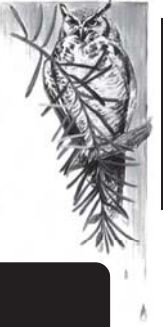# THE CLEAN WATER FACTORY:
## Green infrastructure in Our Watersheds

## KEY CONCEPTS

- SUSTAINABILITY OF WATER RESOURCES REQUIRES CONSERVATION AND BEST MANAGEMENT PRACTICES.
- RESPONSIBILITY FOR WATER IS EVERYONE'S CONCERN.

## METHOD

Students view a demonstration and complete experiments demonstrating the natural filtration processes of forests.

## ACTIVITY INFORMATION BOX:

**TIME REQUIRED:** 60-120 minutes

**GRADE LEVEL:** Grades 8-12

**KEY WORDS:** *infiltration, green infrastructure, erosion, runoff, organic soils, mineral soils, scientific inquiry*

**MATERIALS:**
- sponges or moss
- trays with lip
- 2 litre pop bottles
- scissors
- filter paper, or coffee filters
- water
- "dirty" water – water mixed with mineral soils
- sand, organic soil, gravel
- ring stands
- beakers
- pavement, compacted soils, soils with vegetation (optional)

**SETTING:** indoors

**SKILLS:** Gathering information, hypothesizing, model building, analysis, interpreting, presenting, science process skills

**SUBJECTS:**  Science 8-10
　　　　　　Earth Science 11
　　　　　　Geology 12

## LEARNING OUTCOMES:

**IT IS EXPECTED THAT THE STUDENT WILL:**

- Examine and compare filtration processes of natural systems such as streams, wetlands, and forests;

- Describe the importance of green infrastructure in keeping our water clean.
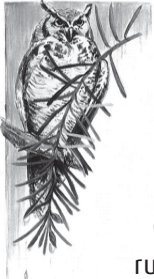
## BACKGROUND

Forests, streams and wetlands can be called a *"clean water factory."* Why? Because they all provide an amazing service to us: clean water. A healthy forest ecosystem will act as a kind of giant filter. Rain falls on the forest floor and slowly soaks (infiltration) through porous organic soils – eventually reaching streams - bringing clean water to lakes like the Sooke Reservoir. Because of the filtering effect in healthy forests, streams commonly run clear even during rain storms.

*"Green infrastructure"* is the term now used to help define ecosystems functions such as cleaning the air, filtering and cooling water, storing and cycling nutrients, conserving and generating soils, pollinating crops and other plants, regulating climate, sequestering carbon, protecting areas against storm and flood damage, and maintaining aquifers and streams. Often infrastructure means things like road, power line, water treatment and distribution systems. These systems provide a service to humans. Likewise, green infrastructure provides a service by filtering and storing water, providing critical habitat, and performing other functions as described. These services are all provided by the existing expanses of forests, wetlands, and other natural lands in the Greater Victoria Water Supply Area.

