further analyze the three water samples by taking a more accurate reading of the pH measure. **7.** They take one strip of green pH paper and place one drop of test substance #4 (Pine Lake) on the end of the pH paper. **8.** They compare the new colour of pH paper to the **Narrow Range Colour Scale** (**BLM 1.2.d**) and decide the pH of the test substance. **9.** Students repeat this process for test substance #5 (Tulip River) and test substance #6 (Cedar Bog). **10.** Have each group use the **Guidelines for Canadian Drinking Water (BLM 1.2.e)** to analyze the three water samples for bacteria, nitrates and fluoride levels. **11.** From the guidelines, students then read information about the sources of these potential pollutants, their effects on humans and the acceptable levels of these factors. **12.** First, they rank the water samples in terms of the total number of coliform bacteria. On their worksheet **(BLM 1.2.b)** students circle the number that best describes the quality of the water sample. One indicates the best water quality, two indicates average water quality and three indicates poor water quality. **13.** Next, using the same method above, they rank the water sample in terms of nitrate levels and fluoride levels.			juice)? **b)** What is the pH of test substance #2 (washing soda)? **c)** What is the pH of test substance #3 (distilled water)? **d)** What is the pH of test substance #4 (Pine Lake)? **e)** What is the pH of test substance #5 (Tulip River)? **f)** What is the pH of test substance #6 (Cedar Bog)? **g)** Why did you use the Narrow Range Colour Scale when analyzing the three water samples? **h)** Which test substances are acidic? **i)** Which test substances are alkaline? **j)** Which test substances are neutral?
Station #2 – Erosion and Deposition Analysis In this activity, students will analyze how water travels through a water system and the effects that erosion and deposition have on it. **Prior Knowledge and Skills:** • Students know the difference between erosion and deposition.	15 minutes		**a)** What is a watershed? **b)** Where is the watershed on the island? **c)** What is it called when moving water picks up pieces of the land?

• Students can compare and contrast a number of items **What to do:** **1.** Students look at the three different types of rivers (Canyon River, Meandering River and Cut-Off River) found on the **Erosion and Deposition Task Card # 2 (BLM 1.3.c)** to compare and contrast the shape of each of them. **2.** On their worksheet **(BLM 1.2.b)**, students identify and draw an “X” where the erosion points are found along the three different rivers and they draw an “O” where the deposition points are found. **3.** Students then discuss with their group and draw what they think will happen to the shape of the third river (Cut-Off River). **4.** They then look at Tulip River on their **Map of Siena Island (BLM 1.1.a)** and mark the erosion and deposition points the same way that they have above. **Station #3 – Turbidity Analysis?** In this activity, students analyze the three water bodies found on Siena Island to determine their turbidity levels. **Prior Knowledge and Skills:** • Students know what turbidity means. • Students recognize that erosion and deposition effect turbidity levels. **What to do:** **1.** Students measure the turbidity of the three water samples found on the island. **2.** Prior to beginning the learning task, students should stir each sample well. **3.** They then slowly lower the Secchi disk into the Tulip Lake water sample until they can no longer see it while looking straight into the water. **4.** When they can no longer see the Secchi disk, students pinch the string at the surface of the water. Keeping their fingers pinched, they pull the Secchi disk out of the water. **5.** Next, students measure the length of the string between the Secchi disk and their fingers, recording this data onto their Student Worksheet **(BLM 1.2.b)**. **6.** Students repeat this process for the other two water samples (Pine Lake and Cedar Bog). **Note Teachers:** Have extra Secchi disks ready because they may break. As an additional learning task, have students make their own Secchi disks for the turbidity test. **Station #4 – Filtration** In this activity, students experiment with various filter materials, to decide which would make the water more potable. **Prior Knowledge and Skills:** Students need to know what a filter is. Students need to know how to use and read a measuring cup.	15 minutes 15 minutes		**d)** What is it called when water lets things go and they settle out? **e)** What type of flowing water will erode the land surface? **f)** What type of flowing water will cause deposition? **g)** Where were the erosion points on the Canyon River? Meandering River? Cut-Off River **h)** Where were the deposition points on the Canyon River? Meandering River? Cut-Off River? **i)** What will happen to the shape of the third river (Cut-Off River)? **i)** Where were the erosion and deposition points on Tulip River? **a)** What is turbidity? **b)** Which sample is most turbid? **c)** Which sample is least turbid? **d)** What is the relationship between the length of Secchi disk and turbidity

