Section 1

Section one consists of science projects that are an outline for a classroom environment. Each project lists the objectives, goals, time constrains, age group, tools needed and procedures. You will also find sections within each of the projects that detail preparation, discussion topics and questions to be use in the class or subsequent tests. Some of the projects are further subdivided for specific age groups or class levels. If you have any question about conducting these projects with your class or organization, please visit us on the web at www.la.nrcs.usda.gov.

Projects:

- **HOW BIG IS YOUR WATERSHED?**
- **LEVELS OF WATERFALL IN YOUR WATERSHED**
- **NONPOINT SOURCE POLLUTION**
- **WATERSHED BUGS**
- **CHEMICAL MONITORING OF A WATERSHED**
- **BIOLOGICAL FERTILIZER RUNOFF**
- **WALKING YOUR WATERSHED**
- **WATERSHED VELOCITY**
- **NONPOINT – LETHAL LOTS AND MANAGEMENT PLAN**
- **STREAM CHEMICAL MONITORING**
- **WATERSHED BREATHTAKING**

How big is your **WATERSHED?**

Objective: Students will learn about, identify, and describe the watershed in which they live.
Location: Indoors
Time Frame: one to two class sessions
Subjects: All science classes
Grades: 6th - 12th

Background:
Watershed is the land area from which water drains to a particular water body. Much like the branches of a tree, a network or stream branches are created as streams increase in flow and join with other streams. A watershed is all the land area around a divide and draining or contributing runoff to a particular body of water. It is a catch basin that guides all the precipitation and runoff into a specific river system. If one site on a watershed is affected, it will eventually affect other sites downstream and possibly upstream. A topographic map can be used to determine the contours of a watershed, identify some land use practices, and plan best management programs to prevent or reduce pollution. To effectively use topographic maps, it is necessary to understand the information depicted. Topographic maps show the shape of the earth's surface using contour lines. Contours are imaginary lines that trace the land's surface at a particular elevation. Elevation is important in analyzing water flow patterns. Because water flows downhill and perpendicular to contours, a watershed can be determined from a topographical map. Intervals between contour lines are indicated on the map scale. A typical interval is 20 feet or 20 meters. Concentric circles, ovals, or ellipses indicate a knob or hill. By marking the hilltops and ridges, it's possible to create a good outline of the complete watershed.

Materials:
- Copies of a topographical map (scale 1:100,000) of the river watershed nearest the school. There needs to be a map for every group in the class.
- A large map of Louisiana (scale 1:24,000) showing the rivers and tributaries
- Transparency pens
- Acetate sheet and tape (plastic) - only needed if the maps are not laminated.

Preparation:
Before giving out the maps, have the Louisiana and topographical maps laminated so they can be used again. Be able to map out a watershed before helping the students.

Procedures:
Part one: Mapping the Watershed (Grades 6th - 12)
Discuss the following terms: watersheds, contour lines, elevation, runoff and non-point source pollution.

1. Divide the class into groups of 3 or 4. Give each group a Louisiana map showing the rivers and tributaries.

2. Have students find their own town or community on the maps.

3. Have students locate the main river closest to the school on the Louisiana map (scale 1:24,000) and trace over it with a marker or crayon.

4. Have students to locate rivers or streams that join to form the main river and trace over them with a different color marker or crayon.

5. Give each group a topographical map. If the maps are not laminated, give each group an acetate sheet to tape to the map.

6. Have the students outline the watershed next to the school. The students should first locate the high points (hilltops) in the areas then draw the watershed following the contours.

8. Ask students to tell the direction the water is flowing and how they know. **Make sure to mark any lakes that are a result of a dam. If a dam is present, discuss the advantages and disadvantages.*

9. Have students determine where the river nearest to you goes. Rivers in Louisiana flow to the Gulf of Mexico.

Part two: (Grades 9th - 12th) - Estimating the size of the Watershed
Materials:
1. After marking off the watershed boundaries from part one of this project, use the scale of the map and longitude and latitude marks to calculate the size of your watershed then convert to acres. (Contact the local Soil Conservation service for watershed acreage.)

2. Optional: Calculate the amount of rain that falls on the watershed by finding out the average rainfall and multiplying the value by the watershed area. It may be more appropriate if the amount of rain is converted to gallons. (Contact the local Soil Conservation Service for rainfall data.)

Discussion:
1. What is a watershed?

2. What is runoff and where does it come from?

2. Knowing the size of the watershed, how do you think the land uses in the watershed affects water quality?

3. Discuss the different land uses that exist in the watershed the students mapped out. (Examples may include farms, cropland, forests, parking lots, etc.)

4. Propose solutions to any existing problems in the watershed.

Questions:
1. What is runoff? What land uses may influence the quality of runoff? (roads, parking lots, farms and lawns)
2. How might this affect the water in the watershed's streams? (fertilizers, pesticides, silt, and other pollutants could run into the streams)
3. How is the volume and rate of runoff affected by the land use in the watershed? (More solid surface in watershed increases both.)
4. Will the conditions of the runoff in your watershed affect others downstream?
5. Where does all of the water eventually go?

Levels of Water Fall in your **WATERSHED**

Objective: The students will calculate the volume of water that falls onto an area of the school parking lot. Older students will compare this volume to common water-consuming activities.

Location: Indoors/Outdoors
Time Frame: divided into two class periods
Subjects: All sciences and math
Grades: 6th – 12

Background:
Contaminants get in our water source from a range of sources. Runoff from paved surfaces is probably going to contain pollutants, since none of the water or pollutants can be absorbed through the pavement. Storm water runoff from more urban areas may have sediment, debris, oil, gasoline, and heavy metals (non-point source pollution). Development may negatively affect stream health by escalating the volume of surface runoff and decrease runoff times. When it rains in areas with solid surface (parking lots, roofs, roads), water runs off at a higher speed because it is not absorbed into the ground. Possible pollutants are carried quickly from the land to the receiving water. This sometimes causes a phenomenon to occur called “shock loading”, a depletion of O_2, which can result in fish kills or algae depending upon the type of pollutants in the runoff. Suspended materials in the runoff can also absorb and store heat, which increases the water temperature. Changes in water temperature can also harm aquatic life. Areas with lots of vegetation absorb rainwater, slow runoff and filter pollutants.

Materials:

Yardstick-Tape measure	Writing materials	Protractors
Graph paper	Calculators	Rulers
Local rainfall data	Long piece of twine (meter and foot intervals)	

Preparation:
Call the local weather center or Local Soil and water Conservation District in the parish to find out the average annual rainfall for your area.

Procedures:
Explain to the students that they are going to calculate the volume of runoff from the school’s parking lot. This volume flows to the nearest stream.

Part one: (Grades 6th - 12th) - Calculate the area of the school parking lot and volume of runoff.

1. Divide the class into teams of 3-5 students.

2. Draw a sketch of the parking lot on the board. Have each team select an area they wish to measure. If the lot has multiple sections, give each group a certain area to measure. Note: Make sure the students use the same measurements (feet or meters).

3. Have the students go outside and take needed measurements. Transfer measurements and any landmarks to sketch on board.

4. Have students draft a sketch of the parking lot with all measurements on a regular piece of paper **(Grades 6th - 8th)** and/or to scale on graph paper **(Grades 9th - 12th)**.

5. Have each team determine the direction of runoff and distance to nearest stream. Note: A map can be used to estimate a distance to the stream, if the stream is not next to the parking lot.

6. Have the students estimate the area of the parking lot. Have the students to divide up the lot into shapes, and then calculate the parking lot area. For example:

   Square: Area=Length X Width
   Triangle: Area = ½ Base X Height

   The values should be in the units the students measured on the parking lot. Add together all the individual shapes' areas to find the total area of the parking lot.

7. Determine the volume of rain falling on the parking lot annually. Multiply the average annual rainfall (convert to feet or meters) by the area of the parking lot (square feet or meters). Volume should be recorded in cubic feet (ft^3) or cubic meters (m^3).

Part two: (Grades 9th - 12th) - Comparisons of runoff volume to everyday water usage.

The following conversions are useful:

1 m^3 = 1000 liters
1 ft^3 = 7.2827 gallons
5 minute shower = 25 gallons or 95 liters
Density of water = 1 gallon = 8.34 lbs.
1 liter = 1 kg.

1. Have students calculate the following:

Average annual rainfall:	_______________ inches
Convert rainfall from inches to feet	_______________ ft (X 1ft/12in.)
Surface Area of Parking Lot	_______________ ft^2
Volume of runoff	_______________ ft^3
Convert volume of runoff to gallons	_______________ gallons of runoff
Determine how many 5 min. showers can be taken with the amount of runoff	_______________ showers
If you took a shower every day, how long would it take to shower this many times?	_______________ years
Determine the weight of runoff in lbs.	_______________ lbs.

2. Compare the student’s estimates to see the variations in values. Make sure all students understand how final answers were derived.

Questions:

1. Where does the runoff from the parking lot go?

2. What route does the runoff take? (Storm drain, drainage ditch, stream, culvert) Is the area from the parking lot to the nearest stream vegetated or paved? If both, estimate percentage of each.

Extension:

1. Predict how much erosion will occur at your school with a 30-minute rain. The following values can be obtained from the Soil and Water Conservation District in your parish

To calculate:

E= R X K X LS X C X P

E = Soil lost by erosion (tons/acre/yr) **R** = Rainfall factor
K = Soil erodiabilty factor (tons/acre) (based on the soil type)
LS = Topographic factor (based on slope) **C** = Cover and vegetation type

2. Place a rain gauge next to the school. During the next rain, record the rainfall duration and amount. Calculate the amount of rain in 30 minutes. Using the erosion calculation from above, determine the amount of erosion occurring as a result of the latest rainfall.

NONPOINT Source Pollution

Objective: Students will evaluate the effects of different land uses on wetland habitats and discuss lifestyle changes needed to minimize non-point source pollution.

Location: Indoors
Time Frame: One class period
Subjects: Science, Social Studies
Level: 6th - 8th grade

Background:
Human use of land influence wildlife habitat, positively or negatively. Land use is a reflection of human priorities and lifestyles. Sometimes people see undeveloped areas of the natural environment as little more than raw material for human use. Others believe that the natural environment is to be preserved without regard for human needs. Still others yearn for a balance between economic growth and a healthy and vigorous natural environment. At the core of land use issues is the concept of growth. Growth in natural systems has inherent limits. Continued survival for plants and animals is determined by food, water, and shelter and space availability. Often, humans do not realize the impacts of their activities on the surrounding environment. Non-point source pollution is one negative impact humans may have on their local environment. Non-point source pollution harms streams.

Materials: Each group will need:

Scissors	Masking tape	Paste or glue Paper
One set of land use cutouts	Large piece of paper to fasten the cutouts.	

Preparation:
Prepare copies of the Pond and Cutout sheets ahead of time, which follows this project.

Procedures:

1. Tell the students they will be responsible for arranging the pattern of land use around the pond in such a way as to do the best they can to preserve the health of this beautiful area.

2. Divide the class into groups of three to five and give out the land use materials. Have the students cut out the land use pieces. Tell them **all** the land use pieces must be used on the pond area. The park and farmland may be cut into smaller pieces, but each piece must be used. Parts may touch, but not overlap. It is important to inform the students that the "bleach factory" must have access to the water for production and the "farm feed lot" is an area of little grass where cows are overcrowded and fed grain. Additional highways can be added. Note: Make sure they indicate which direction the water flows.

3. Have the students arrange the parts on the paper. Once all the groups have agreed on the land use location, have the groups tape the pieces to the paper.

4. Begin a discussion with the possible pros and cons of each land use. The following are a few examples:

PROS CONS

Farm: *produce food *use pesticides that may run off into the water
*economic value *soil erosion *provide jobs
*use chemical fertilizers that may damage water supplies

Businesses: *produce employment *produce wastes and sewage
*provide commerce *contaminate water (detergents, etc.)
*economic stability *use chemical fertilizers

Homes: *provides a sense of place *generate wastes and sewage
*provides a community *use water
*provides shelter *loss of wildlife habitat

5. Have the groups reexamine the pond. Without changing the land use pieces, have each group decide if the pond best supports the :

   a. Residents b. Farmers
   c. Business d. Gas station owners
   e. Parks f. Highway
   g. Bleach factory h. Wildlife

6. Invite each group to volunteer to display and describe their "ponds". Look for the consequences of their proposed land use plan. Be firm about the issues, but fair about this plan. Additional points should include the need for an economic base for the town. Also, farmlands provide habitat for some wildlife, but if the wetland has to be drained for the farmland a habitat will have been destroyed. Make sure to point out the advantages to every plan. In addition, ask for any suggestions.

7. Water drains downstream, so all the wastes that go into the pond will affect the waters downstream. When all the students have finished proposing their plans, have each group tape their ponds to the board with the drainage from one group's plan to another.

8. When each town plans its water use without considering downstream impacts, what happens? Have the students tell the possible consequences and possible solutions to the problem. For example, where will the water be treated? Where will the water go?

9. Ask the students to create a list of things they can do to begin to reduce the potentially damaging effects of their own lifestyles on the "downstream" habitats and protect water quality.

Questions:

1. What are pollutants? Give two examples from the exercise.

2. What affects does industry have on downstream water supplies?

3. What affects does agriculture have on the water supply?

4. List possible solutions to the problems associated with growth.

5. Can you name people or organizations in your area that protect streams and rivers? What do they do?

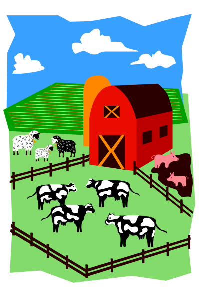
Extension:

1. Trace a stream or river system that passes through your community from its source to the sea. Look at land use adjacent to the stream or river. How does that land use affect water quality?

2. Find out about organizations that work to protect water, land, air quality and animal life. Some examples are, Natural Resources Conservation Service, NOAA Fisheries, US Fish and Wild Life Service, Soil and Water Conservation District, Louisiana Department of Wildlife,

3. Find out the quality of the local stream near the school.


POND



Watershed **BUGS!**

Objective: Students will learn how to evaluate the quality of a stream based on the diversity of aquatic insects found.

Location: Outdoors
Subjects: Math, Science
Time Frame: One class period
Grade: 6th - 12th

Background:
Biological observation involves identifying and counting macroinvertebrates. The reason for biological observation (or monitoring) is to evaluate both the water quality and habitat of a stream. The abundance and variety of macroinvertebrates found is a sign of stream quality. Macroinvertebrates are aquatic insects, crayfish and snails that live in a variety of watershed habitats and are used as indicators of stream quality. Macroinvertebrates are present during all kinds of stream environments -- from drought to floods. These insects and crustaceans are impacted by all the stresses that occur in a stream environment, both man-made and naturally occurring. Follow steps one through three to complete a biological sample of your stream. Note: **It is important to know the potential contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.**

Materials: Optional:
- Kick screen or D-frame net preservation jars or baby food jars
- Sorting pans or white plastic tub rubbing alcohol, for preservation
- Tweezers or forceps bucket with screen bottom
- Pencils and clipboard
- Hand lens
- Rubber waders or old tennis shoes
- Rubber gloves (dishwashing gloves)

Procedures:
1. Find a sampling location in your stream. Macroinvertebrates can be found in many kinds of habitats--places like riffles (where shallow water flows quickly over rocks), packs of leaves, roots hanging into the water, old wood or logs, or the streambed. **If present, riffle areas will have the most macroinvertebrates. If you have a stream with riffles, follow step 2a. If your stream has a muddy or sandy bottom (and no riffles), you will sample using the method in step 2b.** Sample the same stretch of stream each time, to ensure consistency (for example 50 yard stretch). Sample every three months, approximately once each season (spring, summer, fall and winter).

For streams with riffles:

2a. In this “rocky bottom” method, you will sample two different habitat riffles and leaf packs. First, identify three riffle areas. Collect macroinvertebrates in all three riffles with a kick seine, sampling a 2 x 2 feet area (the kick seines are usually 3 x 3 feet). Look for an area where the water is 3 to 12 inches deep. Place the kick seine downstream and firmly wedge the seine into the streambed. Gently rub any loose debris off rocks and sticks so that you catch everything in the seine. When you have "washed off" all the rocks in a 2 x 2 feet area kick the streambed with your feet. Push rocks around, shuffle your feet so that you really kick up the streambed. Now gently lift the seine, being careful not to loose any of the macroinvertebrates you have caught. Take the seine to an area where you can look it over or wash the contents into a bucket. Now look for decayed (old, dead) packs of leaves next to rocks or logs or on the streambed. Add 4 handfuls of decayed leaves to your sample. The total area of stream you will sample is 16 square feet.

For muddy bottom streams:

2b. In this method, you will sample three different habitats, using a D-frame (or dip) net. The habitats are: vegetated margins, wood debris with organic matter, and sand/rock/gravel streambed (or substrate). In this method you will scoop the stream a total of 14 times or 14 square feet. Each scoop involves a quick forward motion of one foot. To maintain consistency, collect the following numbers of scoops from each habitat each time you sample:

- 7 scoops from vegetated margins
- 4 scoops from woody debris with organic matter
- 3 scoops from sand/rock/gravel or coarsest area of the stream bed

As you collect your scoops, place the contents of the net into a bucket. Separate the samples collected from the rocky streambed and vegetated margin or woody debris samples. Keep water in the bucket to keep the organisms alive. Note descriptions below of each muddy bottom habitat and collection tips:

Vegetated margins

This habitat is the area along the bank and the edge of the water body consisting of overhanging bank vegetation, plants living along the shoreline, and submerged root mats. Vegetated margins may be home to a diverse assemblage of dragonflies, damselflies, and other organisms. Move the dip-net quickly in a bottom-to-surface motion, jabbing at the bank to loosen organisms. Each scoop of the net should cover one foot of submerged (under water) area.

Woody debris with organic matter

Woody debris consists of dead or living trees, roots, limbs, sticks, leaf packs, cypress knees and other submerged organic matter. It is a very important habitat in slow moving streams and rivers. The wood helps trap organic particles that serve as a food source for the organisms and provides shelter from predators, such as fish. To collect woody debris, approach the area from downstream and hold the net under the section of wood you wish to sample, such as a submerged log. Rub the surface of the log for a total surface area of one square foot. It is also good to dislodge some of the bark as organisms may be hiding underneath. You can also collect sticks, leaf litter, and rub roots attached to submerged logs. Be sure to thoroughly examine any small sticks you collect with your net before discarding them.

Sand/rock/gravel streambed

In slow moving streams, the stream bottom is generally composed of only sand or mud because the velocity of the water is not fast enough to transport large rocks. Sample the coarsest area of the streambed--gravel or sand may be all you can find. Sometimes, you may find a gravel bar located at a bend in the river. The streambed can be sampled by moving the net forward (upstream) with a jabbing motion to dislodge the first few inches of gravel, sand, or rocks. You may want to gently wash the gravel in your screen bottom bucket and then discard gravel in the water. If you have large rocks (greater than two inches diameter) you should also kick the bottom upstream of the net to dislodge any borrowing organisms. Remember to disturb only one foot upstream of the net for each scoop. Each time you sample you should sweep the mesh bottom of the D-Frame net back and forth through the water (not allowing water to run over the top of the net) to rinse fine silt from the net. This will avoid a large amount of sediment and silt from collecting in the pan, which will cloud your sample.

2. Place macroinvertebrates in a white sorting pan or plastic sheet. Separate creatures that look similar into groups. Use the SOS identification guide to record the types and numbers of each kind of insect. As you sort through your collection, remember that each stream will have different types and numbers of macroinvertebrates. Use the table below to interpret your results.

If you find:	You may have:
Variety of macroinvertebrates, lots of each kind	Healthy stream
Little variety, with many of each kind	Water enriched with organic matter
A variety of macroinvertebrates, but a few of each kind, or **No** macroinvertebrates but the stream appears clean	Toxic pollution
Few macroinvertebrates and the streambed is from covered with sediment	Poor habitat sedimentation

Questions:

1. If you find low diversity of macroinvertebrates in a stream and water quality appears good, what may be influencing your stream? Hint-Is there a lot of sediment in the stream? Where do macroinvertebrates live?

2. If you sampled your stream in the winter and then found a lower diversity index in the summer, does that mean your stream has been negatively impacted? (Not necessarily, there are seasonal variations to the macroinvertebrate populations).

Extension:

1. Enlarge pictures of aquatic insects, laminate and put on poster board. Enlarge names of insects and have students match.
2. Start a regular monitoring program of a local stream. Sample quarterly.
3. Sample different streams and compare results. Be sure and look at the stream habitat AND water quality as influences on your results.

Chemical monitoring of a **Watershed**

Objectives: Students will gain information regarding the conditions of streams by performing chemical water quality tests and interpreting the data. Dissolved oxygen, temperature and pH will be tested in this exercise.

Location: Indoors/Outdoors
Time Frame: Two class periods
Subjects: Biology, Chemistry, Ecology
Grades: 6^{th} – 12^{th}

Background:
Chemical testing allows information to be gathered about specific water quality characteristics. A variety of water quality tests can be run on fresh water-including temperature, dissolved oxygen, pH, water clarity, phosphorus, nitrogen, chlorine, and alkalinity. The basic set of tests includes temperature, pH, settlable solids, and dissolved oxygen. Advanced tests include alkalinity, phosphate and nitrate. These tests allow volunteers to take the "life signs" of their stream. In this exercise, two water samples will be compared. The first will be run inside on tap water and simple solutions, and the second will be a free flowing stream. A regular sampling program can be started, but because water conditions can vary weekly, daily or even hourly, frequent and regular sampling should be conducted (weekly or monthly).

Water temperature is important in determining which species may or may not be present in a stream system. Temperature will affect feeding, reproduction, and the metabolism of aquatic animals. Not only do different species have different requirements, but the optimum temperature may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adults. pH tests indicate the amount of hydrogen ions in the water. A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation removes carbon dioxide (CO_2) from the water during photosynthesis, 2 increasing the pH levels.

Dissolved oxygen (DO) is critical to many forms of aquatic life. DO is measured in parts per million or ppm. One ppm is equal to one milligram of oxygen dissolved per one litter of water. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6 ppm are usually required for growth and activity. Colder water can hold more dissolved oxygen, so the highest DO levels will be found during the winter. Streams that have a high velocity and flow over rocky areas (mountain streams) likewise will have higher DO levels because the water mixes with the air more frequently. Note: Because the quality of the stream may not be known, it is best to take precautions with students in the water. Gloves and wading boots in the stream are a must.

Note: Many of these lesson plans require a class to collect samples from nearby streams. It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities.

Materials:
- Dissolved oxygen test kit (Chemetrics, LaMotte or Hach)*
- pH paper or test kit (fish tank test kit, Chemetrics, LaMotte or Hach)*
- Thermometer*
- Rubber gloves
- Safety glasses
- Container to bring back waste chemicals (old milk jug)
- Bucket with rope (if sampling off a bridge or deep water)
- Pencil
- First Aid Kit
- Lemon juice
- Ammonia or Baking Soda
- Plastic cups
- Certified thermometer, LaMotte or Hach kits used in collecting quality assured data

Procedures:

Part one:
1. Preparing the students to perform these tests on a stream requires the students spend time inside practicing with the kits.
2. Set out the lemon juice, ammonia or baking soda, an aerated water sample (aerate with air hose), and a water sample that is not aerated. Add approximately ½ cup of lemon juice or ammonia to a half gallon of water.
3. Set out thermometers, test kits and water samples.
4. Divide the class into groups and have one member of each group collect a small amount of each sample in a cup. Note: the oxygen level in the aerated sample will quickly change as oxygen diffuses back into the atmosphere.
5. Have each group conduct either the dissolved oxygen test or take the temperature and determine the pH of the samples. If time permits, have the groups switch tests so all students have run all tests.
6. Have students to record results on a blank piece of paper. Compare results.

Discussion:
1. What values did you obtain for each sample? Why is the oxygen level higher in the sample that was aerated? Why does the lemon juice sample have a lower pH then the tap water? Why does the ammonia sample have a higher pH than the tap water?

2. Calculate the percentage difference between answers. Duplicate tests results should be within 15 percent. **Percent difference = [(1st duplicate-2nd duplicate) / average of duplicates] x 100**
3. What values for DO, temperature and pH to you think will be found in a fresh water stream? Why?
4. Why are these parameters important to understanding the health of a stream?

Part Two:

1. Locate a nearby stream, pond or drainage ditch. Look on county or topographical maps to find a waterway or ask local water authorities or extension officers.
2. Review safety precautions at site. Make sure students wear safety glasses and gloves. Know location of nearest phone. Bring first aid kit.
3. Divide the class into groups. Rinse glass tubes or containers twice with stream water before running each test. Collect water samples from midstream and mid-depth. Measure the air and water temperature in the shade, avoid direct sunlight.
4. Have each group measure DO, temperature and pH.
5. Record data on a data sheet.
6. Compare results at site or back in classroom.

Discussion:

1. What values did you obtain for each sample? Why is the oxygen level higher or lower than the classroom samples? Temperature? pH?
2. Calculate the percentage difference between answers. Duplicate tests results should be within 15 percent.
3. What values would you expect at a different time of day? A different time of year?

Questions:

1. What does pH tell you about a stream? What is the optimum pH?
2. What is dissolved oxygen? How does it get into the water? What are the optimum ranges?
3. Why is temperature an important parameter to measure?

Grades 9th-12th

1. What do phosphates and nitrates measure in a stream? Is a high amount of phosphate good for a stream?

Extension:

1. Start a regular chemical monitoring program. Test at least once a month at the same location and time of day. Keep detailed records of the chemical results and graph changes throughout the year.
2. Visit a different stream or river site once a month. Compare results between sites. How do the different watersheds compare and affect water quality? Are there any point or non-point discharges?

BIOLOGICAL Fertilizer Runoff

Objective: Students will identify sources of fertilizer runoff and describe the effects fertilizer has on algal growth by performing an experiment with different water sources.

Location: Indoors
Time Frame: one class periods
Subjects: All sciences, Math and possibly Language Arts
Grades: 6th - 8th

Background:
Excess nutrients are one of the problems facing streams. Nutrients, mostly nitrogen and phosphorus, act as a fertilizer causing an increase in the growth of algae and other aquatic plants. An abundance of nutrients can cause algal blooms, which increase oxygen demand and can limit oxygen available to fish and aquatic breathing organisms. It is important to remember nutrients are important to streams, but when the nutrient load is in excess, it is harmful to the organisms living in the stream. Nutrients naturally occur in streams from leaf litter and plants. The proper amount of nutrients produces abundant plant life. However, domestic sewage, industrial wastes, chemical fertilizers from lawns and fields can reach the stream and build up. Long-term nutrient enrichment may cause a lake to be choked by vegetation, covered with scum and have a foul odor. In addition, a heavy plant bloom can reduce the oxygen and result in a fish kill.

Materials:
- Clear plastic containers, 4/group (ie. 2 liter soda containers)
- Measuring spoons
- Water samples from stream, lake or pond
- Plant fertilizer
- Tap water
- Dissolved oxygen kit (optional)
- Camera and Film (optional)
- Photographs of water bodies with algal problems and eutrophication (optional)

Preparation:
Fill several buckets or other containers with tap water and let them sit for a day or so to allow any chlorine to dissipate. Prepare fertilizer according to the package directions and double its strength. For example, if the directions call for one teaspoon per quart add two teaspoons of fertilizer to one quart of the water sample.

Procedures:
1. Explain to the students that water pollution is (1) any human-caused contamination of water that lessens its value to human and nature; and (2) phosphorus entering lakes in runoff from fertilized area can cause heavy algal blooms and excessive weed growth in lakes.
2. Make a list of all potential sources of nutrients, which might wash into a water body after a heavy rain. The list should include agriculture, forests, plant nurseries, golf courses, home or business landscapes, and home gardens. Remember the leaf litter in the stream is also a source of nutrients.

3. The students will be observing the effects of fertilizer runoff on a water body. The plant fertilizer will represent the fertilizer being washed into streams, rivers, and lakes after a heavy rain.
4. EXPERIMENT: Have the students to bring water samples to class taken from a stream, lake, pond, aquarium, or puddle and place on a table with the bucket of tap water. Divide the class into groups of two or three. Have each group get four jars.

   Label the jars:

   #1 Tap Water (Control)
   #2 Tap water + fertilizer
   #3 Aquarium/pond/lake
   #4 Aquarium/pond/lake + fertilizer

   Have students fill each jar with the appropriate water sample. Then have them add the appropriate amount of fertilizer to jars #2 and #4 (double strength of instructions). Set all four jars in a windowsill or a place where there is good light. Be sure not to place them in a drafty or cold location because constant temperature is needed for best algal growth. **STUDENTS MUST WASH THEIR HANDS AFTER PREPARING JARS**.
5. Have each group write a **hypothesis** of what they think will happen.
6. Observe the jars every day for a week and then once a week for a month. Record any changes in the jars on a data sheet. You may want to photograph the jars. If possible, check the dissolved oxygen in the jars once a week at **THE SAME TIME OF DAY** (oxygen levels vary throughout the day and night)
7. At the end of the experiment, have each group write their result in a report. As a class, discuss the results.

Questions:
1. Which jar has the greatest algal growth? Why?
2. Which jar had the least algal growth? Why?
3. As algal growth increases, what happens to the dissolved oxygen?
4. What happens to the oxygen levels at night? Why?
5. Name land uses and activities that contribute nutrients to streams.
6. What would result if more fertilizer were used?
7. What effects do nutrients have on aquatic life?

Extension:
1. Follow the same procedures listed above, but test for changes in dissolved oxygen rather than algal blooms.
2. Collect additional water samples from different locations of a stream or pond. Test the dissolved oxygen levels in each sample. Note the land uses of surrounding the sampling area. Have the students determine that land uses affect the oxygen level of a stream.
3. Observe algae under a microscope, have students identify types of algae.

Walking **YOUR Watershed**

Objective: Students will understand the concept of a watershed, identify a river's watershed system, and describe the immediate watershed in which they live.

Location: Indoors
Time Frame: one class period
Subjects: Geography, Science, Social Studies
Grades: 6th - 12th

Background:
A watershed is all the land area that contributes runoff to a particular body of water. It is a catch basin that guides all the precipitation and runoff into a specific river system. Changes in a watershed affect all living and non-living things within its boundaries. For example, a mostly forested watershed that is logged will result in changes in water flow and sediment entering streams. Sedimentation in turn will reduce the diversity of macroinvertebrates found in streams. Perhaps the single most important thing to remember about watersheds is that they are single units connected to other watersheds as they are traced downstream. What affects a watershed in one place eventually affects other sites downstream. Impacts can accumulate as water proceeds downstream. A topographic map can be used to determine the contours of a watershed, identify some land use practices, and plan best management programs to prevent or reduce pollution. To effectively use topographic maps, it is necessary to understand the information depicted. During a visit to a stream, students can learn about a watershed. The land use around the area affects the quality of a stream. For example, poor agricultural practices next to a stream may add pesticides and excessive fertilizer to the stream. Urban land uses, such as parking lots and roads contribute small amounts of oil and gas to storm-water. Students should take note of the land use and the condition of the streams. Asking questions like "Is the water silty", "Is the water a green color" and "Are there signs of pollution" will help identify the quality of the stream. See appendices.

Materials:
- Copies of a topographical map (Scale 1:1,000,000) of the river watershed nearest the school. There needs to be a map for every group in the class. A large map of Louisiana Scale 1:500,00) showing these rivers and its tributaries would be helpful.
- Markers, crayons, or transparency pens
- Acetate sheets or laminate for maps (optional)

Preparation:
It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.

Procedures:

Part One:

1. Discuss the following terms: watersheds, runoff, non-point source pollution, and land uses. Have each student look at a map of major watersheds in Louisiana.
2. Take the students to a river or stream, survey a 1/4 mile bank, and fill out the forms to determine land use, erosion, water color, water clarity, animal life, and human impacts on the stream.
3. In the classroom, discuss the categories and overall condition of the stream. If you suspect the stream to be polluted, ask what can be done to improve the quality of the stream? What is affecting the health of the stream?

Part Two:

Laminate the local and topographical maps so they can be used again.

1. Divide the class into groups of 3 or 4. Give each group a city or county map.
2. Have students find their own town or community on the map.
3. Have students locate the river or stream closest to the school and trace over it with a marker or crayon.
4. Have the students locate the streams that join the main river and trace over them.
5. Give each group a topographical map.
6. Have students find and trace the section or tributary of the main river that flows closest to them with a transparency pen.
7. Ask students to outline the watershed. Please see appendixes.

Questions for outline:

1. What are the lands uses in your area? (urban with roads, parking lots and buildings, suburban with houses and lawns, rural with farms)
2. How might these land uses affect the water in the watershed's streams? (fertilizers, pesticides, silt and other pollutants may run into the river).
3. How is the volume of water affected by the watershed? (the size of the watershed, land uses, and vegetation will affect the amount and quality of runoff that reaches a stream.)
4. Will the conditions in your watershed affect others downstream? How?
5. Where does all of the water eventually go?

Extension:

1. Have students identify the rivers that make up the main river watershed. Students should be able to explain how the different waters of the main river watershed are interconnected. Have them draw an imaginary river system, labeling the sources and tributaries of the river, and outlining and naming the watershed.
2. Have the students collect newspaper or magazine articles that reflect the impact of water in one area of the state on others. These could be current articles or historical ones obtained from the library.

Watershed **VELOCITY**

Objective: Students will be able to compute the velocity and discharge of a stream.

Location: Outdoors
Subjects: Math, Physics, Science
Time Frame: two class periods
Grade: 6th - 12th

Background:
Knowing the velocity of a stream is important for determining the aquatic organisms that live at a stream site. Some organisms, such as trout, prefer quickly moving, highly oxygenated water. Other aquatic critters adapt well to slow moving warm waters. Velocity is an important characteristic of your stream. The velocity of a stream equals the distance the water travels per unit of time.

Volume and discharge are also important characteristics and can be easily calculated on your stream. The volume of water flowing through your stream is the area of the stream channel multiplied by stream length. The discharge is the volume per unit of time. The total discharge of a stream is important, how much water is being drained from your watershed? The discharge may vary as land use in the watershed changes and from season to season.

Note: **It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.**

Materials:
- 50-foot piece of string or 5, 10 foot sections (marked in 1-foot intervals).
- Yardstick
- Orange
- Stop watch
- Pencils and notebooks
- Copies of water flow chart.

Procedures:
Note: Do not choose a deep pool or riffle, flowing water is dangerous and students should not be above their knees in the water. Also, consider the flow of the stream if it is moving too fast do not let the students get in the water.

For grades 6th - 8th:
1. Discuss the following terms: velocity and discharge.

2. Using the string, have the students mark off a 50-foot section (length) of a stream moving downstream. Position two students every 10 feet of the measured section. One will hold the string and one will record times.

3. Designate one student to be the timer. This student will call out times as the orange floats past each 10-foot section.

4. Release the orange upstream. Begin timing. Record results. Repeat twice.

5. Calculate stream velocity as follows: V = Distance (feet)/time (second)

For grades 9th - 12th:

1. Discuss velocity, volume and discharge.

2. Follow steps 1 through 5 above.

3. Divide the class into groups of four. Have each group use a string to make several measurements (approx. 4) of the width of the stream within the 50-ft measured section. Record these numbers on the provided worksheet.

4. Have the students make several depth measurements of the stream using the yardstick and record the values on the data sheet.

5. At this point, each group should draw two views of the stream: a top view including widths and a cross section with depths marked on the diagram. In the classroom, each group should:

6. Plot a stream profile. The profile plots the depth of the stream versus the width of the stream.

7. Average the depth measurements to get one number for the depth. Average the stream widths to get one number for the width.

8. Multiply width x depth x length (10 feet) to get the volume of water in that section of the stream. Explain volume as the amount (how much) water is in a certain area.
9. Average the time it takes for the orange to travel 10 feet. The creek's discharge is the volume of water that flows in a certain amount of time. Have each group determine how much water flows by in one second, one minute, and one hour.

Questions:
For grades 6th - 8th:

1. Calculate the velocity of the stream if the orange flows at a rate of 100ft in 1.5 minutes.

2. Can you name two animals that live in fast moving water?

3. What does the velocity tell you about the watershed?

For grades 9th - 12th:

1. If the average depth of the stream is 4 ft and width is 7.5 ft and it took the orange 10 seconds to travel the 10-foot length of the stream, what is the volume?

2. If two streams drain equal sized and comparable watersheds, and one watershed is forested while the other is urban, which will have a greater discharge of water? Why?

Extension:

For grades 6th - 8th:

1. Perform this same exercise, but calculate the velocity of two different sites; a riffle and a pool.

For grades 9th-12th:

1. Calculate the amount of water entering the stream from the watershed. Calculate the area of a watershed. Have the students look at a topographic map and draw out the watershed. Estimate the area of the watershed with a dot grid or a local Soil Conservation Service can measure the watershed. Find out the average annual rainfall for the area by contacting the SCS. Multiply these values and determine the volume of water in the stream. Calculate the value in gallons.

Student Data Sheet:

Velocity

Distance traveled	Time to travel distance (sec.)	Time to travel each 10 ft. section	Velocity (10 ft./sec.)
Average Velocity			

Volume and Discharge

Width measurements:	Depth measurements:
Average -	Average -

Calculations:

Volume = width x depth x length

Discharge = volume (ft^3)/time (sec.)

NONPOINT Lethal Lots and Management Plan

Objective: Students will explain how bioassay methods are used to determine toxicity. By using *daphnia,* the students will determine the toxicity of an urban runoff water sample.

Location: Indoors/Outdoors
Time Frame: 3 class periods
Subjects: Science, Ecology, Biology, and Chemistry
Grades: 9th - 12th

Background:
Daphnia are small freshwater crustaceans that are food sources for many other animals. They are very sensitive to changes in temperature and water chemistry. For this reason, they are sometimes used for detecting the presence of toxic substances in a water supply. The examination of such organisms to detect the presence and relative amounts of toxic substances in a water supply is called biomonitoring. The technique used in this activity is called bioassay. A bioassay is a method used to test the concentration of a substance by observing its effects on the growth of an organism under controlled conditions.

Toxic chemicals in a water supply can harm the plants, animals, and humans that depend on it. Toxic chemicals and other pollutants can enter a water supply from many sources such as urban and rural polluted runoff, leaking landfills, and mining areas. Toxic chemicals from a parking lot, for example, might include oil, antifreeze, brake fluid, lead, chromium, iron, and manganese. Runoff from large areas of pavement is likely to contain pollutants. Since none of the water or pollutants can be absorbed thought the pavement, the water runoff is unfiltered. In this activity, the toxicity of runoff from the school parking lots will be determined.

Materials:
- 3 liters of runoff water from the school parking lot (collect after a storm)
- Clean sponge, turkey baster, or rulers and clean dust pans to collect water
- Plastic containers with lids to store sample
- 50 live *daphnia* (available from biological supply company)
- 5 gallon container or aquarium
- *Daphnia* food:
    - tropical fish food
    - yeast
    - alfalfa
    - distilled water
- Aerator
- Compound microscopes
- Microscope slides and cover slips
- Blender
- 1 aquarium thermometer
- Grease pencil or permanent marker
- Labels or masking tape
- 30 eyedroppers
- 50 ml. cylinder
- 5-500 ml. beakers

- 30-50 ml. beakers
- 2-cycle semi-log graph paper
- Saturation Concentration Dissolved Oxygen data sheet
- Data sheet
- *Daphnia* media:
    - 20 liters distilled water
    - NaHCO3
    - $MgSO_4$ X H_2O (Epsom salt)
    - KCL
    - CaSO 4
- Water quality test kit (optional)
- *Daphnia* anatomy sheet (optional)

Group Discussion:

1. Discuss with the students the role of urban runoff as a non-point source of pollution. Explain that runoff can contain toxic chemicals and pavement runoff will not absorb into the earth allowing it to be naturally filtered. What type of toxic chemicals could be in the runoff?). Note: Explain to the students that storm water runoff is usually piped directly into local streams. The runoff does not go to a treatment plant first before entering a stream. Urban storm water may contain sediment, debris, and toxic chemicals such as herbicides, pesticides, oil, antifreeze, and heavy metals.

2. Discuss that some organisms are more sensitive to pollutants than are others. Why are these sensitive organisms' good indicators of water quality? (It is easier to detect low concentrations of pollutants with sensitive organisms.)

3. Point out the disappearance of certain plants or wildlife in a water body is an indicator of changing water quality.

4. Toxic chemicals can enter a water supply from many sources such as agriculture, mining, construction sites, and landfills, farms, homes and forestry operations.

Preparation:

You may wish to have the students perform the following:

1. When *daphnia* arrive you will nee to acclimate them to the laboratory aquarium. Have the water temperature the same in the shipping container and in the aquarium before transferring daphnia. The culture medium in 5-gallon (20-liter) container/aquarium should be **prepared as follows**:

- Fill a clean 20-liter container to the 19-liter mark with distilled water.
- Pour out approx. 500 ml into a separate clean beaker and completely dissolve the following chemicals in it before adding back to the 20 liter container:
    - 2.88 g NaHCO3
    - 1.80 g $MgSO_4$ X $7H_2O$ (Epsom salt)
    - 0.45 g KCl
- Remove another liter from the 20 liter container into another clean container, add 1.80 g $CaSO_4$. Add this mixture back to the 20-liter container.
- Aerate the mixture for two hours using an aquarium aerator.
- Allow the mixture to reach room temperature before adding *daphnia.*

2. Have the daphnia food prepared and feed them once a day:

6.3 g tropical fish food
2.6 g yeast
0.5 g alfalfa
500 ml distilled water

- Blend all ingredients for five minutes on low speed. Cover and let stand in refrigerator for one hour. Pour off top liquid and save in refrigerator. Dispose of the rest.
- Feed once a day.
- Food is good for two weeks

3. Two days before the experiment, prepare new culture media to be used in the experiment.

Procedures:

Part one:

1. Check the *daphnia* one day prior to running the experiment to ensure that the culture is healthy. If 10 percent or more of the daphnia die between their arrival and this time, you may wish to reorder. Because *daphnia* are sensitive, they must be protected from hair spray, perfume, smoke, bug repellant, and the room temperature should be kept as a constant 68 degrees F.

2. Have the students collect approximately 3 liters of runoff from the school parking lot after a rainstorm in a clean container with a lid and store in the refrigerator (up to 2 weeks) until time for the experiment. Collect the runoff sample by one of the following:
   - A clean sponge to absorb the water and wring into a container, or
   - A turkey-baster to siphon the water into a container, or
   - A cleaning squeegee to push the water into a dust pan and then into a container.

3. Place **10 *daphnia* containing embryos** in each of the five 500ml beakers with 300ml of culture medium and 0.5ml of food. Make sure culture media is at room temperature. Because air bubbles can become trapped under the daphnia, place the daphnia into the media without pouring the sample. Use an eyedropper and release them slowly into the media. Note: Do not use *daphnia* with ephippia or dark eggs because they will not hatch from them in time for the experiment.

4. Use the newborn *daphnia* found in the beakers the next day for the experiment. Newborns will be smaller than the parents. Newborns are used to eliminate some sampling error from the experiments because this assures all organisms used in the experiment are the same age. (If you do not have time to remove newborns, use *daphnia* in the culture, which do not have embryos or ephippia.)

5. If water quality kits are available, test the dissolved oxygen of the media. The DO should be 40 percent saturation or greater. Otherwise, the *daphnia* will be stressed and die from low DO. Try using aerators if the DO is low.

Part two:

1. Divide the students into teams of two.

2. Give each team a compound microscope and *daphnia* (on a slide) to observe.

3. Have the students distinguish between daphnia with embryos and ephippia.

4. In the laboratory, have the students prepare and label four 50ml beakers of each of the following concentrations of runoff water. Each group will be responsible for setting up the experiment and recording the results.

Concentrations	Runoff Water	Culture Media
100%	40 ml	0 ml
50%	20 ml	20 ml
25%	10 ml	30 ml
10%	4 ml	36 ml
5%	2 ml	38 ml
2.5%	1 ml	39 ml

5. Have the students label each beaker using tape or a grease pencil. Have the student write the date, temperature, and time the experiment begins. If a DO kit is available, test the dissolved oxygen.

6. When the beakers are ready, introduce five *daphnia* into each of the beakers.
   - Use an eyedropper to transfer *daphnia*
   - Record time on each beaker
   - Do not collect *daphnia* from top or bottom of beaker.

DO NOT FEED *DAPHNIA* DURING EXPERIMENT

7. Have the students count the number of dead daphnia in each beaker at the end of 24 hours and 48 hours.

8. Distribute 2-cycle semi-log paper.

9. On semi-log paper, the lower half of the paper goes between 1-10 in logarithmic steps on the y-axis and the upper half goes from 10-100 in the same fashion. Have the students plot percent mortality (on the x-axis) and percent concentration (on the y-axis). Explain that the graph will help the students determine at which concentration the parking lot runoff has an LC50. 10. Explain LC50 or lethal concentration. This is the concentration of runoff where 50 percent of the *daphnia* die. On the percent concentration scale, have students locate the point at which 50 percent mortality occurred. This point is the LC50 for the experiment expressed as percent parking lot runoff volume. For example, if 25 percent concentration treatment results in 50 percent mortality, then report the LC50 as 25 percent. (NOTE: If the 2.5 % concentration treatment results in greater than 50% mortality, report LC50 as less than 2.5% or repeat the procedure using a dilute sample.

Questions:

1. Why were four beakers of each concentration used? (Replication)
2. What is the purpose of the control? (To make sure other factors beside the runoff didn't kill the *daphnia*)
3. Why do some *daphnia* die before others? (Some are more sensitive than others)
4. Why is an LC50 used instead of an LC100? (LC50 is more exact. It is difficult to extrapolate because 100 percent of the organisms are dead, the concentration used in the experiment killed them)
5. On the basis of your results would you consider the runoff from the school parking lot to be toxic?
6. What can you do to protect nearby streams? (Monitor regularly and filter storm water before it enters the stream.)

Extension:

1. Invite someone from NRCS or your local Soil and Water Conservation District to visit your school parking lot and discuss what best management practices could be used on your site to prevent pollution from being funneled directly into water bodies. After the guest speaker, have the student's design a **"best management plan"** or BMP for your school parking lots and work with school officials to get it implemented.

Stream Chemical Monitoring

Objectives: Students will gain information regarding the conditions of streams by performing chemical water quality tests and interpreting the data.

Location: Indoors/Outdoors
Time Frame: two class periods
Subjects: Biology, Chemistry, Ecology
Grade: 9th - 12th

Background:
Chemical testing allows information to be gathered about specific water quality characteristics. A variety of water quality tests can be run on fresh water including temperature, dissolved oxygen, pH, water clarity, phosphorus, nitrogen, chlorine, total dissolved solids and salinity. Each of these parameters gives you specific information about your stream's "life signs". Chemical testing should be conducted at least once a month because this type of testing measures the exact sample of water taken, which can vary weekly, daily and even hourly. Temperature is one important factor, which determines which species may be present in the system. Temperature will affect feeding, reproduction and the metabolism of aquatic animals. Not only do different species have different requirements, but optimum habitat temperature may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adults. pH tests indicate the amount of hydrogen ions in the water.

A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation remove carbon dioxide (CO2) from the water during photosynthesis, increasing the pH levels. Dissolved oxygen (DO) is critical to many forms of aquatic life for respiration. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6ppm are usually required for growth and activity. Phosphorous and nitrogen are nutrients found naturally in small amounts in streams. Unfortunately, many suburban and rural areas contribute excessive amounts of these nutrients to streams through fertilizer and livestock runoff. Too much phosphorous or nitrogen leads to algae blooms and fish kills.

Note: It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.

Materials:
- Water quality testing kit (LaMotte or Hach) (Should contain: dissolved oxygen, pH, temperature, phosphate and nitrate)
- Imhoff Cone for settleable solids
- Chemical Survey Sheet from appendix
- Rubber gloves
- Safety glasses
- Container to bring back waste chemicals (old milk jug)

- Bucket with rope (if sampling off a bridge or deep water)
- Pencil
- First Aid Kit

Preparation:
In preparing the activity, it is important to visit the stream. Survey the stream for any dangers, a clear path to the stream, and permission to be on the land. In addition, see the note above.

Procedures:
1. Read through test kits in class. Practice tests in class with tap water if desired. Depending on your kit, directions may vary and some are difficult to follow.
2. At the stream, divide the class into groups of 4. Assign two tests per group. Make sure students are wearing safety glasses and gloves.
3. Measure the air and water temperature in the shade, avoid direct sunlight.
4. Rinse glass tubes or containers twice with stream water before running the test.
5. Collect water for the tests approximately midstream, mid-depth.
6. Perform DO, pH, phosphate, nitrate, settleable solids.
7. Once all the parameters are collected, bring the data into the lab.
8. Have each group write the values on the board.
9. Have students share their results. Next to the parameters, have the students give one reason each parameter could be high or low.

Discussion:
With the water quality values, begin a discussion about potential water problems. Ask the students what accounts for the differences between each group's values. In addition, discuss any parameters that do not fall into the optimum conditions.

Questions:
1. What does pH tell you about a stream? What is the optimum pH?
2. What is dissolved oxygen? How does it get into the water? What are the optimum ranges?
3. What do phosphates and nitrates measure in a stream? What are sources of phosphates and nitrates? Is a high amount of phosphate good for a stream?
4. Why is it important to run duplicate samples? Some groups tested for the same substance. How did the results compare? Account for any discrepancies.

Extension:
1. Visit several streams in your area and compare chemical monitoring results. Test each site at the same time of day to minimize diurnal fluctuations.

Watershed **BREATHTAKING**

Objectives: Students will describe the importance of dissolved oxygen (DO) to the survival of aquatic plants and animals by performing a controlled experiment with fertilizers, debris, and sediment.

Location: Indoors
Time Frame: 4 - 30 minute sessions over 2 weeks
Subject: Science, Ecology, Biology, and Chemistry
Grade: 9th - 12th

Background:
Oxygen is important to the animals living in the water as it is to those living on land. Although oxygen does not dissolve very well in water, enough does to support a wide variety of living organisms. The solubility of oxygen in water depends on water temperature. Cool water can hold more oxygen than warmer water because gases are more soluble in cooler water. The amount of dissolved oxygen (DO) may vary significantly from one place to another and during times of the day in aquatic habitats for a variety of reasons. The highest concentration of DO occurs just at sunset. After sunset, plants respire (use oxygen). The lowest concentration of DO occurs at sunrise.

This is the most likely time that a DO fish kill will occur. DO is in measured in parts per million (ppm). DO in aquatic environments can range from 0 to 15 ppm, but 6-10 ppm is sufficient for most aquatic animals. Non-point sources of nutrient enrichment include fertilizers, livestock wastes, leaking septic tanks, and urban runoff. Phosphate detergents may enter water bodies in surface water runoff activities such as washing the car. Excessive nutrients entering a waterway can accelerate algae growth or cause an "algal bloom." Algal blooms can produce thick surface mats, turn the water green, stain boats, and may be toxic to animals that drink the water. When algae dies, the decaying process reduces the amount of oxygen remaining for use by aquatic animals. Heavy rains can wash a variety of suspended materials into water bodies.

Many other pollutants such as bacteria and harmful chemicals can also be transported on sediment. Sediment decreases light transmission thought the water, thus decreasing plant photosynthesis. In addition, livestock waste is another major non-point source pollutant. Wastes can be a major source of ammonia, a by-product of decomposition of fecal matter, uric acid, and urea.

Materials:
- 10 one-quart wide-mouth jars
- 20 sample bottles
- 10 gallons of pond water
- ½ cup grass clippings
- ½ cup liquid fertilizer
- ½ cup topsoil from garden
- 10 measuring spoons
- 10 measuring cups

- 10 thermometers
- 10 turkey basters
- Masking tape
- Permanent ink pen
- Dissolved oxygen kit or meter
- Aluminum foil
- Goggles
- Gloves
- Data chart
- Optional: ½ cup manure (Make sure to wear gloves when handling animal waste)
- Grow light

Note: Some of the equipment can be shared between groups

Preparation:
Order or borrow dissolved oxygen kits or meters. The day before the experiment, obtain topsoil, manure, and fertilizer and grass clippings. (ALWAYS handle any animal waste with gloves and wash hands afterwards.) Collect the pond-water the morning of the experiment. Water can be obtained from an aquarium. Follow standard safety procedures if students collect sample.

Procedures:

1. Explain that the amount of DO present in the water depends on the following: water temperature, amount of air mixed into the water as it moves, the amount of oxygen produced during photosynthesis by aquatic plants, the amount of oxygen used by plants and animals in respiration, and the amount of oxygen used by bacteria to decompose organic wastes.

2. Divide the class into groups of two or three and give each group a clean jar.

3. Using the chart included, assign one of the ten water samples to each team and have them prepare their samples as indicated.

Sample	Treatment
1 & 2	None; 3 cups pond water only
3 & 4	¼ cup liquid household fertilizer in 3 cups water
5 & 6(Optional)	¼ cup manure in 3 cups water (Estimate)
7 & 8	¼ cup grass clippings or leaf litter in 3 cups water
9 & 10	¼ cup topsoil or potting soil in 3 cup of water

4. Have the students swirl their samples (including controls) to stimulate the natural mixing of a body of water. Keep the pond/aquarium water sample to re-fill the jars on day 3 and 7.

5. Have the students label the jars.

6. Have the students to measure and record the room and water temperature and the appearance of their samples on the data chart.

7. Place the uncapped jars in a sunny location near a window. A grow light can be used if a window isn't available.

8. Have the students to record observations on their water samples daily for a course of 10 days. (You may wish to shorten the activity to five days. If you do, only add ½ cup of extra water on day 3 and demonstrate the DO test near the end of the 5-day period.) They are to answer the following questions on their chart:

   Is the water cloudy?
   Has the color changed?
   Is there more algal growth?
   Is a film forming on the surface?

9. On days 3 and 7, have the students add ½ cup of the extra aquarium water into the samples. Make sure the water is at room temperature.

10. Using the DO meter or kit, on the tenth day measure and record the DO of their water samples. (Use a turkey baster to transfer the water into the test bottle)

11. Compile all the class data on an overhead and discuss:
    - DO levels in water can be reduced by non-point source pollutants.
    - DO levels can be reduced when phosphates and nitrates from fertilizers are mixed with water.
    - Bacteria, which decompose organic material often, actively compete with other oxygen-demanding organisms.

Evaluation:

1. Which samples had the highest DO?

2. Arrange the DO's of the samples from highest to lowest and discuss why you got these results.

3. Assuming the water was taken from a stream, what types of fish and macroinvertebrates would likely be present in each of the streams?

4. What are the most likely non-point sources of organic waste pollution in streams?

Extension:

1. Test DO upstream and downstream from a suspected non-point source of fertilizer or livestock waste. Does the DO content differ in these two areas? Why? What factors may be responsible for these differences? REMEMBER: Follow safety precautions.

2. Perform DO test as before on freshwater streams containing different sediment loads. Correlate DO with sediment loads and discuss the results with each student.