In contrast, when the green infrastructure is damaged, rain falling on cleared land mostly becomes surface runoff. As water flows over the surface of exposed soils, it picks up fine particles (soil erosion). These particles cause the water to become muddy or to have increased turbidity. Increased turbidity is a major problem as makes it more difficult to treat drinking water (reducing the ability of chlorine to disinfect) as well as harming habitat for fish and other aquatic creatures. The particles can settle out in lakes and streams (sedimentation), smothering existing bottom habitat. Another problem with damaged green infrastructure is that streams in the watershed are much more prone to flooding and storm surges due to a lack of natural infiltration. When the green infrastructure is damaged, we have to pay for constructed infrastructure, such as water treatment plants, dams, retaining walls and other services to clean up or store water. It makes more sense to keep our green infrastructure healthy to begin with, since it is free and self-maintaining.
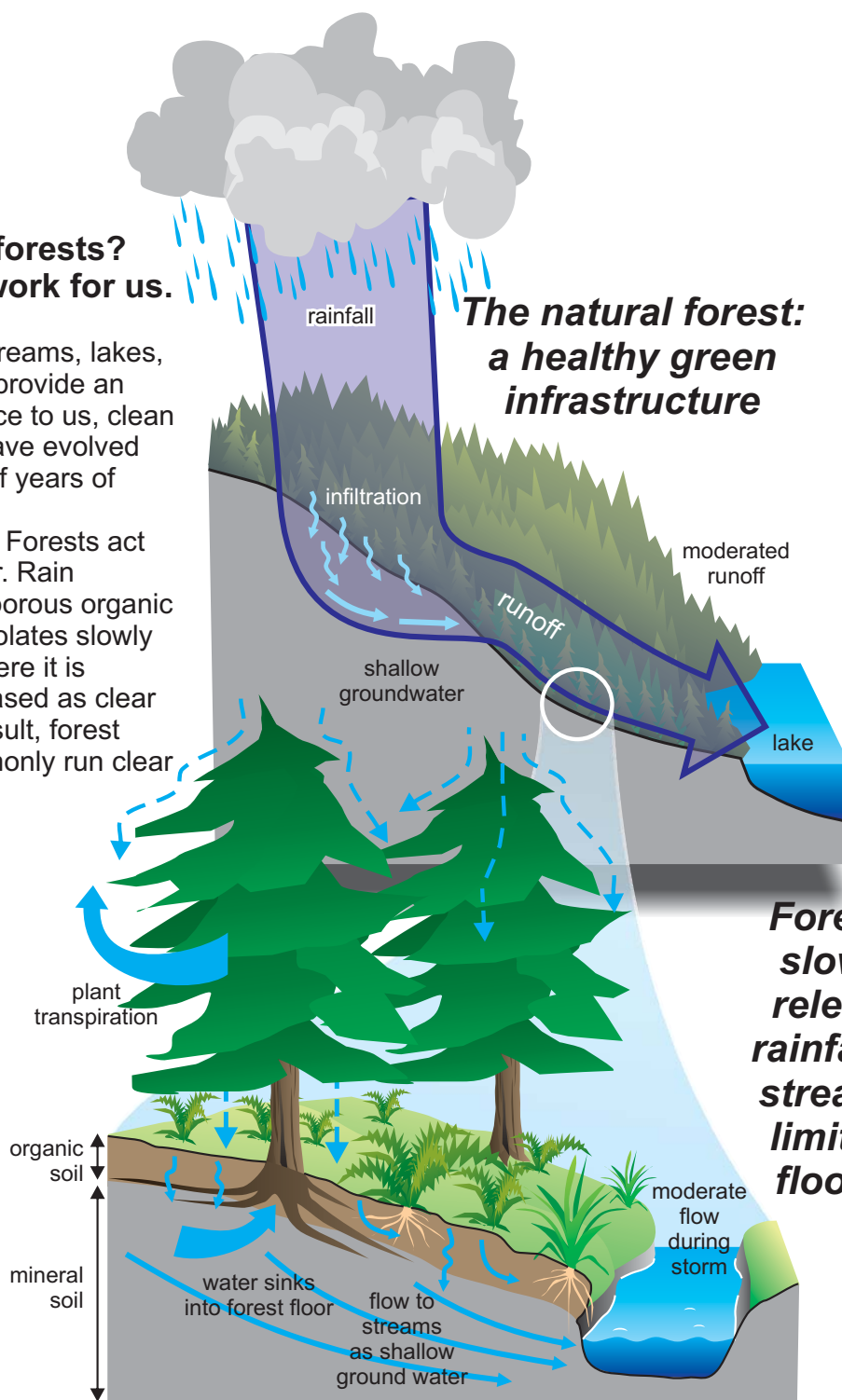
Wetlands also play an important role in maintaining watershed health by acting as a sponge and filter. Wetlands fill with water during rains and slowly release water (holding capacity) through periods without rain. They also filter stream water and offer critical habitat for wildlife.
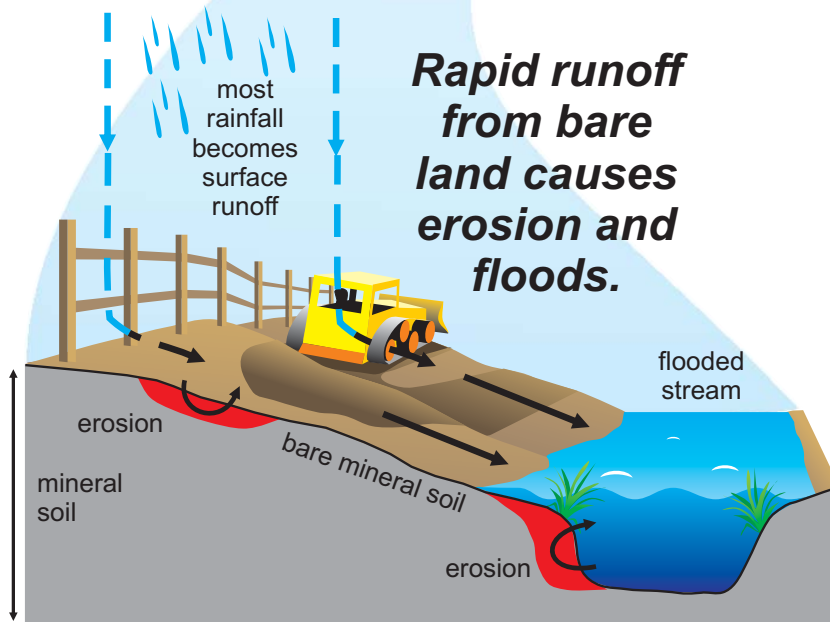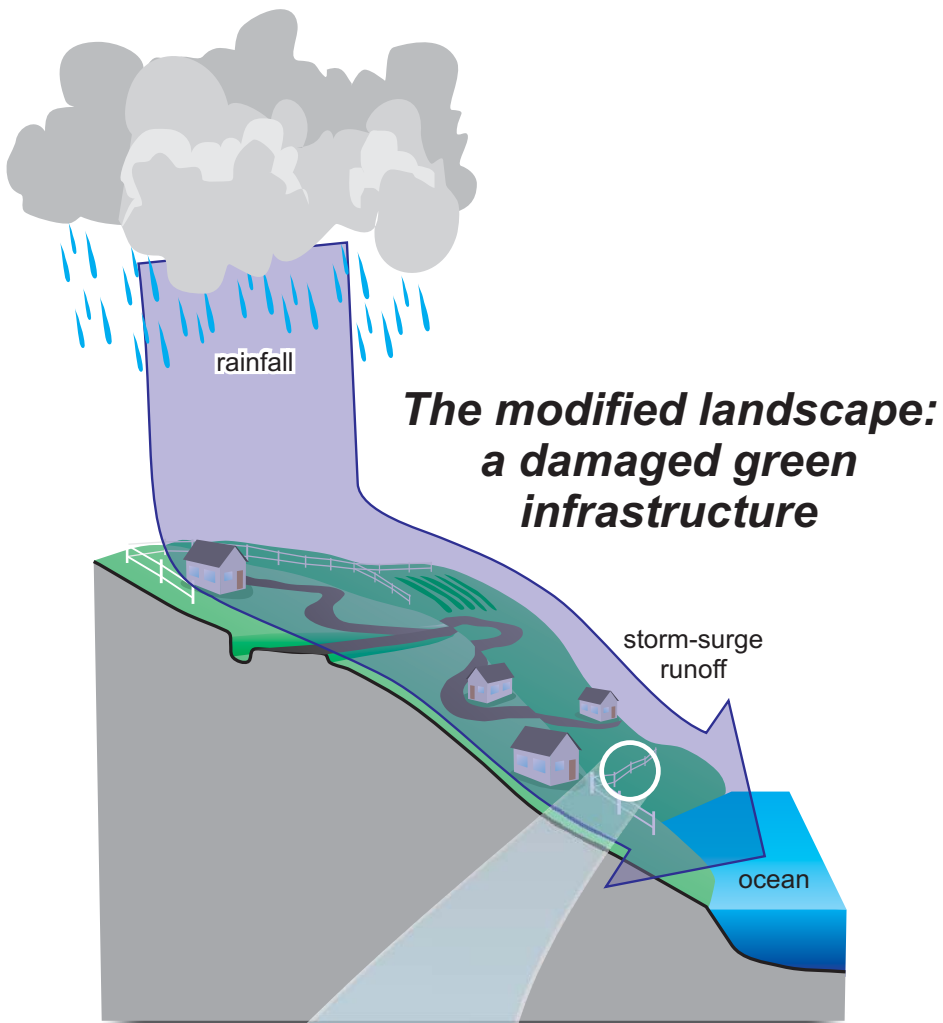
## Hi-tech forests?
## How they work for us.

