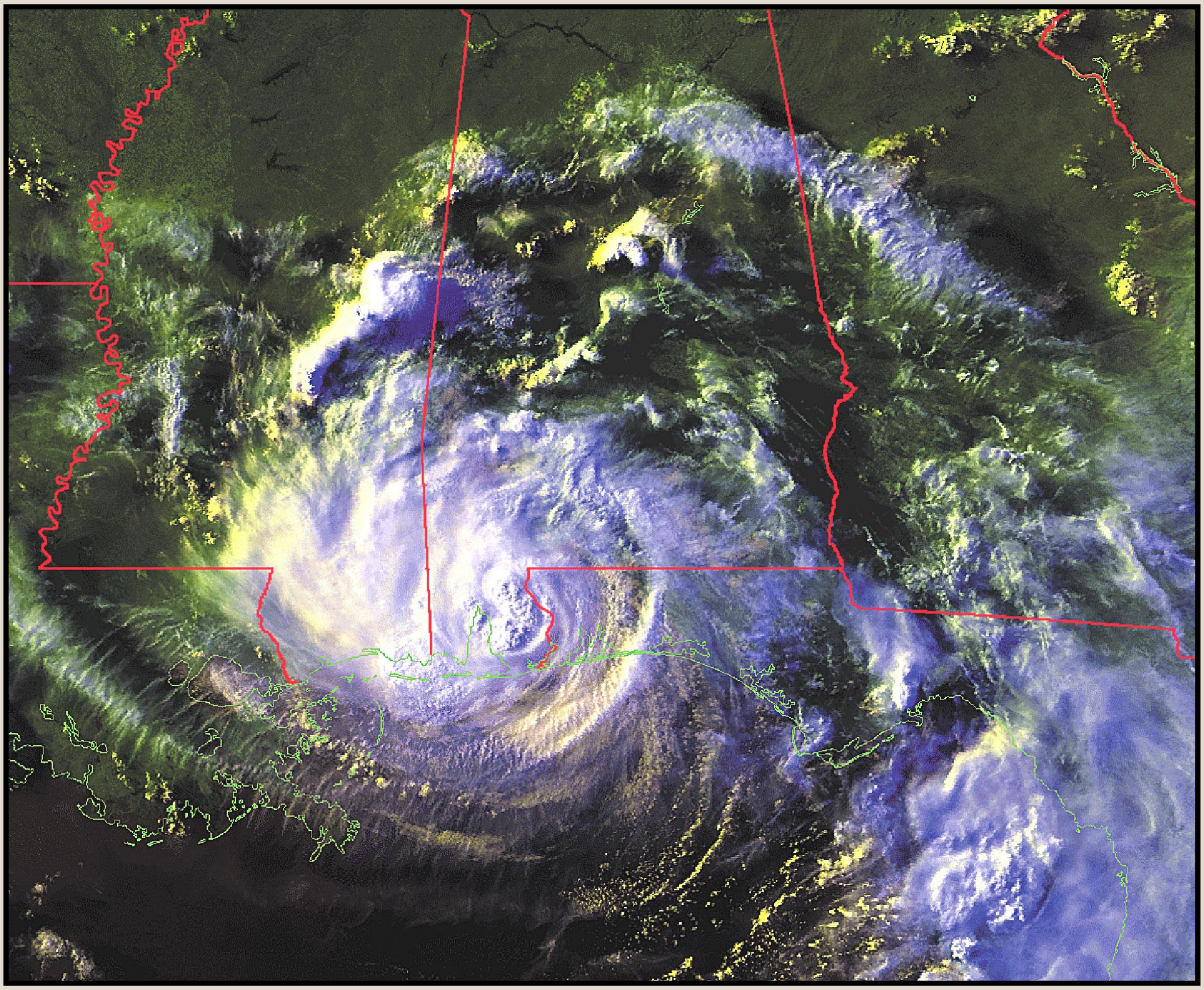
WATER IN ALABAMA
(including basic water data)



Photograph of Hurricane Danny by the Ocean Remote Sensing Group, John Hopkins University Applied Physics Laboratory. Atlantic hurricane images on the Web at *http://fermi.jhuapl.edu.hurr/*

GEOLOGICAL SURVEY OF ALABAMA
CIRCULAR 122O

GEOLOGICAL SURVEY OF ALABAMA

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HYDROGEOLOGY DIVISION

CIRCULAR 122O

WATER IN ALABAMA
(including basic water data)

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and
James D. Moore

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WATER IN ALABAMA
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By

David C. Kopaska-Merkel and James D. Moore

INTRODUCTION

Alabama has abundant surface-water and ground-water resources. However, these resources are being depleted or contaminated in local areas of the state. An increased awareness in recent years of the need to protect water resources has resulted in new federal and state regulations, as well as increased public participation in water-quality protection. Much of the emphasis has been placed on the protection of ground-water resources, on nonpoint sources of pollution, and on the establishment of new maximum contaminant levels for contaminants in public drinking water supplies. Since 1955, per capita use of water has increased by about 100 percent in Alabama. In 1997, about 6.148 billion gallons per day (bgd) of water was withdrawn for use from surface and underground sources in Alabama.

The Hydrogeology Division of the Geological Survey of Alabama (GSA) monitors the quality and quantity of surface and ground waters in the state and collects basic data necessary to develop new water supplies, expand current water systems, and minimize water contamination. Basic ground-water quantity data are collected from a statewide network of observation wells and springs. GSA's ground-water quality monitoring program is currently being revised to better meet Alabama's current needs. Basic surface-water data are collected from selected watersheds around the state. Data on streamflow, ground-water levels, and water quality collected through this program form the basis for many water-related research activities. Other agencies, including the Alabama Department of Environmental Management (ADEM), the U.S. Geological Survey, the Tennessee Valley Authority, the U. S. Department of Agriculture, Natural Resources Conservation Service, and some local governing bodies maintain water-resources programs, collect basic hydrologic data and conduct research investigations on the water resources of Alabama. This report summarizes the activities and programs of the GSA. GSA has published water availability reports for every county in the state. Alabama's surface-water resources are currently being evaluated in a series of watershed studies. Ground-water resources are being evaluated as part of a state-wide program to characterize the vulnerability of Alabama's aquifers to contamination. The Hydrogeology Division of the GSA is developing a Geographic Information Systems (GIS) framework for Alabama via a series of projects involving mapping and educational outreach.

Water-resources data and water-use information are used by GSA staff members in answering information requests and in providing assistance to those who plan to develop or expand supply systems or to those who need information about protecting or managing the state's surface-water and ground-water resources.

CLIMATIC CONDITIONS

Alabama's climate is humid subtropical, with mild winters and hot summers. Average annual temperatures range from 58°F in northeastern Alabama to about 68°F in southwestern Alabama (fig. 1). Average January temperatures range from 44°F in the northern part of the state to 54°F near the Gulf Coast, and average July temperatures range from 81°F in northern and coastal Alabama to 82°F in central Alabama. No climatic data station in the state has an average monthly temperature below freezing.

Rainfall in Alabama usually is abundant and is distributed throughout the year. Average annual precipitation ranges from a low of 49 inches in the Montgomery area to a high of 66 inches near the coast (fig. 2).

Very little snow falls in Alabama in normal years; average annual snowfall ranges from 5 inches in the Tennessee Valley region to less than 1 inch in the southern part of the state. During most years, the southern half of the state receives no snowfall.

During severe droughts, the dry part of the state, which extends across the state from southern Pickens County to Barbour County, may have as little as 30 inches of precipitation. During wet years, however, precipitation in coastal Alabama, which normally receives the greatest amount of rainfall, may be more than 90 inches.

During 1997, rainfall was relatively consistent throughout the state, except in southwest Alabama, where Hurricane Danny produced very intense precipitation. Rainfall amounts ranged from 45.39 inches at a station in Perry County to 74.71 inches at a station in Mobile County (fig. 3). The largest amounts of rainfall occurred in the southwestern part of the state (fig. 3). Rainfall was moderately above normal in the northern half of the state and in southwest Alabama during 1997, and was moderately below normal in southeast Alabama (fig. 4). No significant annual rainfall deficiencies affected Alabama in 1997. A deficit of several inches in March that affected most of Alabama was more than made up for by slightly heavier than normal rainfall later in the year in most parts of the state. Rainfall amounts of 20 or more inches above normal occurred locally in southwestern Alabama. A rainfall station in southern Mobile County recorded precipitation of 23.53 inches above normal for the year. The center of Hurricane Danny made landfall on Dauphin Island on July 19, 1997, and moved very slowly eastward across Mobile Bay and into Baldwin County. The storm's slow rate of

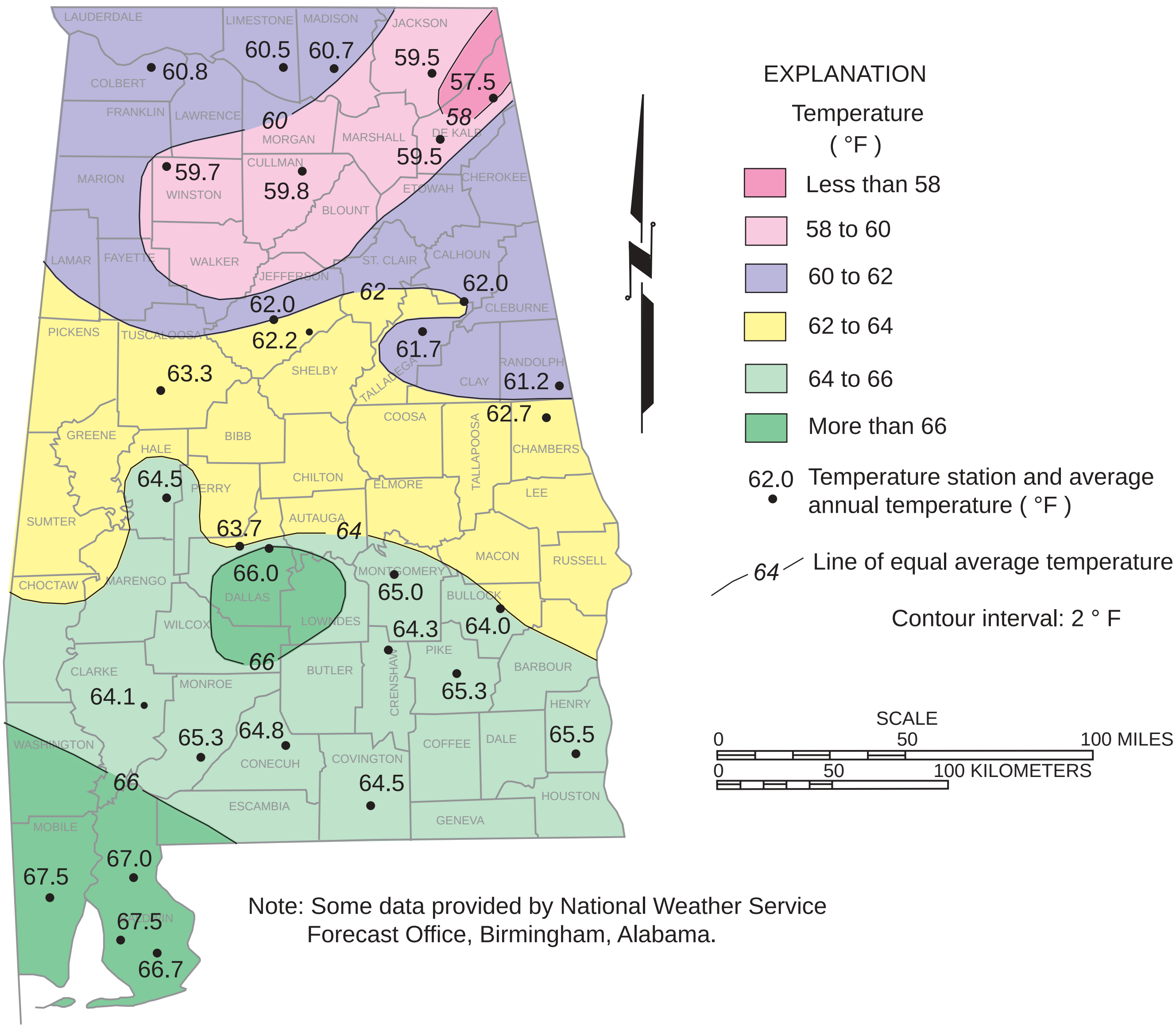


Figure 1.—Average annual temperatures (U.S. Department of Commerce, 1989).

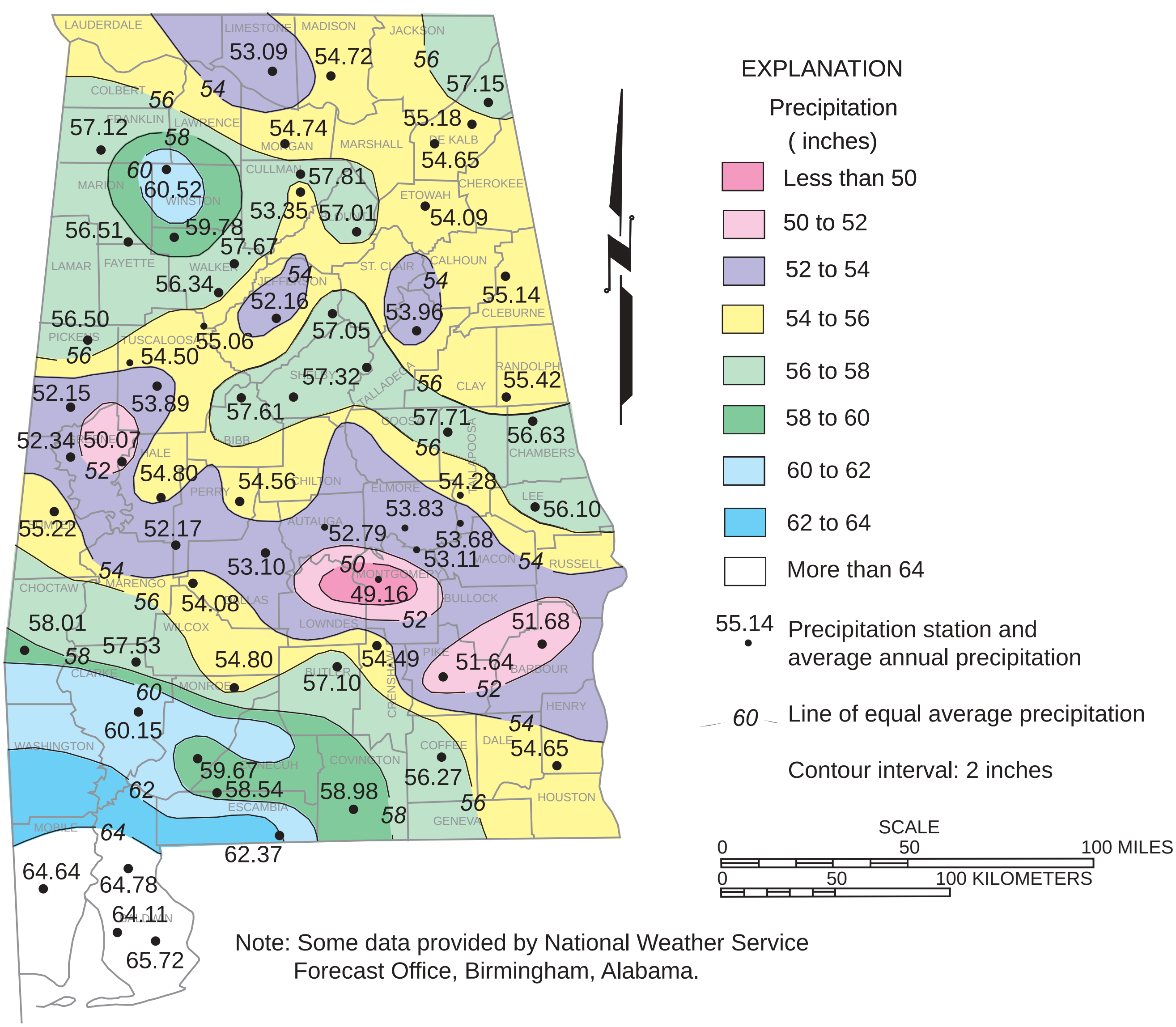


Figure 2.—Average annual precipitation (U.S. Department of Commerce, 1989).

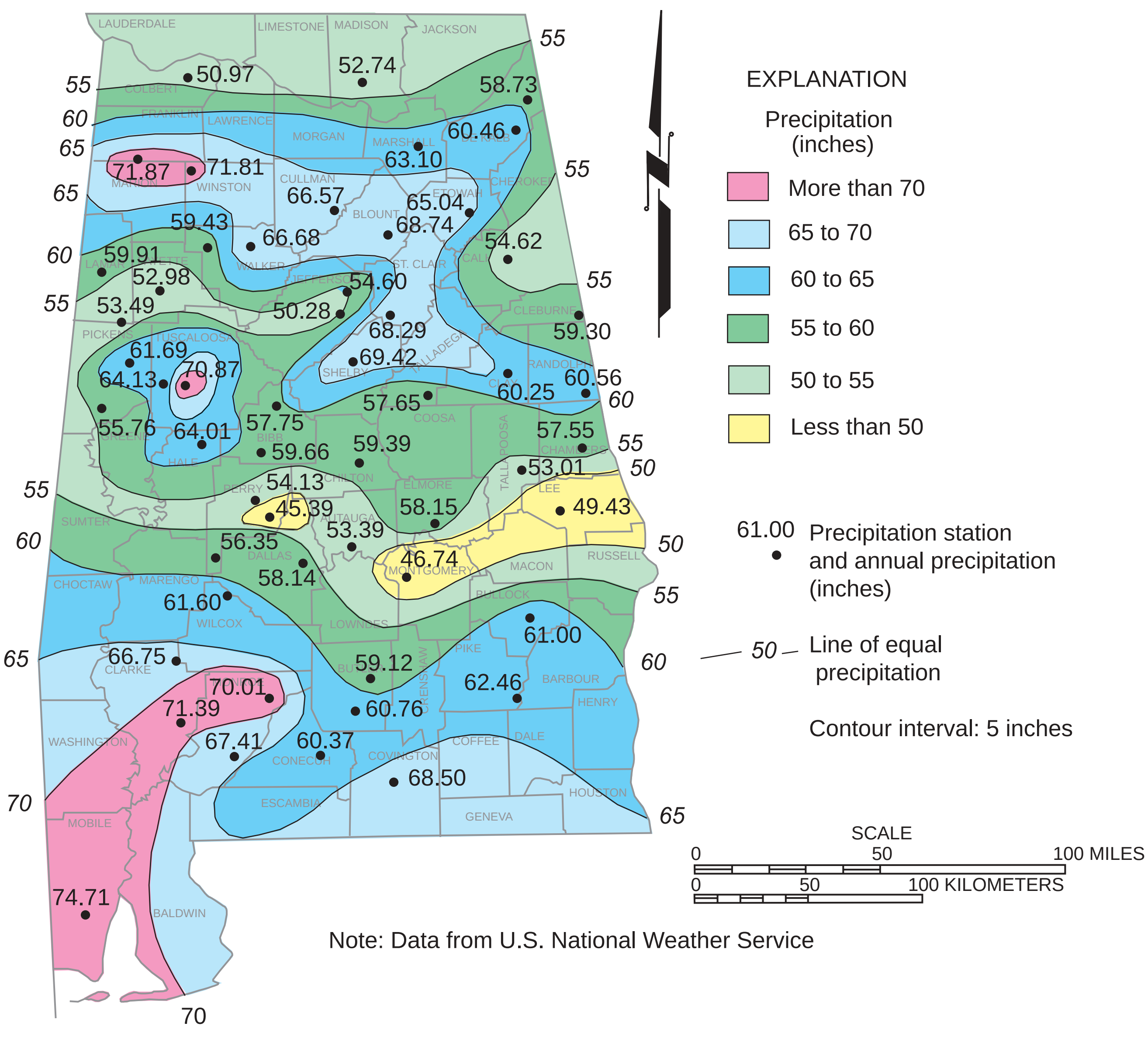
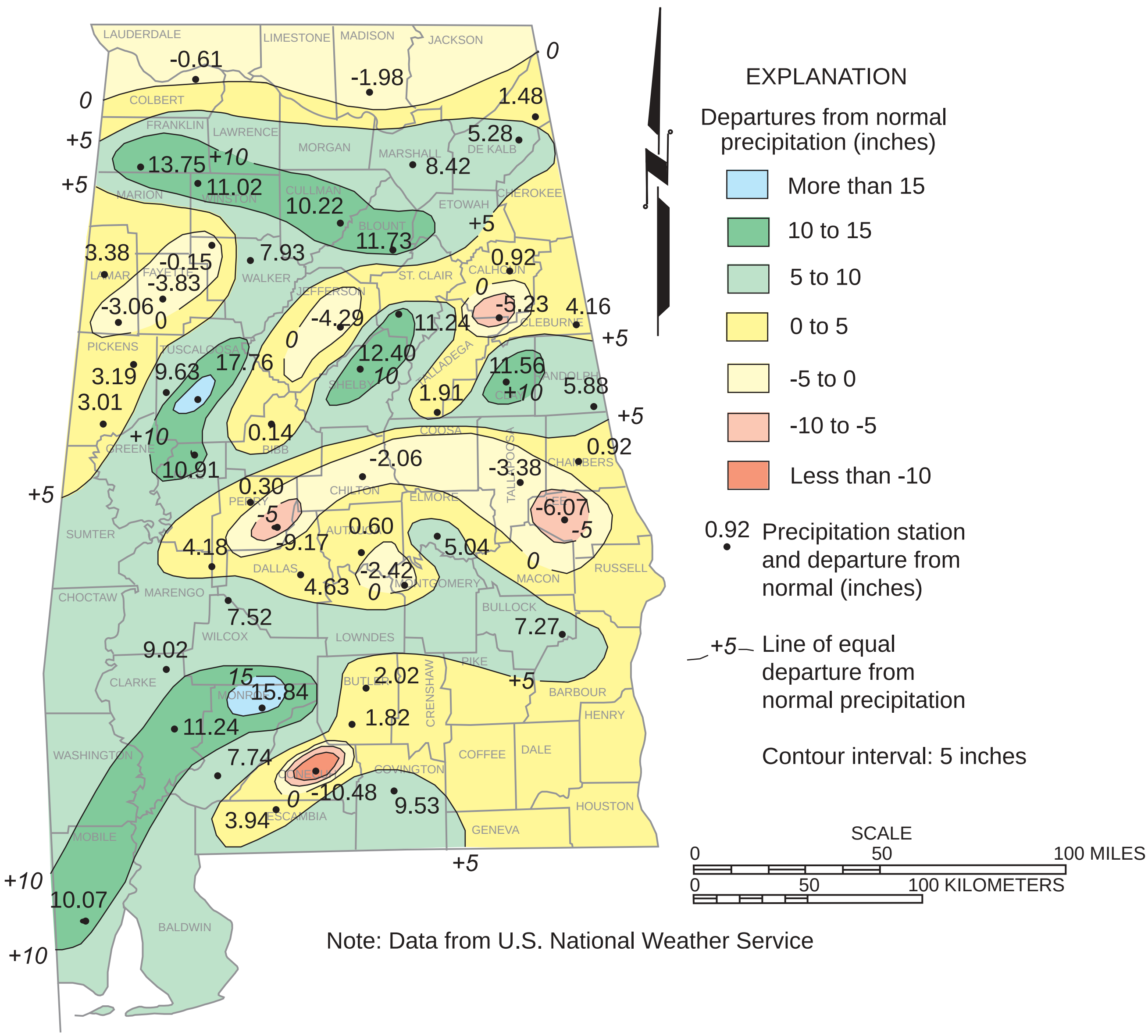


Figure 3.—Annual precipitation, 1997.



Note: Data from U.S. National Weather Service

Figure 4.—Departures from normal precipitation, 1997.

movement resulted in heavy rainfall in southwest Alabama on July 19-20, 1997. Storm precipitation was estimated at 43 inches near Dauphin Island; the storm generated local monthly rainfall excesses of more than 30 inches in southwest Alabama.

Only a part of the state's precipitation results in runoff (fig. 5). Much of the water either evaporates, enters the soil zone where it is retained as soil moisture or is taken up and transpired by plants, or enters the ground-water system. A comparison of figures 2 and 5 shows the large difference in the average amount of precipitation and the amount that can be accounted for as runoff.

GROUND WATER

Ground water is a reliable source of water for many people in Alabama. Several large cities and many smaller towns use ground water for municipal supply, especially in south Alabama where ground water is readily available and of good quality. Many wells throughout the state supply water for rural domestic users and semipublic facilities such as campgrounds and marinas.

Approximately 44 percent of the population of Alabama uses ground water for domestic supplies. The general availability of ground water from aquifers in different parts of the state is shown in figure 6. The water-bearing characteristics of aquifers are controlled by geologic factors such as the type, permeability, and structure of rocks comprising the aquifers. Each of the general geologic areas in the state provides different conditions for ground-water occurrence. The general geology of the state is shown on plate 1. Each area of color on the map corresponds to a named rock or sediment unit that has a characteristic appearance and physical properties. Most geologic units have distinct water bearing properties, and are either aquifers or aquitards (aquitards impede ground-water movement). Aquifers of Alabama are illustrated on GSA Special Map 231.

WATER LEVELS

The GSA maintains a statewide network of wells to monitor ground-water-level fluctuations in important aquifers (pl. 2). Twenty of these wells are equipped with continuous water-level recorders, and 375 wells were used for determining ground-water levels in the fall of 1997, which is normally the low-water-level period of the year. Water-level measurements in the periodic observation wells are taken either with steel or electric tapes. These measurements are made to as many significant figures as can be read accurately. Data from each well are published each year by GSA in Circular 112, "Ground-Water Levels in Alabama."

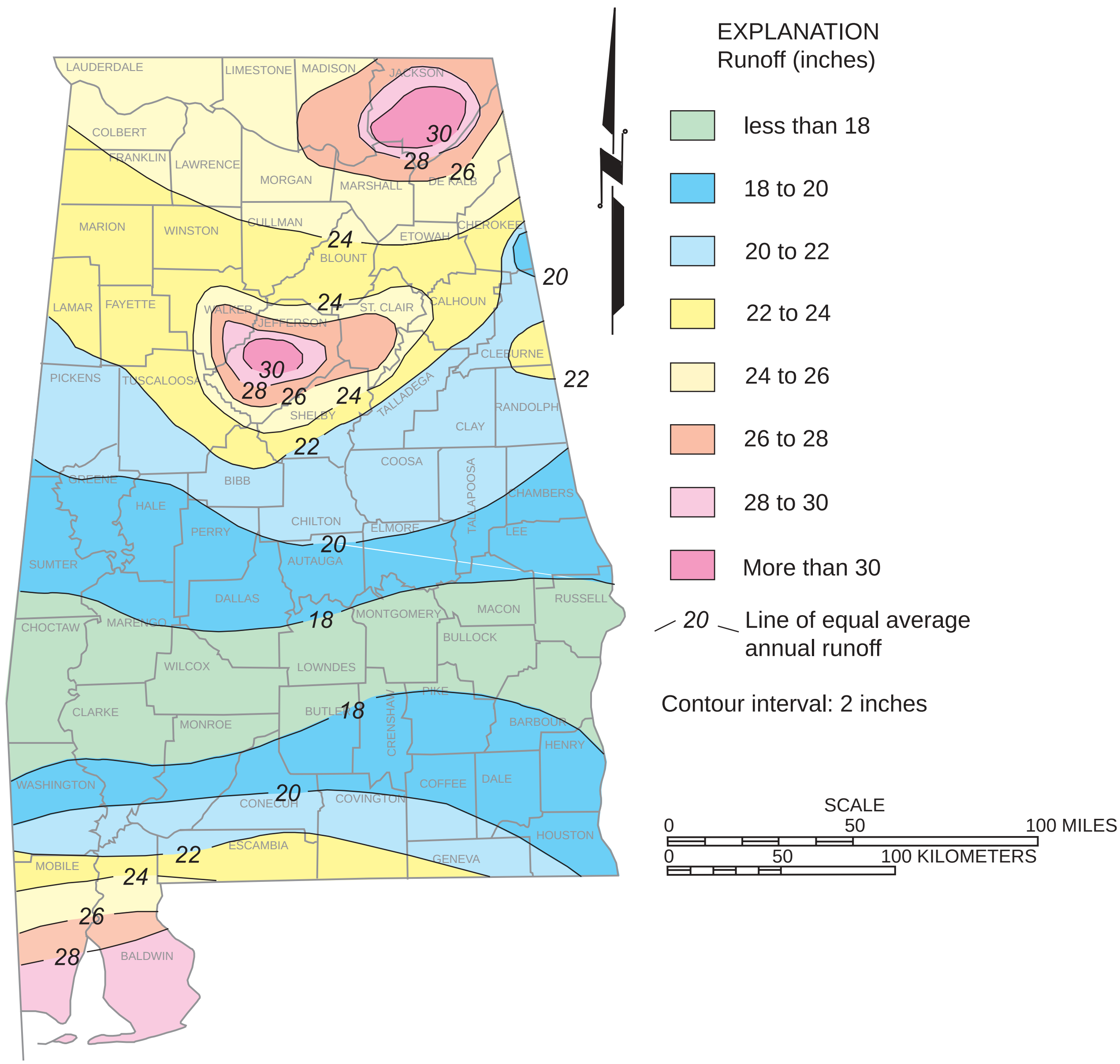
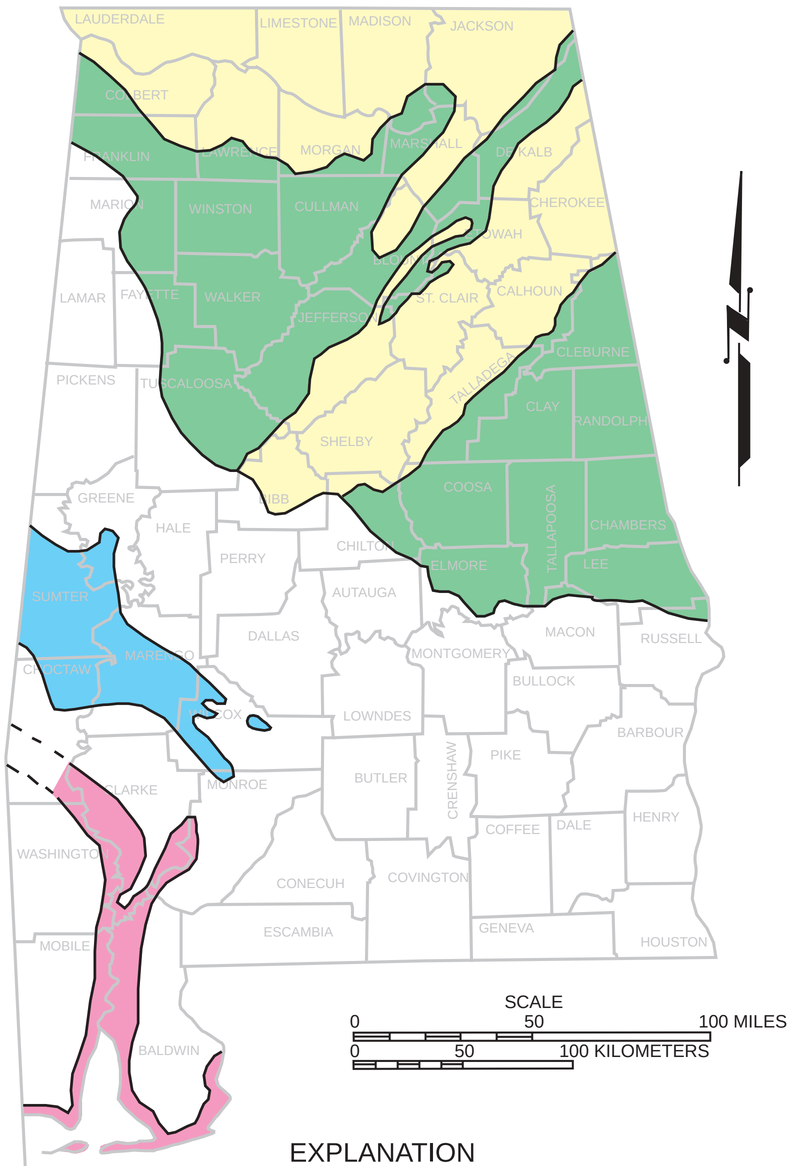


Figure 5.—Average annual runoff in Alabama (modified from U.S. Geological Survey, 1985).



EXPLANATION

- Ground-water supplies are generally sufficient for industrial or municipal development (150 gpm+).
- Relatively high well yields (150 gpm+); shallow depths to salt-water in some places; potential for salt-water encroachment.
- High-yield wells (150 gpm +) may occur primarily in carbonate rock areas where cavity systems have developed.
- Generally low yields (10 gpm). Only a few relatively high-yield wells developed in fracture zones.
- Ground water not suitable for industrial or municipal development; highly mineralized water in major aquifers.Yields of up to 5 gpm of freshwater available in some shallow aquifers.

Figure 6.—Potential yields of aquifers in Alabama.

During the low water-level period of 1997, record low water levels were recorded in about 11 percent of the wells (fig. 7), most of which were located in the coastal plain. About 4 percent of the wells recorded record high water levels, which are uncommon in the fall. The numbers of record high and low water levels were about the same in 1997 as they were in 1996. About 56 percent of the wells had water levels lower in the fall of 1997 than in the fall of 1996, which followed a relatively wet summer. About 44 percent of the wells had water levels higher in the fall of 1997 than in the fall of 1996. Three hundred fifty wells were measured in both 1996 and 1997. Figure 8 shows hydrographs of the lowest daily ground-water levels in selected wells for water year 1997. These hydrographs show the seasonal ground-water level fluctuations and short-term water-level fluctuations in response to changes in recharge or discharge of ground water. High ground-water levels generally occur in March or April, and low ground-water levels generally occur in September or October. However, during water year 1997 water levels were highest in some wells in June, July, and August. High water levels resulted from higher than normal recharge during and after several storm events in the summer and fall, particularly in southwestern and north Alabama. Well Bal-2 experienced high water levels in July and August of 1997 as a result of heavy rainfall associated with Hurricane Danny (figs. 8, 9). Well Mad-2 shows a very pronounced water-level fluctuation. Major rainfall events caused the ground-water level to rise sharply and then decline gradually numerous times during water year 1997. This shallow well is completed in highly permeable strata of the Fort Payne Chert and hence responds dramatically to rainfall events.

WATER-LEVEL TRENDS

Many municipalities in Alabama, primarily those in the coastal plain, depend on ground water either as the primary or sole water source. In the coastal plain, where pumpage has steadily increased for many years, water levels have declined in the vicinity of the major pumping centers. Water-level declines range from a few feet to more than 150 feet. An analysis of water-level data for 65 wells completed in the Eutaw aquifer indicated that water levels in wells completed downdip of the outcrop area decline at an average rate of 10 inches per year. Increasing pumpage of ground water in areas of concentrated population and limited aquifer performance in southeast Alabama have resulted in dramatically depressed water levels near the cities of Dothan, Troy, and Ozark.

Numerous, smaller areas of declining ground-water levels also occur throughout southeast Alabama due to overpumpage of single isolated wells. Water levels in the Nanafalia aquifer near the city of Dothan are about 150 feet below initial levels prior to pumpage. Water levels in this area continue to decline at the rate of about 4 feet per year. Water levels are also declining in the Providence-Ripley aquifer system near the

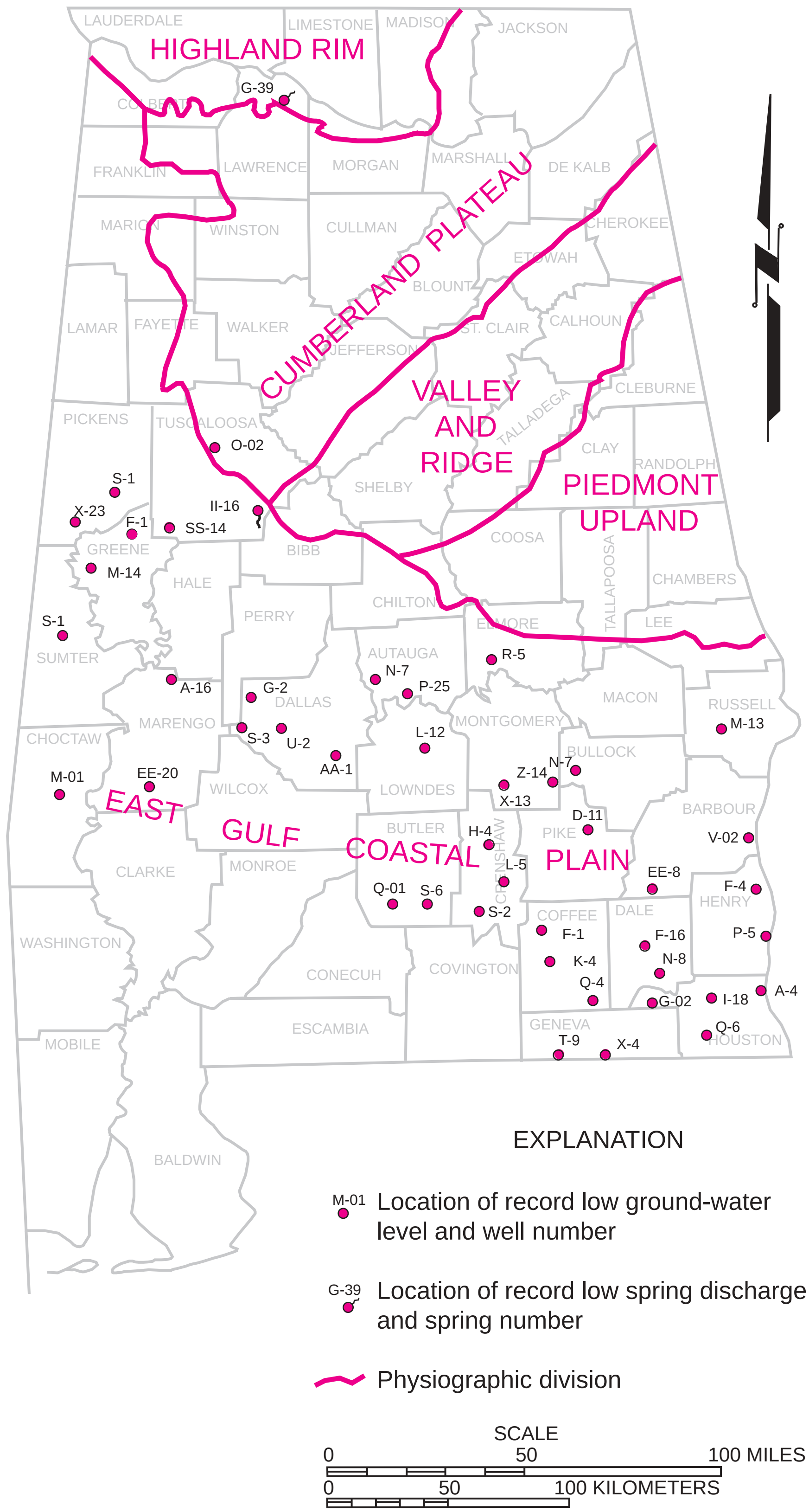


Figure 7.—Locations of record low ground-water levels in observation wells and record low discharges of springs, water year 1997.

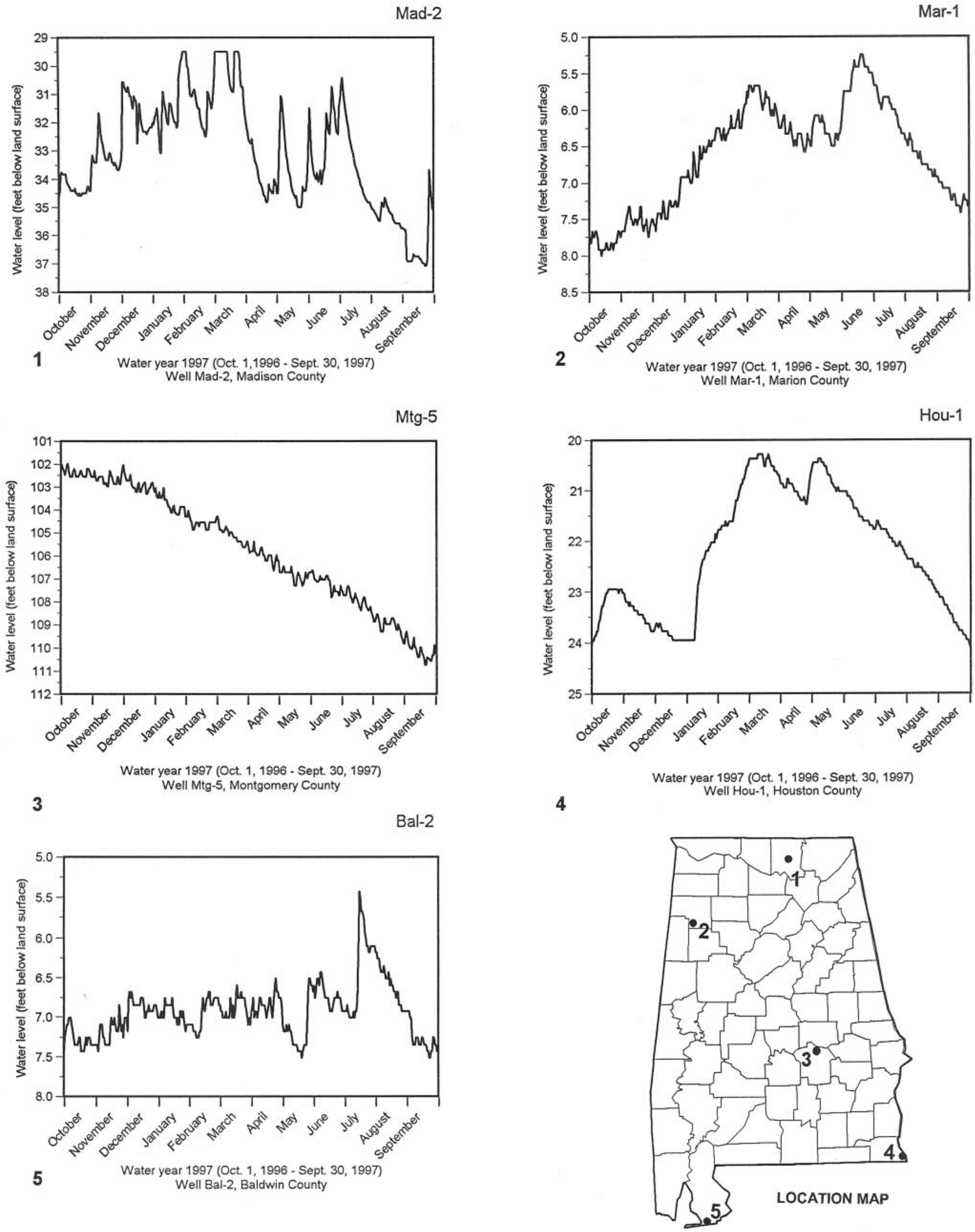


Figure 8.—Lowest daily ground-water levels for selected wells in water year 1997.

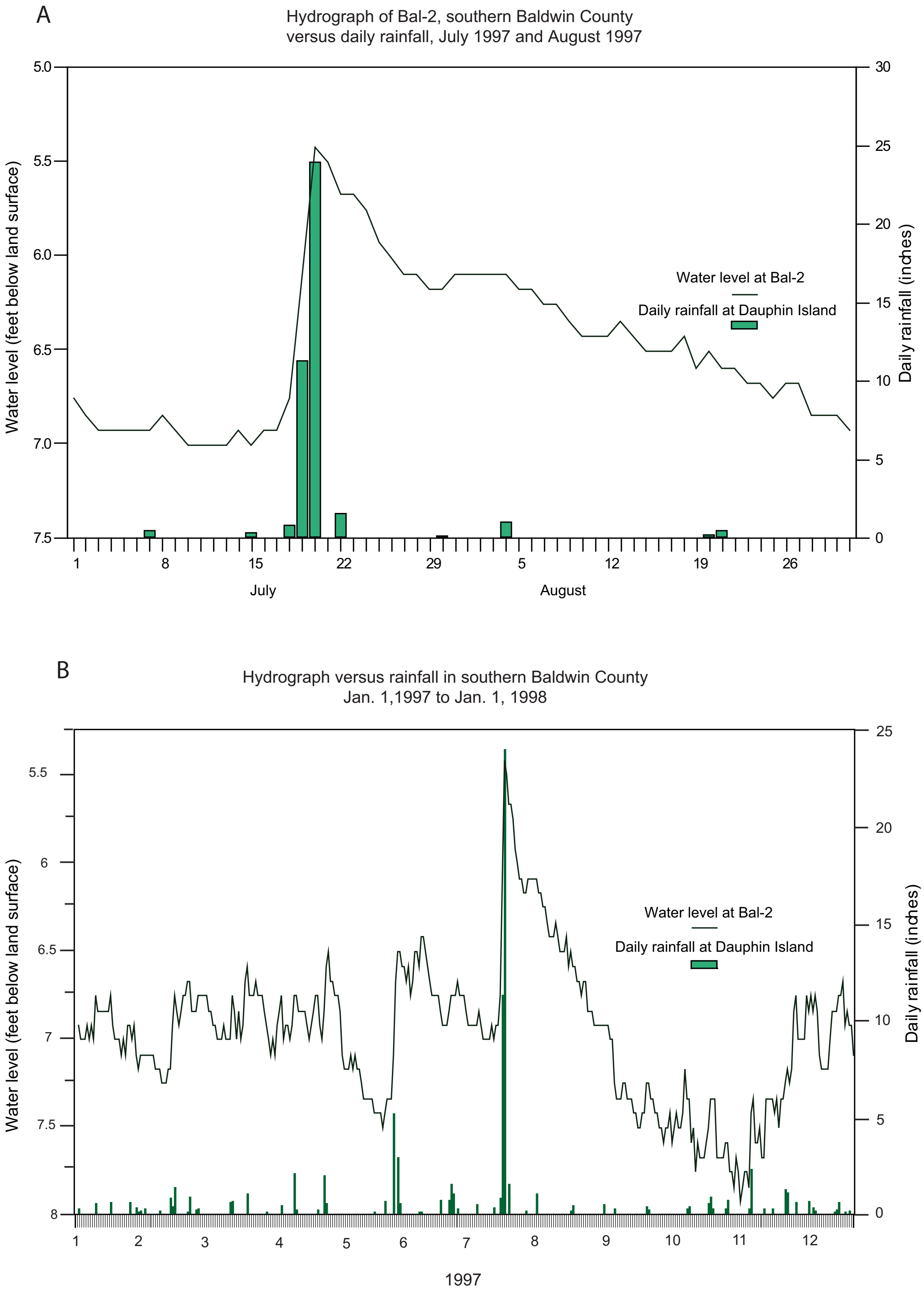


Figure 9.—Ground-water levels in well Bal-2 versus rainfall at Dauphin Island. (A) July and August 1997. (B) 1997.

city of Troy and the Nanafalia and Clayton aquifer systems near the city of Ozark. Current water levels at Ozark are about 125 feet below water levels prior to pumpage. Water levels in this area are declining at a rate of 2.5 feet per year. Water levels at Troy are roughly 70 feet below pre-pumping levels. The rate of water level decline in this area is about 2.6 feet per year. Water-level trends at selected sites are shown by the long-term hydrographs in figure 10. Despite local ground-water-level decline in major aquifers in the Alabama coastal plain, these same aquifers exhibit stable water levels in many regions away from the influence of major pumping centers.

The hydrograph for the monitored well in the Eutaw aquifer in Hale County shows that the water level has declined about 15 feet since the beginning of record in 1978. The hydrograph for the well in the Nanafalia aquifer in Butler County shows a water-level decline of about 3 feet from the beginning of record in 1978 until about 1983, followed by a more gradual decline of about 1 additional foot over the following 15 years. No water-level decline is apparent at the observation well completed in the Miocene aquifer in Baldwin County, at the observation well completed in the Fort Payne chert in Limestone County, at the observation well completed in the Crystal River Formation in Houston County, or at the observation well completed in the Pottsville Formation in Marion County. All of the hydrographs show seasonal water-level fluctuations, which generally range from less than 1 foot in some wells to more than 10 feet in other wells. These fluctuations occur in response to seasonal variations in recharge. More information on water levels is provided in a series of annual reports by GSA entitled “Ground-Water Levels in Alabama” (Circular 112).

SPRING DISCHARGES

GSA measured the discharges of 33 springs in Alabama during the fall of 1997. The discharge of individual springs is highly variable. The amount of discharge depends largely on the amount of rainfall preceding discharge measurements. Of the 33 springs measured in fall 1997 and fall 1996, 10 (30 percent) had larger discharges in 1997. Although discharges are normally low in the fall, one spring (Robinwood Springs in Jefferson County) had a record high discharge in the fall of 1997. Two springs (Wheeler Spring in Lawrence County and Big Sandy Spring in Tuscaloosa County) had record low discharges in the fall of 1997 (fig. 7).

SURFACE WATER

Alabama has abundant surface-water resources. The state contains 14 major river systems or basins, 47,077 miles of perennial rivers and springs, 28,479 miles of intermittent streams, 32 miles of ditches and canals, 490,472 acres of ponds, lakes, and reservoirs, 3,600,000 acres of freshwater wetlands, 27,600 acres of coastal wetlands,

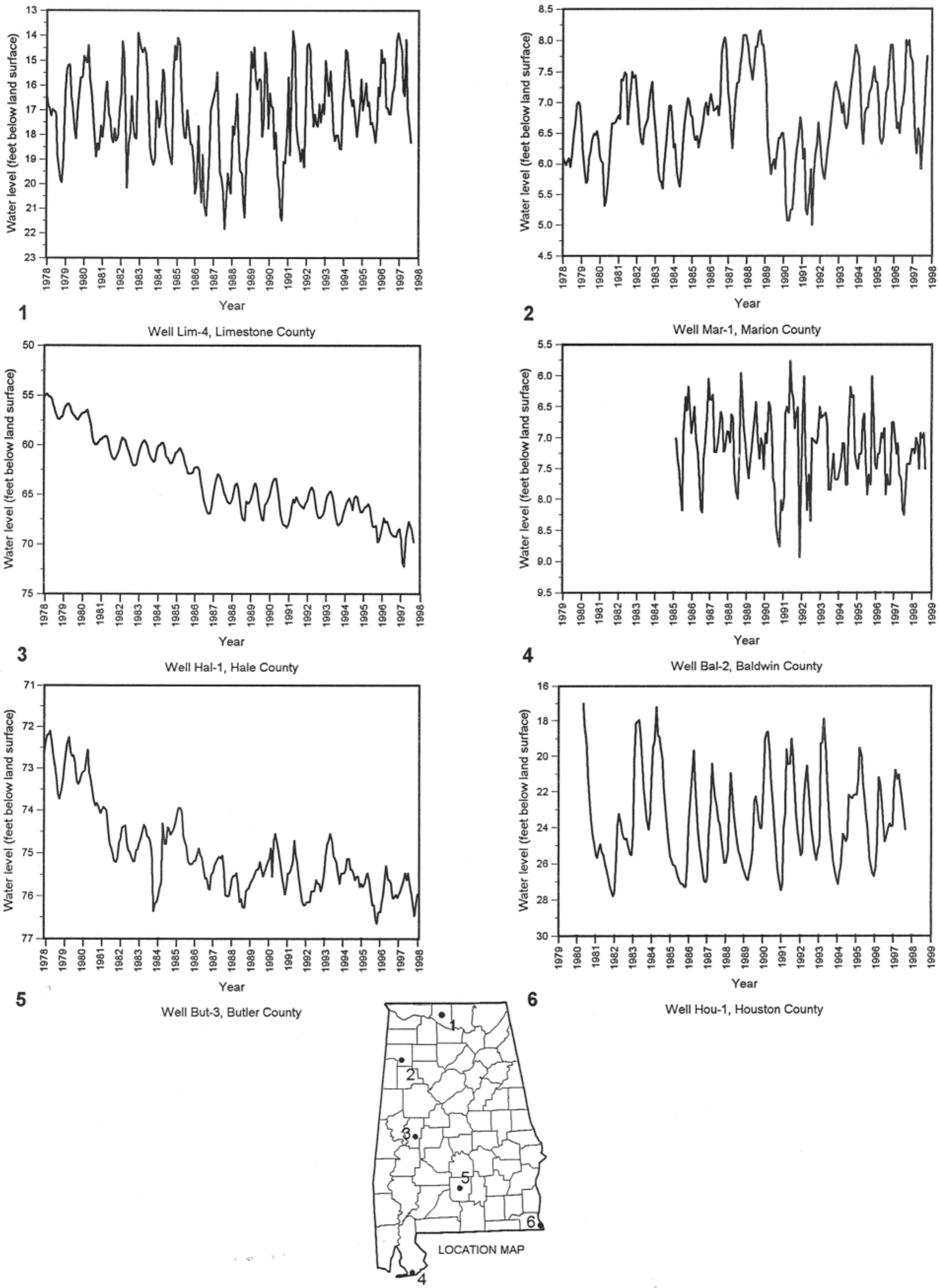


Figure 10.—Long-term hydrographs of monthly low water levels in selected wells.

610 square miles of estuaries in coastal Alabama, and 337 miles of coastal shoreline, including Mobile Bay and island shorelines (ADEM, 1994a). These resources have been developed extensively for many uses. Streams and reservoirs provide water for domestic consumption, industrial uses, transportation, power generation, waste dilution, and recreation. Surface water is used for drinking water supplies by about 56 percent of the population of Alabama.

HYDROLOGIC REGIONS

The state is divided into hydrologic regions, which correspond to river drainage basins and groups of basins (fig. 11). Hydrologic regions may contain several major river basins; subregions correspond to the drainage area of a major river; and accounting units correspond to the basins of major tributaries. Each unit is assigned a two-digit number. These numbers are combined in a sequence from larger to smaller basins, so that an eight-digit number can delineate the position of a tributary basin within a major river basin and a multiple-river basin. This numbering system is used by several agencies, including the U.S. Geological Survey, U.S. Department of Agriculture, Natural Resources Conservation Service, and ADEM.

Within accounting units, gaging stations are assigned arbitrary numbers in downstream order along the main stream. No distinction in numbering is made between partial-record stations, where limited streamflow data are collected periodically, and continuous-record stations, where systematic observations of gage height and/or discharge are measured continuously.

STREAMFLOW

Streamflow information is needed for the development of public and industrial water supplies, power generation, waste assimilation, and proper construction of bridges, dams, causeways, and other structures. To use and develop surface-water resources effectively and to plan for land use and construction in areas affected by watercourses, several types of surface-water data are required. Among the most important of these are data on streamflow duration, average annual discharge, low flow, seasonal distribution of flow, and maximum stream stage. To obtain these and various other types of streamflow information, the U.S. Geological Survey in cooperation with ADEM maintains a network of gaging stations on streams throughout Alabama. Stream-discharge measurements also are made at various sites by other agencies, including the GSA. The U.S. Geological Survey stations range in complexity from sophisticated installations containing continuous recorders, flow-through sampling chambers, climatological instruments, and small automatic laboratories, to simple gage-height scales marked on spillway walls or other structures. The most common

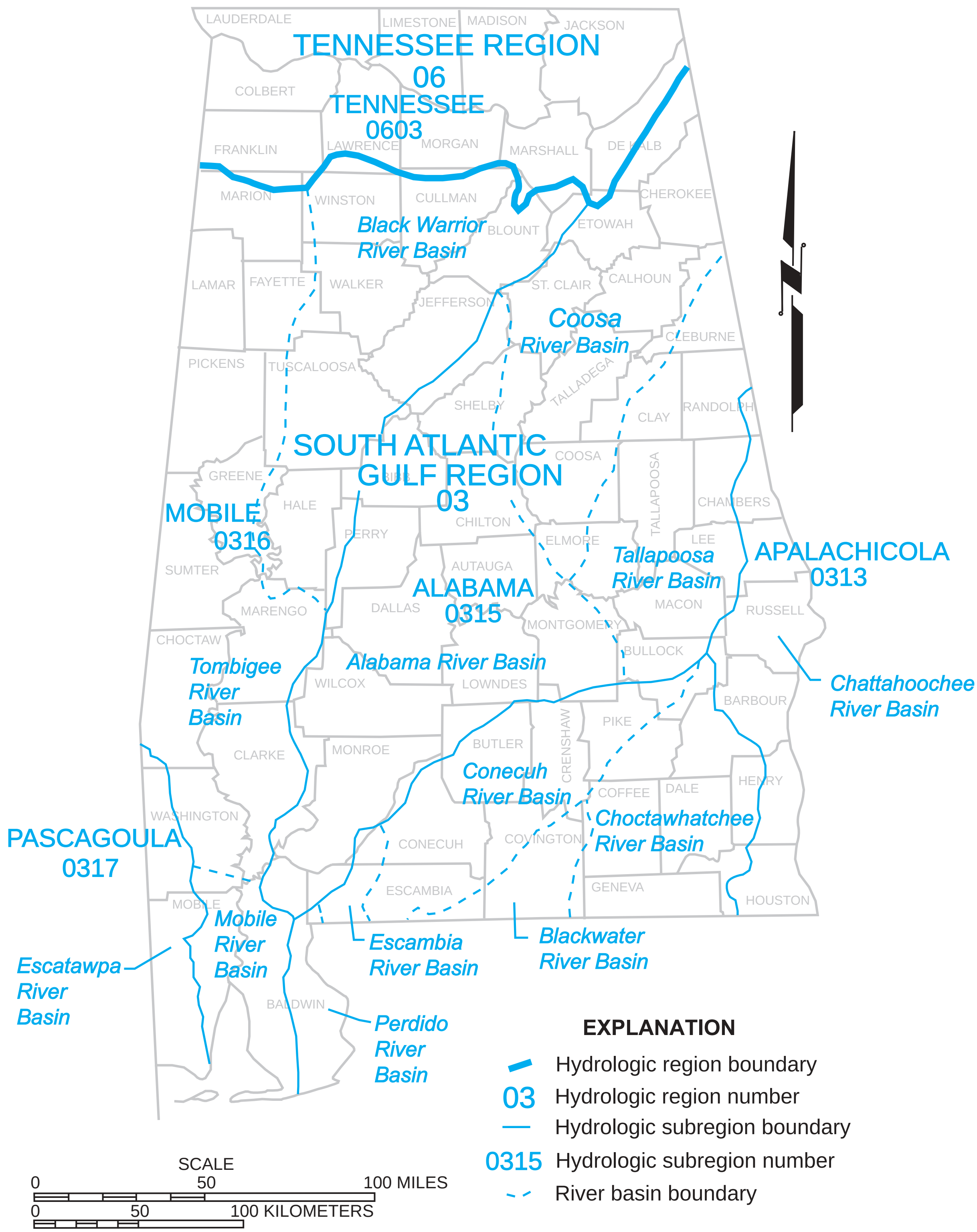


Figure 11.—Hydrologic regions and principal river basins in Alabama.

type of station includes a continuous recorder, which generally is mounted on a galvanized pipe on a stream bank or attached to a bridge. Automated continuous recorders record stage measurements on paper or digital media; nonrecording gages are read directly.

Information on natural low flows of streams is necessary in planning for water-supply availability, disposal of waste effluents into streams, hydroelectric power generation, and wildlife management. The most commonly used values are the annual 7-day low flows of 2-year and 10-year recurrence intervals, called the 7-day Q_2 and 7-day Q_{10}, respectively. The 7-day Q_2 represents the median low flow, or the lowest flow to which the stream will decline during 7 consecutive days on an average of once every 2 years of normal flow. This value also provides an estimate of the amount of flow generally available without the need for storage (fig. 12). The 7-day Q_{10} is the lowest flow for 7 consecutive days that may be expected to occur once in 10 years. The reliability of mean, maximum, and minimum flow values is dependent upon the length of the period of record for which discharge records are available. Usually, the longer the period of record, the more reliable the low-flow values. Low-flow values, especially those determined for extensive periods of record, change very little from year to year except when affected by extreme drought or flood conditions.

The U.S. Geological Survey maintains computer files of streamflow data, and publishes daily values for gaging stations in annual Water Data Reports and water-supply papers for the state.

Large streams and rivers are well distributed throughout the state, and their average discharges range from less than 200 to more than 52,000 cubic feet per second (ft^3/s). Table 1 summarizes streamflow data for gaging stations on selected streams. The lowest discharges of streams in Alabama generally occur in September or October, and the highest discharges generally occur in March or April.

During the 1997 water year (October 1, 1996 to September 30, 1997) the maximum flows recorded on the Sucarnoochee River at Livingston and the Paint Rock River near Woodville were in March 1997; on the Conecuh River at Brantley and on Mulberry Fork near Garden City in May 1997; and on Hatchett Creek below Rockford in February 1997.

During this same period, the minimum flows on the Conecuh River at Brantley, the Sucarnoochee River at Livingston, Hatchett Creek below Rockford, Mulberry Fork near Garden City, and Paint Rock River near Woodville were in September 1997. Data commonly used to assess streamflow characteristics are given in table 1. This table documents pertinent streamflow data for 21 surface water sites monitored by automatic recording instrumentation by the U.S. Geological Survey.

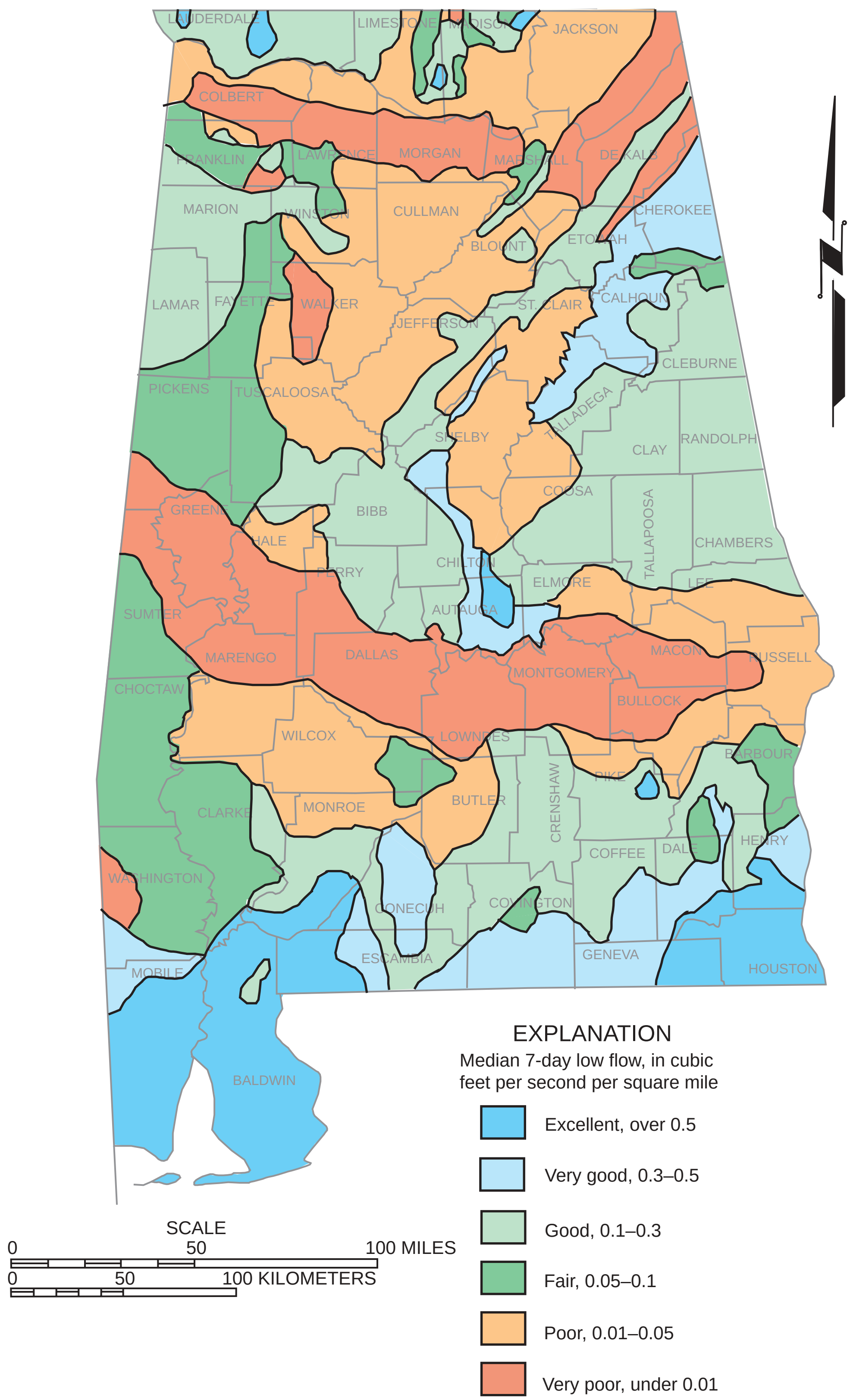


Figure 12.—Areal variation in median 7-day low flow of minor streams (modified from Peirce, 1967).

Table 1.—Mean, maximum, and minimum streamflow for water year 1997 and recurrence intervals at selected streamflow stations in Alabama (Information provided by the U.S. Geological Survey, Alabama District)

Station name	Station number	Years of record (years)	Mean: Yearly mean (ft^3/s)	Mean: Percent of long-term average	Maximum: Peak discharge (ft^3/s)	Maximum: Recurrence interval (years)	Minimum: 7-day average (ft^3/s)	Minimum: Recurrence interval (years)
Uchee Creek near Fort Mitchell	02342500	51	383	88	9,970	< 5	14	< 5
Choctawhatchee River near Newton	02361000	67	991	103	7,430	< 2	109	< 5
Conecuh River at Brantley	02371500	60	497	75	4,430	< 2	37	< 5
Murder Creek at Evergreen	02374500	60	228	80	1,500	< 2	67	< 5
Fish River near Silver Hill	02378500	27	159	137	16,900	< 50	60	< 2
Big Wills Creek near Reece City	02401000	38	398	129	9,480	< 5	83	< 2
Kelly Creek near Vincent	02405500	29	431	129	5,960	< 2	14	< 2
Coosa River at Jordan Dam near Wetumpka	02411000	73	18,330	112	92,400	< 2	regulated	regulated
Tallapoosa River near Heflin	02412000	45	765	111	8,930	< 2	103	< 2
Mulberry Creek at Jones	02422500	55	300	96	5,450	< 2	67	< 2
Cahaba River at Centreville	02424000	70	1,732	108	21,200	< 2	278	< 2
Buttahatchee River below Hamilton	02438000	27	803	150	22,000	< 5	86	< 2
Sipsey River near Elrod	02446500	54	1,093	136	9,520	< 2	101	< 2
Sipsey Fork near Grayson	02450250	31	247	146	10,100	< 5	7.2	< 2
Locust Fork at Sayre	02456500	59	2,070	142	24,100	< 2	101	< 2
Black Warrior River at Northport	02465000	77	10,350	130	65,200	--	regulated	regulated
Tombigbee River at Demopolis Lock & Dam near Coatopa	02467000	69	32,850	138	135,000	--	regulated	regulated
Chickasaw Creek near Kushla	02471001	46	384	138	4,140	< 2	77	< 2
Paint Rock River near Woodville	03574500	61	765	111	8,060	< 2	18	< 2
Tennessee River at Whitesburg	03575500	61	57,610	132	187,000	--	regulated	regulated
Big Nance Creek at Courtland	03586500	50	379	134	5,660	< 2	19	< 2

For the 1997 water year, streamflow was above normal for most of the state with 17 of 21 streamflow stations having yearly means averaging more than the long-term means (Pearman and others, 1998). Pearman and others (1998) indicated that 12 streamflow stations had mean annual flows higher than 125 percent of the long-term means. In general, streamflows in January and May through August were above normal throughout the state (Pearman and others, 1998). Streamflows in the months of April and September were below normal (Pearman and others, 1998). Streamflows at the 21 stations averaged slightly less than in 1996.

Baseflows of streams throughout the state were normal with 13 of the 17 unregulated stations shown in table 1 having minimum 7-day average discharges with less than a 2-year recurrence interval. Annual peak discharges for the 1997 water year were within historical extremes throughout the State except for Fish River near Silverhill, which had its highest peak in more than 50 years of record. Of the 17 unregulated stations in table 1, 13 had instantaneous peak discharges with recurrence intervals less than 2 years, 4 had 5-year floods, and 1 had a 50-year flood. Streams across Alabama had an average number of peaks above base discharge for the water year (Pearman and others, 1998).

Hurricane Danny made landfall on July 19, 1997, but then remained stationary in Mobile Bay for nearly 24 hours, causing torrential rains. Fish River near Silverhill and Fowl River near Laurendine experienced 50-year floods as a result of the storm (Pearman and others, 1998). The storm also caused localized flooding in the Tuscaloosa and Birmingham areas.

TRENDS IN RESEARCH AND REGULATION

New trends in federal environmental legislation chiefly involve turning over regulatory authority to the states, and moving toward a more cooperative approach based on realistic estimates of costs, benefits, and dangers.

New trends in water research include increasing emphasis on the watershed as a unit of study. A watershed may be defined as a region from which all water drains to a common point. The most obvious example of a watershed is a river basin, though there are ground-water watersheds too. A watershed is a natural physical area in nature, as opposed to political regions like states and counties. Therefore, much of the important movement of water and water contaminants is best described when entire watersheds are studied. This is not a new idea, but it has been receiving more attention than ever before. A recent report by the U.S. Geological Survey cited several key ways in which water-research agencies can achieve maximum benefit from their activities. The U.S. Geological Survey suggested that four areas deserve increased attention: large watersheds, urban and urbanizing watersheds, restoration of damaged watersheds, and erosion and sedimentation processes in watersheds (Parker, 1997). This has major implications for Alabama, because our state contains examples of all four cited areas. For instance, the Mobile watershed is one of the largest in North America. Also, erosion is one of the most serious and most intractable problems in watersheds in southeast Alabama. Further, the U.S. Geological Survey study concluded that reliable interpretations are likely to derive from watershed studies only if monitoring continues for at least 10 years (Parker, 1997). This is a longer time than any previous or on-going watershed study in Alabama and represents a tremendous investment of time and money. The study also emphasized the need for collaboration in watershed research. Current watershed studies in Alabama are all collaborative ventures, most at local, state, and federal levels.

Another trend in water research and regulation is an increased emphasis on nonpoint-source pollution. With point-source pollution highly regulated, nonpoint sources have emerged as the highest priority for effective control of water pollution. Nonpoint sources are pollution sources that are too diffuse or too numerous to pin down. Runoff from parking lots, construction sites, lawns, and fields are examples of nonpoint-source pollution. Nonpoint sources are difficult to control through regulation. Instead, public education and encouragement of use of best management practices in a wide variety of activities can significantly reduce nonpoint-source pollution.

Finally, changes in costs associated with delivery of drinking water from different sources (surface water, ground water, and desalinated sea water) may affect Alabama's coastal areas in the foreseeable future. For the first time, the wholesale cost of desalinated sea water is approaching the national average retail cost of tap water (about 0.2 cent per gallon) (WaterWorld, 1999a). Evolving technology has permitted reductions in costs for desalinated sea water. A relatively modest further price decrease for desalinated sea water could make this a viable option for coastal Alabama.

WATER REGULATIONS

FEDERAL LEGISLATION

A new initiative of the USEPA and USDA concerns animal feeding operations (AFOs). Late in 1998, the two agencies released a draft national strategy for AFOs. The purpose of this strategy is to reduce nonpoint-source pollution (polluted runoff) by controlling pollution caused by AFOs. These facilities, including poultry, cattle, dairy, and swine farms, are potential sources of nutrients (the most troublesome are nitrogen and phosphorus) and pathogens, such as harmful bacteria. Many AFO owners have instituted voluntary measures to limit polluted runoff, but as of November 1998, more than 5 percent of U.S. river miles surveyed had been adversely affected by AFOs (WaterWorld, 1998f). The proposed strategy is a combination of voluntary and regulatory measures. Components of the strategy include feed management, controls on land application of manure, land management, record keeping, and other measures in vulnerable watersheds. Voluntary measures focus on AFO owners developing comprehensive nutrient management plans, with a target date of 2008 for this to be complete. Regulatory measures will focus on the largest operations, those with unacceptable conditions such as direct discharge into waterways, and AFOs that contribute significantly to water pollution. USEPA will revise permitting regulations for these targeted operations to include required nutrient management plans by December 2001. USEPA plans to revise national guidelines to limit discharge from poultry and swine operations by December 2001, and from cattle and dairy farms by 2002. The draft strategy is available from USEPA at 1-202-260-7786 and on the web at http://www.epa.gov/owm/afostrat.htm.

Major pieces of legislation passed in recent years include amendments to the Safe Drinking Water Act (SDWA), the reauthorized Clean Water Act, and the Farm Bill.

President Clinton signed the revised Safe Drinking Water Act on August 6, 1996. The revised law tightens drinking water standards and establishes a fund that permits the federal government to lend states more than $1 billion per year to improve water purification systems. Alabama received $12,558,800 in fiscal year 1997, which represents approximately 1 percent of funding available (after set-asides) under this program. Alabama is to receive $8,465,600 in fiscal year 1998, which is 1.19 percent of the total after set-asides. Most of the State revolving loan fund dollars are intended to be lent to public water systems. States can reimburse public water systems for pre-loan construction costs under some circumstances. Up to 25 percent of the money can be used by the states for source-water protection, including wellhead protection projects. This permits considerable flexibility in use of these funds by the states to support source-water protection efforts. The SDWA also requires water systems to notify users within 24 hours of violations of water-quality standards, and mandates annual reports on the quality of tap water. Other provisions of the law include new risk-based and cost-benefit analysis based methods of determining maximum contaminant levels; streamlined monitoring requirements for 64 chemicals; millions of dollars per year for projects including development of regulations and treatment methods; a study of the incidence of water-borne diseases in the United States; technical assistance to small public water systems, including variances, exemptions, and alternate technologies; voluntary guidelines for water conservation; ground-water protection through underground injection control; creation of a new source water quality assessment program (Alabama and other states with primacy have the option of developing their own programs); improvements to water-system operator training; and other technical and financial assistance for water infrastructure. The former requirement that the USEPA regulate 25 new contaminants every three years has been eliminated. Instead, the agency must develop a database containing information on the occurrence of contaminants in drinking water. Every five years, the agency must decide whether or not to regulate at least five contaminants from a list to be published within 18 months of passage of the 1996 SDWA amendments (Clark, 1997). The amendments include specific requirements for ground-water disinfection, arsenic, sulfate, radon, and disinfection byproducts. The Association of Metropolitan Water Agencies threatened to sue the USEPA for failing to set aside $10 million per year from the State Revolving Fund for health effects research (Crow, 1997). This set-aside was required by the 1996 SDWA amendments. The purpose of the set-aside was to fund research that would help USEPA develop scientifically sound regulations. The full text of the SDWA as amended in 1996 can be found on the Internet at http://www.epa.gov/OGWDW. A summary of the SDWA amendments is available at http://www.epa.gov/OGWDW/SDWAsumm.html (document 810S96001). A copy of the amendments can be obtained from the Government Printing Office by telephone (202-512-1808) or by FAX (202-512-2250). Some USEPA documents are also available from USEPA's National Center for Environmental Publications and Information at 1-800-490-9198. USEPA's Safe Drinking Water hotline at 1-800-426-4791 can be contacted for information about the SDWA.

The USEPA published a final rule regarding consumer confidence reports on August 18, 1998. These are annual reports of tap-water quality mandated by the 1996 SDWA amendments. The first reports are due by October 18, 1999, for calendar year 1998 data. The consumer confidence reports should be valuable to consumers, because they will contain general information about contaminants in drinking water, information about detection of regulated contaminants in a water system's drinking water, and information about detection of unregulated contaminants for which monitoring is required. Sources of additional information will be listed in the reports. Water systems serving fewer than 10,000 people will have to prepare the reports but will not have to mail them to each customer as larger systems will be required to do.

In May 1999, the USEPA released a draft copy of the Public Notification Handbook, which will assist public water systems in implementing revised public notification regulations, which were also released in draft form in May 1999. The new public notification regulations result from the 1996 amendments to the SDWA and concern requirements for reporting of violations by public water systems of the SDWA. Copies of the proposed regulation and the draft Handbook may be obtained by calling the Safe Drinking Water Hotline at 1-800-426-4791 or by downloading the documents from the Office of Ground Water and Drinking Water's web site at http://www.epa.gov/safewater.

The USEPA in October 1998, released the first annual national assessment of drinking water system compliance (WaterWorld, 1998e). The report found that 91 percent of community systems, serving 86 percent of the population, had no reported violations of either health-based standards or treatment techniques. Most violations were for reporting requirements, not health-based standards, and most problems occurred in small systems. USEPA plans to respond to most violations with technical assistance. Large systems, especially those that had serious or repeat violations, are most likely to face formal enforcement.

The SDWA amendments of 1996 require the USEPA and the Centers for Disease Control and Prevention (CDC) to jointly conduct a health effects study of sulfate by February 1999, and that sulfate be one of the five contaminants that USEPA considers regulating by August 2001. The health effects study design is underway. USEPA is required to propose revised standards for arsenic in public drinking water supplies by January 1, 2000, and to promulgate a final rule no later than January 1, 2001. USEPA is further required to develop a comprehensive research plan concerning the uncertainty in health risks from low-level exposure to arsenic. This plan is being developed in consultation with the National Academy of Sciences, other Federal agencies, and interested parties. Research is underway (the NAS issued a report in March of 1999 calling for a strengthened standard for arsenic), but final results are not likely to be available by the rule-making deadline (Pontius, 1998). The NAS report is available on the Web at http://www.epa.gov/OGWDW/ars/nrcrpt.html. Current arsenic standards are being reviewed because of evidence that low levels of arsenic may be more harmful than previously thought. Arsenic is a natural constituent of ground water and may be more concentrated in ground water than in surface water (WaterWorld, 1999b). However, water-quality monitoring by the GSA indicates little or no arsenic in Alabama ground water. The highest measured value in 1995 and 1996 was 5.2 micrograms per liter (ug/L), which is far below the current USEPA standard of 50 ug/L (Kopaska-Merkel and Moore, 1999, 2000).

The Disinfection By-Products Rule (DBP), which is being developed in two stages, applies to all community and nontransient noncommunity water systems that treat their water with a chemical disinfectant. In stage one, effective February 16, 1999, a maximum contaminant level (MCL) was set for total trihalomethanes at 80 µg/L and for the total of five haloacetic acids (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid) at 60 µg/L. MCLs were set for bromate at 0.01 milligram per liter (mg/L) and for chlorite at 1.0 mg/L. Compliance with the MCLs will be based on the running annual averages. Under stage one, maximum residual disinfectant levels (MRDLs) were established for chlorine at 4.0 mg/L, monochloramine at 4.0 mg/L, and chlorine dioxide at 0.8 mg/L. Compliance with the MRDLs is based on the running annual averages, which are computed quarterly. Implementation of the stage one rule is scheduled for November 2001. The stage one rule applies to large systems (serving at least 10,000 people) beginning

December 2001, but does not apply to small systems until December 2003 (King and Hethcoat, 1999).

Under stage two of the DBP Rule, additional DBPs will be considered, and the requirements established under stage one may be revised following the collection of additional information. The MCLs for total trihalomethanes and the five haloacetic acids will be 40 and 30 mg/L, respectively, in stage two. According to WaterWorld (1998d), the stage two rule may require significant changes to disinfection practices for utilities that needed to make only minor changes to comply with the stage one rule. The draft stage-two rule is anticipated for promulgation in November 2000 and the final rule in May 2002.

The Enhanced Surface Water Treatment Rule (ESWTR) was developed to provide protection from the microbe *Cryptosporidium*, which is not addressed in the current Surface Water Treatment Rule (SWTR). *Cryptosporidium* has been responsible for a number of waterborne disease outbreaks, including a 1993 incident in Milwaukee in which 400,000 people became ill and at least 50 died. *Cryptosporidium* has not been reported in Alabama drinking water. An interim ESWTR for systems serving more than 10,000 people became effective on February 16, 1999. This rule includes a maximum contaminant level goal (MCLG) of zero for *Cryptosporidium* and stringent filtering and monitoring requirements are included to ensure protection from *Cryptosporidium*. The interim rule also implements measures to comply with new disinfectant and disinfectant by-product standards. The interim rule includes sanitary surveys for public water systems regardless of size, and regulates systems using ground water directly affected by surface water, as well as systems using surface water. A final ESWTR for all systems was to be promulgated in December 1998. However, the interim ESWTR will not be finalized until at least the year 2000 (AWWA, 1996c). Also, the time available for systems to bring their facilities into compliance with both the stage 1 DBP rule and the ESWTR has been increased from 18 months to up to 5 years. USEPA believes that some systems will require capital improvements that could not be completed in less than 5 years. A similar rule for small systems (called the Long Term stage 1 ESWTR) is expected to be proposed in November 1999 and finalized in November 2000 (Pontius, 1998). ESWTR will also have a stage 2 version to be promulgated in association with the stage 2 DBP rule. The proposed stage 2 ESWTR is expected in November 2000, and the final rule in May 2002 (Pontius, 1998). Benchmark studies to determine the effects on targeted microbes of existing disinfection practices are mandated by the ESWTR and are set to begin by March 2000. Monitoring is intended to demonstrate whether changes in disinfection practices are providing better control of harmful microorganisms and disinfectants/disinfection byproducts in drinking water (King and Hethcoat, 1999).

The Groundwater Disinfection Rule, now called the Ground Water Rule, would establish disinfection requirements, if necessary, for public water systems using ground water. Studies are underway in connection with this rule, and a proposed rule is expected early in 1999. The final rule is expected in November 2000 (Pontius, 1998). Sixty-two percent of water-borne disease outbreaks come from ground-water systems, and 81 percent of these derive from contaminated source water (Seacrest, 1998). Studies have focused on occurrence of microbes in ground water, state ground-water requirements, best management practices in widespread use, and vulnerability and risk assessment for microbial contamination of ground-water systems (Seacrest, 1998). A study of the influence of best management practices (BMPs) on bacterial water-system health violations showed that most BMPs reduce violations, and that different BMPs are most effective for systems of different sizes (Groundwater Foundation, 1998). For small systems, operator training is critical; for large systems, proper disinfection was the most important. USEPA expects to take a multi-barrier approach including source-water protection involving BMPs and wellhead protection, and not simply use disinfection to protect ground water from bacteria (Seacrest, 1998). The USEPA and Centers for Disease Control and Prevention have initiated a study of water-borne diseases with an expected completion date of August 2002 (preliminary results by August 2001).

The Unregulated Contaminant Monitoring Regulation is designed to show whether up to 30 contaminants (not now regulated) pose a threat to drinking water. Most unregulated contaminants that would be considered under this regulation are pesticides or microbes. Public water systems serving more than 10,000 persons, and some smaller systems, will monitor for some unregulated contaminants according to a sampling scheme designed to yield representative samples. The regulation and list of contaminants to be monitored are to be published in August 1999, and monitoring is to begin in 2001. A proposed rule, including a proposed list of contaminants to be monitored, was published in April 1999. The list is divided into three groups: (1) contaminants to be monitored as soon as the rule becomes effective, (2) contaminants to be monitored when analytical methods are refined (expected within 5 years of rule promulgation), and (3) contaminants to be monitored when analytical methods are developed (not expected within 5 years of rule promulgation). The first group, those compounds to be monitored as soon as the rule becomes effective, includes 10 organic compounds and one microorganism: 2,4-dinitrotoluene; 2,6-dinitrotoluene; DCPA (dimethyl tetrachloroterephthalate) mono acid degradate; DCPA (dimethyl tetrachloroterephthalate) di acid degradate; 4,4'-DDE (degradation product of DDT, dichloro diphenyl trichloroethane); EPTC (s-ethyl-dipropylthiocarbamate); Molinate; MTBE (methyl-tert-butyl-ether); Nitrobenzene; Terbacil; and *Aeromonas hydrophila.*

Proposed regulations for radon, uranium, radium 226, radium 228, and gross alpha and beta particles were published in the Federal Register on July 18, 1991. The 1996 SDWA amendments included requirements to finalize regulations for uranium, radium 226, radium 228, and alpha and beta emitters by November 2000. Congress also included in the Safe Drinking Water Act amendments of 1996 the requirement that USEPA withdraw the existing proposed radon regulations and propose new regulations by August 1999. The National Academy of Science completed a risk assessment for radon in drinking water in September 1998. This assessment showed that radon in drinking water poses a small but measurable risk of stomach cancer. However, the danger from airborne radon is far greater than that from radon in drinking water. For more information about the NAS study, contact Molly Galvin, Media Relations Officer, or David Schneier, Media Relations Assistant, at telephone number (202) 334-2138 or by e-mail at news@nas.edu. In February 1999 USEPA published a health risk reduction and cost analysis for radon. A pre-publication copy of this report is available on the USEPA web site at http://www.epa.gov/safewater/radon/hrrca.html. The proposed rule, due by August 6, 1999, must include a response to all significant public comments on the published risk and cost analysis. The final rule must be promulgated by August 6, 2000, and must be based on the NAS study and the public comments on health risk reduction and cost analysis (Pontius, 1998).

The USEPA is in the process of revising regulations pertaining to underground injection control in accordance with the SDWA. Underground injection refers to the practice of introducing liquid waste into the subsurface, where it may come into contact with potable ground water. Proposed regulations tighten controls on certain kinds of injection wells known as high risk Class V wells, but only for wells located within Source Water Protection Areas. High risk Class V wells include motor vehicle waste disposal wells, large capacity cesspools, and industrial wells. New motor vehicle waste disposal wells would be banned nationwide, and in Alabama ADEM has already banned this kind of well. Large capacity cesspools in Alabama are prohibited by the Alabama Department of Public Health. Industrial injection wells would have to ensure that injected fluids meet primary maximum contaminant limits for drinking water at the injection point. These wells are regulated by ADEM, which requires a hydrogeological site evaluation prior to permitting, installation of best management practices, injection fluid monitoring, and ground-water monitoring (Scott Hughes, ADEM, written commun., 1998). USEPA must sign a final rule on high risk Class V wells by August 31, 1999, and complete a study of Class V wells not regulated by the high risk Class V well rule by September 30, 1999.

A contentious part of the Clean Water Act has been the requirement that surface waters be made fishable/swimmable. This is called the Total Maximum Daily Load (TMDL) program and falls under section 303(d) of the Act. Lawsuits have been filed in many states, including Alabama, regarding the pace of water-quality improvements under the TMDL program or regarding USEPA's implementation decisions. The purpose of the TMDL program is to require polluters to shoulder shares of the cost of cleaning up water bodies that do not meet the requirements of the Clean Water Act. However, it is difficult to solve such problems equitably, and many citizen groups regard the pace or direction of TMDL program progress as unsatisfactory. One difficulty with the TMDL program is the vast amount of high-quality data that will be needed to determine valid TMDL levels (Werblow, 1999). For most watersheds, including most in Alabama, existing data will probably prove to be inadequate, because TMDL models require data representative of storm events and other kinds of information that may require continuous monitoring of water quality (Werblow, 1999). Storm-water monitoring is important because many surface-water contaminants behave quite differently during storm events than under the more common fair-weather conditions. Most contaminants move farther and in much greater quantities during storm events. Additional water-quality monitoring will be costly, and will likely affect water-quality protection in all parts of the state. In August 1998, a Federal Advisory Committee proposed 170 improvements to the TMDL program (WaterWorld, 1998c). The committee stated that restoring impaired waters must be a high priority both for responsible agencies and for the owners/operators of sources of contaminants, and that the TMDL program is the key to successfully meeting this goal. USEPA is revising the TMDL program, and will consider the committee's recommendations. USEPA proposed in July 1999 that states be required to submit lists of waters still requiring TMDLs every 5 years instead of every 2 years. More information about the TMDL program may be found on the web at http://www.epa.gov/owowwtr1/tmdl/index.html or by calling the USEPA at (202) 260-7074.

The Clean Water Initiative of the Clinton Administration includes the Clean Water Action Plan. This plan increases aid to states and communities for combating nonpoint-source pollution. Most of this will be done through existing programs and through increased coordination among agencies. USEPA proposed $568 million for the Action Plan in fiscal 1999, and $2.3 billion over 5 years. The action plan has four main tools that will be used to achieve its objectives. One of these is the watershed approach, which will be used to set priorities for cleanup actions. Alabama is already actively researching and protecting surface water resources using the watershed approach; several on-going projects are described in the section entitled "Special projects." The second tool is strong federal and state standards for water quality and the effects of nonpoint-source pollution. Natural resource stewardship is the third tool. The aim is to encourage federal natural resource and conservation agencies to assist state and local organizations is protecting and restoring watersheds. The final tool is education of citizens and government officials about watershed health and the safety of beaches, drinking water, and fish (Crow, 1998). The Clean Water Action Plan itself consists of more than 100 actions aimed at preventing or mitigating the effects of various kinds of nonpoint-source pollution. Actions range from beach watch to a national animal feeding operation strategy, and many more. Long-term objectives of the Clean Water Action Plan are to restore 75 percent of U.S. watersheds by the year 2005, and to ensure that at least 95 percent of the population served by community water systems receives drinking water meeting all health-based standards (WaterWorld, 1998b). As part of the Clean Water Action Plan, a report has been published describing the laws of the 50 states that can be used to control nonpoint-source pollution. This document can be viewed on the web at http://www.eli.org/bookstore/rralmanac98.htm, or can be ordered from the Environmental Law Institute, 1616 P St., NW, Suite 200, Washington, DC 20036; telephone number: (202) 939-3800. To order, ask for ELI Order #d8.07. The cost is $30.00.

The number and complexity of regulations are increasing as modifications and amendments are added to the Safe Drinking Water Act and the Clean Water Act. As a result, violations of the acts are likely to increase, and the USEPA may seek to impose severe penalties on water utilities that do not comply with provisions of the acts. However, the USEPA recently announced a new policy permitting greater flexibility in compliance of small public water systems (those serving fewer than 2,500 residents). If the state regulatory authority offers compliance assistance to communities, following USEPA guidelines, then the communities can prioritize water problems instead of being required to solve all of them at once. Also, penalties can be waived and USEPA will defer to the state if the communities are making good-faith efforts to achieve compliance (Canody, 1996c).

President Clinton signed the National Drought Policy Act into law on July 16, 1998 (Wilhite, 1998). This Act established the National Drought Policy Commission, whose 18-month mission is to evaluate the need for and (if necessary) begin developing a national drought policy. The goals of a national drought policy would be to ensure that all stakeholder groups are protected from the effects of drought, to coordinate, and therefore make more efficient, federal, state, tribal, and local drought mitigation efforts, and to focus on mitigation, preparedness, and prevention rather than crisis management.

On April 2, 1999, the USEPA announced that 190 companies have agreed to provide basic hazard information on 1,100 chemicals that are domestically produced or imported in amounts exceeding one million pounds annually. For some listed chemicals, available information is adequate to characterize potential health effects and this information will be made public as part of the Sponsored Chemicals program. Otherwise, the companies that are responsible for the chemicals in question will conduct additional testing. The purpose of this program is to provide data that can be used to evaluate the adequacy of existing health-based regulatory controls. More information about this program may be found on USEPA's web site at the following URL: http://www.epa.gov/chemrtk/spnchems.htm.

On August 2, 1999, the USEPA announced new restrictions on the use of two pesticides: methyl parathion and azinphos methyl. The new controls were put in place because these two organophosphate compounds may pose health risks to humans, especially children.

SUPERFUND SITES

As of May 10, 1999, 13 sites in Alabama remained on the USEPA's National Priorities List (NPL) for cleanup. Two sites have been cleaned up. In total, 109 hazardous waste sites in Alabama were evaluated by ADEM under cooperative agreement with the USEPA in 1993-94 (ADEM, 1994b). The National Priorities List sites are eligible for attention under the Federal Superfund law for long-term cleanup. The locations of the sites are shown in figure 13. Sites that have changed status significantly since preparation of the preceding volume in this series are described briefly below. The site descriptions are based on information provided by the USEPA, which is available on the web at http://www.epa.gov/superfund/sites/index.htm.

AMERICAN BRASS, INC.

This site was added to the NPL on May 10, 1999. American Brass, Inc., is located on State Highway 134 near Headland, Henry County, Alabama. The site was a secondary brass facility that operated from 1977 until 1992 on a 140-acre site surrounded by agricultural land. The process employed at the facility was as follows: Brass- and copper-bearing scrap material were charged into the rotary furnaces and melted. Alloying and fluxing agents were added to obtain an alloy. The metal was cast into ingot form and the remaining slag was taken for further processing. The ingots were allowed to cool. The slag was processed through the crusher and then into a ball mill. Brass particles were recovered from the crushed slag and reprocessed in the furnace. The slag was then sent to storage bins. Fumes from the furnaces and particulate emissions from the crusher and ballmill were controlled by two baghouses. The baghouse dust was collected and sold as a finished product. About 150,000 tons of heavy metal-contaminated furnace waste, ball mill residues, and furnace slag were stockpiled in the facility at various areas on the ground and in a large uncontrolled stockpile approximately one-third mile southeast of the facility.

On February 22, 1996, ADEM conducted a Site Investigation at American Brass, Inc., collecting water samples and sediment samples from Dunham Creek, Cedar Creek, and a breach in the berm around the ball mill stockpile, which drains into a tributary

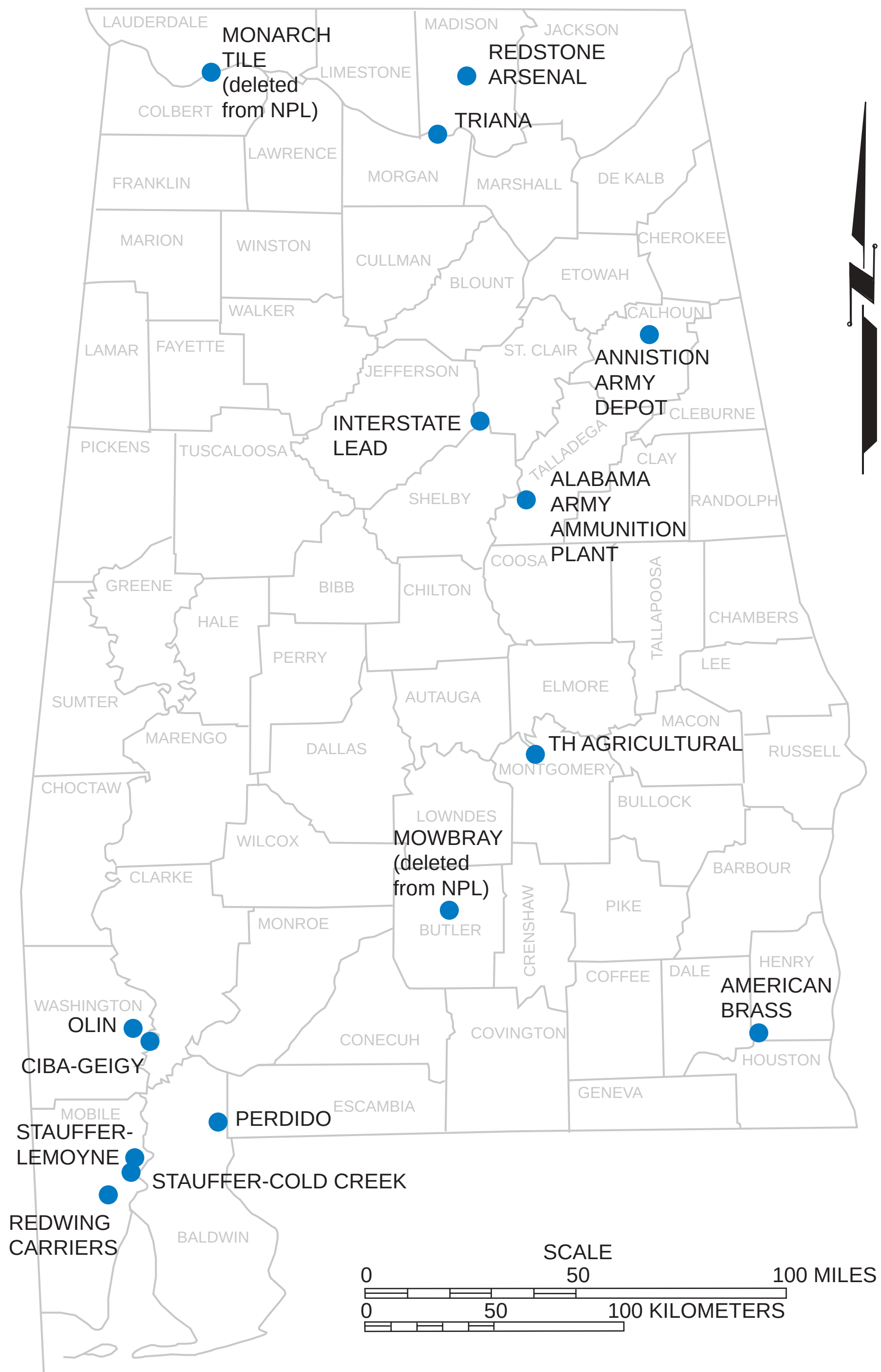


Figure 13.—Locations of sites on the Superfund List.

to Cedar Creek. Water samples collected in Dunham Creek indicated release of barium; the sediment samples indicated release of barium, chromium, copper, nickel, lead, and zinc. Water samples collected from Cedar Creek indicated release of barium; the sediment samples indicated release of barium, chromium, and zinc. Water samples collected below the breach in the berm indicated release of barium, copper, lead, and zinc; the sediment samples indicated release of barium, chromium, copper, nickel, lead, and zinc.

In April 1996, as part of USEPA's removal assessment at this site, a contractor for USEPA collected additional surface soil, ground water, and waste samples to determine site conditions. Analytical results indicated elevated levels of lead in samples of pond sediment and in the ball mill residue stockpile. ADEM had a representative on site to collect split samples and additional samples. In August 1996, the contractor conducted another site investigation, collecting 27 soil samples to determine the extent of soil contamination around the facility. Analyses of the samples indicated levels of lead up to 1,300 parts per million (ppm). Because of the potential threat to human health and the environment, USEPA submitted an Action Memorandum requesting removal of the contaminated soil. USEPA selected a contractor to perform the removal activities on site.

Objectives were to reduce soil lead concentrations, decontaminate the site structures and machinery, and consolidate the waste with the on-site stockpile of ball mill residue for subsequent encapsulation with a high-density polyethylene (HDPE) liner. These activities were concluded on May 7, 1997. A second emergency removal action began in October 1998 and was completed in March 1999, to remove and properly dispose of the material in the ball mill residue pile. During summer 1999, USEPA was to review site conditions and conduct community relations activities.

ANNISTON ARMY DEPOT—SOUTHEAST INDUSTRIAL AREA

The Anniston Army Depot (AAD) comprises about 600 acres in the southeastern part of the Nichols Industrial Complex, in southwestern Calhoun County. The depot's initial mission was limited to storing ammunition as well as refurbishing, testing, and decommissioning combat vehicles and various types of military equipment. A 1979 study revealed that on-site disposal of wastes generated by chemical cleaning, painting, and plating operations resulted in ground-water contamination. As a result of this investigation, a 2-million gallon lagoon and a landfill operation were closed.

About 39,000 people live near the site in Anniston. Coldwater Spring is located about 1.5 miles south of the depot boundary. The spring is the primary source of drinking water for about 72,000 people in Calhoun County.

Ground water, surface water, soil, and sediment have been affected to various degrees by previous activities at the site. A USEPA investigation determined that the deeper portion of the aquifer is interconnected to the shallow ground-water zone and that contaminant migration off-post may be occurring in the deeper zone. The studies show dense nonaqueous phase liquid (DNAPL) pooling beyond the reach of the current Groundwater Interception System (pump and treat system), which is operating at less than its designed capacity. A feasibility study and a proposed plan have been prepared and the remedial action will be described in the Groundwater Final Record of Decision (due out December 1999) for the site.

CIBA-GEIGY CORPORATION—McINTOSH PLANT

The Ciba-Geigy Corporation plant is a 1,500-acre site in McIntosh, Washington County. The plant produces industrial organic chemicals, pesticides, agricultural chemicals, and synthetic resins. Wastes were originally disposed of in unlined pits and in an open burn area. Currently, disposal of wastes is carried out under USEPA requirements. The original disposal areas were contaminated with DDT, lindane and other pesticides, metals, and volatile organic compounds.

The contractor has reported that cleanup of this site is complete, and the final report is under review by USEPA.

INTERSTATE LEAD COMPANY

The Interstate Lead Company (ILCO) is located in Leeds, Jefferson County, Alabama. ILCO owned and operated an 8.5-acre lead battery reclamation facility and secondary lead smelter that generated, treated, stored, and disposed of wastes containing lead. Slag from reclamation operations was used as fill at several public and privately owned facilities in the area. An unnamed tributary to Dry Creek, adjacent to the main facility and parking lot, contains lead-contaminated sediments. Lead and cadmium were detected in ground water at the site in 1985. Chromium, nickel, and arsenic are also present in the ground water as well as in the soils. Lead and other heavy metals occur in streams draining the site.

The Remedial Design for the site was approved on March 12, 1999. The Record of Decision (ROD) calls for a pump and treat system, but does allow for ground-water monitoring to see if a technical impracticability waiver is needed. If ground-water monitoring continues during the Remedial Action at the site, the contaminant levels may be shown to meet the action levels specified in the ROD. Contaminant levels in ground water are far lower than those found during the Remedial Investigation. Lead is not currently detected above action levels in ground water in any of the wells at the site. Several metals still exceed Maximum Contaminant Levels (MCLs), but the concentrations of these contaminants are approaching the MCLs.

OLIN CORPORATION—McINTOSH PLANT

The Olin Corporation (McIntosh Plant) site was placed on the Superfund National Priorities List in 1984. Between 1952 and 1982, Olin Corporation operated a mercury cell chlor-alkali plant on a part of the site. In 1954, Olin acquired adjacent Alabama Chemical and started producing pentachloronitrobenzene (PENB). Later, in 1973, the plant was expanded to produce trichloroacetonitrite (TCAN) and Terrazole (Betty Winter, USEPA, written commun., 1995). Part of the plant operations were shut down in 1982. However, the plant continues to produce chlorine, caustic soda, sodium hydrochlorite and sodium chloride, and blends hydrazine. Heavy metals and chlorinated compounds were initially discovered in shallow ground water at the site in 1980 as a result of monitoring. Site investigations were completed in 1993, and a remedy was selected for the main plant area in 1994. The remedy includes pumping and treating contaminated ground water, extending and upgrading existing caps to include the old plant landfill, and monitoring and maintaining the existing caps. Remedial Action for the main plant area will begin during summer 1999. Also, contamination in the river valley surrounding the plant was evaluated. USEPA determined that site contamination is not currently affecting the river system. The Record of Decision for the lake and wetlands adjacent to the Tombigbee River is scheduled to be issued during 1999.

REDWING CARRIERS, INC. (SARALAND)

Between 1961 and 1971, Redwing Carriers, Inc., a chemical carrier, operated a 5-acre site near Saraland for parking and washing trucks. The trucks transported a variety of substances, including asphalt, diesel fuel, pesticides, oil, and sulfuric acid. In 1971, the parking and washing area was sold, covered, and graded, and an apartment complex was built on the site. Tar-like material began oozing to the surface at numerous locations, including a courtyard and parking lot. The USEPA detected volatile organic compounds in the soil and the leachate coming from the tar-like material.

In July 1997, USEPA collected soil, sediment, and water samples from 23 properties adjacent to the Redwing Carriers Superfund Site. The purpose for this sampling was to address community concerns about possible releases from the site. Based on a risk evaluation of the analytical results of these samples, the USEPA determined that there is no unacceptable health risk or hazard in the neighborhood adjacent to the Redwing site. In an April 1999 Proposed Plan, USEPA sought public comment on the USEPA plan to amend the 1992 Record of Decision based on new data collected during the 1996-1997 Removal Action. The final remedial design for the site is scheduled to be completed by the end of 1999. Remedial action should start in 2000.

T H AGRICULTURAL AND NUTRITION COMPANY—MONTGOMERY

The T H Agricultural and Nutrition Company site is located in Montgomery County and consists of 16 acres in two separate parcels. T H Agriculture was responsible for disposing insecticides, herbicides, and other chemical wastes in the pits behind the plant site. Lead and cadmium were detected in ground water at the site in 1985. Chromium, nickel, and arsenic are also present in the ground water as well as the soils. Lead and other heavy metals are present in streams draining the site.

The present lessee, ELF Atochem, has agreed to implement a detailed study of both parcels of land to determine the extent of contamination. The site is contaminated with lindane, toxaphene, DDT, and other pesticides. Lindane has been recognized in ground water on-site and off-site. An interim cleanup remedy consisting of containment of contaminated ground water was selected in 1995. The remedial design for the ground water was completed in 1996, and construction has been completed for the ground-water recovery/pumping system. As of January 1999, more than 17 million gallons of ground water have been pumped from the shallow aquifer. The final Record of Decision for this site was signed September 28, 1999, and bioremediation was selected as the remedy for the contaminated soils and sediments. The remedial design for soils and sediments is expected to be completed during 1999, with the final remedial action to occur soon thereafter.

TRIANA/TENNESSEE RIVER

The Triana/Tennessee River site occupies roughly 1,400 acres near the small town of Triana in southeast Madison County. DDT was manufactured for commercial use by the Olin Corporation at Redstone Arsenal (RSA) in Huntsville between 1947 and 1970. The manufacturing, handling, and disposal practices at the facility led to the discharge of DDT residues into the Huntsville Spring Branch-Indian Creek tributary system, which flows into the Tennessee River. An estimated 475 tons of DDT residue accumulated in the sediment of the tributary system. The plant was closed and demolished in 1971, but the area remains contaminated with DDT. The rural area surrounding the site has a population of 500 residents. The community has been affected by the contamination because the residents depend to an extent on locally caught fish for food. Until the introduction of a water supply system in 1967, some residents used water from Indian Creek and the Tennessee River for home consumption.

The Olin Corporation submitted its final engineering design for cleaning up the site in 1986, and monitoring shows continued reduction in levels of DDT in selected fish species. Fish, water, and sediment monitoring of the site will continue. The USEPA conducted a 5-year review of the site and found that cleanup has been effective in reducing DDT contamination.

Olin has attained the performance standard in largemouth bass and is approaching the performance standard in channel catfish and smallmouth buffalo. The Consent Decree (CD) for the Triana/Tennessee River Superfund Site originally anticipated 10 years of monitoring of fish to meet the performance standard of 5 ppm DDT in fish. The CD grants an extension of the monitoring if the Review Panel (RP) determines that Olin (the Potentially Responsible Party (PRP)) has acted responsibly in carrying out the work, which Olin has. On April 23, 1999, Judge Lynwood Smith issued an order granting the Joint Petition for Modification of the Consent Decree Schedule for the Olin site. The deadline for attaining performance standards has been extended as follows:

1. for channel catfish from December 31, 1997, until December 31, 2002;
2. for smallmouth buffalo from December 31, 1997, until December 31, 2007.

ALABAMA REGULATIONS

Laws regulating ownership and use of water in Alabama vary. Ground-water laws currently are not well defined. However, the "reasonable use" rule generally applies to ground-water use in Alabama. This rule recognizes the right of a landowner to a reasonable and beneficial use of the waters upon or beneath his or her land, provided the waters are not wasted and do not cause injury to others.

The use and ownership of surface water and submerged lands are based on the distinction between navigable and nonnavigable waters (Griggs, 1978). The legal title to waters and streambeds of navigable waterways is retained by the state, in trust for the people of Alabama. The legislature has authority to make laws pertaining to the use of public waters and lands underlying them and to establish authorities that can regulate use of these waters. Title to nonnavigable waters and streambeds may be vested in private owners, subject to the rule of "reasonable use." Under this rule, a landowner may not divert, dam, or otherwise alter the course of a stream flowing across his or her land, unless these operations neither deprive upstream or downstream owners of their right to use the water, nor adversely affect the lands of other owners. Permits may be required from appropriate state and federal agencies prior to construction of impoundments. The title to land bounded by a nonnavigable watercourse includes the bed of the stream to the center of the main channel, unless the landowner's instrument of title limits the boundary to the bank or to another designated point.

Several state agencies enforce different sets of regulations involving water. ADEM is responsible for regulating the quality of public drinking-water supplies and for water-pollution control. The Alabama Surface Mining Commission is responsible for regulating mining activities that may affect the quality of water, and the State Oil and Gas Board of Alabama regulates oil and gas exploration and development activities that may affect the quality of water. The State Department of Conservation and Natural Resources enforces water-safety traffic laws on waterways and impoundments and regulates activities that may affect the quality of water in wildlife refuges and game management areas. The Office of Water Resources of the Alabama Department of Economic and Community Affairs (ADECA) is responsible for water-use planning. Appendix B lists federal and state agencies responsible for water regulation and water-use planning.

State permits for water-well development in Alabama are not required from the well owners, except in the Coastal Zone. Well drillers, however, are required by ADEM to submit in quadruplicate a form (ADEM Form 60 1/83, Report of Drilled Well) for each water well drilled in the state except for nonpublic supply wells in Baldwin County. A copy of this form is reproduced in appendix A. Completed copies of the form must be provided to the Water Supply Branch of ADEM and to the Hydrogeology Division of the GSA, where they are filed as part of the water-information records of the state. Water well drillers in Alabama, except in Baldwin County, must be licensed by ADEM.

The Water Supply Branch of the Water Division of ADEM regulates public water supplies. Public water systems include community, nontransient noncommunity, and noncommunity supply systems. A community water system is defined as a water-supply system that has at least 15 service connections for year-round residents or regularly provides water to at least 25 year-round residents. A nontransient noncommunity water system is defined as a public water supply system that serves at least 25 of the same individuals a minimum of 6 months per year. A noncommunity water system is a public supply system that does not meet the requirements of either a community water system or a nontransient noncommunity water system (ADEM, 1992). Five hundred eighty-eight community water systems, 126 transient noncommunity water systems, and 56 nontransient noncommunity water systems are permitted in Alabama. These water systems provide water to approximately 3.5 million of Alabama's citizens (ADEM, 1994b). Self-supplied industrial/commercial and agricultural users of ground water generally are not regulated by the state. However, some local governing bodies in Alabama have some control over ground-water management in their areas of jurisdiction; some cities have adopted ordinances that require a permit for the construction and operation of a water-supply well.

ADEM administers regulatory aspects of the Alabama Coastal Area Plan designed to prevent adverse impacts on Alabama's coastal resources, particularly water. Under provisions of the plan, development of a well in the coastal zone, which includes areas with land-surface elevations of 10 feet or less, requires a permit.

The Alabama Water Pollution Control Authority, created by legislative act, provides aid to public bodies such as counties, cities, and state agencies in financing waste-water treatment facilities. The Authority established a revolving loan fund that provides low-interest loans to cities in need of new or improved sewage treatment systems. The fund was established under requirements of the Federal Clean Water Act. Since the program began in 1989, and through the 1998 fiscal year, $526 million has been awarded in 121 loans for the construction and improvement of waste-water treatment systems (David Hutchinson, ADEM, oral commun., 1998).

The Alabama Legislature has passed several acts related to water. The Alabama Agricultural Nonpoint Source Financial Assistance Act of 1988 was enacted to assist in controlling the contamination of water in Alabama's lakes, streams, rivers, aquifers, and estuaries. The act provides for the Alabama Soil and Water Conservation Committee and Soil and Water Conservation Districts to administer a federal cost-share program established by the legislature in 1986. The program provides financial assistance to land users to control soil erosion, prevent water pollution, and improve forests.

The Alabama Hazardous Waste Management Act has been amended so that the Alabama statute is consistent with federal requirements. This amendment allows portions of the hazardous-waste program to operate in lieu of the federal program. The act excludes from coverage those wastes that have not been specified under the Federal Resource Conservation and Recovery Act. It also states that hazardous-waste transportation permits may be issued for periods up to 3 years. However, these permits can be revoked or modified at any time.

After the Alabama Underground Storage Tank and Wellhead Protection Act was authorized in 1988, ADEM promulgated rules concerning underground storage tanks and established a state program regulating the storage tanks. To provide revenue for regulation, an annual fee of $15.00 per regulated tank was authorized. The USEPA approved the state congressional act. The deadline for upgrade, replacement, or closure of underground storage tanks not meeting the requirements of the 1988 law was December 22, 1998. As of July 20, 1999, 13,386 (77 percent) of the 17,400 active tanks in Alabama are shown in the ADEM database to be in compliance with release detection requirements; 12,709 (73 percent) of the active tanks in the state are in compliance with corrosion protection requirements; 12,431 (71 percent) have spill and overfill prevention equipment installed; and 10,559 (61 percent) are in full compliance with

UST guidelines that became mandatory in December 1998. However, 1,124 spot inspections of facilities with USTs showed 86 percent compliance, suggesting that the database provides a conservative estimate of tank regulation compliance (Scott Hughes, ADEM, written commun., 1999).

The chief concern with regard to leaking USTs is that hydrocarbons, particularly gasoline, may contaminate shallow ground water. A recent study of state regulations regarding cleanup standards for ground water contaminated by hydrocarbons indicated that Alabama's regulations are similar to those of many other states (Simmons and others, 1999). Seventeen states, including Alabama, have essentially identical action and cleanup levels for four important constituents of gasoline (benzene, ethylbenzene, toluene, and xylene). Most other states have action and cleanup levels that are either broadly similar, more stringent, or determined on a site-specific basis. Of neighboring states, Georgia has action and cleanup levels for the four chemicals listed that are identical to Alabama's; Florida's are more stringent; Mississippi's were undergoing revision at the time of the survey; and Tennessee's are similar to those of Alabama and Georgia.

Alabama drinking water systems will have help in upgrading their plants and complying with regulations as the result of a Drinking Water State Revolving Fund law passed by the Alabama Legislature in 1997 (ADEM, 1997). The law establishes the Alabama Drinking Water Finance Authority, which will have the ability to issue bonds and use the proceeds to provide low interest loans to water systems. The authority consists of the governor, lieutenant governor, speaker of the house, finance director and the ADEM director. Many of the nearly 800 public water systems in Alabama need financial assistance to improve services and provide safe water. A USEPA needs assessment survey found that the state's water systems would need to spend about $1.6 billion in the next 20 years to upgrade facilities and expand service. With an estimated 700,000 individuals in the state dependent on private wells for drinking water, there is also great demand to extend public water systems into rural areas. The program will operate similar to the Wastewater State Revolving Fund, which has provided more than $400 million to 100 wastewater systems since 1989. The total amount of loan funds available depends on the amount included for this program in the general fund budget. Federal rules require a 20 percent match from the state. Up to $12,558,800 is available for Alabama in FY 1997, depending on the amount of state match included in the budget. Federal funds for Alabama for FY 1998 are projected to be $8.4 million with at least $5 million per year until FY 2003.

Projects that would be eligible for funding include the planning, design, and construction of improvements to:

- rehabilitate or develop water sources to replace contaminated sources;

• install or upgrade treatment facilities if the project would improve the quality of drinking water to comply with primary or secondary standards;

• install or upgrade water storage tanks to prevent microbiological contaminants from entering the water system;

• install or replace distribution pipes to prevent contamination caused by leaks or breaks in the pipe;

• consolidate water supplies when customers have an inadequate quantity of water, the water supply is contaminated, or the system is unable to maintain compliance for financial or managerial reasons.

Priorities for determining the order in which projects will be funded in Alabama are calculated by assigning points to various factors affecting public water system performance, such that a high number of points corresponds to a high priority for funding, as follows:

• **Violations of National Drinking Water Standards** - Projects for systems tht exceed MCL's during the 30-month period prior to pre-application submittal (3 years for secondary contaminants) may receive up to 40 points for each item that applies in this category (for example, 40 points for more than 2 bacteriological violations, 20 points for exceeding MCL's of secondary standards, 5 points for 1.0 - 5.0 mg/L of nitrate).

• **Quantity Deficiencies** - Projects for systems with quantity deficiencies or shortages due to water source or storage may receive between 5 and 30 points for each item that applies in this category (30 points for continual shortages, 5 points for inadequate storage without implemented conservation program).

• **Treatment/Design Deficiencies** - Projects for systems with design deficiencies that could be corrected by enlargement, repair, installation, or replacement of the system or a portion of the system may receive between 10 and 30 points for each item that applies in this category (30 points for no filtration for surface water or ground water under the influence of surface water, 12 points for inadequate treatment or process facilities). In addition, projects may receive 10 or 15 bonus points if they have committed to or implemented a source water protection plan or delineated source water areas and assessed contaminants.

• **Affordability Factor** - Projects will receive points based on the relative needs of applicants on a per household basis. The number of points is determined by the ratio of the average annual household water bill to the 1997 median household income for the project area multiplied by 100 (24 points if the number is greater than 2.0, 3 points if the number is less than or equal to 0.5).

• **New Customer Connections Served -** Projects will receive between 10 and 26 points based on the number of new customer connections that they will serve (26 points for more than 600 new connections, 10 points for fewer than 20 new connections).

• **Consolidation -** Projects that result in the consolidation, interconnection, or improvement of services for two or more drinking water systems may receive between 10 and 50 points depending on the action being taken (50 points for total system consolidation, 10 points for improvement of services).

• **Benefit/Cost Factor -** Projects will receive between 2 and 22 points depending on the factor resulting in dividing the number of benefiting connections by the amount of the DWSRF loan in millions of dollars (22 points if the factor is greater than 10,000; 2 points if the factor is between 0 and 25).

Repayment of the loans will be set up for 20 years and, while interest rates are not set, they are expected to be about two percent less than the AA rated tax exempt municipal bond.

ADEM established the Alabama Wellhead Protection Program Development Committee in 1990 to develop a regulatory program for wellhead protection in Alabama. The program furnished guidelines to protect public water systems that provide ground water to almost half the water users in Alabama. As part of the original local wellhead-protection program, ADEM specified the following requirements: (1) the delineation of a wellhead-protection area for each ground-water source, (2) an inventory of potential contamination sources that could impact each ground-water source, (3) a management plan for potential contamination sources, and (4) a contingency plan that describes procedures and identifies alternate water sources in the event of an emergency or interruption of public water used from a ground-water source. Under modified requirements of the wellhead-protection program, ADEM in 1997 no longer required the development of a management plan. As of 1998, the Wellhead Protection Program has been replaced by the Source-Water Assessment Program (SWAP), described below.

