IV PRE-SITE VISIT PREPARATION

1. Site Survey

Once you have chosen your site, have your class learn as much about it as they can. Examine maps of the site's watershed area, such as road maps, USGS maps that show the topography, and town maps.

The conditions in the watershed area will affect the quality of water at your site. Understanding these factors will lend significance to the tests your students will perform. Use the maps to discuss the following:

- Wetlands and Marshes: Wetlands and marshes help to purify water. They can use up excess nitrogen. An abundance of healthy plants can recharge the oxygen level. These areas also act as sponges to retain water during dry spells and absorb the flow of streams during wet times, thereby limiting the effect of floods. (Erosion during floods increases the amount of sediment and accompanying pollutants entering streams.)

- Land and Water Uses: Your maps will give you many clues about how land and water are used; supplement these clues with your class's personal knowledge of the area. Areas of development (residential, urban, industrial) usually cause increased pollutants, higher temperature and changes in such factors as pH and dissolved oxygen. Recreational uses of water, such as swimming, fishing and boating, usually mean that the water in that area is relatively clean. Likewise, if your site is in a protected wilderness area, the water will probably be relatively free of human-made pollutants from the immediate area. (It can, however, be affected by conditions upstream.) If your site is part of a public water supply, such as a reservoir or a stream that feeds a reservoir, its conditions will be closely monitored and conditions that would adversely affect its suitability for human use would be prohibited or corrected. What general predictions can your class make about the water at your site based on the land and water uses?

- Sewage Discharges and Storm Drains: Sanitary and storm water discharges affect many factors in water. Pollution can increase the amount of algae and other plant life in the water, and it can decrease the level of dissolved oxygen. These changes can affect the type of fish that live in the water and often indicate the presence of impurities that make the water unfit for recreation or drinking. Sewage discharge points and storm drains generally contain harmful bacteria; the presence of coliform bacteria in the water indicates the presence of pathogenic bacteria. These discharges also often increase the turbidity level of the water and the water temperature. These factors, in turn, affect other water quality factors, such as dissolved oxygen and pH.

  Cooling water discharge from industrial plants may contain no new pollutants, but it can raise the water temperature, which in turn impacts other factors. Water samples from upstream and downstream of these discharges can differ dramatically. If you choose a site near a discharge point, you might try to collect samples from at least two locations to compare them.

- Highways: Highways can affect water quality even in undeveloped and protected areas. Runoff from highway areas can contain salt and oil, and can carry increased levels of sand and dirt.

- Soil, Rocks and Vegetation: The type of rocks and soil in the surrounding area affect some water quality factors, particularly the pH and turbidity levels. Soil that contains a lot of decaying vegetation has lower pH levels than soil without much organic material. Decaying organic material produces carbon dioxide which in turn raises the acidity of the water (lowers the pH) and might raise the BOD (biochemical oxygen demand). Certain types of vegetation, such as oak and pine trees, thrive in acidic soil. Groundwater that contains runoff from areas with oak or pine forests or with soil rich in decaying organic material will likely have a relatively low pH level.

  Other geological factors may mitigate these conditions. Soft rocks, such as limestone, act as pH buffers and raise the pH level of water. Hard rocks, such as granite, have no buffering capacity, so the water is more susceptible to acid precipitation and runoff. If groundwater seeps through rock formations in the watershed, the type of rock will help determine the pH level.

The condition of the banks along streams, ponds and lakes also affects water quality. Loose, bare soil can lead to erosion. Soil erosion can increase the turbidity of the water, which in turn affects, among other things, photosynthesis. Rocky banks, banks covered with dense plant growth, or surrounding wetlands can reduce soil erosion.

The amount of vegetation at the site can affect water temperature, which in turn affects the potential level of dissolved oxygen, the rate of fish metabolism, and the fish species that live in the water. (Some fish, such as trout and bass, for example, require cool water.) Dense, overhanging trees keep the water cooler, while the sun warms up unprotected water surfaces. Heavily shaded water may appear clearer than water in the sun, because the lower levels of photosynthesis reduces plant growth and decreases the amount of algae.

- Velocity and Depth: The speed at which streams and rivers move influences such factors as water temperature, turbidity and dissolved oxygen. Fast moving streams do not warm up from the sun as much as slower moving water or standing water in wetlands, ponds and lakes. They also may pick up more sediment if the banks are prone to soil erosion.

  Deep bodies of water are generally cooler than shallow ones. In addition, deep bodies of water tend to stratify, so a sample taken in a shallow cove might differ greatly from a sample taken from the bottom or from the surface far from shore. (Because of safety considerations, you may not be able to get samples from the bottom or the middle of most deep bodies of water. The samples you take from the shore may not represent the general conditions of a lake, river, or body of sea water.)

- Fish and Wildlife: The abundance and type of fish and wildlife in a body of water can indicate a lot about the water conditions. Some fish can only live in certain temperatures and at certain levels of pH and dissolved oxygen. If possible, find out from local residents, fishermen or town officials what type of fish live in the water at your site. You can use this information as an indicator or predictor of certain water quality factors.

Send a Scout

If you or any of your students can visit the site before the site visit, your class can gain additional information for your site survey. How does the water appear? Look for signs of pollution, litter, and erosion. Notice the condition of the banks and the vegetation both in and around the water. How clear is the water? How deep? How fast does it move? How high are the waves? Do you see any frogs, insects, or other forms of life? Are there buildings around the site? How close are roads and other development? Use this information to make predictions about the quality of the water.

Complete the Site Survey

Have the students fill out the *Site Survey Form* before completing the tests. If you cannot complete the form, the exercise will still provide a good basis for discussion. After your site visit, you can return to these issues. What can you deduce from the results of the tests your class conducted? For instance, if you found that a pond had a neutral pH level despite surrounding pine forests, you might deduce that limestone rock formations were buffering the acidity of the soil. On the other hand, you might discover that the town's water department limes the pond to reduce the acidity because it is part of the water supply, or that the state's Fish and Wildlife Agency limes it in order to restore fish populations.

2. Water Quality Predictions

NOTE: *You may want to make these predictions and hold this discussion after you have described and discussed the tests.*

Based on the information you have learned about your site, what water quality conditions might your class expect to find? What effects would these conditions have on humans? Animals? Fish? Suppose, for instance, your site has many single-family homes surrounding it. The lawn fertilizers or septic tanks of these houses might increase the nitrogen level of the soil. Because of the elevated level of nutrients, you might predict increased algae growth, decreased DO, and increased BOD. If the map showed wetlands between the houses and the water, however, you might expect that the nitrogen level would not be unusually high because the wetlands would absorb and process the nitrates. If your scout reported large overhanging trees at the site, you might predict that the water temperature would be cool and that, as a result, the dissolved oxygen level might be high. However, the dissolved oxygen level might be lower than you expect because of the presence of pollutants you could not predict, or because of more aquatic vegetation than you expected.

In making predictions, emphasize the importance of understanding the interrelationship of factors, such as temperature effects on pH, dissolved oxygen, and salinity. The class should also take into account the season in which you conduct the field test. Encourage your students to make predictions based on what they know, while emphasizing the importance of verifying these predictions based on field experiments.

Do not be concerned about whether or not your class predictions prove accurate; be concerned about the process by which they arrived at their predictions.

Use the *Prediction Form* for students to record their expectations. Have them complete it either individually, in groups, or as a class. Do not worry if you do not have enough information to make predictions about every factor.

You can compare your predictions to the results of your experiments later. If your results do not closely match your predictions, the class should not conclude that they predicted "wrong". Many factors could lead to unpredicted results. When the predictions differ from the actual results, try to determine why. What information did you not have that might have helped you predict more accurately?

3. Practice with Test Equipment and Procedures in the Classroom

The success of your field testing will depend upon the ability of your students to perform the tests properly. That ability will depend on their familiarity with the equipment. Before the site visit, you should devote at least one class period to practicing the tests and learning to use the equipment (see notes below).

Depending on the age and experience of your students, your class may need to practice simple measuring techniques with plain water before performing the tests. For example, some students have difficulty pouring water into a test tube to a certain metered line, or squeezing just one drop of water from a dropper.

In practicing these skills, students should also practice working in groups. One student could hold a test tube, while another adds drops and a third reads the instructions and records data. They can then switch roles so that everyone has a turn at every task. Make sure that each student in each group can accomplish each task the group will be responsible for in the field and back in the classroom. You may want to set up stations for the different tasks so that groups can rotate.

List of Specific Skills to Practice

- Collecting samples and capping the bottles

  Collecting water samples lies at the heart of all the field tests. Fill a large tub or bucket of water. Students should lower a collection bottle into the bucket gently. In the field, they must be cautious not to stir up the water and disturb any bottom sediments. These sediments would make readings for turbidity and total dissolved solids unreliable.

  The dissolved oxygen test requires that no bubbles be trapped in the water and that the water fill the bottle completely. Students should gently lower the bottle into the water sideways without creating bubbles. When the bottle is immersed they should turn it so the mouth faces upwards (still under water) and gently tap the bottle so that any small bubbles trapped inside the bottle rise to the surface.

- Pouring measured quantities of water

  Many tests require pouring precise amounts of water from a sample bottle into a measured container. Students should practice pouring water from the sample bottle to specific metered lines, such as 5 mL.

- Using pipettes and titration tubes

  Pipettes (droppers) and titration tubes allow students to add small, measured quantities of chemicals or reagents to the water sample. Students should practice using plain water. Have them add a specific number of drops (such as one, five and ten) to a sample using the pipette. They should be comfortable getting one drop at a time into the sample bottle. Also, have students practice using the titrator in the DO test kit.

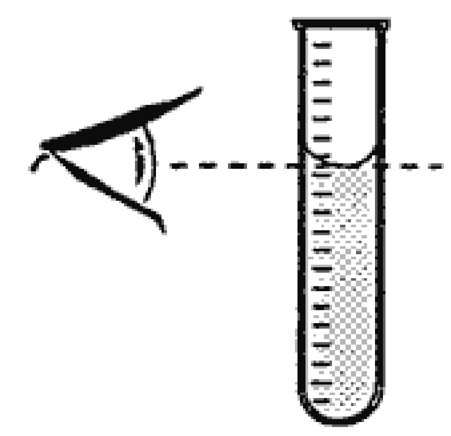
- Comparing colors on a colorimeter

  Using the reagents for the pH test, prepare several test tubes with different pH levels. (You can make different levels by adding a drop of carbonated beverage, lemon juice, or bleach, or a pinch of baking soda.) Ask the students in each group to compare the colors of the tubes to the colorimeter to determine the pH level. They should hold the test tube and the colorimeter up to the light. They might double check their pH measurement using a strip of litmus paper, or by comparing notes with other groups.

- Using a Thermometer

  Temperature readings must be recorded immediately at the field site. Students should practice holding the thermometer in the bucket and quickly reading the temperature. (Some students need practice figuring out what the temperature reading is when the alcohol stops between numbered lines.)

- <u>Reading water level in a test tube or graduated cylinder</u>
  Because of surface tension, water in a test tube or graduated cylinder takes on a concave shape, called the *meniscus.* Students should read the water level by looking at the tube at eye level and reading from the bottom of the meniscus.



4. Working in Groups

For the site visit, you may want to divide your class into groups. Each group will collect a water sample and conduct one or more tests. Working in groups will help these tests go smoothly and help guard against error.

However, group work does not always come naturally. Have your students begin to work in their groups during your pre-site visit preparation. While practicing the methods and learning to use the equipment, each student can have a turn at the different roles in the group. To promote group cohesion and collective support, you may want to consider evaluating the group's work rather than the work of the individuals within the group.

Before heading out to the field, make sure that each group knows what tests it will perform and what role each student will play. Every student should have an assignment so no one wanders around disturbing other groups.

Within each group,

PERSON 1 should read the instructions aloud and record the results.
PERSON 2 should add and mix the reagents.
PERSON 3 (optional) should open and close reagents, check the testing procedure and verify the results.

Groups should work cooperatively, sharing test equipment and comparing results. In selecting students for groups and assigning tests, keep the following points in mind:

- The DO and BOD tests require acidic reagents and should be done only by your most responsible students. In addition, the waste must be neutralized before disposal. For lower grades, teachers may want to complete this test as a demonstration.
- The nitrates test results in a hazardous waste that must be properly disposed of in the collection jar in the kit.
- The pH paper is simple and flexible. It is perfect for those students who may not attend well to more precise, lab-oriented activities. If possible, you may want to let those students test a variety of liquids in addition to the water sample.

- A single run of any test may result in incorrect results. To ensure accuracy, try to run each test at least two or three times with different groups.

5. Additional Materials Recommended for the Field

In addition to the equipment contained in the kit, you will need some or all of the following materials:

- *A jug of fresh water:* Fresh water is necessary for rinsing hands and equipment, and for making demineralized water for salinity testing.
- *Bottles for holding your sample water:* Two-liter soda bottles work well, but they are hard to submerge in shallow water without stirring up the bottom.
- *Plastic containers, such as deli containers:* These are ideal for scooping water from shallow sites. Students may then pour the water into appropriate sampling bottles, such as two-liter soda bottles or the DO test bottles.
- *Rope with depth markings:* If you are testing deep water from a safe location, mark a rope into meters so you know the depth at which you are measuring temperature or drawing water. Electrical tape works well to make depth markings on a piece of rope.
- *Plenty of extra rope:* You may need it for lowering a sample bottle or for offering security on a slippery slope.
- *Watch*: Certain tests, such as the test for nitrates, require timing.
- *Marking pens:* Permanent markers that will not wash off are needed for labeling.
- *Cups or beakers:* These are for holding small samples and are especially important for the TDS and Salinity test.
- *Aluminum foil:* This is needed to wrap the sampling bottle for the BOD test. BOD samples must remain in the dark for five days.
- *Milk crates:* These are perfect if you are sampling from a beach. You can walk out into about a foot of water without getting wet.
- *Warm shoes and clothes!!!*

6. Setting Up for Field Work

To keep your class organized and efficient, you may want to either assign specific students to conduct each test or set up work stations and have groups of students move among them.