Our forests, streams, lakes, and wetlands provide an amazing service to us, clean water! They have evolved over millions of years of "research and development". Forests act as a giant filter. Rain infiltrates the porous organic soils and percolates slowly to streams where it is gradually released as clear water. As a result, forest streams commonly run clear

rainfall

*The natural forest: a healthy green infrastructure*

infiltration

moderated runoff

runoff

shallow groundwater

lake

*Forests slowly release rainfall to streams, limiting floods.*

plant transpiration

organic soil

mineral soil

water sinks into forest floor

flow to streams as shallow ground water

moderate flow during storm

*Forests: Most rainfall becomes shallow groundwater*

rainfall

**The modified landscape: a damaged green infrastructure**

storm-surge runoff

ocean

**Rapid runoff from bare land causes erosion and floods.**

most rainfall becomes surface runoff

flooded stream

erosion
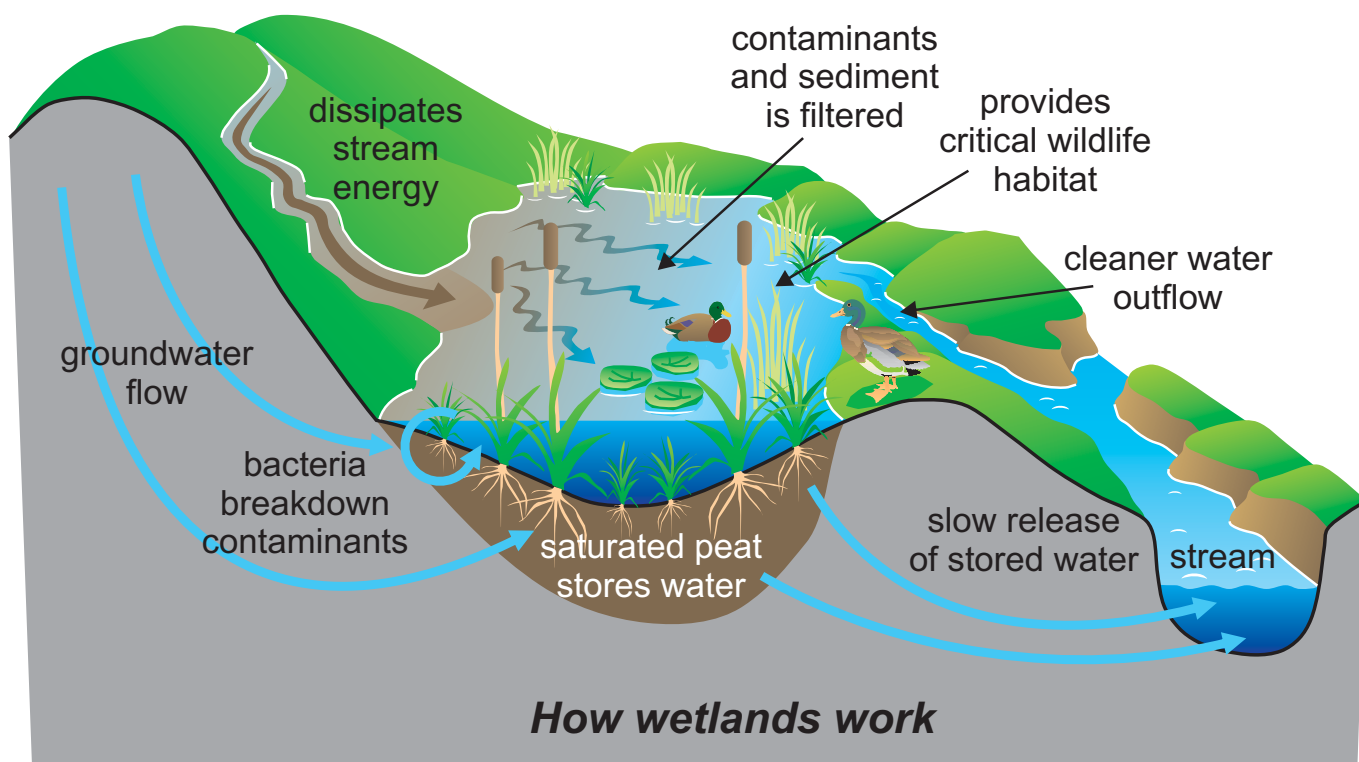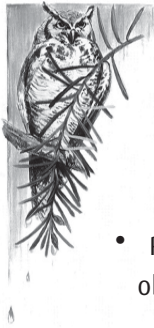
mineral soil

bare mineral soil

erosion

*Cleared Land: Most rainfall becomes surface runoff*

# Wetlands: nature's sponge and filter

Wetlands  swamps, marshes, bogs, and fens  provide many services. They filter stream waters, store water, and offer critical habitat for many plants and animals. Wetlands fill with water during rains and slowly release water through droughts. Before we understood their critical role, we used to ditch and drain wetlands to create lawns, pastures, or farms.

contaminants and sediment is filtered

provides critical wildlife habitat

dissipates stream energy

cleaner water outflow

groundwater flow

bacteria breakdown contaminants

saturated peat stores water

slow release of stored water

stream

*How wetlands work*

## PROCEDURE

1. Set up the following demonstration using a sponge or moss, tray with a lip, and a 250 mL beaker filled with water. Explain that the sponge/moss represents organic soils and wetlands in healthy green infrastructure as they absorb and hold water.

- Place a dry sponge on the tray and pour water slowly over the sponge – soaking it. Have students record their observations. The sponge should soak up most of the water.

**TRY ALSO:**

- Moistened sponge – representing soils with some moisture

- Sponge on a slope – representing soils or a wetland on a hill or sloped terrain

- Vary the rate of pouring the water over the sponge – representing light to heavy rainfall

- Moss – try all of the above with a piece of moss that fits in the tray

2. Explain to students that healthy green infrastructure helps keep our water clean by storing and filtering our water in a similar way as the sponge demonstrated. Introduce the terms "healthy" and "damaged" green infrastructure and describe how wetlands work using the graphics provided (see background).

3. Divide the class into small groups to complete an experiment on how healthy green infrastructure can act as a natural filter to clean water.

4. Provide each group with a 2 litre pop bottle with cap, organic soil, sand, sponge, filter paper, ring stand, and a container with 250 mL of a mixture of soil and water.

5. Students should first cut off the bottom of the bottle (see diagram) and then follow the diagram to place the filter paper, sponge, sand, and organic soil in the bottle – placing the whole unit in a ring stand (leave on bottle cap). A beaker should be placed under the bottle.

6. Have students use the Student Worksheet provided to record observations, hypothesis, predictions, variables, analysis and conclusions as they complete the worksheet.

7. To wrap up, students can present their findings and discuss the importance of natural processes such as infiltration and holding capacity as green infrastructure.


## EVALUATION

Have students:

- Explain how forests, soils, and wetlands act as green infrastructure;

- Describe how a wetland acts as a sponge and a filter;

- Explain the importance of protecting green infrastructure.


## EXTENSIONS:

1. In the demonstration, instead of a sponge on a tray, put different media such as compacted soils, pavement, soils with plant cover such as grass or moss, or frozen soils on the tray. Do the demonstration again with increased/decreased slope, differing rates of "rainfall" intensity, etc.

2. Have students run the experiment again, this time using water that is cleaner or more dirty than the original sample. Record their observations.

## COMMUNITY CONNECTIONS

Discuss that would happen if we logged or developed our water supply watersheds. What impact would these activities have on our other infrastructure such as water treatment and distribution? How would they affect conservation of our water supply? For further information on local watersheds go to;
**http://www.crd.bc.ca/watersheds/protection**

## ADDITIONAL RESOURCES

*BC Science 8.* 2006. See section on Science Skills – Scientific Inquiry (pages 476-479)

## REFERENCES

*Waterscapes Posters* from Natural Resources Canada from: **http://geoscape.nrcan.gc.ca**

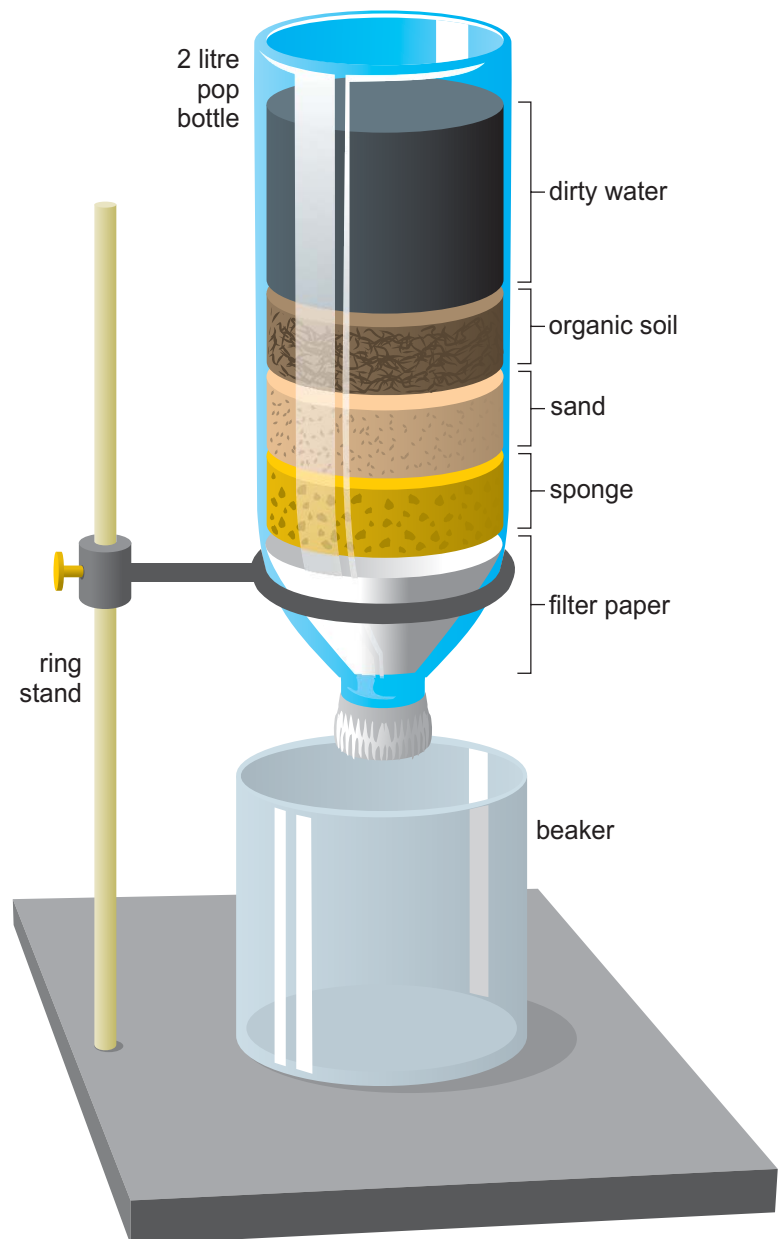## CLEAN WATER FACTORY EXPERIMENT ASSIGNMENT INSTRUCTION:

### AIM:

To demonstrate that healthy green infrastructure helps keep our water clean by storing and filtering our water.

### MATERIALS:

pop bottle with lid, scissors, ring stand, beaker, water, sponge, filter paper, sand, organic soils.

### PROCEDURE:

1.  Cut off the bottom of the bottle, turn upside down and then following the diagram: place the filter paper, sponge, sand, and organic soil in the bottle – placing the whole unit in a ring stand (leave bottle cap on).

    A beaker should be placed under the bottle.

2.  Observe the water sample provided: note water colour, smell, and any other features. Record your observations.

3.  State a hypothesis and make a prediction about what you might expect to observe when you pour the dirty water through the pop bottle filter.

4.  Remove the bottle cap and slowly pour the dirty water into the filter, observing the water that comes out of the bottom of the filter. Record your observations, noting any changes in water characteristics.

5.  Fill remainder of worksheet.

2 litre
pop
bottle

dirty water

organic soil

sand

sponge

filter paper

ring
stand

beaker

## CLEAN WATER FACTORY EXPERIMENT: DATA SHEET

### PRE-FILTER WATER SAMPLE:

COLOUR:

SMELL:

OTHER:

HYPOTHESIS:

PREDICTION:

### POST-FILTER WATER SAMPLE:

COLOUR:

SMELL:

OTHER:

EXPERIMENT VARIABLES:

### ANALYSIS AND CONCLUSIONS: