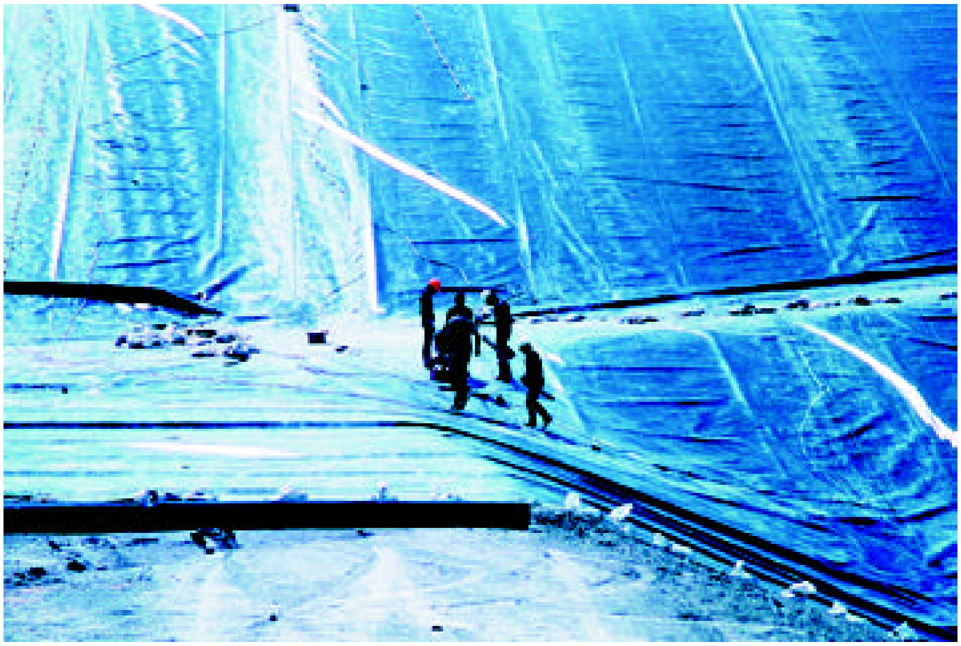
# GROUND WATER CONTAMINATION

Alabama enjoys an abundant supply of ground water that, if managed wisely, will help fulfill our need for clean water indefinitely. As citizens, we should be aware of potential threats to our ground water supplies and help to protect those supplies from contamination. Contaminated ground water may be unfit for certain uses and may become harmful to humans, animals, vegetation, and property. Treatment of contaminated ground water is usually expensive, and sometimes a contaminated water supply must be abandoned and a new supply located. Preventing contamination before it occurs is the best solution. Because ground water contamination can have such serious consequences, many citizens, as well as local, state, and federal agencies, are taking action to protect ground water resources.



*Installation of liner in hazardous waste storage pit.*

# POTENTIAL CONTAMINANT SOURCES

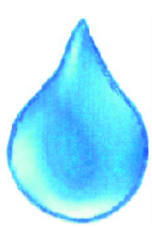
Common sources of anthropogenic contaminants include septic tanks and privies; underground storage tanks; areas where fertilizer, pesticides, or herbicides are used or stored; landfills; and unauthorized dump sites. A more complete list of potential sources of ground water contamination is shown in Table 1.

The most common sources of ground water contamination nationwide are underground storage tanks (**UST**'s), septic systems, pesticides, and nitrates. The Alabama Department of Environmental Management (**ADEM**) considers UST's and failing septic systems to be the most serious threats to ground water in Alabama, because they are so numerous. Other sources of potential ground water contamination include unauthorized hazardous waste disposal sites, old landfills, unauthorized dumps, and abandoned wells.


*Common products which can contaminate ground water*

*Applied correctly, pesticides and fertilizer have minimal impact on ground water quality.*

Ground water contamination occurs when ground water comes in contact with naturally occurring contaminants or with contaminants introduced into the environment by anthropogenic activities. Naturally occurring substances found locally in soil and rocks that can affect ground water include lead, iron, manganese, aluminum, selenium, and arsenic, as well as petroleum, **microorganisms**, and **brine** (salty water). Contaminants associated with human activity most commonly include bacteria, petroleum products, natural and synthetic organic compounds, fertilizer, pesticides, herbicides, and metals.



*One gallon of gasoline can render more than one million gallons of water unfit to drink!*


Potential Sources of Ground Water Contamination
Precipitation
Strip mine
Chemical plant
Lake
Crop dusting
Farmland
Ocean
Confined animal lot and lagoon
Hazardous waste landfill
Wetland
Runoff
Sinkhole
Septic system
Spring
River
Flowing well
Sanitary landfill
Irrigation
Beach development
Abandon
undergroun
coal mine
Limestone
Domestic well
Cave
Direction of ground water movement
Municipal well
Underground storage tank
Water table
Coastal Plain sediments
Freshwater-salt-water interface

**Table 1.** ***Potential Sources of Ground Water Contamination (Based upon lists compiled by EPA and ADEM)***

1. Improperly functioning septic tanks
2. Gas stations/service stations
3. Dry cleaners
4. Agricultural chemicals, fertilizer, and pesticides spreading/spraying
5. Truck terminals
6. Fuel oil distributors/storage
7. Oil pipelines
8. Auto repair shops
9. Body shops
10. Rustproofers
11. Auto chemical suppliers/ wholesalers/retailers
12. Pesticide/herbicide/insecticide wholesalers/retailers
13. Small engine repair shops
14. Furniture strippers
15. Painters/finishers
16. Photographic processors
17. Printers
18. Car Washes
19. Laundromats
20. Beauty salons
21. Medical/dental/veterinarian offices
22. Research laboratories
23. Food processors
24. Meat packers/slaughterhouses
25. Concrete/asphalt/tar/coal companies
26. Treatment plant lagoons
27. Railroad yards
28. Stormwater impoundments
29. Cemeteries
30. Airport maintenance shops
31. Airport fueling areas
32. Airport firefighter training areas
33. Industrial manufacturers
34. Machine shops
35. Metal platers
36. Heat treaters/smelters/descalers
37. Wood preservers
38. Chemical reclamation sites
39. Boat builders/refinishers
40. Industrial waste disposal sites
41. Wastewater impoundment areas
42. Municipal wastewater treatment plants and land application areas
43. Landfills/dumps/transfer stations
44. Junk/salvage yards
45. Subdivisions
46. Individual residences
47. Heating oil storage(consumptive use) sites
48. Golf courses/parks/nurseries
49. Sand and gravel mining/other mining
50. Abandoned wells
51. Manure piles/other animal waste
52. Feedlots
53. Agricultural chemical storage sites
54. Construction sites
55. Transportation corridors
56. Fertilized fields/agricultural areas
57. Petroleum tank farms
58. Existing wells
59. Nonagricultural applicator sites
60. Sinkholes
61. Recharge areas of shallow and highly permeable aquifers
62. Injection wells
63. Drainage wells
64. Waste piles
65. Materials stockpiles
66. Animal burial sites
67. Open burning sites
68. Radioactive disposal sites
69. Salt-water intrusion
70. Mines and mine tailings

# UNDERGROUND STORAGE TANKS

UST's are commonly used at service stations, refineries, and other industrial sites where gasoline, fuel oil, and other chemicals are used. If these tanks develop leaks, ground water supplies can be seriously contaminated. Between 5 million and 6 million UST's exist nationwide. About 17,000 inventoried UST's are currently in use in Alabama at about 6,000 locations. To date, soil or ground water has been contaminated by leaking UST's at about 9,000 sites in Alabama. Cleanups have been completed at about 75 percent of these sites. Cleanup is continuing at approximately 1500 more locations. Sometimes owners cannot be found or do not have the money to clean up these sites. **EPA** and **ADEM** are requiring new UST systems to meet standards that should sharply reduce the incidence of new leaks and aid in detecting leaks quickly when they do occur.