What to do:			
What to do: **1.** Students will filter out water from the island to remove some of the debris and living organisms that are naturally present. Their task is to make the water on the island suitable for drinking by building a complex filter. Using materials found on the island, each group will analyze each of the filter materials and decide how they would order them to make the best possible filter. **2.** Prior to beginning this learning task, students stir the filtration water sample well. **3.** They then measure out a 50 mL sample from the water and pour it slowly through one of the filters (small gravel). **4.** Students repeat this process with the other filters (cotton balls, filter paper and sand). **5.** On their worksheet, students rank the filter material so that they can build a more complex filter that will remove the most debris from the water. **6.** Students tidy up area and complete their worksheet as a group. **7.** Prepare for group presentations and recommendations.			level? **a)** Why we filter our water? **b)** What is a filter? **c)** Which material worked well at filtering the large debris? **d)** Which filter removed only the small items? **e)** Which filter removed most of the debris? **f)** Which order did you rank the filter materials?
C) Culminating Activity (Wrap Up Activity): Group Presentations and Group Discussion	**Time**	**Assessment Techniques**	**Key Questions**
1. Have students sit at their desks for the wrap up discussion. Each group will be given 5-10 minutes to discuss their results and recommendations. **2.** Compile results in a whole class chart and discuss the water quality of Siena Island. Depending on their findings, have students make suggestions on how to make the water more potable, listing the processes (filtration, desalinization, water treatment, etc) that are most viable for the Island. **3.** Students glue data sheet into science learning log/journal. **4.** Review the importance of water and discuss sustainable practices that can be incorporated into daily living, to reduce the human impact on water resources.	**40 minutes**	**Anecdotal Record** **Rubric** **Checklists for Group Presentation** **Peer/Self Assessment**	

Notes to Teacher:

Vocabulary Definitions:

- **Acid/acidic--**A substance that has a pH of less than 7.0, such as lemon juice or vinegar. It has a high number of H^+ ions.
- **Acidity**--The strength (concentration of hydrogen H^+ ions) of an acidic substance; measured as pH.
- **Acid rain--**Rain with a pH of less than 5.6, resulting from atmospheric moisture mixing with sulphur and nitrogen oxides ($S0_2$ and NO_x) emitted from burning fossil fuels or volcanic activity.
- **Algal bloom**--A heavy growth of algae in and on a body of water. It usually is caused by high nitrate and phosphate concentrations entering water bodies from fertilizers and detergents.
- **Alkalinity**--The amount of all the bases in the water. It is the ability of water to neutralize acids.

- **Base/base--**A substance that has a pH of greater than 7.0 (e.g. soap or milk of magnesia). It has a high number of OH^- ions.
- **Bioremediation--**The use of oil-eating organisms (petrophiles), such as bacteria and fungi, to remove pollutants in the water. These petrophiles require oxygen, oil and nutrients to survive and grow in large quantities. The growth of these micro-organisms is stimulated when high concentrations of nitrogen and phosphorus are added to the water, promoting the process of bioremediation.
- **Bog**--A type of wetland that is soft, spongy and has naturally waterlogged and acidic ground. It is usually composed of sphagnum moss, peat, shrubs, herbs and sometimes trees
- **Chlorination**--Awater treatment process where a small amount of chlorine is added to water to disinfect it.
- **Contamination--**The introduction of microorganisms, chemicals, toxic substances and waste into water, air and soil.
- **Coliforms--** Bacteria that come from dead, decaying organic matter, which are used as an indicator of fecal contamination in water.
- **Corrosion**--A chemical reaction between a metal and the gases in the air.
- **Dehydration**--A dangerous lack of water in the body resulting from inadequate intake of fluids.
- **Deionized water**--Water that has the anions and cations removed by an ion exchange process. Generally, deionized water is used in laboratories for making reagents. It is more economical to produce than distilled water.
- **Deposition**--The process where materials from fluids settle because they are too heavy, or the flow of the fluid is too slow to keep them elevated.
- **Distilled water--**Water that has the salts removed by distillation. The water has been purified, but d still contains some dissolved gases.
- **Distillation--**The process of heating a liquid or solid until it sends off a gas or vapour and then cooling the gas or vapour until it becomes a liquid.
- **Erosion**--Wearing away of land surface by wind, ice, and/or water. Fast water flow will erode the land around and underneath the water.
- **Fecal matter**--Waste matter discharged from an animal's body.
- **Fertilizer run-off**--Chemicals (nitrogen-rich compounds) used to promote the growth of crops by farmers make their way into rivers, lakes and oceans. Fertilizers create blooms of algae that deplete oxygen and leave large areas of dead zones in the water systems.
- **Filtration--**A treatment process for removing solid particles from water by means of a porous media such as sand or a man-made filter.
- **Fluoride**--A binary compound of fluorine with another element. It is added to some drinking water to help prevent tooth decay, although it is found naturally in waters.
- **Groundwater--**Water that infiltrates into the Earth and is stored in usable amounts in the soil and rock below the Earth's surface. Most groundwater comes from precipitation, which percolates into the Earth.
- **Hydration--**Replenishing of body fluids..
- **Methemoglobinemia--**A condition called blue baby syndrome, resulting in bluish skin discoloration in infants. Methemoglobinemia is caused by ingesting water that is contaminated with nitrate in which the blood's capacity for oxygen transport is reduced.
- **Natural rain--**Rain without any pollution and with a pH of 5.6 to 5.8.
- **Nitrates--**Materials containing NO_3, an ion made of nitrogen and oxygen. Nitrates are the most water soluble of all salts. Sources include animal wastes and some fertilizers.
- **Organic matter--**Mainly composed of decaying plants and animals. Also includes living organisms.
- **Ozonization**–A water treatment process where ozone is used to remove iron, manganese and sulphur without having to add chemicals. This process helps destroy bacteria and other microorganisms in drinking water.
- **pH--**A measure of the concentration of hydrogen ions in a solution. The pH scale ranges from 0 to 14, where 7 is neutral and values less than 7 are acidic and values greater than 7 are alkaline or basic in nature.
- **Pollutants--**Waste matter that contaminates the water, air or soil.
- **Pollution**--The introduction of contaminants into an environment that causes instability, physical harm and discomfort to a system.
- **Potable--**Water that meets Health Canada standards and is thus suitable for drinking.
- **Reverse osmosis**–A water treatment process where water pressure is used to force water molecules through a membrane that has extremely tiny pores, leaving the larger contaminants behind.
- **River**--A large natural waterway, emptying into an ocean, a lake or another river.

- **Seawater--**The salt water in or coming from the sea or ocean.
- **Secchi disk--**An instrument used to measure water clarity, usually in deep bodies of water, in bodies such as lakes or ponds.
- **Sewage**--Waste matter that is carried away in sewers or drains.
- **Surface water--**Precipitation that does not seep into the ground or return to the atmosphere by evaporation or transpiration. It is stored in streams, lakes, rivers, ponds, wetlands, oceans and reservoirs.
- **Turbidity--**Lack of clarity (cloudiness) in the water from having the sediment or foreign particles stirred or disturbed. It is the measure of suspended particles in a water sample.
- **Ultraviolet radiation**--Water treatment process where water is exposed to ultraviolet (UV) light, which effectively destroys bacteria and viruses.
- **Watershed/drainage basin--**An area that drains all surface run-off and groundwater into a river or stream system that eventually has the same outlet (e.g.a lake or the ocean).
- **Water treatment--**Process of purifying the quality of water to make it suitable for drinking or for any other use.
- **Water Quality--**The characteristics of water (microbial, biological, chemical and physical aspects) in relation to guideline criteria of what is suitable for human consumption.

Water Chemistry Activity-pH Testing and Water Quality Guidelines

a) pH and Bodies of Water:

A body of water that has a pH between 6.7 and 8.6 can support a well-balanced fish population. However, many species can tolerate pH levels lower than 6.7, but only for a limited time. In general, if the pH of water is not between the above range, various plants and algae also become affected, resulting in slower nutrient uptake.

Many factors can affect the pH of water. For example, if the area experiences acid rain and there is limestone or dolomite bedrock, it will create a more alkaline lake. In addition, industrial acid spills, smelters and coal burning power plants affect the pH by emitting sulphur dioxide into the air, which creates sulphuric acid into the atmosphere. The release of sewage into water systems usually raises pH levels, but the decay of it, by bacteria, also produces ammonia which is a base and by-product of this process.

a) pH and Drinking Water:

The pH of drinking water is normally between 6.5 and 8.5. The main purpose of controlling pH is to produce water in which corrosion and incrustation are minimized. Metal corrosion generally occurs when the pH is less than 6.5 and incrustation results when the pH is above 8.5. Both of these processes are impacted when dissolved solids and gases, hardness, alkalinity and temperature interact with pH levels.

The following table are examples of pH levels of various common substances:

pH Level	Common Substance
2.2 – 2.4	Lemon
2.4 – 3.4	Vinegar
2.5 - 3.5	Soft drinks
3.0 – 4.0	Oranges
4.0 – 4.4	Tomatoes
6.3 – 6.6	Cow’s milk
6.4 – 6.9 6.6 – 7.6	Human saliva (during rest) Human milk
6.5 – 8.0	Drinking water

7.0 – 7.3	Human saliva (while eating)
7.3 – 7.5	Human blood
7.6 – 8.0	Fresh eggs
7.8 – 8.3	Seawater
10.5	Milk of magnesia
10.5 – 11.9	Household ammonia

a) **Coliforms:**

Coliforms are bacteria that live in plants, soil or in the large intestines of many animals, including humans. Fecal coliforms that are found in animals have a symbiotic relationship with them. The animal provides water, food and other necessities to the bacteria, while the bacteria helps the animal make nutrients (vitamins). Eighty to 95 percent of the coliforms that leave the human body in dry feces are of the species *Escherichia coli*, or *E. coli*. In heavily populated areas, fecal coliforms are used as indicators of fecal contamination in the water.

a) **Fluoride:**

Fluoride is naturally present in water, but is increased by human use and waste. High concentrations can cause spotting on children's teeth and palatability may be affected. Most urban drinking water in Canada contains fluoride in small amounts to help prevent tooth decay.

a) **Nitrates:**

Nitrogen is found in all living things as ammonia or nitrate. It can be harmful to wildlife and humans, especially to infants if there are excessive amounts in the environment. Infants are the most susceptible to obtaining methemoglobinemia (Blue Baby Syndrome) from high concentrations of nitrogen in the drinking water. As well, if a water source, such as a lake or river, has too much nitrogen then an algal bloom could result which in turn, could be detrimental to the ecology of that water source.

Turbidity Activity:

a) **Turbidity:**

There are several ways that turbidity can be measured. The most common method to measure turbidity in drinking water is by using an instrument called a Nephelometer, which measures in NTU. However, in deep water a Secchi disk is usually used. A measurement, normally in meters, is taken of the depth of water in which the Secchi disk disappears from sight. Despite the simplicity of this instrument, it provides very reliable and repeatable data. There is no easy way to convert between Secchi depth and NTU. In theory these numbers are inversely related. That is, the larger the Secchi depth the less turbid the water and therefore the smaller the NTU.

In North America the turbidity of surface water ranges from one NTU to less than 100 NTU. In Canada, a large part of how we manage turbidity levels in our drinking water varies depending on the location of the watershed. For example, Ontario, who draws most of its water from lakes or rivers which are also being used for transportation and/or recreation, uses intensive filtration and various disinfection methods. On the other hand, British Columbia draws most of its water from watersheds that are not impacted by human activity, making the water naturally cleaner. During times of high run off, which tends to cause higher turbidity levels, certain watersheds are not used.Only watersheds with less suspended solids are used.

Erosion and Deposition Activity:

a) **Watersheds/Drainage Basins:**

The terms watershed and drainage basin are interchangeable. Either is an area that collects all surface run-off and groundwater and allows it to drain to a body of water such as a lake or ocean. These areas are defined by divides, usually ridges of some kind, in which water flows in the opposite direction on the other side. As the water runs down the terrain of the watershed, it collects different materials and carries them to a different location. This process is called ***erosion*.** When erosion occurs, it makes the water more turbid. This means that there is more material being held in the water, decreasing the water quality for drinking and many other things. On the other hand, when water flow is slower, solid particles begin to settle out, causing deposition to occur. Both erosion and deposition processes change the landscape, creating valleys and flood plains.

Most running water meanders, which means it simply follows the curve in the river. This “S” shape pattern illustrates the normal progression of a river and often is the cause of any changes to the landscape.

Normally, the outside curve of a meandering river has faster running water, causing erosion to occur on this side. Sometimes the water will cut the river bank, creating what is known as a “cut bank”.

The inside curve of a meander will have a slower water flow, which allows materials to settle out or deposit, creating a “slip-off slope”. As a result of both these processes, an older river will often cut itself off creating an oxbow lake.

Filtration Activity:

A Water Treatment Process

a) **Filtration: Toronto**--The city of Toronto draws all of its drinking water from Lake Ontario, where there are approximately four water treatment plants to service this water. The water intakes are approximately one to three kilomteres offshore and up to 10 metres below the surface. Prior to entering the treatment plant, water is passed through moving screens to remove large debris. When the water enters the plant it then undergoes five stages of treatment:

1. ***Coagulation, flocculation and sedimentation***--Chemicals used in this stage include aluminum sulphate, polyaluminium chloride and other polyelectrolytes.
2. ***Filtration***--Water flows by gravity through dual media filters made of sand and anthracite (coal-like mineral).
3. ***Disinfection***--Chlorine is added to the raw and treated water to kill disease-causing organisms. Sulphur dioxide is then added to remove residual chlorine in order to bring chlorine levels to acceptable standards for ammoniation.
4. ***Fluoridation***--Fluoride is then added to the water to raise the level to 1.2 mg/L in order to help combat tooth decay. The fluorine actually replaces the calcium in the enamel of teeth making them less susceptible to decay.
5. ***Ammoniation***--At the end of the treatment process ammonia is added to any residual chlorine to stabilize the chlorine so that it can remain dissolved in the water for longer periods of time.

a) **Reverse Osmosis (RO):** The process of RO can significantly reduce salt, most inorganic material and some organic compounds found in drinking water. Many parasites (including viruses) are removed by this high water pressure treatment. The disadvantages to this process include large quantities of waste water being flushed down the drain for the production of filtered water; some pesticides, solvents and other volatile organic chemicals are not completely removed; and the filter’s membrane is extremely sensitive, thus affecting the efficiency in reducing the amount of contaminants in the water.

b) **Ultraviolet Light:** The advantages of using UV light for water treatment are the following: a) no toxic or non-toxic by-products are introduced; b) leaves no smell or taste in the treated water; c) many pathogenic microorganisms are killed in the process; d) does not affect the minerals in the water; and e) the process requires very little contact time to treat the water.

c) Ozonation: Ozone is a disinfectant that effectively kills biological contaminants and helps to filter iron, sulphur and manganese out of drinking water. The process of ozonation produces no taste or odour in the water and eventually vanishes once it has been used. Unfortunately, ozone treatment can create by-products such as formaldehyde and bromate. As well, ozone is not effective at removing dissolved minerals and salts.

Answers to Learning Activities:

Water Samples	Physical Properties	Water Chemistry			
	Turbidity	PH	Bacteria	Nitrates	Fluoride
Pine Lake	**2**	**1**	**3**	**1**	**1**
Tulip River	**1**	**2**	**1**	**2**	**2**
Cedar Bog	**3**	**3**	**2**	**3**	**3**

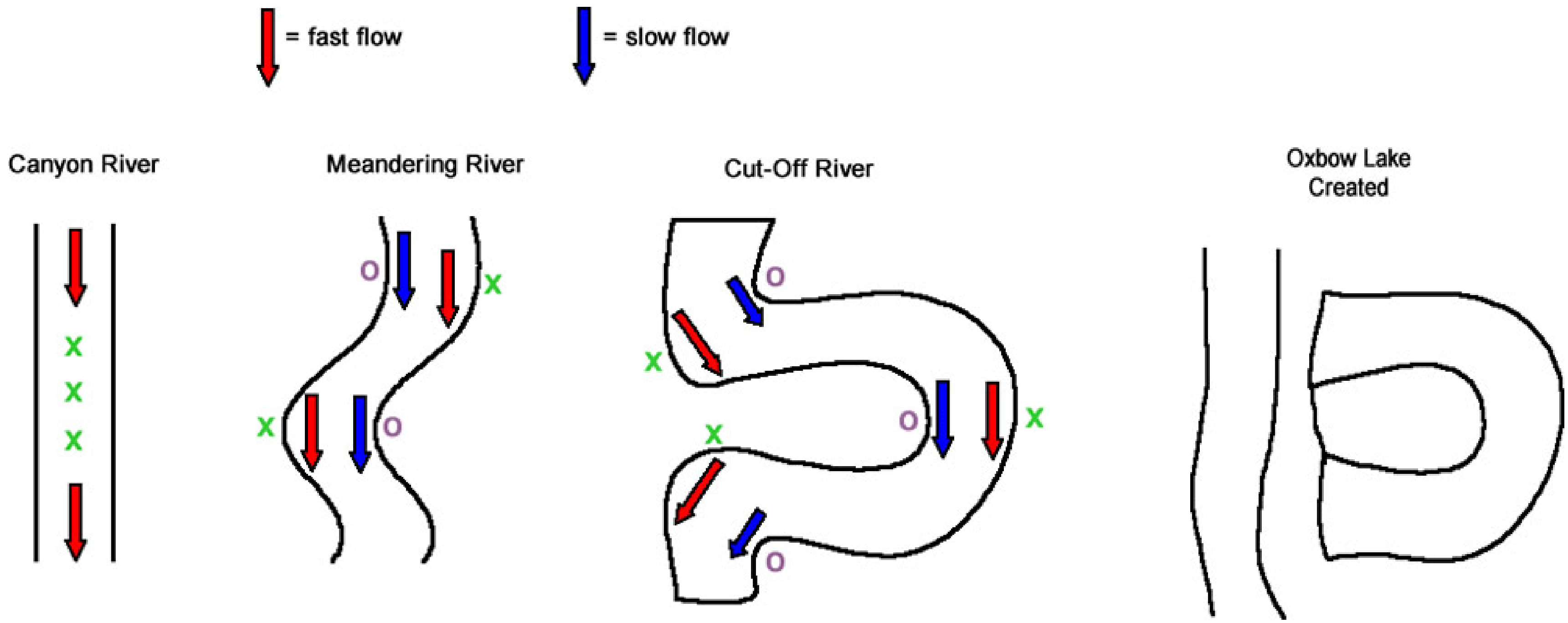
Water Chemistry Activity-pH Testing and Water Quality Guidelines:

The pHs of the test substances are the following:

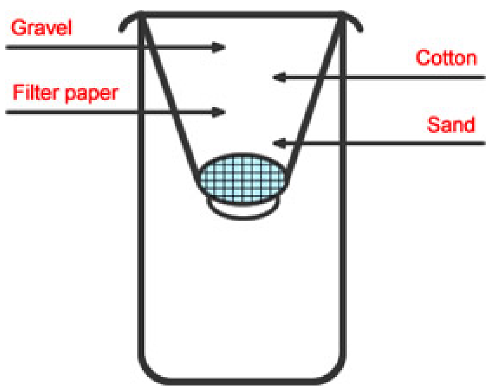
1. Lemon juice: 2 – 3
2. Washing soda: 9 – 10
3. Deionized/distilled water: 6 – 7
4. Pine Lake: 8 - 9
5. Tulip River: 6
6. Cedar Bog: 4-5

Erosion and deposition:

Erosion occurs on the outside of a curve and deposition occurs on the inside. Water tends to pick up speed along the outside of the curves and slingshots to the next curve, thereby producing the “S” shape of meandering rivers.



A complex filter needs to remove large particles first and smaller particles last. A complex filter might look like this: gravel, cotton, filter paper, and sand



Overall Results:
The overall findings from the water chemistry, turbidity, and erosion and deposition analysis conclude that Pine Lake should rank the highest in every category, excluding bacteria. The total coliform bacteria count found in Pine Lake is high and could be extremely dangerous for drinking. On the other hand, Cedar Bog should rank last and therefore would not be suitable for drinking water. Tulip River should be ranked average in all categories.

Adaptations:

All accommodations must take into account the student's Individual Education Plan. All of the learning tasks and activities are created to accommodate the needs of students at different ability levels. The lesson plan includes pictures and/or examples of a step-by-step process, lists, and graphic organizers to enhance learning. The series of pictures are used to break tasks into easier, more understandable steps. Many of the learning activities provide opportunities for peer or group interactions, encouraging the use of cooperative learning/social skills and risk taking. Adaptations can be made in the following manner:

- Alternatives to written tasks (data sheet), such as drawing, pointing to the correct answers, and fill-in-the blanks can be done as well. The use of keypads, word processors and writing software to support the writing task can be utilized.
- For cooperative learning tasks, students can take on a role that they are comfortable doing rather than that of the recorder or presenter.
- Reduction in the length or number of written responses to the Student Worksheet.
- Students should be given extended timelines for task completion if required.
- All materials, equipment and manipulative resources should be labelled with text and visual aids.
- Students can be given exemplars (e.g., sample of a complex filter, indication where erosion and deposition occurs on a river to demonstrate the expectations of the task.).

Teacher Reflections: