Into the Watershed DVD
Ancillary Materials

The following lessons were designed to be used with the "*Into the Watershed*" DVD; however, the lessons can be used independently of the DVD if wished. The lessons were designed by Hope College students participating in the summer of 2007 science research program. Educators have permission to reproduce and distribute these materials for classroom use. Please see below for a brief description of all three lessons with the materials for the lessons further down.

Anticipatory Set:
Description: For the introduction to the lesson, introduce the DVD and explain to the students what they will be doing and investigating. Students will work in groups of 3-4 to learn about water quality of the Lake Macatawa watershed area. They will run three tests on four different samples of water, it is best to always contain a control sample to compare the results. The samples will be labeled A, B, C, and D in the beginning; at the end, the students will find out which sample is which.

Lab Exercise:
Description: In this lab exercise, students will explore the impact of pollution in seemingly random water samples. The samples are labeled from where they came from or their chemical concentration. With a set color scheme, which can be created using blue food coloring in various concentrations, the students use a reagent solution that reacts with any phosphorus in the water to compare their test samples and gage the contamination. The reagent solution turns the water a shade of blue depending on the phosphorus concentration, thus is why a color scheme of blue food coloring is used. The phosphorus solutions can be prepared ahead of time in various concentrations for students but in nature, phosphorus is added to the environment via multiple anthropogenic sources as well as through natural occurrences: agriculture, fertilizers for lawn care, washing one's car in the drive way, etc.

Assessment:
Description: Research has proven that the best way for students to retain knowledge is to provide concrete experiences for them. For this lesson, the assessment is rather informal but hands-on thus creating an experience that engages all students. The students are provided a handout that contains helpful instructions on how to stencil storm drains around the watershed area. The handout also provides many helpful tips on how to do the job well. Before the active assessment period, the students each receive a responsibility (a job) they'll switch with other members of their group. This allows students to focus during the activity as well as allows them to create ownership of their work. The teacher/chaperone is equipped with helpful questions that encourage the students to apply the information they learned from the video and the previous activities.

Anticipatory Set - Introduction

Notes:
- Underlined means teacher does this.
- Words in brackets are the answers to questions posed to the students.

Summary: Students will work in groups of 3-4 to learn about water quality. They will run three tests on four different samples of water. The samples will be labeled A, B, C, and D in the beginning; at the end, the students will find out which sample is which.

Intro:

Today, we're going to talk about water quality; we're going to look at the things that are in water.

Q: Have you ever thought about what might be in the water you drink? What is in the water that you swim in?

→ Write ideas on the board. [chlorine, sodium, …]

We can't test for these things specifically today, but we can get an idea of how much stuff is dissolved in the water. To do that, we will run some tests on water from our area.

The students will work in groups of 3 or 4 students

Bring out the water…

- There are four samples of water here, labeled A, B, C, and D. Each one is from a different place.

    1) Lake Macatawa
    2) Tap water from the Science Center
    3) Water from the river by Windmill Island and
    4) Mystery water (purified water)

Your job is to test these and try to figure out where each one comes from.

- You will run three tests on each of these.

    1) pH- Who knows what pH is? [it measures how acidic or basic a solution is on a 0-14 scale] What is the pH of an acidic solution? [<7] [Familiar acids include vinegar, citric acid, and stomach acid] What is the pH of a basic solution? [>7] [Familiar bases include baking soda, ammonia, and soap] How acidic is the water? [samples will vary, but water from ponds and lakes should be slightly basic]

2) Conductivity test- How well does it conduct electricity? Or, how easy is it to get electricity to flow through that water? We are going to use the conductivity of the samples to tell how many ions are dissolved in the water. Water with lots of ions dissolved in it will conduct electricity very well while purified water is actually a very poor conductor. Which of the samples do you think will have the lowest conductivity? [purified water]
3) Silver Nitrate- When added to a solution containing chlorine, silver nitrate will react and form the white solid, silver chloride. Add 3 drops of silver nitrate and if you see a solid, that means there is chlorine in the water. demonstrate

Teacher will have groups of students take water from the four samples. The samples will be unknown. Label them A, B, C, D.

Wrap up:

After the exercise

Raise your hand if you think A is from Lake Macatawa…

- chart on board in front of classroom
- record the number of students who vote for each option

	A	B	C	D
Lake Macatawa				
River				
Drinking Fountain				
Purified water				

Ask for student input on why they think samples are from certain areas [high conductivity, formation of silver chloride, color can all be used to identify samples]
Tell which sample is which.

- Was conductivity high for the sample from Lake Mac? [YES] What does this mean? [The water has a high concentration of dissolved ions. List several possible ions and state that phosphorous is of particular interest.]

Show DVD *Into the Watershed* about Lake Macatawa and water quality. This DVD is going to go into a little more depth about the watershed and how things like phosphorus, get into the lake.

Materials:

- water samples
- pH paper
- conductivity meters
- $AgNO_3$ (1 Bottle of solution per group)
- black construction paper (to better see the formation of silver chloride)
- 100 mL beakers (4 for each group)
- wash bottles w/ RO water (1 per group)
- 50 mL beakers (to contain water used to wash conductivity meters)
- video

Group Member Names:

_____

_____

Describe what happens when you run each test:

1) Dip the pH strip into the samples. Let it sit for 3 seconds, and compare to strip on bottle.

2) Be careful with the conductivity equipment. Put probe into sample until the reading stabilizes. Rinse the probe with purified water between samples.

3) Add 3 or 4 drops of silver nitrate $AgNO_3$ to each solution and watch for the formation of a solid.

	pH	conductivity	precipitate
A			
B			
C			
D			

- ❖ Where do you think each sample comes from? Why?

sample A _____

sample B _____

sample C _____

sample D _____

Lab Exercise
Phosphorus Test Procedure

Making the Combined Reagent Solution

1) Take 70 mL of concentrated Sulfuric acid (H_2SO_4) and add to 430 mL of water. *CAUTION*: This dilution is very exothermic. Please handle with care as the beaker will become very hot.

NOTE: Concentrated Sulfuric acid is a very corrosive and dangerous chemical. When handling, be sure to take all necessary precautions. Also, add the acid to the water. NEVER add water to acid. If any of this acid is spilled while making the solution, neutralize immediately with base. When disposing of excess acid, neutralize first with base. DO NOT POUR ACID DOWN THE SINK.

2) Weigh out 1.3715 g of Potassium Antimony Tartrate and dissolve in 500 mL of water.
3) Weigh out 20 g of Ammonium Molybdate and dissolve in 500 mL of water.
4) Weigh out 5.28 g of Ascorbic Acid and dissolve in 300 mL of water. This solution should be clear or urine colored.
5) **MIX TOGETHER** 500 mL of the H_2SO_4 solution, 50 mL of the Potassium Antimony Tartrate solution, 150 mL of the Ammonium Molybdate solution, and 300 mL of the Ascorbic Acid solution, giving you 1,000 mL of combined reagent solution.

The Combined Reagent solution will last for one week and should be refrigerated when not in use.

Running the Phosphate Analysis

1) Measure out 50 mL of your sample into a 125 mL flask.
2) Add one drop of phenolphthalein indicator to your sample and swirl to mix. If a pink color develops, add hydrolyzing acid drop wise until the color disappears.
3) Using a micropipette, transfer 100.0 μL of the "Spike" solution (50,000 ppb Potassium dihydrogen phosphate) into your flask.
4) Add 8.0 mL of the combined reagent solution. Swirl to mix.
5) Set the solution aside and begin the stopwatch. Let the color develop for 10 to 30 minutes. It is the teacher's choice as to what timeframe to use.

Calibrating the Colorimeter

1) Make sure the calculator, LabPro, and the colorimeter are all connected and powered.
2) Enter the "DataMate" (7) program in the "Apps" menu.
3) Make sure that the word "Absorbance" appears at the top of the screen, and that a value is displayed on the screen. If not, press the "CLEAR" button on the calculator to make it detect the proper sensor.
4) On the colorimeter, press the arrow keys until it is set to 635 nm. This is so when the LED light is underneath the 635 nm.
5) To calibrate the colorimeter, fill a cuvette 2/3 full with DI water, place it in the colorimeter and press "CAL" on the colorimeter. If a zero value (or 0.001 or 0.002) is displayed, then skip to step 7. If a different value is displayed, go to step 6.
6) To zero the colorimeter, enter the "Setup" (1) screen. Select "Zero" (3) in the setup screen. Press "Enter" on the calculator to zero the colorimeter. If a zero value appears, press the "CAL" button on the colorimeter, then move onto to step 7. If a zero value still does not appear, repeat step 6.

Obtaining a Beer's Law Plot

1) 5 Standard solutions of increasing known phosphorus content should be made. Once these solutions are created, they must be put through the phosphorus analysis laid out above.
2) As the standard solutions are digesting, enter the "Setup" (1) menu of DataMate. Make sure that "CH1" says "colorimeter" and that "MODE" says "Events with Entry". If the "MODE" does not say this, press the arrows keys down to "MODE" and press enter. Then select "Events with Entry" (3). Return to the main menu.
3) Once the standards are done digesting, take a clean cuvette and rinse it once with DI water and then rinse the cuvette twice with the *standard solution*. Then fill the cuvette 2/3 of the way and place it in the colorimeter.
4) Select "START" (2) on the calculator. The calculator will begin displaying readings from the colorimeter. Wait until the value levels off to a constant value, then press enter on the calculator.
5) The calculator will now ask for the known concentration. Type in the concentration of the standard solution used and then press enter.
6) Rinse the cuvette with DI water **twice** and then rinse the cuvette twice with the next standard solution. After rinsing, fill the cuvette 2/3 of the way with the standard solution and place it in the colorimeter. The calculator should still be taking readings. Once the value levels off to a constant value press enter. Then type in the concentration of the standard and press enter. Continue this until you have taken measurements of all your standard solutions.
7) After all the measurements have been taken, press the "STO" key on the calculator to stop the experiment. You will be taken back to the DataMate main menu. From this menu, select "ANALYZE" (4).
8) Select "CURVE FIT" (2) from this menu. From the next menu, select "Linear (CH1 VS ENTRY)" (1). The calculator will now give you a formula of the line that fits the data. The formula should be in the form of "$y = ax + b$". Record this formula and the "R" value. If the R-value is below 0.9, new standards should be run.

Running Unknown Samples and Using the Beer's Law Plot

1) After your unknown samples have been digested using the phosphate analysis procedure, rinse the cuvette twice with DI water and then twice with the digested unknown solution. After the rinse, fill the cuvette 2/3 of the way with the digested unknown solution and place it in the colorimeter.
2) The calculator should be displaying readings. Wait till the readings level off and then record the value in a table or an Excel spreadsheet.
3) Repeat these two steps until you have obtained readings for all your unknown samples.
4) Once all your unknowns are run through the colorimeter, you should have an absorbance value for each unknown. These absorbance values correspond to the "*y*" variable in the Beer's Law plot. In order to determine the phosphorus concentrations of the unknown samples, you must first solve this formula for the "*x*" variable.
5) Take out your TI-83 calculator and press the "Y=" button to enter the graph menu. In the "Y1=" line, type in "(X – *b*) / *a*" where *a* is the slope of your Beer's Plot line and *b* is the y-intercept of your Beer's plot line.
6) Press the "2ND" key and then press the "TRACE" key. From this new menu, select "VALUE" (1). You should now see the graph of the line displayed and "X=" at the bottom corner of the screen. Type in the first absorbance value and press enter. A cursor will be taken to that point on the line. In the lower right corner of the screen, a "Y=" value will be displayed. This value is the phosphorus concentration that corresponds to the typed in absorbance. Record this concentration value in your table or Excel spreadsheet.
7) Repeat step 6 until you have determined the phosphorus concentration for each sample.

Special Preparation for
Qualitative Analysis

The preparation of the reagent solution is the same for this laboratory as it is in the quantitative analysis of phosphorus. The primary difference is the creation of color standards so that the students have something to compare their results to. To create these standards, use any form of dark blue colored dye. You can use blue food coloring or any other form of blue coloring that you have available.

6) Prepare five flasks with standard phosphorus concentrations. Recommend concentrations of 500 ppb to 100 ppb in increments of 100 ppb. Submit each of these solutions to the phosphorus analysis using the reagent solution. Also, have five vials with dark blue colored solutions ready before you begin the phosphorus analysis

7) As each standard comes to the end of the development time that you decided on (between 10 and 30 minutes), take a blue colored solution and dilute the solution with distilled water until the blue matches the blue color of the standard solution. Since this is a qualitative experiment, precise color matching is not required, though for the students to the most out of the lab, each color standard should be visibly different from the rest.

8) Once the color standards are created, you can use the standards for all subsequent experiments, unless the color standards deteriorate. This will depend on the colored dye that you choose to use.

The rest of the lab procedure is the same as laid out in the quantitative lab procedure. The only difference is, instead of comparing your experimental results to the obtained Beer's Law plot, the students will compare their experimental results to the colored standards.

SPECIAL NOTE:
To make this lab more intriguing for students, have the students procure their own soil samples from their homes. Have a map of the area and have the students mark on the map where they obtained their soil samples. Then, after the lab, students can see which areas have high concentrations of phosphorus and which areas have low concentrations of phosphorus.

In order to prepare the soil samples for the phosphorus analysis, have the students weigh out 40 g of their soil solutions and place it in a sealable bottle that can hold at least 500 mL of fluid. Add 400 mL of distilled water to the soil in the bottle, seal the bottle, and then shake the bottle vigorously. Let these soil solutions sit for at least 3 days before testing so that the suspended particles are able to settle back out. When procuring 50 mL of the soil solutions for testing, be sure that the solution has a minimal amount of small particles.

NAME: _____ Date:___/___/_____

Phosphorus Testing Laboratory

Introduction: Today you will be testing various water samples for phosphorus. Phosphorus is a chemical that is used by many forms of plant life to grow. However, when too much phosphorus gets into the watershed, it indirectly causes serious problems for aquatic life in our streams, rivers, and lakes.

What You Will Do: Using water samples provided by your teachers, you will test the water samples for phosphorus using a special chemical procedure. The chemical reagent used in this lab is ***DANGEROUS*** and must be handled with extreme caution!! Therefore, lab goggles are required and you must take great care not to spill the reagent solution on yourself. If you do, notify a teacher ***IMMEDIATELY***!!

Procedure:

6) Obtain 5 Erlenmeyer flasks, one 50 mL graduated cylinder, one 10 mL graduated cylinder, and a small beaker containing the reagent solution. A teacher will pour the reagent solution into your beaker. DO NOT POUR THE REAGENT YOURSELF.

7) Obtain 50 mL of each sample solution and pour them each into a separate Erlenmeyer flask. Be sure to label the flasks so you do not forget which sample is which. One sample is regular distilled water, one sample is a concentrated phosphorus solution, one sample was taken from the North Side of Holland near the beach, one sample was taken from a residential neighborhood in Zeeland, and one sample was created by letting potting soil soak in water.

8) Once you have your samples back at your work area, *carefully* pour 8 mL of the reagent solution into your 10 mL graduated cylinder.

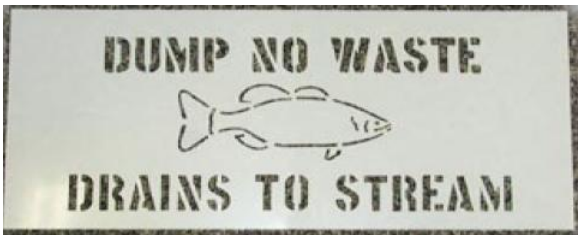
9) Pour the reagent into the first flask and swill it around. Set the flask aside for 15 minutes. After 15 minutes, compare your sample to the standards at the front of the room and make an X mark on the table.

10) Repeat this process for your other 4 samples.

Sample	Very Light	Light	Middle	Dark	Very Dark
Distilled Water					
Conc. Phosphorus					
North Side					
Zeeland Residential					
Potting Soil Solution					

Concrete Assessment Experience
Teacher Instructions for Storm Drain Stenciling Activity

The picture at the right shows one of the possible stencils that can be used for the storm drain stenciling activity. These stencils can be borrowed from the Macatawa Area Coordinating Council (MACC) to use for this activity. The MACC also has put together kits to be used for educational storm drain stenciling activities. Included in each kit:



- Orange safety vests for students to wear so cars can easily see them
- Cones (to set out on the road around where you are working)
- A cardboard box (to place around stencil when spray painting to keep excess paint off students and surroundings)
- Stencils
- Stencil carriers (to prevent wet paint from getting on students)
- Spray paint
- Broom and dustpan
- Paper towels
- Masking tape
- Clip boards
- Rubber gloves

To use the storm drain stenciling kits for your own classroom activity, call (616) 395-2688. **Make sure you obtain permission from the unit of government in which you would like to work prior to stenciling storm drains in our area. Please contact the MACC for further information.**

Responsibilities/ roles for <u>students</u> during activity:

Sweeper(s)
- In charge of using broom and dustpan to clear off area around the storm drain and surface that will be stenciled

Painter's Assistant
- Helps the painter to secure the stencil with masking tape
- Places and holds the box around the stencil

Painter
- Spray paints the stencil with a light first coat and a second coat if needed

Informer
- Passes out information to people walking by
- Puts information on doorknob(s) of the house that you stenciled the storm drain in front of

Responsibilities of <u>teacher/ leader</u> during activity:
- Record each location that you stencil- The MACC wants to know where and how many stencils you completed
- Oral assessment (see document)

Watershed Assessment

Questions to ask for oral assessment while students are stenciling storm drains:

- What are we hoping to keep out of these storm drains by stamping them today?
- What are some ways that you can help the watershed?
- What ideas have you learned about helping the watershed that you will do yourself?
- Why do we need to protect the watershed?
- What is a watershed, in your own words?
- Why do we want to clean the water in our watershed?

Ask two questions to each student. If they struggle with one, either re-ask the question in different words or ask them questions that guide them to what you are looking for.

Give full credit to students who demonstrate understanding of both questions, and partial credit to students who demonstrate understanding of only one questions.

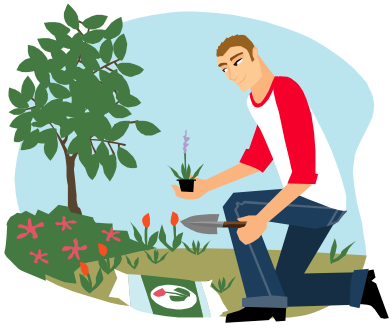
Only students who refuse to participate will earn no credit for this oral assessment

Watershed Tips

In your Home

- **Do not** pour toxic household chemicals down the storm drains. Take them to a local hazardous waste collection center instead
- Use non-toxic household products whenever possible
- Recycle and dispose of all trash properly
- Use less water- take shorter showers, fix leaks, etc.

In your Yard



- Use hardy plants that require little or no watering, fertilizers, or pesticides in your yard
- Avoid over-watering lawns and gardens
- **Do not** over apply fertilizers. Consider using natural fertilizers such as compost, manure, etc.
- Leave grass clippings in the yard
- Use surfaces like wood, brick, or gravel for decks, patios, and walkways. They allow rain to soak into the ground (not run off into storm drains)
- Pick up after your dog, and dispose of the waste in the toilet or trash. Pet wastes contain harmful bacteria that you **do not** want to drink in your water
- Maintain septic systems properly. Reduce bacteria in the water by making sure your septic system is working properly

Maintaining your Car

- **Never** pour used motor oil or antifreeze into the storm drain or the street. Visit www.earth911.org to find out where you can go to dispose of hazardous wasters properly
- Be "green" when washing your car. Take your car to a car wash that recycles water or wash it yourself in the lawn to prevent soap and other pollutants from getting into a storm drain
- Drive less- walk or bike instead. Many pollutants in our waters come from car exhaust and car leaks

Visit www.the-macc.org to learn more about the Macatawa Watershed!