*Testing an underground storage tank for leaks.*

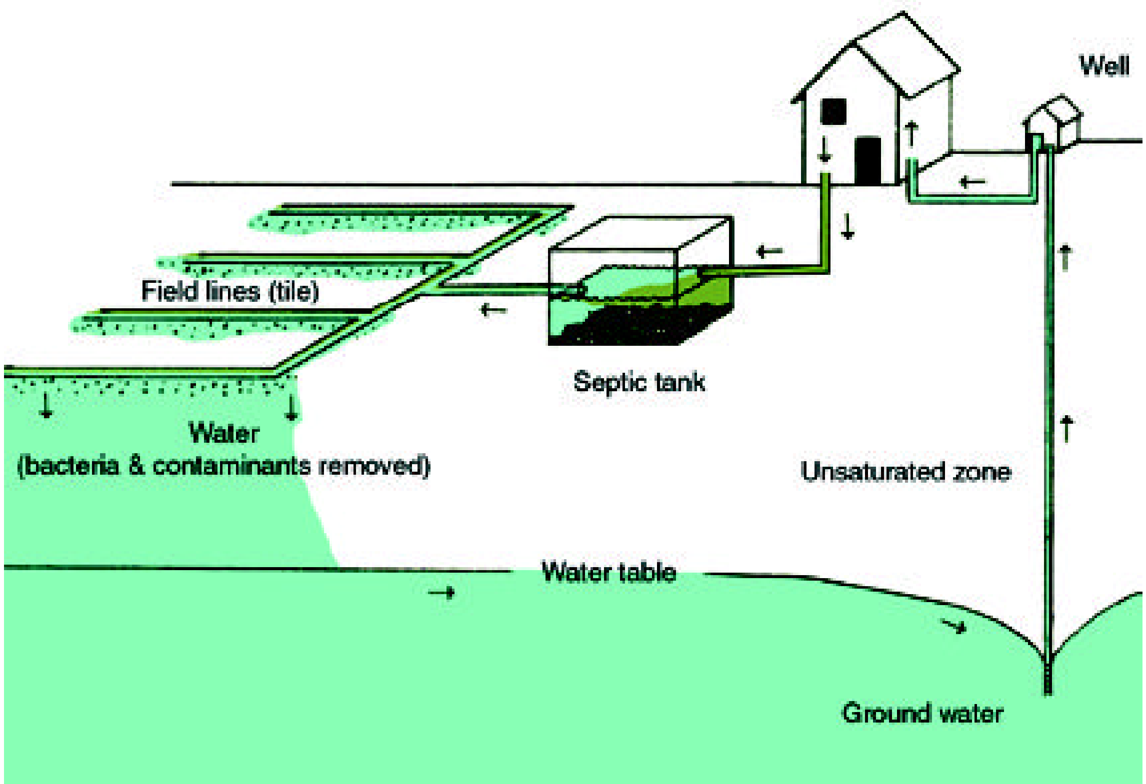
*Leaking underground storage tanks have caused more than 90 percent of soil and water contamination in Alabama, but 75 percent of known releases have been cleaned up.*

*Leaking underground storage tanks are the leading cause of ground water contamination in Alabama. Underground storage tanks must meet standards to prevent and detect leaks and spills.*

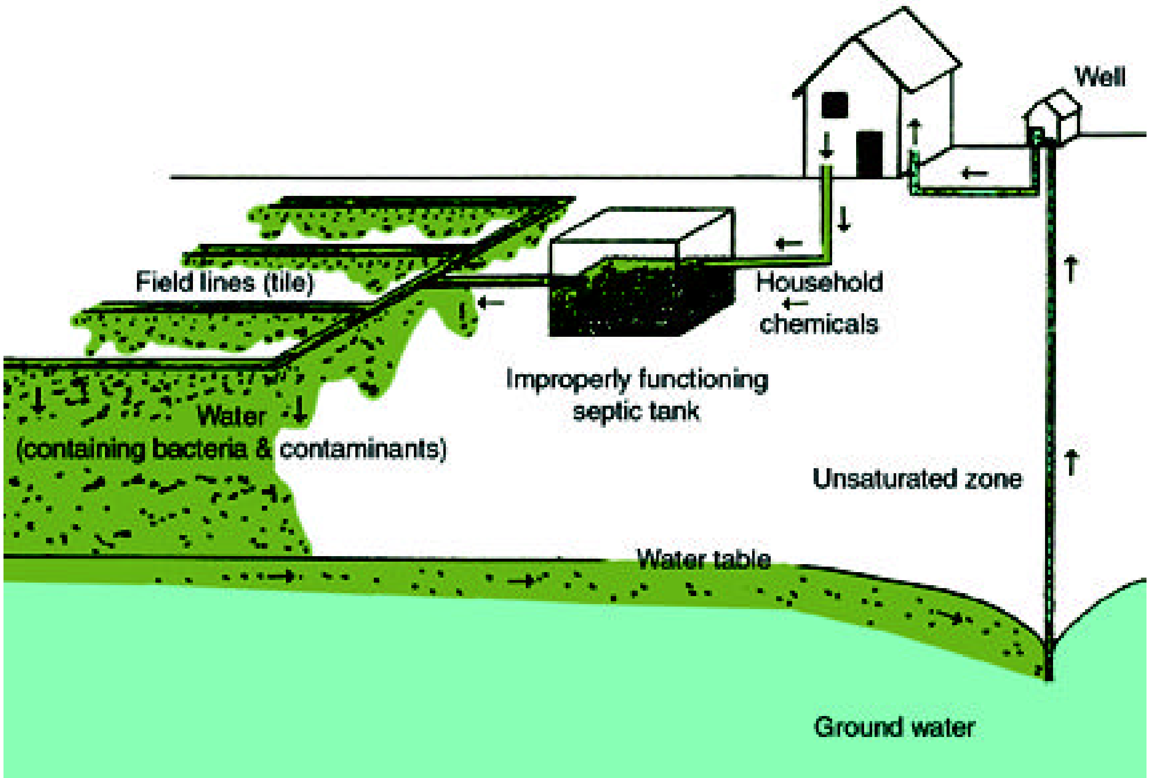
# SEPTIC SYSTEMS

Septic systems are the most common on-site domestic waste disposal systems in use. It is estimated that more than 670,000 active septic systems exist in Alabama, along with an unknown number of older, abandoned systems. More than 20,000 new systems are permitted annually. If properly installed, used, and maintained, septic systems pose no threat to water quality; however, the Alabama Department of Public Health estimates that as many as 25 percent of all septic systems in Alabama could be failing. Every septic system that malfunctions is a potential source of ground water contamination and can have consequences that extend beyond the boundaries of the owner's property.

Properly functioning septic systems are a simple and effective way to manage household waste. The waste first enters a tank where solid materials settle out and are digested by bacteria. The solids must be periodically cleaned from the tank to prevent blockage of field lines and subsequent overflow. Liquid waste passes from the septic tank into the field lines, where it percolates down through the soil. Breakdown of these wastes is accomplished before the wastes reach the water table by bacterial action in the septic system and the soil and by the filtering effect of the soil. Introducing hazardous household wastes, including oil, powerful cleaners, and other substances into the septic system may kill the bacteria in the septic system and impair the system's efficiency. Septic systems do not work well in some parts of the state, such as the coastal areas because soil conditions there are unfavorable. To provide adequate filtering of liquid wastes, septic systems require a fairly thick and moderately permeable unsaturated zone. In some locations, soils may be thin and the underlying rock, for the most part, impermeable. Near the coast, the sandy soils may be too permeable to properly filter out contaminants or the water table may be too near the land surface to allow for proper operation. If a septic system ceases to function correctly, contaminated wastewater may enter the shallow aquifer, which could threaten the homeowner's own well. If contaminated wastewater from a malfunctioning septic system saturates soils this could also result in a surface discharge that could be a health hazard and would not be allowable under state law.




*If a septic tank is well designed and functioning properly, contaminants are removed before reaching the water table.*




*Contamination from a malfunctioning septic system. This household is in danger from a contaminated water supply.*

# PESTICIDES

Pesticides are common ground water contaminants. About 3.8 million pounds of solid pesticides and 450,000 gallons of liquid pesticides are applied in Alabama each year to kill insects, rodents, mold, and weeds. Some pesticides are now prohibited by EPA because they were contaminating surface and ground water. Others are being studied to determine how their use should be restricted.

Most modern pesticides when used properly degrade naturally with time and generally do not pose long term contamination problems. Therefore, contamination of aquifers by pesticides travelling long distances is unlikely. Instead, pesticide contamination of shallow aquifers through direct runoff and **infiltration**, and contamination through abandoned or improperly sealed wells and sinkholes are more likely.

*Agricultural Spraying Utilizing Aerial Application*

The presence of trace quantities of pesticides in drinking water is not uncommon, but instances where concentrations exceed permitted levels are rare. Nationwide, about 10 percent of public water supply wells contain detectable amounts of pesticides, but less than 1 percent contain quantities sufficient to constitute a public health risk. Where this occurs the water must be treated to remove contaminats before being provided to the public. One quarter of the private wells and springs tested by ADEM have contained detectable quantities of pesticides. Three percent of the private wells and 6 percent of the springs had concentrations that exceeded drinking water standards or health advisory limits.

# NITRATES

Nitrates, chemical compounds commonly used as fertilizer, can be a significant threat to ground water quality. On-site residential septic tanks can also be a source of nitrates. Nitrates, unlike most agricultural and lawn chemicals, do not chemically degrade with time. If more nitrate compounds are applied than can be absorbed by plant root systems, they are likely to contaminate shallow ground water. Nitrate in drinking water can cause health problems in small children, notably a type of anemia called methemoglobinemia, or blue baby disease. About 1 percent of public drinking water wells in the United States exceed established levels of nitrates for public drinking water supplies. Nitrate contamination has caused the abandonment of more ground water supplies nationwide than toxic wastes. More than 42 billion pounds of fertilizer is used annually in the United States.

**Nitrate contamination has caused the abandonment of more ground water supplies nationwide than toxic wastes.**

Unsafe levels of nitrates have been found in some private wells in Alabama, although the extent of the problem is difficult to determine. Agricultural areas characterized by large amounts of rainfall and sandy, permeable soils, such as the southern part of Alabama's Coastal Plain, tend to be more vulnerable to nitrate contamination.

