Unit 9: Controlling Nonpoint Source (NPS) Pollution

TABLE OF CONTENTS

Unit 9: Controlling Nonpoint Source Pollution

Objectives: Each student will be able to:

- Examine causes and results of NPS pollution
- List ways to control different types of NPS pollution

Technical Terms:

$ algal bloom	$ erosion	$ herbicides	$ point source
$ ammonium	$ eutrophication	$ insecticides	$ riparian zones
$ BMPs	$ fecal coliform	$ IPM	$ sedimentation
$ coliform	$ filter strips	$ legumes	$ sinkholes
$ conservation tillage	$ forage	$ nitrate	$ USTs
$ contour planting	$ fungicides	$ NPS pollution	$ watershed
$ cryptosporidium	$ giardia	$ permeable	

Background Information

Nonpoint source (NPS) pollution is defined as pollution which comes from a widespread area and cannot be traced to a particular source. The other type of water pollution is called **point source** pollution. Point source pollution *can* be traced to a definite source. (Examples include a drain pipe leaking chemicals into a lake, or a leaking underground storage tank). Pollutants which cause nonpoint source pollution can come from many different sources. Stormwater runoff can carry these pollutants for long distances. Both rural and urban areas contribute to NPS pollution.

In the United States, NPS pollution is now considered the greatest threat to water quality. In Alabama, the most common type of NPS pollution is **sedimentation** that results from soil erosion.

The Watershed. Because NPS pollution comes from widespread areas, it is more difficult to correct or reduce than point source pollution. We must often examine the entire watershed to find causes of NPS pollution. As we learned in the unit *How Our Water Becomes Polluted*, a watershed is defined as the land area that drains water to a specific point such as the mouth of a river, stream, dam or lake. Watersheds have physical (not political) boundaries. Therefore, watersheds cross community, county and state lines according to the geographical features of the land. Although the boundaries of a particular watershed are somewhat arbitrary, Alabama can be divided into 10 major river basin watersheds (Figure 9.1).

It is important to approach the control of NPS pollution from the watershed perspective because all human activities in the watershed can contribute to possible pollution: animal and crop production on farms, urban construction sites, forestry operations, mining, home lawns, gardens, etc.

In a watershed, water will drain downhill from higher land. Rainwater will accelerate the movement of water. To control NPS pollution, the entire watershed must be effectively managed to control runoff and the transport of pollutants in runoff.

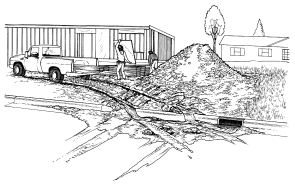
Causes and Results of NPS Pollution

The most common pollutants due to nonpoint sources are:

1) **sediment** from soil erosion
2) **nutrients**
3) **toxic substances**, and
4) **microorganisms**

Sediment. When vegetative cover is removed, soils are more likely to suffer from erosion. The sediment which results from **erosion** is a major cause of water pollution. Erosion is defined as the detachment, transport and deposition of soil particles by water, wind or gravity. Certain soils will erode more easily than others. Sandy soils which have loose particles allow for easy detachment, while clayey soils are usually more resistant to detachment but will wash away more easily once individual particles are detached. Groundwater pollution is more likely to occur in sandy soils because these soils are more **permeable**, making it easier for water to move soluble substances down through these soils. But the type of material immediately below the soil is also important. In Alabama, soil varies quite significantly from one part of the state to another (see map "Soil Areas of Alabama" at the end of this unit).

The slope of land influences soil erosion potential. A hillside will lose more soil in runoff than a flat area when they receive identical rainfall. Disturbing soils for construction or growing crops increases the potential for erosion.



Vegetation protects soil from the beating action of falling rain drops. If the soil is bare, with no plant cover, more soil will be detached and wash away as sediment. Not only do plant leaves break the fall of rain drops, but their roots also help physically hold soil particles in place.

The intensity and amount of rainfall on soil are the main forces that cause erosion. Alabama receives more rainfall than most other states and often this rain comes as strong thunderstorms. The energy from this rain striking the soil, and the runoff that results, can cause more soil erosion than light rainfall in other areas.

Results of Sedimentation

The sediment from eroded soils can cause a threat to water quality by increasing the process of **sedimentation**. Soil particles which have been moved by erosion can deposit in or near waterways. Sand size particles settle to the bottom of water fast but clay may remain in suspension for days. Although some sediment is found in the bottom of most streams due to natural erosion, accelerated erosion can cause levels to increase enough to be a threat to water quality. Largely because of sediment from the Alabama River system, Mobile Bay has to be dredged annually because of a buildup of sediment. As you can see from Figure 9.2, much of the waterways in Alabama eventually drain into Mobile Bay. Results of soil erosion and/or sedimentation effects on water quality include:

- **suspended sediment:** it blocks out light from the sun. Solar energy is necessary for aquatic plant growth, a food supply for fish and other water organisms.
- **deposited sediment:** it clogs waterways and interferes with navigation, increases flooding problems, decreases the holding capacity of reservoirs and destroys wildlife habitat.
- **suspended fine sediment:** it makes water undesirable for drinking.
- **erosion:** it results in the loss of valuable top soil.

- **sediment:** makes water too muddy for swimming, fishing and other recreational activities

Nutrients. Nutrients are chemical elements which are needed by living organisms for proper growth and nourishment. Plants get nutrients from the soil and animals receive nutrients from the food they eat. Nutrients are returned to the environment through plant and animal wastes.

The three most important nutrients for plants are the elements nitrogen, phosphorus and potassium. These elements are often supplied as chemical fertilizers to optimize plant growth in both farm crops and in home landscapes. It is when excess nutrients end up in waterways that pollution problems may occur.

Nitrogen is the most important nutrient for plant and animal growth. Without enough nitrogen, plants may become yellow and stunted with poor fruit and flower production. Plants cannot utilize nitrogen in organic forms such as found in protein, manure, etc.). However, in the soil, nitrogen from organic materials can be converted into **ammonium** (NH_4^+) and eventually into **nitrate** (NO_3^-) forms. Nitrate is the form preferred by most plants. It is very soluble in water and is taken up by plant roots. When soils are deficient in nitrogen, additional sources can be added through chemical fertilizers, manure or by planting **legumes**.

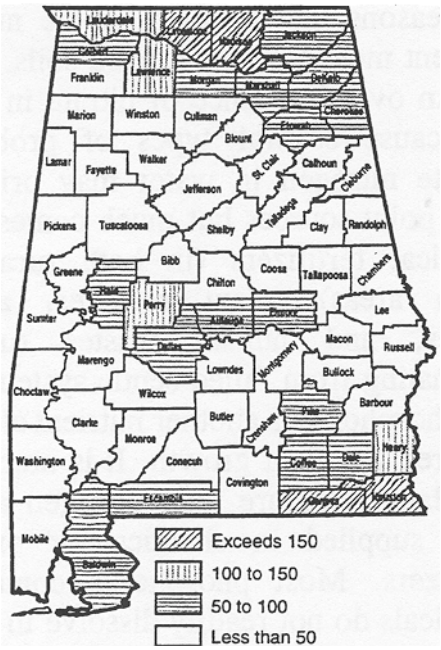
Because nitrate nitrogen is so easily dissolved in water and does not attach to soil clay particles, excess amounts can leach into groundwater or wash out of the soil into streams. This high solubility and poor attraction of nitrate to soil clay are the reasons that nitrogen is the nutrient element most easily lost from soils.

An overabundance of nitrate in water can cause several types of problems. Nitrate nitrogen in water may originate from point sources but much comes from chemical fertilizers (in both rural and urban areas), plant residues, animal wastes, and human wastes (usually originating from failed septic systems).

Phosphorus is another nutrient element required for plant growth. It is much less abundant in nature than nitrogen and is often supplied in chemical or organic fertilizers. Most phosphorus containing chemicals do not readily dissolve in water as well as nitrogen and bind more to soil particles or tend to form insoluble compounds. In NPS pollution, phosphorus presents a problem when eroded soil particles containing excessive phosphorus end up in lakes or streams. New information shows that phosphorus may wash out of soil, even under low erosion rates, where excessive rates of animal manures have been applied. Another source of phosphorus is in the form of phosphates used in some detergents.

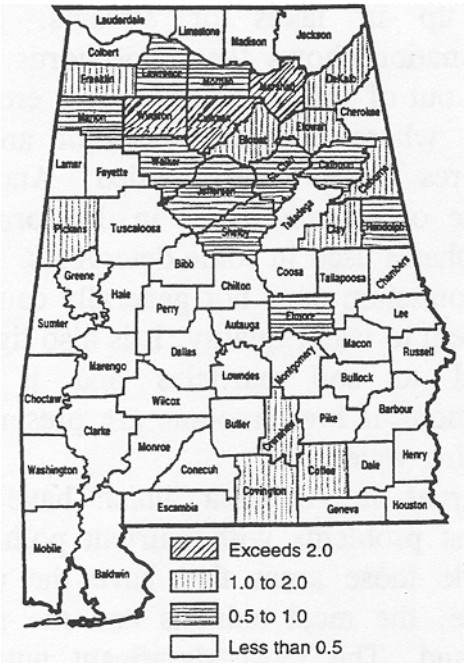
Potassium does not generally cause a problem to water quality. It is also tightly bound to soil particles and is not hazardous if low amounts are present in drinking water.

Areas in Alabama which have the biggest problems with nutrient pollution include those areas that have the most people, the most animals and the most cropland. The most significant nutrient problems from animal waste in Alabama are found in those areas with the most poultry and livestock production like the Sand Mountain area. The following figures show those regions which correspond to the highest concentrations of cropland and animal waste production in the state.



Density of cropland in Alabama in acres of crops per square mile.

Source: ADEM Nonpoint Source Management Program, 1989.



Animal waste production in Alabama in tons per acre per year of cropland and pastureland.

Source: ADEM Nonpoint Source Management Program, 1989.

Results of Nutrient Pollution

In Alabama, since sediment from eroded soils is the most common nonpoint source pollutant in surface water, excess phosphorus attached to these eroded soil particles is also a big threat to nutrient contamination of surface waters. Nitrates, which are more soluble in water, pose more of a threat to groundwater. Results of nutrient pollution include:

- **Eutrophication**. Eutrophication is the accelerated aging of a water body caused by the rapid growth of aquatic plants and low oxygen from the decompostion of plants; it occurs when the water becomes overly enriched with nutrients. In lakes and ponds phosphorus stimulates the growth of blue-green algae which results in **algal blooms.** Algal blooms are large mats of algae which choke out other aquatic life. When they die and decompose the oxygen supply is used up. Not only does this result in fish kills, but the overgrowth of weeds limit water use for fishing, swimming, boating, etc. Decayed and dying aquatic life also creates bad odors and taste problems in drinking water.
- **Nitrates in groundwater.** High concentrations of nitrates in drinking water can be a health risk to infants less than 6 months old. A condition called the "blue baby" syndrome can occur if nitrate is converted to nitrite in a baby's stomach and then gets into the baby's bloodstream. Bacteria in an infant's gut converts nitrate (NO_3^+) to nitrite (NO_2^-). A compound in blood called hemoglobin is responsible for carrying oxygen. If nitrite is present, this binds to hemoglobin instead,

preventing it from binding to oxygen. As a result, the baby is deprived of oxygen; this may cause the baby to turn blue and can result in suffocation in extreme cases. Because infants are on exclusively liquid diets, they are even more susceptible to nitrate-contaminated water. Pregnant women and young livestock are also at risk for this condition.

Toxic Substances. Another category of potential nonpoint source pollutants is toxic (poisonous) substances. These substances include pesticides (both in homes and on farms), petroleum products (from oil spills or leaking underground storage tanks), chemical solvents and cleaners and other toxic chemicals used in industry or in the home and improperly dumped in the environment.

Pesticides. Pesticides, because they are in such widespread use, present the largest potential nonpoint source of water pollution caused by toxic substances. They are used in agriculture, in and around our homes, gardens and lawns, along our roads and rights of way, on our pets and even on our own bodies. Most pesticides are synthetic, or man-made, and are chemicals used to control pests. They can be **herbicides** (to control weeds), **insecticides** (to control insects) or **fungicides** (to control fungi). Some pesticides are very toxic and even very small concentrations in water are unsafe. Others are less toxic, but proper caution should always be used when applying poisonous substances.

Many pesticides are synthetic organic compounds (these are compounds containing the element carbon). They also contain other elements such as hydrogen, nitrogen or chlorine. These compounds do not occur naturally in the environment. You may have heard about "chlorinated hydrocarbons." The insecticide DDT is a chlorinated hydrocarbon—it is a synthetic organic carbon chemical that contains five chlorine atoms. Although DDT was a very effective agent used to control mosquitoes, boll weevils and other insects, the problem with this type of chemical is its long persistence in the environment. (DDT is now banned from use). Toxic effects from some chlorinated hydrocarbons can last for many, many years because they do not break down very readily and pose a problem by building up in the food chain. Most pesticides break down rather quickly in the soil and do not have long-lasting toxic effects (an example is the herbicide Roundup). See Figure 9.3 for a list of several different types of pesticides and their toxicity.

In the United States, it is estimated that over 30% of crops are lost to pests each year; therefore, some sort of pest control is crucial to farmers. In the South, particularly, the warm and humid climate is conducive not only to bugs but also various mold and mildew problems.

There are four main factors which affect the likelihood of pesticides reaching groundwater or surface water:

1) *the properties of the chemical*: its solubility in water, its ability to adsorb to soil particles, its volatility (conversion to a gas), and its ability to degrade, or break down, in the soil.

2) *the properties of the soil*: the texture, permeability of the soil and the amount of organic matter and living organisms present in the soil.

3) *the site conditions*: the proximity to surface and/or groundwater, type of soil, slope of the land and weather conditions.

4) *management practices in the use of pesticides*: the method used to apply the pesticide and the amount and timing of the application.

Some pesticides are not very soluble in water, but instead adsorb to soil particles. These include the following synthetic organic compounds: DDT, aldrin, dieldrin, chlordane, heptachlor, lindane, endrin and toxaphene (of these, only lindane is still in use). Another

group of pesticides are the organophosphorus compounds; these include malathion and diazinon. These compounds break down rapidly in the soil. Carbamate pesticides include aldicarb, carbofuran and oxamyl. These are very soluble in water and are not strongly absorbed by the soil and pose the most threat to groundwater. Therefore, when applying a pesticide, it is important to consider all the factors that could lead to its contamination of water.

In Alabama, more pesticides are used in those areas that have the most agricultural cropland, but pesticides are also used in many other places. Monitoring by the Alabama Department of Environmental Management so far has shown that Alabama does *not* have a problem with widespread pesticide contamination, largely because of the very different geologic regions in the state. Areas that have aquifers in limestone are most susceptible to pesticide leaching because of very permeable soils and the presence of **sinkholes** that connect to groundwater. If you look at the map of the soils of Alabama (notably ones with limestone formations) and the map showing the density of cropland, you can see why these areas are most at risk.

Farmers are not the only ones who need to be concerned with pesticide use. Actually, homeowners generally use more pesticide per square foot on their lawns and gardens than farmers do on their fields. Farmers usually apply pesticides to much larger areas and use calibrated applicators and cannot afford to use rates of two to ten times that recommended by professsionals (which homeowners sometimes do!).

Leaking **underground storage tanks (USTs)** can cause toxic pollutants. These tanks, which are buried underground, are used to store gasoline, diesel fuel, fuel oils and other chemicals. Starting in the 1920's many fuel tanks were buried because people thought they would take up less space and be safer from potential damage. The problem is that they start to leak after a while and cause a danger to groundwater. And there is no way to visually inspect them. Many of the older tanks were not properly sealed and used unprotected steel. There are millions of these tanks underground in both rural and urban areas. Federal laws passed in the 1970's and 1980's, govern the construction, installation, monitoring and maintenance of these tanks. Because pollutants from USTs and discharging of hazardous wastes are considered more of a point source pollution problem, we will not go into a detailed discussion of them here. But petroleum products are the number one pollutant of groundwater.

Results of Pesticide Pollution

Pesticide losses in runoff or leaching not only poses problems to water quality but also economic losses to farmers, homeowners, and society in general when environmental damage occurs. Results of pesticide pollution or the overuse of pesticides include:

- **The destruction of beneficial** insects: Some pests have natural insect enemies. Ladybugs are one example: they help to control aphid populations. Bees are crucial for pollination of fruits and vegetables. When pesticides are applied, not only are the pests killed, but the beneficial insects may also be killed.
- **An increase in pest-resistant plants:** After a while, some plants become resistant to certain pesticides. Through the process of natural selection, these plants (usually undesirable weeds) will survive pesticide applications.
- **The contamination of groundwater:** People in rural areas depend largely on well water for drinking water. If pesticides contaminate this water source, it is very expensive and difficult to clean up.
- **The contamination of surface water:** This can cause fish kills and harm

drinking water supplies for people and wildlife.

Microorganisms. The most common threat to human health from poor water quality is contamination by microorganisms (bacteria, viruses or parasites). Although there is much concern about chronic health effects due to contamination from pesticides, microbial contaminants in water cause more health problems in Alabama and throughout the world.

In the United States, public water supplies are tested for contaminants, filtered and disinfected to remove or kill microbial agents and are generally quite safe. (See unit on *Where Do We Get Our Drinking Water?*). Water contaminated by microorganisms can be more of a problem in rural areas where individuals rely on private wells for drinking water. Private well owners are responsible for having wells tested to make sure the water is safe to drink.

Water can become contaminated with microorganisms; in fact, most surface waters contain many different types of microorganisms. Most of these organisms do not cause human health problems. Generally, the microorganisms introduced through runoff carrying human or animal wastes are of most concern in surface waters.

Bacteria that come from animal feces and even the soil, such as **coliform**, are some of the most common microorganisms that contaminate water. There are several types of coliform bacteria present in the environment. **Fecal coliform** is a harmless bacteria found in the gut and the feces of warm-blooded animals. Although coliform bacteria itself may not be harmful, the presence of total coliform bacteria, and more specifically fecal coliform, in water is an indicator that fecal waste products and other microorganisms might be present. Since it would be difficult to test water for all disease-causing organisms, usually the total coliform count is what is measured. Coliform bacteria are easily detectable by water test kits.

Groundwater is not usually polluted with bacteria unless wells are either improperly placed or improperly constructed or maintained. The major source of bacterial contamination of well water by microorganisms is by surface water entering the well.

Results of Microorganism Pollution

The possibility of serious illness is the greatest consequence of water contaminated by microorganisms, since some of these organisms cause disease. In the United States, particularly in public water supplies, the threat of disease is minimal because water is purified. However, diseases caused by polluted water are of concern in third world countries and can be a threat in private well water that has become contaminated. Illnesses caused by bacterial contamination are usually intestinal disorders with symptoms including diarrhea, nausea and dehydration. Some diseases which may be transmitted by water are: gastroenteritis, dysentery, hepatitis A, cholera and typhoid fever. The following two organisms are ones that have been responsible recently for outbreaks of illness in the United States:

- ***Cryptosporidium*.** You may have heard of the ***cryptosporidium*** outbreak which occurred in Wisconsin in 1993. This organism is a parasite which was found in a public water supply that met all state and federal drinking water standards. Approximately 400,000 people became ill. This parasite can live in the intestinal tract of animals and humans, and is excreted in feces. Runoff of animal wastes after heavy rains or failure of sewage treatment plants can cause it to enter surface waters. Although our water treatment plants purify water fairly well, one form of *cryptosporidum* is not killed by

chlorine which is the typical disinfectant used in treatment plants and swimming pools. The only reliable way to remove this parasite is by extra micro-filtration methods that are not always used in treatment plants. Boiling water can kill *cryptosporidium* in home water supplies. Normally healthy people usually recover from an infection with *cryptosporidium*, however, people with weak immune systems, such as those suffering from AIDS or undergoing chemotherapy for cancer, are more at risk for severe complications.

- ***Giardia.*** This organism is also a parasite which can live in the gut of warm-blooded animals, birds and frogs. It is shed in the feces of these animals and can potentially contaminate water supplies. It also causes intestinal ailments and is difficult to remove by chlorine alone. It is difficult and expensive to test water for *cryptosporidium* and *giardia*. Although some problem organisms such as these do sometimes show up in public water supplies, water treatment plants in the United States generally do an excellent job of delivering good quality water.

Control of NPS Pollution

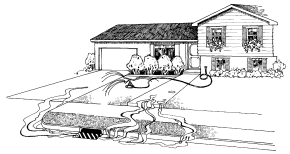
The best way to control nonpoint source pollution is by *prevention* of potential polluting practices. BMPs (best management practices) are methods designed to prevent or reduce pollution while preserving water quality. They can be used both in urban and rural areas. And, of course, when dealing with NPS pollution, it is best to approach solutions from a watershed perspective. The following are some ways we can minimize NPS pollution:

Control of Soil Erosion and Sedimentation

" **conservation tillage:** This leaves at least 30% of the soil surface covered with plant residue after crops are harvested. It decreases erosion and runoff because soil is less disturbed and bare soil is covered.

" contour planting: Plant crops in furrows perpendicular to the slope direction. This reduces soil losses because water runs across the slope instead of straight down.

" **control runoff from yard:** Use mulch and shrubs to allow water to soak into soil, instead of pavement and bare soil. When land is converted to urban subdivisions, natural vegetation is cleared and the soil is much more susceptible to runoff. Too much runoff from urban lots can overload storm sewers. In fact, according to the E.P.A., a city block can generate 9 times more runoff than a wooded area.



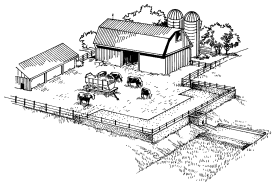
" **filter strips and riparian zones:** Vegetation planted on edges of fields and/or along streams and ponds helps prevent sedimentation. It also aids in filtering nutrients or other pollutants in the soil before they reach surface water. Willow wattles (clumps of willow branches) can also be set into streambanks. Willows will sprout, grow into shrubs and their roots will help hold soil in place. It is preferable to maintain native vegetation along streambanks if land is to be cleared. Riparian zones are ecosystems that support animal and plant life along edges of waterways and can easily be destroyed if the land is altered.

Control of Nutrient Pollution

" **control runoff:** Controlling runoff will help keep nutrients in place. The most valuable soil is the topsoil (usually only the top 8-12"). This is the soil which contains most of the nutrients.

" **proper application timing for fertilizer:** Apply fertilizer at the stage when plants most need nutrients for growth.

- **planting legumes:** Legumes (such as alfalfa, clover, beans and peanuts) can provide ground cover and add nitrogen to the soil. The roots of these plants have nodules which contain bacteria which release nitrogen into the soil. They are also used as forage plants which provide important nutrients to grazing animals.
- **perform a soil test:** Before using any fertilizer, you should first test the soil to find out which nutrients are needed. This is important not only on farms but also in home yards. Apply only the amount of nitrogen, phosphorus, etc. needed. Also, consider the type of soil: very sandy soil cannot hold many nutrients. Use slow-release fertilizers. It was recently determined that most of the nutrient contamination of the upper Chattahoochee River (which is in Georgia) was due to the city of Atlanta. Although farmers often get blamed for much of the pollution problems, homeowners typically use many more pounds of fertilizers per square foot on their lawns and gardens. Also, the tremendous growth of Atlanta in recent years has produced erosion from construction and overloaded water treatment systems.
- **restrict use of phosphate detergents:** Phosphates from detergents may go directly into water systems. Most wastewater treatment plants are not very effective in removing phosphorus before the wastewater is released into a stream.
- properly maintain septic systems: Do not dispose of grease, toxic chemicals or large items down drains. Keep the area over absorption fields clear of tree roots, hard surfaces such as concrete and don't drive machinery over the area. Make sure it is located downslope of any well.
- **properly maintain well:** If you use a well for your water supply, make sure it is properly maintained; the casing should be intact, i.e., not cracked or corroded, and in a proper location.



- **limit livestock access to streams**
- **construct proper storage facilities for manure**
- **use animal wastes for fertilizers:** Using animal wastes or composted vegetation will increase organic matter in the soil and increase the soil's capacity to hold water in addition to adding nutrients. Synthetic fertilizers only add certain elements lost by soil; they do not actually add to the soil itself. The process of building new soil takes a long time.

- **alternate types of crops:** In nature, wide ranges of plant species can grow in the same environment. Some nutrients are required more by some plants than others and growing only one type of plant may use up particular nutrients.
- **store and mix fertilizers properly:** Chemicals should be stored and mixed in a dry location with an impermeable, curb-lined floor.
- **avoid using nitrate-contaminated water:** To prevent "blue-baby" syndrome, avoid mixing powdered formula with water contaminated with nitrates. If using private well water, be sure to have your water tested. Unless the mother is consuming exceedingly high quantities of nitrate, usually little nitrate gets into breast milk.

Control of Toxicants/Pesticide Pollution

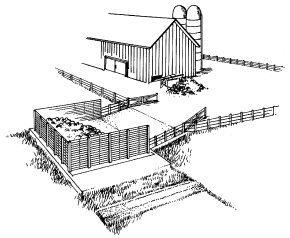
- IPM (Integrated Pest Management): IPM uses a combination of techniques to control insects, diseases, weeds or other pests. Its goal is to control pests with less reliance on chemical pesticides and with the least destruction to the environment.
- plant pest-resistant or disease-resistant strains of plants
- rotate crops: By varying types of crops, crop-specific pests are less likely to get established.
- minimize use of toxic substances: Try using less toxic substitutes for cleaning around the home. For a list, see unit "*How Our Water Becomes Polluted"*

- mix and dispose of pesticides properly: On farms, keep pesticides in a dry location with an impervious curb-lined floor that will contain spills. Triple-rinse and recycle pesticide containers.
- properly calibrate pesticide application equipment: Use only necessary amounts of pesticide and take into consideration soil type and weather conditions (rain, wind, etc.) when applying pesticides.
- do not mix or store pesticides within 100 feet of a well
- recycle used motor oil
- make sure well is properly constructed: A well should be drilled deep enough and the casing should be free of cracks.
- "scout" at least weekly for pests: If your home garden is small, you should "scout" or look carefully at least weekly for any pests. If there are only a few, you may be able to pick them off by hand instead of spraying pesticides.
- attract beneficial insects: By planting flowering plants that will attract beneficial insects that prey on pests, you may be able to rely less on pesticides.

- plant early: Since Alabama has a mild climate, try planting early in the spring, before pests have become established. Till the soil well before planting so that plants will get good early growth.
- keep garden area free of weeds: Insects like aphids and thrips may begin on weeds. Discard diseased lower leaves of plants that are susceptible to water splashing and transporting pests from soil.

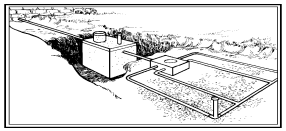
Control of Microorganisms

- **properly place and drill well:** Wells should be upslope of any possible contaminants. The well casing should extend far enough above ground to prevent surface water from entering it. The casing should also be free of cracks and resistant to corrosion.



" **manage animal waste:** Animal waste creates bacterial contamination as well as nutrient contamination. The following procedures may need to be performed:

collection: to prevent runoff
transportation
storage: wet (ponds, lagoons) or drystack
treatment: may be able to compost dead poultry



" maintain septic system: Make sure septic system is properly placed downslope from drinking water. Microorganisms which may be present in waste water are usually absorbed by soil until they are eventually destroyed; therefore, the area around the absorption field should be carefully maintained (see note about septic systems in Control of Nutrient Pollution).

" test private drinking water: It is up to individual homeowners to test drinking water from private water supplies (such as a well). If bacteria or other microorganisms are found, it may be necessary to boil or disinfect the water before using.

As teaching aids to demonstrate the effects of nonpoint source pollution, the Alabama Cooperative Extension System has available for loan the following items (Note: these items are available to anyone in the state of Alabama through the Extension System and the first three are available in several locations):

EnviroScape: This is a table top model of a watershed that can demonstrate results and control of NPS Pollution. If interested in borrowing this model, please contact an Environmental Educator at the ACES Four-H Youth Development Center in Columbiana, Alabama (205-669-4241). Some of the Regional Offices in ACES may also have this model available for loan. Contact your local county agent.

* Septic System and Drainfield Model: A plexiglass model of a septic tank and drainfield that is an excellent teaching aid; a lesson plan is available with this model. Contact the Environmental Education Specialist in 4-H at ACES--Auburn University, your county agent or the 4-H Center in Columbiana to borrow this model.

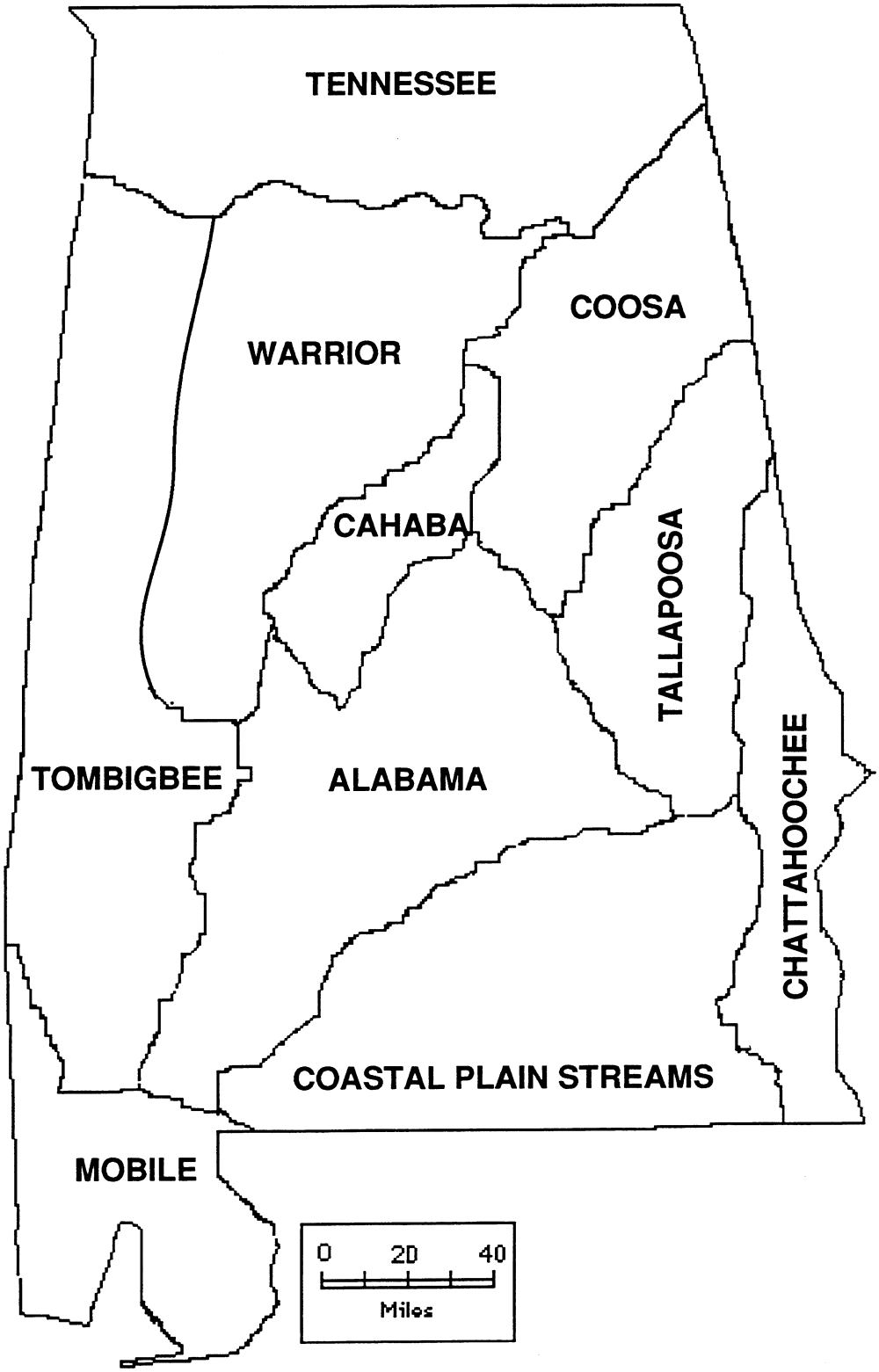
* Groundwater Model: also a plexiglass model, similar to the septic system. Contact the above locations to borrow this model.

soil testing kit: Available for loan, instructions for use included. Contact the 4-H Center in Columbiana.
* Note: these plexiglass models are *extremely fragile*; educators please be careful when handling and transporting.

Sponsor a community "clean-up" of your watershed. Organizations like Alabama PALS (headquarters in Montgomery) sponsor the Adopt-A-Stream program. Also, there is an annual Beach Clean-up for the Gulf of Mexico area.

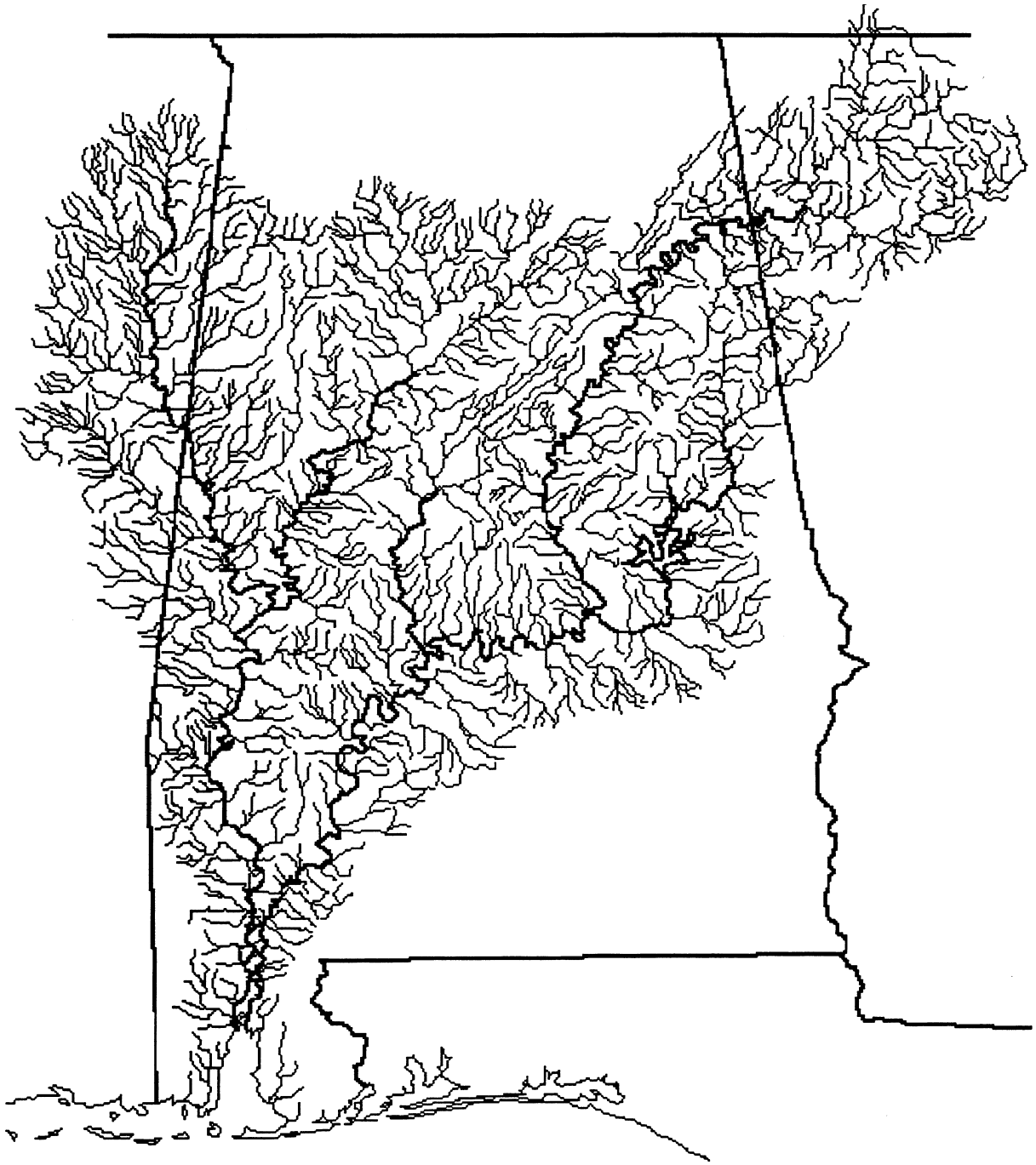
Have your group join the Alabama Water Watch to monitor a local waterway. For information on certification and training to be a member of this organization to monitor Alabama's waters, contact their office at 888-844-4785.

FIGURE 9.1: Watersheds in Alabama



Source: Alabama Water Watch Materials

FIGURE 9.2: Mobile Bay Drainage Basin



Source: Alabama Water Watch Materials

FIGURE 9.3: Toxicity of Pesticides

Chemical Name	Trade Name	[1] Toxicity Class	[2] LD-50 (mg/kg)	[3] Leaching Potential	[4] Adsorption Potential
Insecticides					
acephate	orthene	III	1030	S	S
aldicarb	Temik	I	0.93	L	S
carbaryl	Sevin	III	500-850	S	S
chlorpyrifos	Dursban	II	97-276	S	M
diazinon	Spectracide	II	300-400	S	M
hydramethylnon	Amdro	III	1131-1300	XS	M
lindane	Lindane	II	88-125	M	L
malathion	Malathion	III	1375	S	S
permethrin	Ambush, Pounce	III	4000	XS	M
Herbicides					
alachlor	Lasso	I	930-1350	M	S
atrazine	Scotts Bonus	IV	3080	L	M
dicamba	Banvel	III	1707	L	S
glyphosphate	Roundup	II	4320	XS	L
2,4-D Amine	Weed-B-Gone	III	300-1000	M	S
Fungicides					
benomyl	Tersan, Fertilome	IV	10,000	S	L
chlorothalonil	Daconil, Bravo	I,II or III	10,000	S	L
metalaxyl	Ridomil, Scotts Proturf	II	669	L	M
triforine	Funginex	I or V	716,000	S	S

[1] Toxicity Class

I. Highly Toxic
II. Moderately Toxic
III. Slightly Toxic
IV. Low Toxicity

[2] Oral LD-50 (LD means lethal dose, 50 means 50% and is the amount that will kill 50% of the exposed animals--it is tested in laboratory rats (the higher the number, the safer or less toxic the substance)

[3,4] Leaching and Adsorption Potential (its potential to leach into water or adsorb to soil particles)
XS = extra small
S = small
M = medium
L = large

Note: This is a general list; these chemicals may be available in different concentrations. Generally, formulations for the home are less concentrated than those used on the farm. Also, the LD-50 is given for oral ingestion, some chemicals are also quite toxic if they come into contact with skin. When handling chemicals, proper gloves and safety glasses should be worn and proper mixing and disposal procedures should be followed.

GLOSSARY: Controlling Nonpoint Source Pollution

algal bloom — A sudden large growth of algae in lakes and ponds that can be caused by excessive nutrient (particularly phosphorus) pollution.

ammonium — The ion NH_4^+ derived from ammonia gas which is often combined with other substances and used in fertilizers.

BMPs — Best management practices; methods designed to prevent or reduce pollution while preserving water quality.

coliform — A harmless bacteria found in the gut and feces of warm-blooded animals; the most common microorganism contaminant found in water.

conservation tillage — A method of cultivating farmland that produces less potential for erosion; it leaves at least 30% of crop residue on the soil surface after harvesting crops.

contour planting — Planting crops in furrows perpendicular to the slope direction to reduce soil losses.

cryptosporidium — A parasite found in water that can cause disease; it is resistant to chlorination and requires extra microfiltration methods for removal.

erosion — The detachment of soil particles caused by water, wind, or gravity.

eutrophication — The natural process by which water becomes enriched with nutrients; this process can be accelerated when excessive nutrients are present.

fecal coliform — A harmless bacteria found in the gut and feces of warm-blooded animals; the presence of this bacteria in water supplies indicates that it is contaminated with waste products and may contain other microorganisms.

filter strip — A strip of permanent vegetation above ponds and other structures that retards the flow of runoff water; this causes transported material to be deposited and reduces sediment flow.

forage — Food, such as alfalfa or clover, for grazing animals.

fungicides — Pesticides used to control fungi.

giardia	A parasite found in the gut of warm-blooded animals which can cause disease; it requires extra microfiltration methods for its removal from water.
herbicides	Pesticides used to control weeds.
insecticides	Pesticides used to control insects.
IPM	Integrated Pest Management; a management technique that uses a variety of techniques to control insects, diseases, weeds and other pests; its aim is to rely less on chemical pesticides so that destruction to the environment is minimized.
legumes	Plants (such as alfalfa, clover, beans and peanuts) that can help increase nutrients in the soil; they release nitrogen through their roots.
nitrate	A compound of nitrogen and oxygen (NO_3^-) commonly contained in fertilizers; it is very soluble in water.
NPS pollution	Nonpoint source pollution; pollution which comes from a widespread area, not just a particular point. An example is when sediment is carried by stormwater into waterways.
permeable	Having openings that allow liquids or gases to pass through.
point source	Pollution traced to a single source, such as a factory discharge of contaminated water into a river.
riparian zones	Ecosystems that support animal and plant life along edges of waterways.
sedimentation	The movement of sediment and the addition of soils to lakes or other water bodies.
sinkholes	Openings in the soil that occur when soluble rocks (such as limestone) dissolve below the soil surface and create holes.
USTs	Underground Storage Tanks which store gasoline or other chemicals.
watershed	The area of land which drains into rivers and lakes; it may contain many smaller streams and creeks.

ACTIVITY 9.1: Monitoring Water Quality

Goal:

To become aware of different factors affecting water quality.

Objective:

- To collect information about the physical/chemical characteristics of a stream or lake
- To estimate the water quality of the stream/lake based on knowledge gained through information collected
- To test the following parameters:
  - temperature
  - turbidity
  - pH
  - total hardness
  - total alkalinity
  - dissolved oxygen

Materials:

- Alabama Water Watch test kit and Reporting Forms
- clipboard
- pen or pencil
- rubber boots (knee-high or hip waders, preferably) or old pair tennis shoes
- safety glasses
- rubber or latex gloves
- USGS topographic map of area (optional--available through USGS and some sporting goods stores

Procedure:

1. Select a local waterway: a creek, stream, lake, pond river, etc. You will be performing various tests on this water to determine its water quality for a projected period of time. ***Note: In order to use the Alabama Water Watch test kit, one must be trained and certified through the Water Watch Program.*** The purpose of this program is to train citizen volunteers to monitor water quality in streams and lakes of Alabama. The equipment in the kit will test for several different physical and chemical properties of water. When a specific site is consistently monitored, any changes in the waterway can be identified. Because the data collected is useful only if it is accurately and consistently sampled, it is important that all citizen volunteers be trained in a standardized manner. For information on training, contact the Alabama Water Watch Association (334) 844-4785 or toll-free (888) 844-4775.
2. If possible, try to incorporate a hiking trip with your field trip. This would add some adventure to the activity and give you the chance to examine the area surrounding the waterway.
3. If you are monitoring a creek or stream, try to pick one at least a foot deep. The

site should be fairly easily accessible at all times of the year. Locate your area on the topo map and pay attention to where this waterway is located in the watershed.

4. Being careful not to disturb the natural habitat, wade out to an area of the stream at least a foot deep and away from the shore.
5. Perform the various procedures on the following pages (Temperature, pH, Total Hardness, Total Alkalinity, Turbidity and Dissolved Oxygen). Be sure to be careful when following the directions so that the measures are accurate. Since this activity will be carried out over a period of time, try to be consistent in performing the analyses. Try to perform the tests around the same time of day each time you monitor the stream. You might want to laminate these pages to make them handy to use in the field.
6. Mark your data on the Alabama Water Data Reporting Form and send completed data forms in to the Alabama Water Watch Program at the address provided.
7. Try to monitor your site every month or bimonthly to assess any changes to this waterway.

Discussion:

The purpose of stream monitoring by individuals is both to make citizens more aware of their watershed and to help detect any nonpoint source pollution problems. As these data are collected by the Alabama Water Watch Association across the state, any changes to the water quality of our waterways can (hopefully) be accurately measured.

Discussion Questions:

1. Describe the area surrounding your waterway. Are there any activities upstream of this waterway which may impact its water quality?
2. In terms of the environmental surroundings, what are some of the positive and negative features of this waterway?
3. How do you think this waterway has changed over the years?
4. Which of the tests do you think is the best indicator in assessing the water quality of this water?
5. How would you rate the water quality of your site and which time of year do you think the water quality is best? Why?
6. What have you learned about your watershed by doing this activity?

Desired Outcome:

Students should make an effort to accurately perform all the tests. Based on these data, and in comparing data collected monthly (or at specified intervals), students should try to evaluate the water quality of this site.

Evaluation:

1. To accurately perform various physical and chemical tests.
2. To use the data collected to interpret water conditions and their impact on water quality.
3. To examine this waterway and its relationship to the rest of the watershed in detecting any nonpoint sources of pollution.

Extended Activities

1. Monitor a waterway above and below areas you might think would disturb this water; e.g. a sewage treatment plant, a farm, a golf course, a factory, etc. Be sure to test both sites on the same day so that the conditions will be the same. Are there any differences? If so, which tests showed the most differences?
   Have students hypothesize why there is a difference and how it can be remedied. This is a good way to introduce students to the scientific method: accurate data collection, testing hypotheses and discussion of results. Perhaps the students could write up their findings following formal scientific journal articles. Include an abstract, introduction, methods, results, discussion, etc.
2. Use this activity as a way to have high school students teach a younger group of students (See Creek Teach reference below on the Internet.) If working with a classroom or group of elementary-age students, the older students can have stations set up along the creek where different tests are performed. For example, Station 1 is the pH test, Station 2 tests turbidity, etc. The high schoolers could have signs with their number set up and the younger students would travel from station to station until they have completed the testing. The older students could have the data sheet where all numbers are recorded. This is a good way to compare results. The high school students should be prepared to answer any questions about the testing procedure they perform.
3. Test for stream microorganisms. The presence of E. coli (Escherichia coli) is a coliform bacteria that can be tested in water. The Alabama Water Watch has petri dishes and instructions available if you would wish to test for this organism. Test results must be read on the plates in less than 42 hours and are much more reliable if done in duplicate. A couple of students may wish to take these dishes home, count the number of coliform bacteria that grow within the specified time and compare results. Be careful to properly store and dispose of these plates.
4. Streambank Stabilization Activity: If there is a streambank in your area that has been drastically altered, such that erosion and/or sedimentation could occur, perhaps your group could organize a project to help re-establish the streambank. Willow wattles (clumps of willow branches) have been planted along streams to help stabilize the soil. Willows grow fairly rapidly in moist areas and have shallow root systems that help hold the soil in place. Contact your local county Extension office or the Natural Resource Conservation Service for help in obtaining supplies.

References:

Alabama Water Watch materials

Internet: www.gene.com/ae/ (Access Excellence/Genentech Activities Exchange). Environmental Monitoring Adventure, Creek Teach.

TEMPERATURE

Test Procedure

A thermometer protected by a plastic or metal case should be used to measure temperature in the field.

1. Record air temperature by placing the dry thermometer in the shade until it stabilizes. Record the temperature of the air before measuring water temperature.

2. Submerge the thermometer in a sample of water large enough that it will not be affected by the temperature of the thermometer itself. The sample should be in a clear container so the submerged thermometer can be read when the reading stabilizes.

3. To measure temperature at a particular depth, quickly immerse the thermometer in a sample of water collected from that depth.

Note: Water can usually hold a lot of heat, however drastic changes in temperatures may affect aquatic organisms. Note any power generating plants or hot pavement in area which may generate runoff if you detect high temperatures.

pH

Test Procedure

1. Rinse test tube (0230) with sample water. Fill to 5 mL line with sample water.

2. Add 10 drops of indicator solution. Hold the dropper bottle or pipette vertically to dispense uniformly-sized drops.

3. Cap and invert several times to mix.

4. Insert tube into the color comparator. Match sample color to a color standard. **Record as pH.**

Note: Normally water pH values should be between 5 and 10. Levels outside this range may indicate contamination from such sources as acid rain, fertilizers, pesticides, industrial wastes, etc.

TOTAL HARDNESS

Test Procedure

1. Fill the tube (4488) to the **upper** mark with the water to be tested. 2. Add five drops of Hardness Reagent #5 (4483). Mix.

3. Add one Hardness Reagent #6 Tablet (4484-J). Cap and shake until tablet disintegrates. A red color will develop.

4. Holding the pipette (0352) **vertically** (so that drop size will be uniform), add Hardness Reagent #7 (4487PS-H) one drop at a time, swirling to mix after each drop until the red color changes to blue. Count the number of drops added.

5. To determine the Total Hardness test result, multiply the number of drops added in Step 4 by 10 ppm $CaCo_3$.

(# drops added x 10 = mg/L)

Note: The hardness of water is usually a measure of the amount of calcium and magnesium in water which come primarily from rocks. The origin of the water (coastal water, from a spring (groundwater), surface water, etc.) influences its hardness.

TOTAL ALKALINITY

Test Procedure

1. Fill test tube (0289) to 10 mL line with sample water.

2. Add one BCG/MR tablet (T-2311-J). Cap and shake to dissolve tablet. This turns the water blue.

3. Use the pipette (0352) to add Alkalinity Titration Reagent B (4493PS-H) one drop at a time, shaking the tube after each drop. Continue to add drops until the green-blue color changes to pink. Hold pipette **vertically** while adding drops so that drop size will be uniform. Count the number of drops added.

4. Multiply the number of drops used in Step 3 by 5. Record as parts per million (ppm) total alkalinity as calcium carbonate ($CaCO_3$).

Drops added x 5 =ppm $CaCO_3$ T.A.

Note: Alkalinity measures the amount of bases in water (e.g., bicarbonate, carbonate, phosphate, etc.). These materials which are dissolved in water have the ability to buffer the water against changes in pH (like the addition of acidic substances). Therefore, the higher the alkalinity value, the more stable and resistant the water is to changes in pH.

TURBIDITY

Test Procedure

1. Fill one Turbidity tube (0835) to the 50 mL line with the water to be tested. If the black dot on the bottom of the tube is not visible when looking down through the column, pour out a sufficient amount of the test sample so that the tube is filled to the 25 mL line.

2. Fill the second turbidity tube (0835) with the amount of turbidity-free water that is equal to the amount of sample being measured. Distilled water is preferred; however, clear tap water may be used. This is the "clear water" tube.

3. Place the two tubes side by side and note the difference in clarity.

4. Shake Standard Turbidity Reagent (7520-H) vigorously and then add 0.5 mL to the "clear water" tube. Use the stirring rod to stir contents of both tubes to equally distribute turbid particles. Check for amount of turbidity by looking down through the solution at the black dot. If the turbidity of the water sample is greater than that of the "clear water", continue to add Standard Turbidity Reagent by 0.5 mL increments to the "clear water" tube, mixing after each addition until the turbidity equals that of the sample. Record total amount of Turbidity Reagent added.

5. Each 0.5 mL addition to the 50 mL size sample is equal to 5 Jackson Turbidity Units (JTU's). **If a 25mL sample is used, each 0.5 mL addition of the Standard Turbidity Reagent is equal to 10 Jackson Turbidity Units.

*** Optional: See Test Procedure for Secchi Disk)

TURBIDITY TEST RESULTS

# Measured Additions	Amount in mL	50mL Grad.	25mL Grad.
1	0.5	5JTU	10JTU
2	1.0	10JTU	20JTU
3	1.5	15JTU	30JTU
4	2.0	20JTU	40JTU
5	2.5	25JTU	50JTU
6	3.0	30JTU	60JTU
7	3.5	35JTU	70JTU
8	4.0	40JTU	80JTU
9	4.5	45JTU	90JTU
10	5.0	50JTU	100JTU
15	7.5	75JTU	150JTU
20	10.0	100JTU	200JTU

*** Optional Test Procedure--Secchi Disk

In the deeper water of lakes, ponds, rivers and estuaries the Secchi disk is often used to measure turbidity. Secchi depth measurements have proven to be remarkably repeatable.

1. Attached to a calibrated line, the stick is lowered into the water until it just disappears from sight.

2. The depth (distance from disk to surface of the water) is noted and the disk is slowly raised until it reappears.

3. The depth is noted again and the **average** of the two readings is recorded (in meters) as "Secchi depth," If the Secchi disk reaches the bottom before disappearing, the Secchi Depth is greater than the water depth and cannot be accurately measured. When this occurs it must be noted in your data.

Note: Turbidity is a measure of the cloudiness in water. This can result from sedimentation, a growth of dissolved organic matter or an abundance of plankton. A high amount of turbidity blocks light required for aquatic organisms.

DISSOLVED OXYGEN

Collection and Treatment of the Water Sample

Steps 1 through 5 below describe proper sampling techniques in shallow water. For sample collection at depths beyond arm's reach, a special water sampling apparatus is required. 2 samples are necessary.

1. To avoid contamination, thoroughly rinse the Water Sampling Bottles (0688-DO) with sample water.

2. Tightly cap the bottle and submerge to the desired depth. Remove caps and allow the bottles to fill.

3. Tap the sides of the submerged bottles to dislodge any air bubbles clinging to the inside. Replace caps while the bottles are still submerged.

4. Retrieve bottles and examine them carefully to make sure that no air bubbles are trapped inside. Once a satisfactory sample has been collected, proceed immediately with steps 6 and 7 to "fix" the sample.

5. Duplicate samples must be taken to insure accuracy. Submerge 2 water sampling bottles available in each kit simultaneously. If the 2 readings are more than 0.6 mg/L apart, a third measurement will be taken and the two closest readings will be averaged and reported as the DO value.

TEST PROCEDURE

NOTE: Be careful not to introduce air into the sample while adding the reagents in steps 6 and 7. Simply drop the reagents into the sample. Cap carefully, and mix gently.

6. Add 8 drops of *Manganous Sulfate Solution (4167-G) and 8 drops of *Alkaline Potassium Iodide Azide (7166-G). Cap and mix by gently rotating several times. It will turn brown and cloudy. A precipitate will form. Allow the precipitate to settle below the shoulder of the bottle before proceeding.

7. Add 8 drops of *Sulfuric Acid, 1:1 (6141WT). Cap and gently shake until the reagent and the precipitate have dissolved. A clear-yellow to brown-orange color will develop, depending on the oxygen content of the sample. Some particles will not dissolve after several minutes; these will not interfere with the oxygen analysis.

*NOTE: Reagents marked with an asterisk(*) are considered hazardous substances. Children using these chemicals should be carefully supervised; safety glasses and gloves are recommended.

Following the completion of Step 7, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in the manner, it is not necessary to perform the actual test procedure immediately. Thus, several samples can be collected and "fixed" in the field, and then carried back to a testing station or laboratory where the test procedure is to be performed.

1. Fill the titration tube (0299) to the 20mL line with the "fixed" sample and cap. (This cap has a small hole in its center).

2. Fill the Direct Reading Titrator (0377 syringe) with Sodium Thiosulfate, 0.025N (4169). **Fill the titrator exactly to the "0" line, making sure there are no bubbles.** Insert the Titrator into the center hole of the titration tube cap. While gently swirling the tube, slowly press the plunger to titrate until the yellow-brown color is reduced to a very faint yellow.

3. Remove the Titrator and cap. Be careful not to disturb the Titrator plunger, as the titration begun in Step 2 will be continued in Step 4. Use the screw-cap pipette to add 8 drops of Starch Indicator Solution (4170PS-G). Sample should turn blue.

4.Replace the cap and Titrator. Continue titrating until the blue color disappears and solution turn clear. Read the test result where the plunger tip meets the scale. Record as parts per million (ppm) dissolved oxygen. Each minor division on the Titrator scale equals 0.2 ppm dissolved oxygen.

5. If the plunger tip reaches the bottom line on the Titrator scale (10ppm) before the endpoint color change occurs, refill the Titrator and continue the titration. When recording the test result, be sure to include the value of the original amount of reagent dispensed (10ppm).

6. Remember to do this procedure on 2 samples. Take the average of the 2 results. If the numbers are more than 0.6 mg/L apart, do a third sample and average the 2 closest readings.

Note: Aquatic organisms need oxygen for survival. Low dissolved oxygen levels in water may indicate the presence of pollutants such as sewage or an overgrowth of algae.

ACTIVITY 9.2: Home Water Pollution Prevention

Goal:

To recognize that we can voluntarily reduce water pollution risks around our homes.

Objective:

To fill out the questionnaire on Home Water Pollution Prevention.

Materials:

Questionnaire: Home Water Pollution Prevention

Procedure:

The following questionnaire is to be filled out by students in their homes. It is designed to be a stand-alone activity. The pages may be stapled together to form a packet. The purpose of this questionnaire is to make us more aware of possible pollution risks around our homes and to provide information about ways to prevent these risks.

This questionnaire is patterned after the Farm*A*Syst program: the Farmstead Assessment System. These are a series of questionnaires (or assessments) originally developed to help farmers and rural residents to identify pollution risks on their properties. The results of these findings are used to develop a voluntary action plan to lower these risks. The Farm*A*Syst program has been funded at the federal level by the Cooperative State Research, Education and Extension Service, the National Resource Conservation Service and the Environmental Protection Agency.

These assessments have been used in most all states in America, and many states have developed their own set of assessments that focus on particular pollution risks that may be common in their state. In Alabama, our program is called S*E*A (Self Environmental Assessment). There are three assessments available: Agriculture, Home and Small Business. These assessments are available through the Alabama Cooperative Extension System.

The following questionnaire or assessment was developed to be used by youth and was patterned on the above-mentioned programs. Additional materials were also generously supplied by the Inland Empire West Resource Conservation District in Ontario, California. A youth program called "Protecting Your Water Through a Farm & Home Assessment" was developed by Farm*A*Syst and adapted by the Inland Empire West RCD for youth in their area.

Students may wish to evaluate their own homesites or this could be a community project if these assessments were distributed and the results tabulated to see if certain pollution risks were common to the area. The questionnaires are meant to be strictly confidential--no names--the intent of the questions is to help educate the public on pollution problems and what can be done voluntarily to prevent them.

Home Water Pollution Prevention

WHY WATER?

You may wonder why some people are so concerned with our water resource. Why is it so important to protect this precious resource? Ask yourself what kind of role water plays in your everyday life and you may find the answer.

Did you know that two-thirds of your body consists of water? Because the body relies so heavily on water to perform its functions, we must drink at least six to eight cups of water a day. Our animal and plant communities also depend on water as well for food, nourishment and shelter.

On a larger scale, 75% of our earth is covered in water. It connects us to other parts of the world and provides us with the ability to live here on earth. We depend on water for growing food, cooking, drinking, transportation, growing fibers to make cloth, fishing, swimming and producing electricity through hydropower dams. It is difficult to imagine one item or action that is not connected to water in some way.

It is unfortunate that people have not always recognized the degree to which we rely on water. In the past water has not been used in the best, most efficient and protective ways possible. It has been used to carry away industrial and agricultural waste. Often hazardous materials have been left in the ground where they seep into the water thereby contaminating it. Furthermore, water has been used in a frivolous manner without thought to conservation.

Because we use so much water, and because we ***are*** water, it is important to take steps to improve our water resources. We can achieve this through practicing water conservation in our homes, cleaning industrial waste before it reaches rivers and lakes, and preventing home and farm pollutants from contaminating our water source. Making *small* changes in the ways that people affect water can have a *large* overall effect. Changes made in your community can help to conserve water, improve its quality **now** and provide for our **future.** The first step to achieving this goal is getting the information to learn what **you** can do to be a part of this important project!

WHAT IS A WATERSHED?

Knowing what a watershed is and how it affects the water supply is extremely important. A watershed consists of an area of land where all water drains to a common body of water (e.g. pond, lake, bay). The hills and valleys of a land area define thewatershed. All the water you drink comes from some part of your watershed - whether it is from surface

water or groundwater. Paying careful attention to activities in and around your watershed can have an effect on its water quality. The physical characteristics of your watershed also have an effect on water quality. Soil type, depth to water table (how far from the top of the soil water exists), and distance to surface water may play a positive or negative role in the quality of the water.

Some threats to water quality include pesticide and fertilizer use and storage, septic system maintenance, waste disposal, animal waste and well construction and maintenance. How water is used throughout the entire community is important. However, do not underestimate the importance of responsible water usage right in your own home.

FOCUSING ON YOUR HOME

Acquainting yourself with the physical characteristics of your homesite and becoming aware of potential problem areas are important initial steps to protecting your water. In the water cycle, water travels through the air, over the ground, and through the soil where it encounters many opportunities for contamination. This is where the activities and physical characteristics in your watershed we mentioned above come into play. By taking this simple risk assessment test, you may be alerted to potential problem areas.

HOME CHECKLIST

*Note: POI stands for "point of information."

Drinking Water Quality

1. If your drinking water comes from a well, is it tested for nitrates, bacteria, and other contaminants?
   POI: If your house is located near a factory, farm or drycleaning business your water should be tested for certain contaminants. This is particularly important if you are downhill from pollutants. In rural Alabama, wells are often the most important source of water for home and for farm uses.

   _____ yes,it has been tested
   _____ no, it has not been tested
   _____ not applicable

2. If your drinking water comes from the public water supply, have you requested results of nitrate, bacteria and pesticide testing from your local health department or the water supplier?

   _____ Yes, I did request that information
   _____ No, I did not request that information
   _____ Not applicable

3. Has the water in your home been tested for lead?
   POI: Homes built prior to 1984 may have lead solder in their pipes. Homes built prior to 1939 may have actual lead pipes. Both may contaminate your water. Also, lead is more of a problem in paint. Paint containing lead was banned in 1978.

   _____ Yes, my water has been tested
   _____ No, my water has not been tested

4. Do water faucets located outdoors have backflow prevention devices which prevent contaminants from entering the indoor water supply?

   _____ Yes, these devices have been installed
   _____ No, these devices have not been installed

Water Conservation

5. Are there any leaks in your home water system?
   POI: Record your water meter prior to leaving your home for a period of at least 2 hours. Upon returning, record the water meter reading again. If the readings are not the same, a leak exists somewhere in the system.

   _____ Yes, leaks have been found
   _____ No leaks have been found
   _____ Water meter has not been checked

6. Do you take steps to conserve water at home (i.e. turn off water when brushing teeth, handwash dishes, take short showers, wash large loads of laundry, use low-flow shower heads?)
   POI: Be aware of how much water home activities require.
   toilet = 5.7 gallons per flush
   showerhead = 5 gallons per minute
   dishwasher = 25 gallons
   washing machine = 20-45 gallons per load

   _____ Yes, I conserve water at home
   _____ No, I do not conserve water at home

7. Do you take steps to conserve water in your lawn and garden?
   POI: Watering in the morning and evening conserves water since less evaporation occurs at these times. Using mulch in your garden helps the soil retain water, and planting items that don't require a lot of water such as wildflowers and prairie grasses cuts down on water usage. Keep a rain gauge so you are aware of how much water your yard has received. About one inch of rain per week should be sufficient.

   _____ Yes, I conserve water in the yard
   _____ No, I do not conserve water in the yard

8. Do you use a compost pile rather than a waste disposal?
   POI: Garbage disposals require a lot of water during use. Using a compost could save countless gallons of water. Also, compost added to the soil helps to add nutrients and decrease reliance on fertilizers.

   _____ Yes, I use a compost.
   _____ No, I use a garbage disposal.

9. Does water leak from your toilet?
   POI: You may determine this by adding a few drops of food coloring to the tank of the toilet. If the food coloring appears in the toilet bowl after about 30 minutes without the toilet being flushed, then the toilet leaks water.

   _____ Yes, my toilet leaks water
   _____ No, my toilet does not leak water

10. Do you try to substitute home products that do not contain hazardous ingredients for those that do whenever possible? Some examples include using baking soda, vinegar, soap flakes, citrus solvents. These do not pollute the water supply.
    POI: Words such as CAUTION, WARNING, HAZARDOUS and DANGER indicate that ingredients may be hazardous when used improperly.

    _____ Yes, I substitute with non-hazardous products
    _____ No, I do not substitute with non-hazardous products

Controlling Water Pollution

11. Do you dispose of hazardous wastes (motor oil, paint, varnish, etc.) properly?
    POI: These wastes should be taken to a recycling center or hazardous waste disposal site.

    _____ Yes, I dispose of wastes properly
    _____ No, I do not take my waste to a disposal site

12. Do you limit use of fertilizers and pesticides in your yard?
    POI: You may pull or dig out weeds by hand to prevent use of herbicides. Organic fertilizers such as compost or manure decrease the need for fertilizers.

    _____ Yes, I limit their use
    _____ No, I do not limit their use

13. Do you use salt on icy sidewalks?
    POI: Salt can be harmful to plants, animals and nearby waterbodies. Using cat litter or sand can prevent such damage.

    _____ Yes, I use salt
    _____ No, I do not use salt

14. Do you dispose of pet wastes properly?
    POI: Pet waste should be buried at least 5 inches in the soil or flushed down the toilet. It should never be buried near a vegetable garden or play area, and it should not be used as a compost.

    _____ Yes
    _____ No

15. Do you properly dispose of yard waste, keeping it out of the streets and gutters?
    POI: Lawn clippings should never be swept in the street or ditch. Clippings can either be collected and composted or mulching mowers can be used to leave clippings on the lawn. Many cities collect leaves or yard waste separately from other garbage.

    _____ Yes, I properly dispose of yard waste
    _____ No, I do not dispose of yard waste

16. Do you use a septic system to dispose of wastewater in your home?

    _____ Yes
    _____ No (If answer is no, proceed to question 19).

17. Is the absorption field of the septic system properly placed?
    POI: The absorption field should be located downhill from wells used for drinking water. Also, the area over the absorption field should be free of tree roots, and no heavy machinery should be driven over this area

    _____ Yes
    _____ No

18. Has your septic tank been pumped regularly (at least every 5 years)?

    _____ Yes
    _____ No

19. What type of soil do you have?
    POI: Sandy soil is more susceptible to water contamination. Soil with a fine texture (like clay) produce slow water movement, thus providing a filter that decreases contamination. If you need help in identifying your soil type, contact the Extension System, NRCS or the Geological Survey.

    _____ Coarse, sand-like soil
    _____ Medium, silt/loam
    _____ Fine, clay-like soil

20. Do you actively take measures to prevent soil erosion?
    POI: Although it is a natural process, the erosion process can be accelerated when land is used intensely. Erosion can have an effect on water by contaminating it with sediment or pesticides present in soil particles.

    _____ Yes
    _____ No

21. Can runoff water from your property area reach any nearby surface water bodies?
    POI: Runoff from irrigation, drainage, or stormwater can have an impact if it reaches nearby water bodies. The level of impact is determined by what type of contaminant is in the water, the amount of water, and the landslope.

    _____ Yes
    _____ No

FARM CHECKLIST

If you live on or near a farm, answer the following questions:

Farm Animal Management

22. Do you have livestock/poultry on your property?
    POI: Having animals on your property can have a definite impact on water quality. Animal manure produces nutrients, bacteria and other microorganisms.

    _____ Yes
    _____ No
    If the answer is no, proceed to question 26.

23. Are livestock/poultry located within 100 feet of your water supply?
    POI: It is important to test water for bacteria and nitrate levels. Livestock should be located at least 100 feet downhill from any private water system (well, cistern, etc.). Their access to streams should be limited.

    _____ Yes
    _____ No

24. Is manure stored within 250 feet of your water supply?
    POI: Manure must be stored safely in proper storage facilities to prevent water contamination. At least 250 feet should separate storage sites form the water supply. Manure should also be stored downhill from the water supply.

    _____ Yes
    _____ No

25. Is manure used in garden, lawn and field maintenance?
    POI: Manure can be a valuable resource if used properly. It must be stored under a shelter until it can be used for crops, and it should always be tested for its nutrient content. Be sure to record when manure is applied, and always use calibrated equipment for application.

    _____ Yes
    _____ No

Proper Pesticide Use

26. Are pesticides used on your farm?
    POI: Pesticides are important in agriculture. They have helped the farmer control pests and increased productivity on the farm. However, pesticides are toxic substances and need to be handled properly.

    _____ Yes
    _____ No

27. Is the equipment used to apply pesticides properly calibrated?
    POI: If applicators are not properly calibrated, excess pesticides could be used. It is also important to follow the label before handling pesticides.

    _____ Yes
    _____ No

28. Are pesticides mixed at least 200 feet away (downslope) from your well or any surface water?

    _____ Yes
    _____ No

29. Are your pesticides stored in a safe place?
    POI: A pesticide storage area should be located at least 200 feet downslope from any wells or surface water. The floor should be impermeable (such as concrete, with no cracks). Also, a locked area that is well-labeled provides extra security. All pesticides should be properly labeled.

    _____ Yes
    _____ No

30. Are empty containers disposed of properly?
    POI: Empty containers should be triple-rinsed and taken to a recycling site or approved landfill.

    _____ Yes
    _____ No

Fertilizer Use

31. Are fertilizers used on your farm?

    Yes
    No

32. Do you test your soil for nutrient analysis before applying fertilizer?

_____ Yes
_____ No

33. Is the equipment used to apply fertilizers properly calibrated?
(See POI for question 27)

_____ Yes
_____ No

34. Are fertilizers mixed at least 200 feet away (downslope) of any wells or surface water?

_____ Yes
_____ No

35. Are fertilizers stored in a safe place?
(See POI for question 29)

_____ Yes
_____ No

DISCUSSION

There are other considerations in evaluating your homesite and/or farm that were not introduced in this assessment. Furthermore, there are different focus areas used when evaluating a community area, school or farm. Hopefully, this has given you a general idea of where your home stands in the areas of water protection and conservation. Do not be discouraged if your findings were less than desirable. (A "Yes" answer is not always the most desirable answer to each question). Just being aware of problems makes you better able to take action to reduce risks. Remember, voluntary prevention of pollution is much less expensive than taking measures to fix problems later. Now, it is up to **you** to follow through with the changes that will provide a safer, more abundant water supply for our future!

If you need any additional information on how to correct some of the risks on your home or farm, contact your local county Extension agent. The mission of the Alabama Cooperative Extension System is to educate the public on issues such as agriculture, community resources, nutrition, family and child development and to educate youth with the 4-H program. By using the resources of the Land-Grant Universities, the most current scientific knowledge is able to be delivered to the people in all counties of the state.

ACTIVITY 9.3: Storm Drain Stenciling

Goal:

To use stencils to paint messages about water pollution on storm drains.

Objective:

To create an awareness of the hazards produced by disposing of wastes through the storm drain systems while utilizing various means to prevent continued water pollution.

Materials:

Map of neighborhood
Stencils (made of Mylar--available for loan through the 4-H Youth Development Center in Columbiana, Alabama (205) 669-4241)
Five different stencils are available with the following wording:
Dump No Waste - Drains to Stream
Dump No Waste - Drains to Lake
Dump No Waste - Drains to River
Dump No Waste - Drains to Bay
Dump No Waste - Protect Your Ground Water
Paint (traffic zone latex spray)
Whisk broom
Wire brush
Traffic cones, flag
Safety vests
Cardboard box
Cleanup rags and bags

Procedure:

1. Call city/county Public Works Department for permission to stencil on sidewalks. If you are unable to stencil on sidewalk, place your sign next to the drain where it is clearly visible. (The Public Works Department may even help out by providing paint, cones, maps, etc.)
2. Always remember safety first. Neighborhood areas are safer to work in than downtown city streets. Always have one person designated to watch traffic. Place safety cones around the area to draw attention to your presence.
3. Wait for a day when the weather is dry and the temperature is greater than 50 degrees to get best results. Have stencilers wear old clothes, protective rubber gloves and eyewear, and plastic bags over their shoes. Always have plenty of plastic bags handy to dispose of used gloves, rags, and any garbage you may pick up. Be sure to have a large cardboard box on hand to shield the surrounding areas from the paint drifting.
4. Designate teams of 4 to 6 people, remembering to include one member as a safety lookout. Rotating tasks will allow everyone to have fun on the job.
5. Scrub the area to be stenciled with a wire brush. Dust it off with the whisk broom.
6. Lay the stencil on the designated area while two people hold it in place.
7. Shake the spray paint can for 1 minute.
8. Holding the can 6-8 inches form the stencil, spray the paint while moving the

can back and forth in a sweeping motion until the letters are completely covered. Be careful not to use too much paint, as it will run underneath the stencil causing blurred letters.

9. When completed, carefully lift the stencil from the street. If the stencil is not perfect, do not attempt to wipe the paint and try again. Your stencils will improve with each try.
10. When stenciling is complete, lay the stencils out to dry in a warm, dry place for a day or more. When the paint is dry, the Mylar stencils can be rolled to chip off the paint.

Discussion:

Completing this activity is certain to raise public awareness of the hazards of improper waste disposal. Many people are simply unaware that storm drains are a part of the watershed, connected to local water. Furthermore, most citizens want to protect their local water source and will take steps if they are made aware of what these steps are.

Discussion Questions:

1. Which of these steps was easiest to do? The most fun? Why?
2. What are some other activities in which you can spread this message?
3. What are some ways you can follow up on your work to see that it is still intact?
4. Discuss why protecting water is such an important part of all of our lives.

Desired Outcome:

Students will follow the directions for the stenciling activities, and through their application they will understand that the posting of the message for water protection awareness is an important step in protecting our water source. They will be able to create a stenciled message by using spray paint and a pre-cut stencil. They will also learn how to expand on their project awareness by using flyers, the media, and word of mouth.

Evaluation:

Can students discuss the importance of water source protection awareness and site specific activities that accomplish this goal?

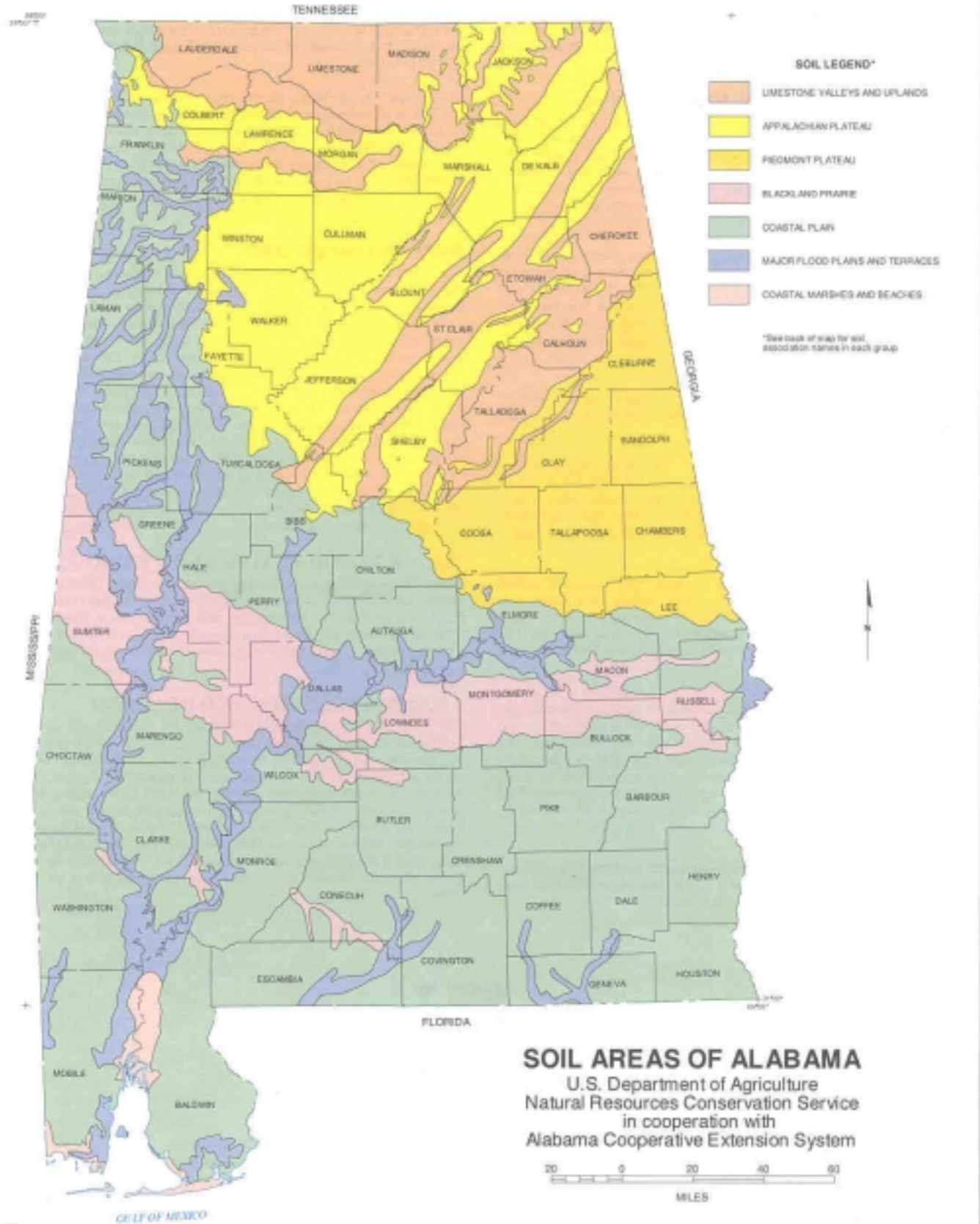
Extending the Idea:

1. Have the students write out the steps to their activity. Have them approach a local media source with their written plan asking for help spreading their message.
2. Have students make fliers stating the following points:
   - ! Most storm drains are not connected to treatment systems, therefore what enters the drains is introduced directly to local waterways.
   - ! Activities such as lawn overfertilization, washing your car on pavement, and dumping yard waste into the gutter pollute storm drains.
   - ! These individual actions accumulate to have a drastic polluting effect on the waterways.

   Make sure these fliers also include alternatives to these hazardous waste disposal practices. Provide residents with recycling facility locations, alternative lawn care, and locations of local government offices offering informative brochures.

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE



Source:
USGS 1:2,000,000 DLG data and information from NRCS field personnel.
Albers Equal Area Projection, 96°W & 23°N, NAD27.

DR. AMI-343
Revised February 1997 1003452-01

USDA, NRCS, NATIONAL CARTOGRAPHY & GEOSPATIAL CENTER, FORT WORTH, TX, 1997

Soils of Alabama

Alabama has several major soil areas. Most of the soils within each area were formed from materials with similar characteristics. Detailed soil surveys, available for most counties, show that each area has several major soil series. A soil series is a part of the landscape with similarities among its properties such as color, texture, arrangement of soil horizons, and depth to bedrock.

LIMESTONE VALLEYS AND UPLANDS

Soils in this area were formed mainly in residuum weathered from limestones. Soils of the Tennessee and Coosa river valleys were weathered from pure limestones and are mainly red clayey soils with silt loam surface textures. Decatur and Dewey soils are extensive throughout the valleys. Topography is generally level to undulating. Elevation is about 600 feet. Most of the land is open and cropped to cotton or soybeans.

Most of the soils of the uplands are derived from cherty limestones. Bodine and Fullerton soils are extensive in many of these landscapes. They typically have gravelly loam and gravelly clay subsoils and gravelly silt loam surface layers. Elevation is about 700 feet, and topography ranges from level to very steep. Cotton and soybeans are major row crops. Much of the area is used for pasture or forest.

APPALACHIAN PLATEAU

The Appalachian Plateau comprises Cumberland, Sand, Lookout, Gunter, Brindlee, Chandler and other smaller mountains. Most of the soils are derived from sandstone or shale.

The more level areas are dominated by Nauvoo, Hartsells and Wynnville soils which were formed in residuum from sandstone. They have loamy subsoils and fine sandy loam surface layers. Most slopes are less than 10 percent. Elevation is about 1,300 feet. Corn, soybeans, potatoes and tomatoes are major crops. Poultry is very important in this area.

The more rugged portions of the Appalachian Plateau are dominated by soils such as Montevallo and Townley, which were formed in residuum from shale. These soils have either a very channery loam, or a clayey subsoil and silt loam surface layers. Most areas are too steeply sloping for agriculture. Elevations range from 300 to 700 feet.

PIEDMONT PLATEAU

Most of the soils in this area are derived from granite, hornblende, and mica schists. Madison, Pacolet and Cecil soils, which have red clayey subsoils and sandy loam or clay loam surface layers, are very extensive. Elevations in most areas range from 700 to 1,000 feet, although in the Talladega Hills, elevations range from 900 to 2,407 feet (highest point in Alabama). Topography is rolling to steep. Most rolling areas were once cultivated but are now in pasture or forest.

COASTAL PLAIN

Most of the soils in this area derived from marine and fluvial sediments eroded from the Appalachian and Piedmont plateaus. The area consists of Upper and Lower Coastal Plains.

Smithdale, Luverne and Savannah soils are extensive in the Upper Coastal Plains. They have either loamy or clayey subsoils and sandy loam or loam surface layers. Savannah soils have a fragipan. Topography is level to very steep. Narrow ridgetops and broad terraces are cultivated, but most of the area is in forest. Elevations range from 200 to 1,000 feet.

Dothan and Orangeburg soils are very extensive in the eastern part of the Lower Coastal Plains. They have loamy subsoils and sandy loam or loamy sand surface layers. Smithdale and Ruston soils are very extensive in the western part. These soils have loamy subsoils and sandy loam surface layers. Most slopes are less than 10 percent. Major crops are corn, peanuts, soybeans and horticultural crops. Timber products and hogs are very important. Elevations range from sea level to 500 feet.

BLACKLAND PRAIRIE

This area of central and western Alabama is known as the "Black Belt" because of the dark surface colors of many of the soils. These soils were derived from alkaline, Selma chalk or acid marine clays. Acid and alkaline soils are intermingled throughout the area. Sumter soils, which are typical of the alkaline soils, are clayey throughout and have a dark-colored surface layer and a yellowish colored subsoil. Oktibbeha soils are acid and clayey throughout. They have red subsoil layers overlying chalk. The clayey Wilcox, Mayhew, and Vaiden soils are the dominant soils of the rolling pine woodlands along the southern edge of the "Prairie." They are acid and are somewhat poorly drained or poorly drained. They are locally known as "flatwoods" or "post oak clays." These clayey soils contain a high percentage of smectitic clays and they shrink and crack when dry and swell when wet. The area is level to undulating. Elevation is about 200 feet. Soybeans is the main crop. Most of these soils are used for timber production and pasture.

MAJOR FLOOD PLAINS AND TERRACES

The soils are not extensive but important where they are found along streams and rivers. They are derived from alluvium deposited by the streams. The Cahaba, Annemaine, and Urbo series represent major soils of this area. A typical area consists of cultivated crops on the nearly level terraces and bottomland hardwood forests on the floodplain of streams.

COASTAL MARSHES AND BEACHES

The soils are not extensive. They are on nearly level and level bottomlands, and tidal flats and beaches along the Mobile River, Mobile Bay, and the Gulf of Mexico. Most of the soils are deep and very poorly drained Dorovan and Lafitte series have very dark grayish brown, muck surfaces over a thick blackish muck which is over brownish sand. Axis soils have a very dark grayish brown mucky sandy loam surface over a very dark gray sandy loam subsoil. Levy soils have a gray silty clay loam surface over gray clay. Fripp and Duckston soils have a grayish sand surface over white, grayish or pale brown layers of sand. Elevation is from sea level to a few feet above sea level.

Charles C. Mitchell, Jr.,
Extension Agronomist,
Professor, Agronomy and Soils,
Auburn University

J. Cameron Loerch,
State Soil Scientist, USDA-NRCS

ALABAMA COOPERATIVE Extension SYSTEM

Issued in furtherance of Cooperative Extension work in agriculture and home economics,
Acts of May 8 and June 30, 1914, and other related acts, in cooperation with the U.S. Department of Agriculture.
The Alabama Cooperative Extension System (Alabama A&M University and Auburn University) offers educational programs, materials,
and equal opportunity employment to all people without regard to race, color,
national origin, religion, sex, age, veteran status, or disability.
USDA-NRCS,10M, Rep. 2:97, ANR-340

ALABAMA WATER WATCH DATA REPORTING FORM

Group/Collector Name_____Contact/Phone_____

Date (mmddyy)_____Time (24h or military)_____Site Code___**Test Kit Number**_____

Watershed_____Waterbody Name_____

Sampling Site Location_____

Weather Conditions (Circle One)

1 = Clear 2 = Partly Cloudy (30-60%) 3 = Cloudy 4 = Fog

5 = Drizzle 6 = Intermittent Rain 7 = Rain 8 = Haze

Streamflow (Circle One)

1= Ponded 2 = Low 3 = Normal 4 = Bank Full 5 = In Flood

Tide Conditions (Circle One)

1 = Rising 2 = Falling 3 = High Tide 4 = Low Tide

Stream/Lake Conditions (Circle One)

1 = Rising Stage 2 = Falling Stage 3 = Level Stage

Stream Appearance (Water Color etc - Describe site/water conditions - i.e. odors, oily sheens, foam, debris).

PARAMETER	VALUE	UNITS	COMMENTS
Air Temperature		C	
Water Temperature		C	
pH		SIU	
Dissolved Oxygen		mg/l	
Alkalinity		mg/l	
Hardness		mg/l	
Turbidity		JTU	
Secchi Depth		m	
Salinity		Spec. Gravity	
Diss. Oxygen Saturation		%	
Acidity		mg/l	
Ammonia		mg/l	
Carbon Dioxide		mg/l	
Nitrate		mg/l	
Nitrite		mg/l	
Phosphate		mg/l	

If you have additional parameters use a second form and attach it to the first.

To report macroinvertebrate bioassessment data use bioassessment data forms.

Signature _____Date Form Completed_____

Send white and yellow copies of completed data forms to: Alabama Water Watch Program, Fisheries Dept., Swingle Hall, Auburn University, AL 36849.

White Copy - Alabama Water Watch
Yellow Copy - ADEM
Fink Copy - Collector's Organization
Gold Copy - Collector

TSU Publications 209-056

To be completed by data checker -

Date Checked: _____ Initials of Checker _____

Followup needed: _____ Yes _____ no

Type of followup _____