Concentrations of nitrate will also vary with the season and rainfall. The detection of nitrate above 3.0 milligrams per liter (mg/L) usually indicates that nitrate from anthropogenic sources is entering the ground water. In a study conducted on 158 residential wells in Houston County, about 5 percent of the wells contained nitrate concentrations between 5 mg/L and 10 mg/L. Less than 1 percent of the samples showed nitrate levels exceeding the drinking water standard of 10 mg/L. In a Geneva County study no samples had nitrate concentrations exceeding 5 mg/L. A similar study conducted in the Tennessee Valley region of the state showed approximately 20 percent of the samples to contain between 5 and 10 mg/L of nitrate; only 1 percent showed nitrate levels at or above 10 mg/L. The Alabama Department of Public Health recently tested 479 wells throughout the state for nitrate. Three of these wells exhibited unsafe levels of nitrate, but one of these was located between two chicken houses which could be a source of nitrates. The other two were old and shallow wells, the kind most susceptible to contamination. The other 476 wells (more than 99 percent of the total) contained levels of nitrate lower than 10 mg/L.

Some midwestern states with heavy agricultural production have more serious problems with nitrates in ground water than Alabama. This difference might be explained by differing soil types and agricultural practices.

# LAND DISPOSAL

People have used the land to dispose of unwanted materials and garbage since the beginning of civilization. We have learned much about early cultures by studying artifacts found in their garbage heaps. As knowledge grew of how diseases are spread, the practice of burying waste began, especially organic, degradable waste, which contains or supports the growth of **pathogens** (microorganisms that cause disease). These materials are sometimes referred to as putrescible waste.

While the burial of these materials eliminated a pathway for the spread of disease, it meant that they were placed close to or sometimes within the water table, creating sources of ground water contamination. Rainfall infiltrates the layers of waste, creating contaminated **leachate** that can pose a threat to surface waters as well as ground water. Today, our country is having to deal with soil and ground water contamination caused by land disposal of industrial waste as well as wastes typically sent to

*An authorized non-hazardous waste landfill* sanitary landfills. Sanitary landfills continue to be the receptacles for residues of acidic or caustic household cleaners, batteries, leftover paint, and common engine cleaning products containing solvents.

The federal Resource Conservation and Recovery Act, **RCRA**, now requires protective liners in landfills, leachate collection systems, and monitoring of area ground water. This is true for landfills used for disposal of hazardous waste and non-hazardous waste from residential sources. Industrial and commercial waste sent to landfills may contain much more concentrated sources of toxic materials. Toxic materials that may be concentrated in industrial and commercial waste include metals, and solvents used for dry cleaning and degreasing such as tetrachloroethylene and trichloroethylene.

Because suitable landfill locations are becoming increasingly difficult to find, and no one wants a landfill located next to his or her property, landfill space is at a premium. Many communities have begun aggressive recycling efforts to conserve landfill space so it will last longer.

# TRASHING THE LANDSCAPE

> **Our country is having to deal with soil and ground water contamination caused by land disposal of industrial waste as well as wastes typically sent to sanitary landfills.**

In many rural areas, dead end dirt roads and sinkholes commonly become disposal sites for garbage and other waste materials. These places are eyesores, posing a threat to ground and surface water quality and promoting the spread of disease through the growth of insect or rodent populations that can transmit disease. Organisms such as these which carry disease-causing pathogens are called **vectors**.

Hazardous materials, dead animals, and even household garbage placed in uncontrolled dumps where surface water has easy access to the underlying aquifer can quickly contaminate that aquifer. Limestone aquifers with sinkholes are particularly susceptible to contamination in this way, but all shallow aquifers can be seriously damaged by unregulated dumping.

Sinkholes like this one are thoughtlessly used for dumping trash, with unsafe and expensive consequences for ground water supplies.

# UNDERGROUND INJECTION

There are state laws and regulations which prohibit illegal dumping. If you find an illegal disposal site, you should contact the Solid Waste Branch of the Alabama Department of Environmental Management.

The subsurface environment has been used for centuries to dispose of liquid wastes such as household wash waters and sewage. This was commonly done through construction of underground catchment basins called cesspools. These structures allowed liquid wastes to gradually discharge to the surrounding soils and ground water. Today, in areas where there are no sanitary sewers or central treatment systems for homes to connect to, septic tanks and drainage fields are used.

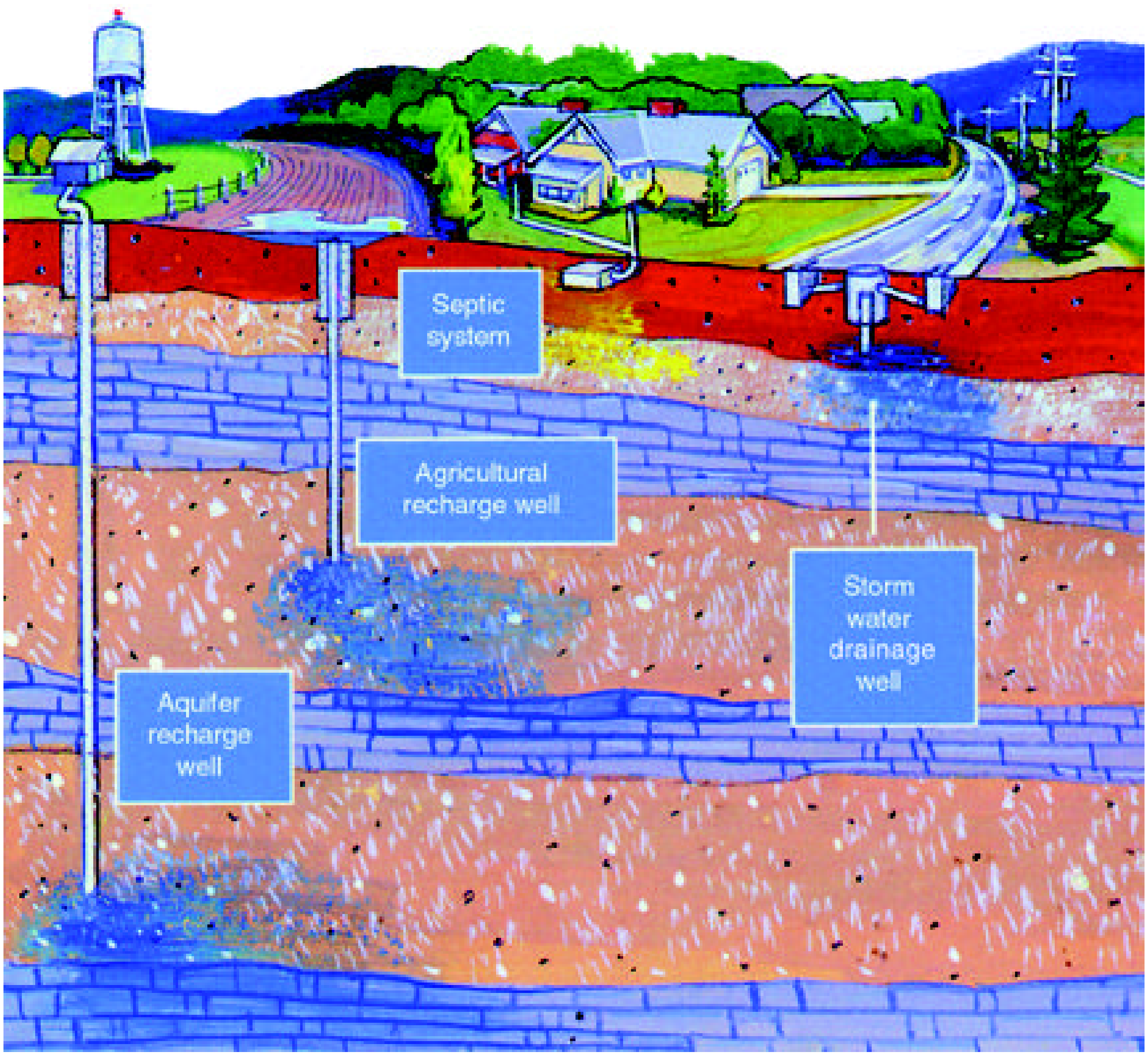
As our civilization has developed, new types of liquid wastes, such as those from manufacturing operations, had to be disposed of. Most of the time, liquid wastes were discharged to surface streams. If a stream or river was not available, the subsurface was again used. Wastes were sometimes pumped under pressure into surrounding soils, rock, and ground water. Typically, these wastes were given little or no treatment.

Improper subsurface waste disposal can contaminate ground water and threaten both public and private drinking water wells. The **Underground Injection Control** (**UIC**) Program was developed under the federal **Safe Drinking Water Act (SDWA**, 1974) to prevent contamination of underground sources

**Improper subsurface waste disposal can contaminate ground water and threaten both public and private drinking water.**

of drinking water by improper disposal of wastes through underground injection, or injection wells.

In Alabama, subsurface disposal of household wastewater and sewage through septic tanks and field lines is permitted through the county offices of the Alabama Department of Public Health. The Alabama Department of Environmental Management regulates any other type of subsurface liquid disposal through the UIC Program. This national regulatory program separates the different types of underground injection activities into five classes of disposal wells.




Shallow injection wells

Class I – Wells used to dispose of wastes below the deepest aquifer that could be used as a source of drinking water. This type of well is no longer permitted in Alabama, and all existing wells have been closed.

Class II – Wells used to inject fluids associated with the production of oil and natural gas. Injection occurs below the deepest aquifer that could be used as a source of drinking water. This type of well is regulated by the State Oil and Gas Board.

Class III – Wells used to inject fluids for the solution mining of minerals. An example of this would be injection of fresh water into naturally occurring underground deposits of salt. Salt can then be recovered from the solution as a product.

Class IV – Wells that dispose of hazardous or radioactive wastes into or above an underground source of drinking water. These wells are banned nationwide. If an operating well of this type is found, it must be closed.

Class V – Wells not included in the other classes, that inject non-hazardous wastes into or above an aquifer that could be used as a source of drinking water. Under Alabama's UIC program, permits are required for these types of wells. Regulations prohibit these wells from contaminating ground water above Maximum Contaminant Levels, or drinking water standards.

Disposal of wastes through Class V wells is a type of pollution source that historically has been poorly regulated in our country, and which has led to many instances of soil and ground water contamination.

The decision to require permits for Class V wells in the state was made in 1983 when Alabama received approval from EPA to implement the UIC program. The permit requirement allows the review of proposed activities prior to beginning operation so that discharges can be required to have treatment, if needed, or a permit could be denied if ground water contamination could result.

There are about 300 permitted Class V wells in Alabama. The majority of these wells are for facilities such as car washes or laundromats located in rural areas where there are no sanitary sewers that could receive the wastewater. In most cases, a drainage field, such as would be used for household wastewater disposal, is used to discharge wastewater, after treatment, beneath the surface to soils. Another common activity requiring a Class V UIC permit is the discharge of treated ground water from ground water corrective action systems. For example, contaminated ground water may be pumped to the surface, treated to remove contaminants, and then put back into the ground, thus improving the quality of ground water at that location. Substances such as oxygen releasing compounds and nutrients are sometimes injected to stimulate ground water cleanup.

In many parts of the country Class V wells are used to recharge aquifers where water tables may be declining. They may also be used to drain storm water to prevent flooding. These types of uses are uncommon in Alabama. Class V wells are also used to discharge water from some types of heat pumps.


*A Class V storm water drainage well in Colbert County. Only a few of these types of wells are known to be in use in Alabama.*

# ABANDONED WELLS AND BOREHOLES

There may be more than 100,000 active private water wells in Alabama. As public water supply systems continue to expand into areas that previously depended on private water wells as their water supply, more and more of these wells have been abandoned. In 1980, public water systems in Alabama supplied 6 times as much water as did private domestic wells; by 1990, the number had increased to 27 times as much. The total number of abandoned water wells in Alabama is probably in the tens of thousands.

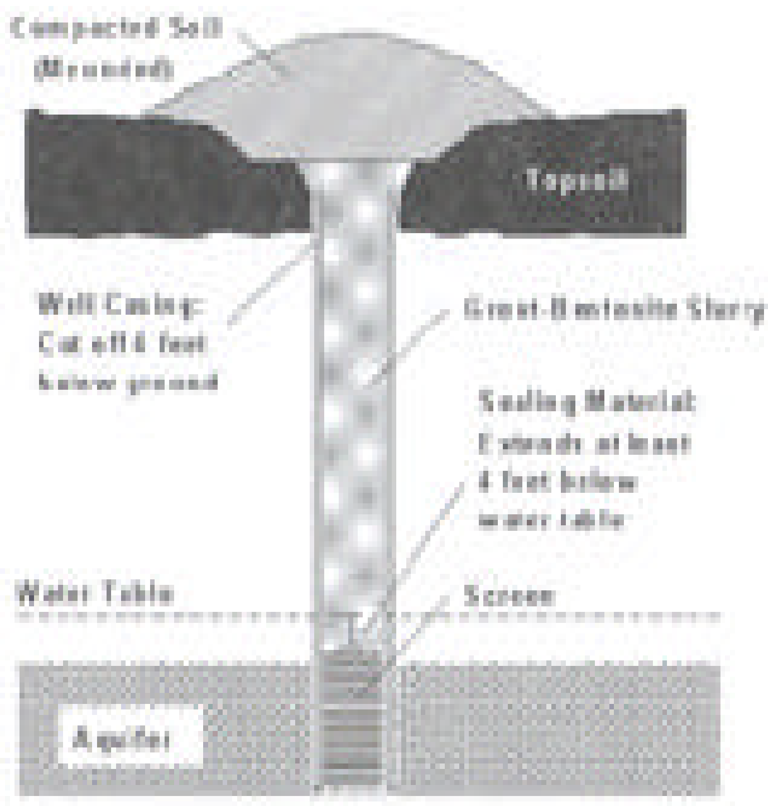
Like sinkholes, abandoned wells are directly linked to aquifers and can channel harmful materials such as sewage, pesticides, fertilizer, toxic chemicals, and bacteria from the land surface into aquifers. Abandoned wells are not difficult to seal properly, but many remain open. Because of their large number and wide distribution, abandoned wells pose a significant threat to local ground water supplies.

Because Alabama is a mineral-rich state, widespread mining operations exist, all of which use boreholes. Boreholes penetrating shallow aquifers which have not been properly sealed could also become conduits for surface pollutants to enter the subsurface.

The Department of Environmental Management has developed guidelines for abandonment of water wells and boreholes in Alabama. When a well is no longer useful, it should not simply be left as an open hole. Any open well is a threat to the environment. A few years ago a small child became trapped in an open abandoned well, attracting national attention. If the well is a flowing well, millions of gallons of water can be wasted if the well is simply allowed to flow unchecked. If more than one aquifer is penetrated by a well bore, waters from several aquifers may mix. If one aquifer is contaminated then contaminated water could flow from it into the well bore, and from there into other aquifers. For all these reasons, it is important to properly seal wells and boreholes when they are no longer needed.

Abandonment methods vary depending on the kind of well involved. For instance, a very deep well, or a monitoring well near a hazardous waste disposal facility, requires more care in abandonment than does a 10-foot deep hand-dug private well. Wells in farming country must be cut off and sealed at least 4 feet below the surface to prevent damage to farm equipment.

In general, proper well abandonment involves three tasks. First, one must clean out any debris or equipment that may partially block the well bore and prevent a proper seal. Second, remove the casing (if possible), also for the purpose of ensuring a tight seal. Third, fill the well bore from bottom to top with material, such as cement bentonite (clay) grout, that will prevent mixing of water from different aquifers and also prevent surface water from entering the aquifers. Anyone planning to abandon a well should contact the Ground Water Branch of the Alabama Department of Environmental Management for more detailed instructions.



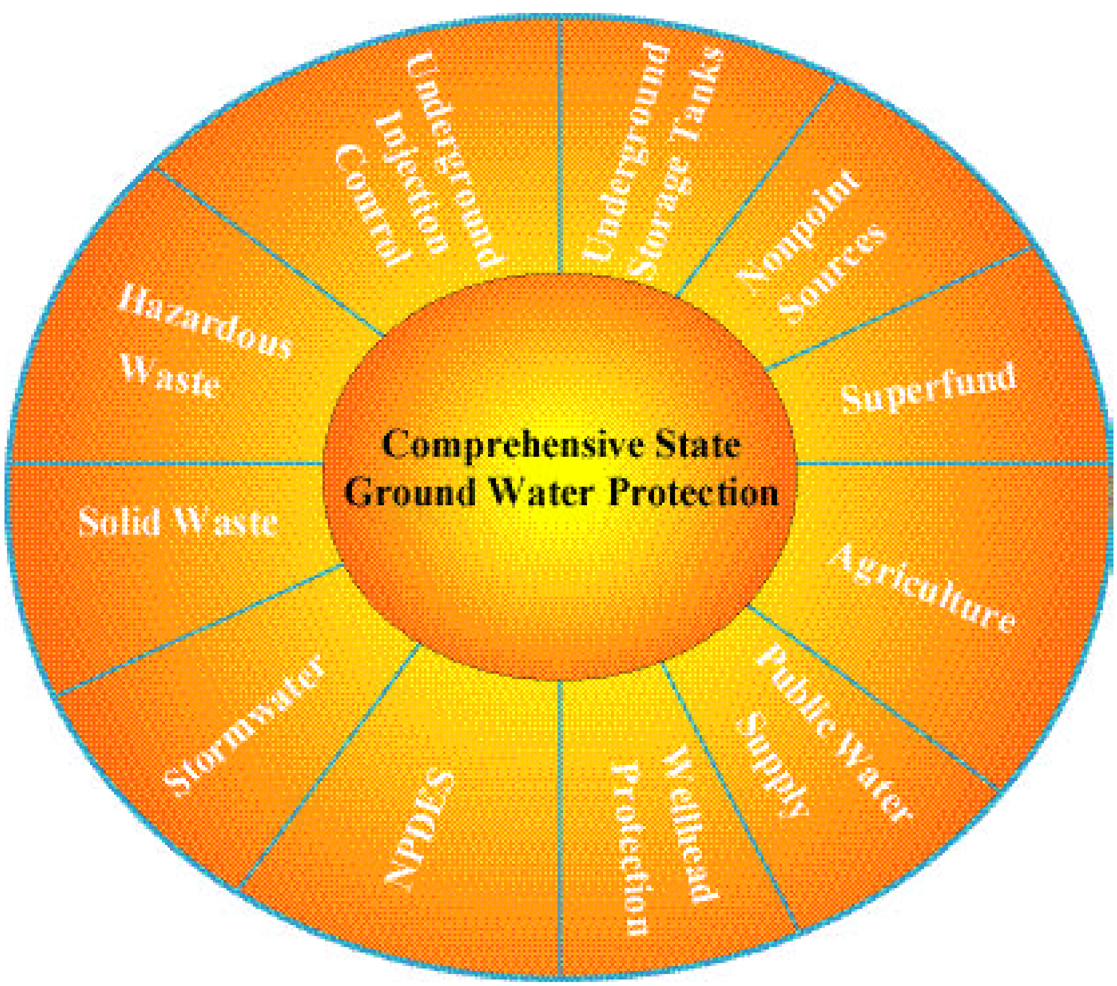

*Water Well Abandonment Procedure*

# GROUND WATER PROTECTION IN ALABAMA

Ground water is protected by laws at both the federal and state levels. The U.S. Environmental Protection Agency (EPA) has been designated by Congress to be one of the primary federal agencies responsible for ground water protection. Congress authorized EPA to carry out requirements of federal laws having provisions that protect ground water quality. One such law is the **Safe Drinking Water Act**, which requires that standards be set for maximum contaminant levels in drinking water. This act also established the **Underground Injection Control**, **Wellhead Protection**, and **Source Water Protection Programs**, which in Alabama are administered by ADEM. Other important federal environmental laws include the **Resource Conservation and Recovery Act (RCRA)**, which regulates disposal of solid and hazardous wastes and established a national program for the regulation of underground storage tanks. The **Comprehensive Environmental Resource, Compensation, and Liability Act** (**CERCLA**) set up a Superfund and authorized the federal government to clean up chemical spills or hazardous substance sites that threaten the environment. The **Federal Insecticide, Fungicide, and Rodenticide Act** (**FIFRA**) allows EPA to control the availability of potentially harmful pesticides. The **Toxic Substances Control Act**

**(TSCA)** authorizes EPA to control toxic chemicals that could pose a threat to the public and contaminate ground water. The **Surface Mining Control and Reclamation Act (SMCRA)** regulates mining activities, some of which can negatively impact ground water.

In 1993 Alabama joined a pilot program with EPA to document the environmental programs in Alabama that together make up a **Comprehensive State Ground Water Protection Program**. Alabama's Ground Water Protection Program was one of the first in the nation to receive EPA endorsement and is the core of an evolving plan for statewide ground water protection. The program focuses on prevention and concentrates efforts in areas of the state determined to be most vulnerable to ground water contamination. Specific laws passed by the Alabama Legislature that



address protection of ground water include the **Alabama Water Pollution Control Act**, the **Hazardous Waste Management and Minimization Act**, the **Alabama Underground Storage Tank and Wellhead Protection Act**, and an act which established the **Hazardous Substances Cleanup Fund**. The goal of Alabama's Ground Water Protection Program, is *the protection of ground water for drinking water and other beneficial uses*. This goal is found in the Alabama Water Pollution Control Act.

With the authority provided by these state laws, EPA allows the State of Alabama to administer the national environmental programs previously discussed. ADEM administers all of these programs except for those under **FIFRA,** which are carried out by the Alabama Department of Agriculture and Industries. State and federal laws dealing with ground water protection are summarized in Tables 2 and 3.

A basic step in protecting Alabama's ground water resources is to identify and assess areas affected by contaminants. Several different agencies are involved in ground water assessment in Alabama.

ADEM is presently conducting studies designed to evaluate nitrates and pesticides in wells throughout the

Geologist analyzing a water sample

## Table 2. *State Laws Affecting Ground Water Protection*

| Laws | Date | Summary |
|---|---|---|
| AL Solid Wastes Disposal Act | 1969 | Regulates solid Waste collection and disposal and landfill construction, authorizes local goverments to provide necessary services |
| AL Water Pollution Control Act | 1975 | Authorizes programs to protect waters of the state, including standards, permits, and compliance assurance |
| AL Water Well Standards Act | 1975 | Regulates construction and driller qualifications for potable water wells |
| AL Hazardous Waste Management & Minimization Act | 1975 | Regulates the transport, storage, treatment, disposal, and other management of hazardous wastes |
| AL Coastal Area Management Act | 1975 | Requires Coastal Consistency Determinations of any permitting activity affecting coastal resources |
| AL Safe Drinking Water Act | 1977 | Authorizes programs for potable ground and surface water supplies, systems, and distribution for public and certain private sources, including standards, permits, and compliance assurance |
| AL Environmental Management Act | 1982 | Consolidated various environmental agencies and programs into the Department of Environmental Management; provided for permits/license fees and administrative penalties |
| AL Underground Storage Tank & & Wellhead Protection Act | 1988 | Regulates the construction and operation of USTs and sets requirements for leak detection standards, corrective actions, and financial responsibility |
| AL Underground Storage Tank Trust Fund Act | 1988 | Provides a fee-supported fund for participating UST owners for corrective actions and for third-party claims arising from leaking USTs |

**Table 3.** ***Federal Laws Affecting Ground Water Protection***

| Laws | Date | Summary |
|---|---|---|
| Federal Insecticide, Fungicide, & Rodenticide Act | 1969<br>1988* | Authorized EPA to control pesticides |
| Safe Drinking Water Act and Amendments (SDWA) | 1974<br>1986*<br>1996* | Authorized EPA to set standards for maximum contaminant levels in drinking water, regulates underground waste disposal, designates areas that rely on a single aquifer, established the Wellhead Protection Program and the Source Water Protection Program |
| Resource Conservation & & Recovery Act (RCRA) | 1976<br>1984* | Regulates storage, transport, treatment, and disposal of solid and hazardous waste to prevent gound water contamination |
| Toxic Substances Control Act (TSCA) | 1976<br>1988* | Authorized EPA to control toxic chemicals |
| Clean Water Act (CWA) | 1977 | Authorized EPA to make grants to the states for the development of ground water protection (affects ground water shown to have a connection to surface) |
| Surface Mining Control & Reclamation Act (SMCRA) | 1977 | Regulates mining activity |
| Comprehensive Environmental Response Compensation, & Liability Act (CERCLA) | 1980 | Authorized federal government to clean up contamination caused by chemical spills or hazardous waste sites that could or do pose threats to the environment |
| Superfund Amendments & Reauthorization Act (SARA) | 1988 | Authorized citizens to sue violators of Superfund and established community right-to-know programs (Title III) |

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The Geological Survey of Alabama (GSA) has conducted an annual ground water sampling program from wells and springs in Alabama for many years, testing for the presence of inorganic contaminants.

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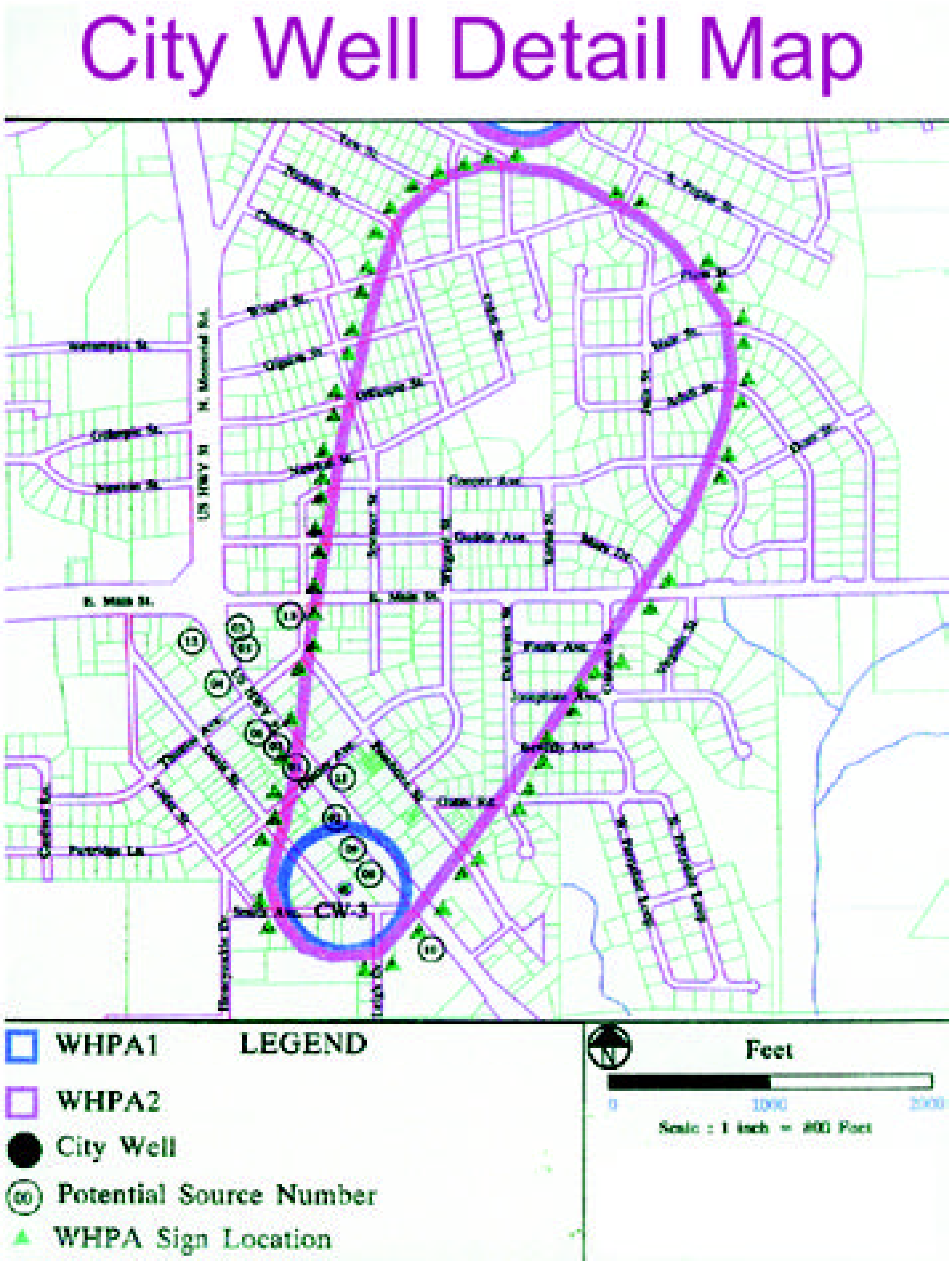
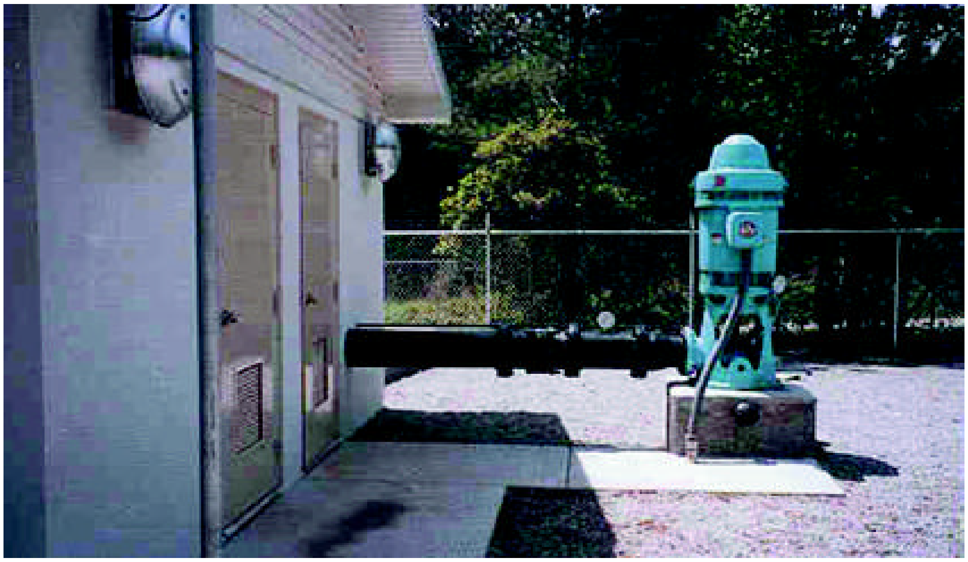
The GSA is also participating in a number of other projects that involve detailed ground water assessments, including several wellhead protection program projects. The Wellhead Protection and Source Water Assessment Programs are designed to protect ground water used for public water supplies. Wellhead Protection and Source Water Protection projects emphasize the need for managers of public water supply systems to understand how ground water reaches public water supply wells. Public involvement is also emphasized to prevent contamination of these wells. Wellhead and Source Water Assessment projects begin with geological and hydrological evaluation of the aquifers used for public water supplies. The goal of these evaluations is to determine what land areas should be included in protection programs for public water supplies. Potential sources of contaminants within the critical areas are then inventoried. A map of a Wellhead Protection Area for a public water supply well in Prattville, AL is shown on the adjacent page. Finally, for a wellhead protection program, management plans are developed to help ensure that public water supplies are kept safe.

Wellhead protection study. Pouring nontoxic dye for an aquifer time-of-travel test (dye tracing).




*Map showing wellhead protection ares for a public water supply well*



*Water Supply Well in Butler County*

The U.S. Geological Survey (**USGS**) has conducted regional aquifer studies that included Alabama, and is currently conducting a national water quality survey, which will include detailed sampling of several Alabama **watersheds**.

The Alabama Department of Public Health (**ADPH**) also plays an important role in protecting the state's ground water by analyzing water samples for bacterial contamination to locate and eliminate potential contaminant sources. These are only a few of the agencies and programs involved in assessing and protecting Alabama's ground water resources. A more complete list is provided in Table 4.

The most effective way to protect a ground water supply is by isolating it from potential contaminants. Once an aquifer has become contaminated, cleanup is usually a lengthy and expensive process. An industrial site in Butler County contaminated with PCB's is one of the 12 identified **superfund** sites in Alabama. Work at this site has been on going since the early 1980's with the total cost estimated at $25 million for full clean up. The total estimated cost for cleaning up all 12 superfund sites in Alabama is $300 million.

The responsibility for protecting the state's ground water does not stop at the federal and state levels but extends to the local level and to every citizen. Individuals can help

# Table 4. *Agencies with Ground Water Programs*

## Alabama Department of Environmental Management (ADEM) (334) 271-7700

| | | |
|---|---|---|
| **ADEM Water Division** | (334) 271-7823 | Surface and Ground Water Protection Programs |
| ADEM Ground Water Branch | (334) 270-5655 | |
| Hydrogeology Unit | | Hydrogeologic Support |
| UST Corrective Action Unit | | UST Trust Fund, Assessment, and Corrective Action Programs |
| UST Compliance Section | | UST Regulatory Compliance Program |
| Underground Injection Control | | Class I, III, and V UIC Wells |
| Wellhead Protection Program | | Protection of Public Water Supply Wells |
| ADEM Municipal Branch | (334) 270-7810 | NPDES Permitting, Municipal Land Application Projects, Engineering & Compliance |
| ADEM Industrial Section | (334) 271-7943 | NPDES Permitting, Industrial Land Application Projects, Engineering & Compliance |
| ADEM Water Supply Branch | (334) 271-7773 | Source Water Protection, Municipal Water Supply Program |
| **ADEM Land Division** | (334) 271-7730 | Solid and Hazardous Waste Management, Permitting, Engineering & Compliance |
| ADEM Hazardous Waste Branch | (334) 271-7874 | Hazardous Waste Management |
| Industrial Facilities Section | | Hazardous Waste Management Permitting, Engineering |
| Northern Section | | Hazardous Waste Management Compliance |
| Southern Section | | Hazardous Waste Management Compliance |
| Government Facilities Section | (334) 271-7738 | Hazardous Waste Management Permitting, Engineering |
| Site Assessment Unit | | State Superfund Program, Spills, Soil Cleanup, Hazardous Substances Control |
| ADEM Solid Waste Branch | (334) 271-7771 | State Solid Waste Management Program Permitting Engineering |
| Compliance Section | (334) 271-7761 | State Solid Waste Management Program Compliance |
| **ADEM Field Operations Division** | (334) 394-4382 | ADEM Field Offices, Emergency Response |
| Mobile Branch | (334) 450-3400 | Emergency Response, UST Compliance |
| Montgomery Branch | (334) 260-2711 | Sampling, Emergency Response |
| Birmingham Branch | (205) 942-6168 | Emergency Response, UST Compliance |
| Decatur Branch | (205) 353-1713 | Emergency Response, UST Compliance |
| **State Oil and Gas Board** | (205) 349-2852 | Regulates the Oil and Gas Industry |
| Underground Injection Control | | Class II Underground Injection Control (UIC) Program |

## Alabama Department of Public Health

| | | |
|---|---|---|
| Environmental Health Services | (334) 206-5673 | On-Site Sewage Treatment |
| County Health Departments | Local Listings | On-Site Sewage Treatment |

NPDES = National Pollutant Discharge Elimination System (Surface Water Discharge Permitting)

UST = Underground Storage Tank

# Table 4. Agencies with Ground Water Programs

## State Nonregulatory Agencies Wtih Ground Water Responsibilities

### Geological Survey of Alabama

| | | |
|---|---|---|
| Hydrogeology Division | (205) 349-2852 | Wellhead Protection, Public Education/Outreach, Hydrogeological Research |
| Ground Water Section | (205) 349-2852 | Ground Water Resources, Ground Water Level Database |
| Water Information Section | (205) 349-2852 | Water Well Database |
| Environmental Geology Division | (205) 349-2852 | Environmental Health, Water Quality Database |

### Alabama Department of Agriculture and Industries

| | | |
|---|---|---|
| | (334) 242-2650 | Pesticides |

### Alabama Department of Economic and Community Affairs

| | | |
|---|---|---|
| Recycling Program | (334) 271-5651 | Recycling |
| Water Resources Office | (334) 242-5499 | Water Use Database |

### Natural Resources and Conservation Department

| | | |
|---|---|---|
| Fisheries Program | (334) 242-3465 | Environmental Health |
| Wildlife Program | (334) 242-3469 | Environmental Health |

## Federal Agencies with Ground Water Programs

### United States Environmental Protection Agency (USEPA)

| | | |
|---|---|---|
| USEPA Region 4, Ground Water | (404) 562-9329 | Public Water Supplies, UST and UIC Regulation, and Wellhead Protection and Drinking Water Branch |
| USEPA RCRA/CERCLA Hotline | (800) 424-9346 | Solid Waste and Hazardous Waste Information |
| | (202) 382-3000 | Solid Waste and Hazardous Waste Information |
| USEPA Safe Drinking Water Hotline | (800) 426-4791 | Environmental Health Information |
| USEPA Region 4, WHP Coordinator | (404) 562-9453 | Wellhead Protection Regulation and Information |

### United States Department of Agricuture (USDA)

| | | |
|---|---|---|
| USDA Rural Development Administration | (202) 720-9589 | Agricultural Contamination, Solid and Hazardous Waste, |
| USDA Natural Resources Conservation Service | (334) 887-4506 | Agricultural Contamination, Evnironmental Health |

### United States Department of Commerce (USDC)

| | | |
|---|---|---|
| USDC National Oceanographic and Atmospheric Administration | (704) 271-4800 | Environmental Health, National Climatic Data Center |

### United States Department of the Interior (USDI)

| | | |
|---|---|---|
| USDI Geological Survey | (334) 832-7510 | Water Resources, Water Research |

safeguard ground water supplies by responsible use of potentially harmful materials such as fertilizers, pesticides, and household products. Manufacturer's information and county agents can aid in selecting and applying lawn and garden chemicals that produce minimal impact on ground water supplies. Individuals, farms, industry, and other operations may apply pollution prevention methods through education, best management practices, and safeguards to prevent ground water pollution.

Many common household products contain hazardous or toxic substances that could contaminate ground water. Some of these products are listed in Table 5. Care should be taken in disposing of these materials. because some of them contain substances that are not easily removed from sewage and that may damage or ruin septic systems.

*Perdido Ground Water Contamination*

*The 15-acre Perdido Site, located in Baldwin County, was contaminated as a result of a train derailment in 1965. Approximately 7,600 gallons of the toxic chemical benzene were spilled into drainage ditches and seeped into the underlying aquifer. The contaminated area extends about 1,000 yards from the derailment site. Contamination of nine private wells has been confirmed. Baldwin County Health officials recommended that residents within a 1-mile radius of the derailment use alternate water supplies, which have been provided. In 1988, EPA selected a plan to clean up the ground water that included extraction and treatment of the ground water by a technology called air stripping. Water is pumped out of the aquifer using wells drilled for that purpose. After the benzene is removed, the treated water is returned to the aquifer by specially designed injection wells. Construction of the treatment facilities was completed in 1992, and treatment will continue until the ground water contaminant levels meet the cleanup goals established by EPA. The treatment program shows continuing progress in reducing ground water contamination at the Perdido Site. The estimated cost for the cleanup at the Perdido Site is $2,900,000 for capital investment plus $270,000 per year throughout the cleanup process.*

**Table 5.** ***Common Household Products and Some of their Hazardous Components***

| Product | Hazardous Components |
|---|---|
| Antifreeze | methanol, ethylene glycol |
| Battery acid | sulfuric acid |
| Degreasers | petroleum solvents, alcohols, glycolether, chlorinated hydrocarbons, toluene, phenols |
| Engine and radiator flushes | dichloroperchloroethylene |
| Hydraulic (brake) fluid | hydrocarbons, fluorocarbons |
| Motor oil, grease, lubes | hydrocarbons |
| Gasoline, diesel fuel, heating oil | hydrocarbons |
| Kerosene | hydrocarbons |
| Rustproofers | phenols, heavy metals |
| Transmission fluid (automatic) | petroleum distillates, xylene |
| Car wash detergent | alkylbenzene sulfonates |
| Car wax or polish | petroleum distillates, hydrocarbons |
| Asphalt, roofing tar | hydrocarbons |
| Paint, varnish, stain, dye | heavy metals, toluene |
| Paint thinner | acetone, benzene, toluene, butyl acetate, methyl ketones |
| Paint and varnish removers | methylene chloride, toluene, acetone, xylene, ethanol, benzene, methanol |
| Paint brush cleaners | hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones |
| Floor and furniture strippers | xylene |
| Metal polishes | petroleum distillates, isopropanol, petroleum naptha |
| Laundry soil and stain removers | petroleum distillates, tetrachloroethylene |
| Spot removers and dry cleaning fluid | hydrocarbons, benzene, trichloroethylene, tetrachloroethylene, 1,1,1 trichloroethane |
| Other solvents | acetone, benzene |
| Rock salt (Halite) | sodium and chloride |
| Refrigerants | 1,1,2 trichloro – 1,2,2 triffluoroethane |
| Bug and tar removers | xylene, petroleum distillates |
| Household and oven cleaners | xylenols, glycol ethers, isopropanol |
| Drain cleaners | 1,1,1 trichloroethane |
| Toilet cleaners | xylene, sulfonates, chlorinated phenols |
| Disinfectants | cresol, |
| Pesticides | napthalene, phosphorus, xylene, heavy metals, chlorinated hydrocarbons |
| Photochemicals | phenols, sodium sulfite, cyanide, silver halide, potassium bromide, selenium |
| Printing Ink | heavy metals, phenol-formaldehyde |
| Wood preservatives(creosote) | pentachlorophenols |
| Wood pressure treatment | heavy metals, cyanide |
| Swimming pool chlorine | sodium hypochlorite |
| Lye or caustic soda | sodium hypochlorite |
| Jewelry cleaners | sodium cyanide |
| Fertilizers | nitrate |

**(Modified from "Natural Resources Facts: Household Hazardous Wastes" Fact Sheet No. 88-3, Department of Natural Science, University of Rhode Island, August 1988)**

Lessons learned from past mistakes have led to better siting and design of facilities such as industrial wastewater treatment facilities and landfills, which in the past have been sources of ground water contamination. Shown below are above ground treatment units which have replaced earthen treatment ponds. Other facilities such as landfills are now designed to effectively prevent ground water contamination, using devices such as double liners and leachate-collection systems. Monitoring of ground water is required of facilities having the potential to adversely affect ground water quality.

Several options are available to communities and city governments desiring to protect ground water resources. These include source-water assessment and wellhead protection programs. A number of communities have initiated wellhead protection studies. These efforts help to safeguard public ground water supplies by evaluating the local aquifer system, identifying potential sources of contamination, and developing a wellhead protection management plan to protect ground water supplies, as well as a contingency plan in case contamination occurs. Public participation in developing the wellhead protection plans is encouraged.

A landmark example of a group of individuals organizing to protect

Above ground treatment units at Ciba Specialty Chemicals, McIntosh, Alabama.

and control the development of their water resources occurred in a group of watersheds in southeast Alabama. The group first formed into a local organization, which later became a legislatively funded local agency called the Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority (CPYRWMA). The CPYRWMA is administered locally and focuses on the water resources of the entire Alabama portion of the Choctawhatchee River and Pea River watersheds in Alabama, an area including parts of 10 counties.

Another good way for citizens to get involved in source water protection is the Groundwater Guardian program, founded by the Groundwater Foundation. This voluntary program encourages local groups of citizens to organize creative projects to protect their ground water. Madison County was the first community in Alabama to establish a Groundwater Guardian program and also the first to host a Ground Water Festival for elementary aged school children.

Other ways that local governments can protect ground water quality are through regulating land uses that could degrade water quality in the recharge areas of municipal wells; by supplying water, sewer, and waste disposal services; by monitoring water supplies for possible contaminants; and by establishing a collection and disposal schedule for hazardous household wastes. Because many households have no safe place to dispose of hazardous wastes, this last suggestion is potentially of great importance. A collection day for hazardous wastes, called an amnesty day, was held in the Flint Creek area and was very successful, resulting in the collection of


*Tuscumbia is a Ground Water Guardian Community* thousands of pounds of unwanted and out-of-date chemicals.

It is important to emphasize that ground water should not be considered an isolated resource, but rather as an integral part of the total freshwater resource. If surface water in the recharge area of an aquifer becomes polluted, the aquifer itself may become polluted through recharge. Many communities, such as Auburn, Birmingham, Gadsden, Mobile, Montgomery, Muscle Shoals, Talladega, and Tuscaloosa depend on surface water for part or all of their water supplies. The surface water on which these communities depend is, in the dry season, largely supplied by ground water discharge to streams. For these reasons, the most effective resource protection program should be comprehensive in scope and not restricted to ground water or surface water alone.

*Swift Creek Park, Autauga County*

The very best and most cost effective way to ensure adequate long term ground water protection is through education. Providing planners, students, and the general public with a knowledge of our ground water is the best guarantee that all Alabamians will enjoy clean, safe drinking water for generations to come.

# GLOSSARY

(Glossary terms used in the definitions of other glossary terms are italicized where used.)

**ADAI** Alabama Department of Agriculture and Industries

**ADEM** Alabama Department of Environmental Management.

**ADPH** Alabama Department of Public Health.

**Artesian well** An artesian well is drilled into an aquifer that is under pressure (a confined aquifer). If the pressure is high enough, water flows to the surface

.

**Aquifer** Rock, soil, or sediment that contains ground water and is capable of yielding significant amounts of water to a well or spring.

**Brine** Salty water.

**Calcite** A mineral, the primary constituent of limestone. The most common form of calcium carbonate ($CaCO_3$).

**CERCLA** *Comprehensive Environmental Response, Compensation, and Liability Act*. Also called Superfund.

**Concentration** In chemistry, the concentration of a substance is the decimal fraction or percentage of that substance in a mixture of two or more substances, per unit volume. Thus, if one part of salt is mixed with nine parts of water, then the salt concentration is 10 percent, or 0.1.

**Confined aquifer** An aquifer bounded above and below by confining units. A confined aquifer is entirely filled with liquid and may be under pressure.

**Confining unit** A confining unit is a rock, soil, or sediment unit that stores water, but does not transmit significant quantities of water.

**Contaminant** A substance which either by its presence or concentration makes water unsuitable for a desired use. Some contaminants occur naturally.

**CSGWPP** Comprehensive State Ground Water Protection Program.

**Discharge** In the context of ground water, the movement of water from the ground water system to the surface water system.

**Dolomite** A mineral ($Ca,Mg(CO_3)_2$) related to calcite and common in some limestones.

# PESTICIDES

Pesticides are common ground water contaminants. About 3.8 million pounds of solid pesticides and 450,000 gallons of liquid pesticides are applied in Alabama each year to kill insects, rodents, mold, and weeds. Some pesticides are now prohibited by EPA because they were contaminating surface and

**EPA** United States Environmental Protection Agency.

**Evaporation** The conversion of a liquid to a gas.

**Evapotranspiration** *Evaporation* plus transpiration.

**Fall line** The boundary between older, hard, igneous and metamorphic rocks and the younger, soft sedimentary rocks of the coastal plain. Marked by a break in slope and waterfalls in rivers.

**FIFRA** Federal Insecticide, Fungicide, and Rodenticide Act.

**Formation** A rock unit that has recognizable characteristics and that is thick and extensive enough to be mappable. An aquifer is commonly a formation, part of a formation, or two or more formations.

**Ground water** Water in the saturated zone below the surface of the ground.

**GSA** Geological Survey of Alabama.

**Hardness** See *hard water*.

**Hard water** Hard water does not readily produce a lather with soap. Because it contains substantial amounts of dissolved carbonate, hard water tends to form a chalky white scale on hot water heaters and in tea kettles. The origin of the name is unknown, but it may have referred to the "hard rocks" (limestone and dolomite mountains) from which hard water comes in southern Europe where the name was coined.

**Hydrogeologic province** A region, typically much larger than a county, defined by a certain kind or kinds of aquifers. Hydrogeologic provinces approximately correspond to physiographic provinces, which are defined by characteristic kinds of rocks. For example, the Coastal Plain physiographic province, with its gently dipping sands, shales, and limestones, coincides with the Coastal Plain hydrogeologic province, with its evenly layered sand and limestone aquifers.

**Hydrogeology** The scientific study of ground water and rock, sediment, and soil units (aquifers) containing ground water.

**Hydrologic cycle** The circulation of water from the oceans, through the atmosphere and back to the Earth's surface, over the land surface and underground, and eventually back to the oceans.

**Infiltration** In soil science and hydrology, the downward movement of water into soil during and after a precipitation event.

**Ingeous rock** Rocks that solidified from a hot, liquid state.

**Leachate** See *leaching*. Liquid product of leaching.

**Leaching** Generally, any process in which a fluid selectively removes material from a solid through which it passes. Leaching commonly refers to the downward passage of surface water or rain water through soil, sediment, or landfill material,

**Leachate** See *leaching*. Liquid product of leaching.

**Leaching** Generally, any process in which a fluid selectively removes material from a solid through which it passes. Leaching commonly refers to the downward passage of surface water or rain water through soil, sediment, or landfill material, and the resulting transport of dissolved contaminants into the ground water system.

**Limestone** A sedimentary rock composed chiefly of calcium carbonate ($CaCO_3$) particles made by marine animals and plants.

**MCL** Maximum contaminant level, the maximum permissible level in drinking water of a particular chemical, established by the EPA.

**MGD** Million gallons per day.

**Metamorphic rock** made by heating and squeezing preexisting rocks so that new minerals replace the preexisting ones.

**Microorganisms** Organisms such as bacteria and viruses which are too small to see with the human eye.

**Nonpoint source pollution** Pollution whose sources are diffuse, multiple, or widespread.

**NRCS** Natural Resources Conservation Service. Formerly the Soil Conservation Service. Part of the U.S. Department of Agriculture.

**Overpumping** Withdrawing more water from an aquifer than is replenished by recharge.

**Pathogens** Microorganisms which cause disease.

**Permeability** A measure of the interconnectedness of a pore or fracture system, which determines the ability of a rock unit to transmit fluids.

**Physiography** The genesis and nature of land forms.

**Point source pollution** Pollution from a known and well defined source. For example, a factory, waste treatment plant, or leaking underground storage tank.

**Porosity** The amount, usually represented as percent, of open pore space in an aquifer.

**PPM** Parts per million. One ppm=1 unit of a substance in 1,000,000 units of another substance.

**Public water system** A system to provide piped water to the public for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals at least 60 days of the year.

**RCRA** *Resource Conservation and Recovery Act*.

**Recharge** Water that enters an aquifer from the surface or the process of aquifer replenishment.

**Recharge area** That region in which an aquifer is exposed at the surface (perhaps covered by *soil*), so that water falling within the recharge area can penetrate into the aquifer.

**Runoff** That portion of precipitation that flows on or just beneath the land surface until it reaches a surface water body, enters the ground, or evaporates.

**Sand** A sediment consisting of small rock particles (62 micrometers to 2 millimeters in size). The most common mineral in sand is quartz ($SiO_2$), which is the primary ingredient in glass.

**Sandstone** A rock consisting chiefly of sand-sized particles cemented together by some natural cement (typically quartz, calcium carbonate, or iron oxide).

**Salt water intrusion** The introduction into a freshwater aquifer of sea water or subsurface brine. Usually caused by excessive pumping of wells, which permits salt water to flow into the aquifer laterally or from below.

**Saprolite** A soft, earthy, decomposed rock formed in place by chemical weathering of igneous and metamorphic rocks. Saprolite is commonly red or brown, and forms in warm, humid climates.

**SARA** *Superfund Amendments and Reauthorization Act*.

**Saturated zone** That region below the water table in which all voids are filled with liquid.

**Sedimentary rock** A rock that consists chiefly either of small pieces of rock cemented together (e.g., sandstone) or of crystals that grew from water (rock salt). There are some odd earth materials that are commonly considered sedimentary rocks, such as coal. The other two kinds of rock are igneous and metamorphic.

**Shale** A sedimentary rock consisting of very small fragments (less than 62 micrometers) that tend to be thin and flat. Shales are not good aquifers because the holes between particles are too small and because the chemical properties of many shale minerals permit them to hold onto a large amount of water. Shales generally form confining units.

**Sinkhole** A hole caused by collapse of the land surface, commonly because underlying limestone rock has dissolved away, forming a cavity.

**Soil** Particulate matter, commonly containing sand, silt, clay, and organic material and having a definite layered structure, forming a layer a few inches or many of feet thick that covers most of the earth.

**Source Water Protection** A program initiated by the EPA in 1996 to protect public water supplies. Source water assessment is required of each water system and involves delineating source water protection areas, inventorying significant contaminants in these areas, and determining the vulnerability of each public water supply to contamination. Source water protection is voluntary and involves actions taken to protect drinking water supplies.

**Spring** A point or zone of natural discharge of water from underground to the land surface or to the bottom of a surface water body.

**Strata** Layers, specifically layers of rock, laid down during a certain period of time, and commonly possessing certain physical and paleontological characteristics.

**Superfund** See CERCLA.

**TSCA** *Toxic Substances Control Act*.

**Transpiration** The passage of water vapor out of plant leaves through pores and into the air.

**UIC** (Underground Injection Control) A national environmental program authorized by the federal *Safe Drinking Water Act* to protect underground sources of drinking water.

**Unconfined aquifer** An aquifer consisting of an overlying unsaturated zone and underlying saturated zone, separated by a water table.

**Unsaturated zone** That region of soil, sediment, or rock above the water table containing both air and water in void spaces.

**USGS** United States Geological Survey.

**UST** Underground Storage Tank.

**Vectors** Organisms carrying pathogens.

**Water budget** An estimate of the amount of water moving through each part of the *hydrologic cycle* for a given region.

**Water table** That surface within soil or rock below which all pore spaces are filled with water and above which at least some of them contain air.

**Waters of the State** The *Alabama Water Pollution Control Act* defines this as all surface or ground water in the state except water entirely confined and retained completely upon the property of a single individual, partnership or corporation unless the water is used in interstate commerce.

**Watershed** A natural unit of land from which the surface water runoff subsurface, and ground water drain to a common outlet.

**Well** A bored, drilled, or driven shaft or dug hole. Wells range from a few feet to more than 6 miles in depth, but most water wells are between 100 and 2,000 feet in depth.

**Wellhead protection area** The surface and subsurface area surrounding a public water supply well or well field that a community has taken steps to protect, and through which contaminants are likely to move toward and reach such well or well field.

**Wetland** Land characterized by any of the following: water loving plants, hydric soils, and flooding part or all of the year. Hydric soils have distinctive characteristics resulting from the common presence of abundant moisture.

**WHPP** Wellhead Protection Program.

# FURTHER READING

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# BY THE NUMBERS

696 Public Water Systems in Alabama serve a population of approximately 5.0 million.

499 systems (72%) utilize Ground Water as a Source.

16 Systems in Alabama utilize Ground Water along with Surface Water.

Approximately 1.98 million (40%) of Alabama's population are served by Ground Water.

Figures based on 2001 data

# Ground Water Guardian

The Department was designated a Groundwater Guardian Affiliate by the Groundwater Foundation in November 1997 and again in November 1998. The Groundwater Guardian program is designed to empower local citizens and communities to voluntarily protect their groundwater resources and generate local solutions that effectively address local groundwater protection priorities.

In being named an affiliate, ADEM was honored for promoting the program in Alabama, assisting with the first two Groundwater Festivals in the state, and financially supporting the Alabama Cooperative Extension Service workshops on groundwater protection.