In 1998 ADEM developed a new program called the source-water assessment program, required for all public water systems. The SWAP was mandated by the 1996 Safe Drinking Water Act Amendments. The three elements of the SWAP are source water recharge area delineation, potential contaminant source identification (including contaminant identification), and susceptibility analysis for public water supplies. The ultimate goal of SWAP is drinking-water protection. The SWAP replaces wellhead-protection programs, but a system that has developed a WHPP will meet all SWAP requirements except susceptibility analysis. The susceptibility analysis will consider the susceptibility of each water source to each potential contaminant source located within its recharge area. In conjunction with development of the SWAP, there are no longer three levels of priority for water systems as there were under the WHPP. Instead, all public water supply systems have the same requirements and deadline to assess their source water. The development of management and contingency plans, which was required by the WHPP, will become voluntary under the SWAP program. However, systems that develop protection plans may be eligible for monitoring waivers or other tangible benefits. About 1,000 community water system wells, about 85 surface water intake sites, and 112 transient noncommunity sites in Alabama will be affected by these regulations. ADEM regulations concerning SWAP became effective in January 1999, and the source-water assessment program is to be completed in the year 2003 (Jim Arnold, oral and written commun., 1998; Power, 1999). A list of WHPPs and their status is available on the ADEM web site at http://www.adem.state.al.us/drkwater.html.

Highly publicized concern about concentrated animal feeding operations (CAFO) in Alabama have been accompanied by study and the drafting of a proposed rule by ADEM. The proposed rule (first draft written in July 1997) involves registration of animal feeding operations (AFO) and CAFO. The proposed rule includes requirements that meet or exceed USEPA requirements. The rule has been developed in cooperation with stakeholders and the USEPA. For information, contact ADEM's Permits/ Compliance Unit, Field Operations Division, telephone (334-213-4301), FAX (334-213-4399), or e-mail (mnps@adem.state.al.us).

WATER MANAGEMENT

In 1991, by Executive Order the Governor of Alabama directed that the Director of ADECA establish an Office of Water Resources in the department. The Office of Water Resources was commissioned to develop comprehensive plans and strategies for the use of the state's water resources. The Office of Water Resources was also requested to assess areas of the state analytically to determine if available water supplies are sufficient to satisfy existing and future demands. The Office of Water Resources was officially created on February 23, 1993, when the legislature passed the Alabama Water Resources Act. The act identified the functions and duties of the Office of Water Resources, summarized as follows:

- Monitoring and managing the water resources of the state;
- Developing state policy relative to water resources;
- Developing long-term strategic plans for the use of water resources;
- Implementing comprehensive quantitative water-resources programs, projects, and plans;
- Serving as a repository for water data;
- Encouraging efficient uses of water;
- Participating on behalf of the state in discussions between the state and other entities concerning water resources, hydrologic events, and water-conservation programs;

- Entering into agreements or contracts with other entities;
- Holding public hearings and requesting public comments;
- Applying for, accepting, and disbursing advances, loans, grants, and contributions;
- Sponsoring, encouraging, and facilitating plans, projects, policies, and programs for the conservation, coordination, protection, development, and management of water resources;
- Conducting education and public enlightenment programs about water;
- Acting on behalf of the state in negotiation and consummation of any compact with other states; and

Participating on behalf of the state in all studies, investigations, and analyses regarding the water resources of the state.

The Alabama Water Resources Act also created the 19-member Alabama Water Resources Commission. The commission will (1) advise the Governor and the presiding officers of the House and Senate about water-related matters, (2) provide guidance to the Chief of the Office of Water Resources, (3) assist in formulating policies, plans, and programs of the Office of Water Resources, (4) establish, adopt, modify, repeal, or promulgate rules or regulations pursuant to the Alabama Water Resources Act, (5) advise the Office of Water Resources to implement policies, plans, and programs governing the waters of the state, and (6) hear and determine appeals of administrative actions of the Office of Water Resources.

The Alabama Water Resources Act directed the Alabama Water Resources Commission to adopt rules and regulations for the operation of the commission and for governing declarations of beneficial water use and certificates of water use. The rules and regulations were adopted on December 9, 1993, and became effective on February 22, 1994. The Alabama Water Resources Act requires all public water-supply systems and any person who diverts, withdraws, or consumes more than 100,000 gallons of water each day to submit a Declaration of Beneficial Use to the Office of Water Resources. However, no Declaration of Beneficial Use will be required for in-stream uses of water or for impoundments less than 100 acres in size that are confined upon one's property or are solely used for recreational purposes.

The Office of Water Resources will issue a Certificate of Use to water users after they submit a Declaration of Beneficial Use. Each year, water users who are required to submit a Declaration of Beneficial Use must report the amount of water consumed, diverted, or withdrawn each month as a condition of reissuance of the Certificate of Use. This certificate will be issued for a period ranging from 5 to 10 years, at the discretion of the Division Chief of the Office of Water Resources.

Water users required to file a Declaration of Beneficial Use who either fail to file or provide false information are violating the Alabama Water Resources Act. Also, violations of the act after issuance of the Certificate of Use could result in suspension, revocation, termination, or modification of the Certificate of Use. Violations of the Act may result in civil penalties that are assessed by the Office of Water Resources. The penalties will not exceed $1,000 for each violation; however, each day a violation continues constitutes a separate violation. The maximum penalty will not exceed $25,000 in any calendar year.

The Comprehensive Water Resources Study of the Alabama-Coosa-Tallapoosa (ACT) and Apalachicola-Chattahoochee-Flint (ACF) River Basins, jointly conducted by Alabama, Georgia, Florida, and the U.S. Army Corps of Engineers, was initiated to craft an equitable plan for the development of water resources shared among the three named states. The project has been divided into four categories of study elements: process support elements, water availability, water demand, and comprehensive management strategy. The study group has released a lengthy status report, which details progress to date. Copies of this report can be obtained from Mr. Walter B. Stevenson, Jr., Chief, Office of Water Resources, Department of Economic and Community Affairs, P.O. Box 5690, Montgomery, Alabama 36103-5690. The legislatures of the three states passed identical water-sharing agreements in 1997, and the agreements were ratified by Congress November 20, 1997. The water allocation formulas have undergone extensive review, and the three states' governors were to negotiate the water allocation by the end of 1998. In December 1998, the states agreed to extend the deadline for agreement by one year. As of July 1999, no agreement had yet been made by the negotiating teams of the three states. The U.S. Army Corps of Engineers released draft Environmental Impact Statements on the ACT and ACF basins in October 1998. The draft reports are available in hard copy or CD-ROM format from the U.S. Army Corps of Engineers, Mobile District, Inland Environment Section, P.O. Box 2288, Mobile, AL 36628-0001. A copy of the full document may also be viewed at 60 libraries in the major cities and universities in Alabama, Florida, and Georgia, or it can be viewed on the Mobile District Web Page (http://www.sam.usace.army.mil/sam/pd/actacfeis).

USEPA has initiated a program titled *Protecting the Nation's Groundwater: EPAs Strategy for the 1990s*. This effort includes the Comprehensive State Ground Water Protection Programs (CSGWPP) that consist of strategic activities designed to protect the nation's ground water.

Alabama was chosen as the lead state in Region 4 by the USEPA and was the site of the initial pilot project in the region. A water program advisory committee was formed in December 1992 to prepare Alabama's ground-water protection plan. The core program was completed and submitted to USEPA in March 1994 and was endorsed by them in November 1994. Although the CSGWPP is not mandated by law, USEPA hopes the states will participate voluntarily to ensure a coherent and comprehensive approach to protect the nation's ground-water resources.

The benefits to be derived from the CSGWPP include:

- Better coordination of current federal, state, tribal, and local ground-water-related programs resulting in more effective and consistent ground-water protection;

- Better resources within the constraints of federal hazardous waste, pesticide, and solid waste laws; and

- More consistent deference to state priorities when implementing federal ground-water related laws.

The Alabama Non-Point Source (NPS) Management Plan of 1989 was developed and implemented using funding supplied via section 319(h) of the Clean Water Act of 1972. USEPA guidelines published in 1996 call for revision of state NPS management plans. States whose revised NPS management plans receive USEPA approval are eligible for additional section 319(h) funds. Also, the Clean Water Action Plan of 1998 provides additional funding, beginning in fiscal year 1999, for states with USEPA approved revisions. The Auburn University Environmental Institute, in cooperation with ADEM, is revising Alabama's NPS management plan (Auburn University Environmental Institute, 1998).

DRINKING-WATER STANDARDS

The quality or chemical character of water is the most important factor affecting its use. A water supply must meet, or be amenable to treatment to meet, certain sets of standards for each type of use.

Water-quality regulations are set and enforced for various water uses by federal, state, and local governments. The most important regulations are those dealing with drinking-water standards for public supply (table 2). Public water supplies must meet the standards for contaminant limits established by the Safe Drinking Water Act of 1974 and its amendments.

The USEPA has the primary responsibility for establishing and enforcing water-quality regulations. However, Alabama has received primacy for enforcing drinking-water regulations by adopting regulations at least as stringent as the federal standards. Revisions to the Safe Drinking Water Act in 1986 mandated that certain regulations be modified and that the number of regulated contaminants be increased. Alabama's Primary Drinking Water Standards are enforced by ADEM. These standards include

Table 2.—Alabama's drinking water standards (modified from Alabama Department of Environmental Management, 1992)

Data are given in milligrams per liter (mg/L) unless otherwise indicated; mL=milliliters; tu=turbidity unit; pCi/L=picoCurie per liter; mrem=millirem (one thousandth of a rem).

Primary Drinking Water Standards

Inorganic chemicals	Level
Antimony	0.006
Arsenic	.05
Asbestos	7 million fibers at least 10 micrometers long/liter
Barium	2.0
Beryllium	.004
Cadmium	.005
Chromium	.1
Cyanide	.2
Fluoride	4.0
Lead	.015
Mercury	.002
Nickel	.1
Nitrate (as N)	10
Nitrite (as N)	1
Total Nitrate/Nitrite (as N)	10
Selenium	.05
Sulfate	500
Thallium	.002

Organic chemicals	Level	Organic chemicals	Level
Nonvolatile synthetic		Nonvolatile synthetic	
Alachlor (Lasso)	0.002	Oxamyl (vydate)	0.2
Aldicarb	.003	Picloram	.5
Aldicarb sulfone	.002	Simazine	.004
Aldicarb sulfoxide	.004	2, 3, 7,8-TCDD (dioxin)	$3x10^{-8}$
Atrazine	.003	Trihalomethanes (total) (the annual average of quarterly samples)	.1
Carbofuran	.04		
Chlordane	.002	Volatile synthetic	
1, 2-Dibromo-3-chloropropane	.0002	Benzene	.005
2, 4-D	.07	Carbon tetrachloride	.005
Endrin	.002	1, 2-Dichloroethane	.005
Ethylene dibromide	.0005	Trichloroethylene	.005
Heptachlor	.0004	Para-Dichlorobenzene	.075
Heptachlor epoxide	.0002	1, 1-Dichloroethylene	.007
Lindane	.0002	1, 1, 1-Trichloroethane	.2
Methoxychlor	.04	Vinyl chloride	.002
Polychlorinated biphenyls	.0005	Cis-1, 2-Dichloroethylene	.07
Pentachlorophenol	.001	1, 2-Dichloropropane	.005
Toxaphene	.003	Ethylbenzene	.7
2, 4, 5-TP (Silvex)	.05	Monochlorobenzene	.1
Benzo(a)pyrene	.0002	o-Dichlorobenzene	.6
Dalapon	.2	Styrene	.1
Di(2-ethylhexyl) adipate	.4	Tetrachloroethylene	.005
Di(2-ethylhexyl) phthalate	.006	Toluene	1
Dinoseb	.007	Trans-1, 2-Dichloroethylene	.1
Diquat	.02	Xylene (total)	10
Endothall	.1	Dichloromethane	.005
Glyphosate	.7	1, 2, 4-Trichlorobenzene	.07
Hexachlorobenzene	.001	1, 1, 2-Trichloroethane	.005
Hexachlorocyclopentadiene	.05		

Turbidity	
Surface water	<0.5 tu in 95% of filtered samples each month
Ground water	<5.0 tu in treated water

Table 2.—Alabama's drinking water standards (modified from Alabama Department of Environmental Management, 1992)—Continued

Microbiological	Total coliform bacteria in less than 5.0 percent of samples for systems collecting 40 or more samples. Total coliform bacteria in not more than one sample per month for systems collecting less than 40 samples per month.
Radionuclides	
Natural	
Gross alpha particle (including radium-226, but excluding radon and uranium)	15 pCi/L
Combined radium-226 and radium-228	5 pCi/L
Manmade	
Tritium	20,000 pCi/L
Strontium 90	8 pCi/L
Beta particle and photon radioactivity	4 mrem/yr

Special monitoring requirements	**Special monitoring requirements**
Unregulated synthetic organic chemicals	Unregulated volatile organic chemicals
Aldrin	Isopropylbenzene
Butachlor	Tert-Butylbenzene
Carbaryl	Sec-Butylbenzene
Dicamba	Fluorotrichloromethane
Dieldrin	Dichlorodifluoromethane
3-Hydroxycarbofuran	Bromochloromethane
Methomyl	n-Butylbenzene
Metolachlor	Naphthalene
Metribuzin	Hexachlorobutadiene
Propachlor	1, 3, 5-Trimethylbenzene
Unregulated volatile organic chemicals	p-Isopropyltoluene
Chloroform	2, 2-Dichloropropane
Bromodichloromethane	1, 2, 4 Trimethylbenzene
Chlorodibromomethane	1, 2, 3-Trichlorobenzene
Bromoform	1, 2, 3-Trichloropropane
1, 1-Dichloropropene	1, 1, 1, 2-Tetrachloroethane
1, 1-Dichloroethane	Chloroethane
1, 1, 2, 2-Terachloroethane	m-Dichlorobenzene
1, 3-Dichloropropane	o-Chlorotoluene
Chloromethane	p-Chlorotoluene
Bromomethane	Bromobenzene
1, 2, 3-Trichlorobenzene	1, 3-Dichloropropene
n-Propylbenzene	Dibromomethane

Secondary Drinking Water Standards

Constituent or property	Level	Special Monitoring Requirements for Corrosivity Characteristics
Aluminum	0.2	pH
Chloride	250	Total alkalinity
Color	15 units	Carbon dioxide
Copper	1	Sodium
Foaming agents	.5	Sulfates
Iron	.3	Calcium
Manganese	.05	Magnesium
Odor	3 threshold odor number	Hardness
Silver	.1	Temperature
Sulfate	250	Specific conductance or total dissolved solids
Total dissolved solids	500	
Zinc	5	

monitoring and contaminant-level requirements for selected inorganic, organic, microbiological, and radionuclide contaminants.

An important source of information used to develop drinking-water standards is the USEPA National Recommended Water Quality Criteria. These do not have the force of regulations, but provide guidance where federal regulations do not exist. The latest revision of the criteria, "National Recommended Water Quality Criteria," is available from USEPA, National Center for Environmental Publications and Information, 11029 Kenwood Road, Cincinnati, Ohio 45242. The telephone number is (513) 489-8190.

ADEM adopted revised Division 7 Drinking Water Standards effective January 2, 1996. These regulations require monitoring for 17 inorganic contaminants, although a statewide waiver for asbestos monitoring has been granted. Regulations also require raw and finished water monitoring for bacteriological quality on a monthly basis and for turbidity when there is a suspected turbidity problem or if a surface source is involved. Community and nontransient noncommunity systems must also monitor for 36 synthetic organic contaminants. However, a statewide waiver for dioxin has been issued. Twenty-one volatile organic contaminants (VOCs) must be monitored and all surface-water systems and ground-water systems serving more than 10,000 people must monitor for total trihalomethanes. Five radiological contaminants are monitored and special lead and copper monitoring is required for all systems. Associated corrosion indicator parameters such as pH, alkalinity, total solids, and hardness may be required if necessary to demonstrate that water is noncorrosive. Ten unregulated SOCs and 35 unregulated VOCs must be monitored as the regulated contaminants are monitored.

USEPA has established secondary maximum contaminant levels for selected constituents and some aesthetic properties (taste, color, and odor) of water. These secondary standards are guidelines for states and are not federally enforceable. As part of the new regulations for secondary maximum contaminant levels, monitoring for sulfates is now required for public water-supply systems. This requirement is included as part of the special monitoring for corrosivity characteristics.

USEPA's secondary maximum contaminant levels for fluoride (2.0 mg/L) and pH (6.5 to 8.5) have not been adopted by Alabama, but other secondary maximum contaminant levels established by the USEPA have been included in Alabama's regulations. For waters subject to public water-supply regulations, samples must be collected at specified intervals and analyzed by a laboratory certified by ADEM.

New standards for bottled water have been adopted by the U.S. Food and Drug Administration. The new regulations set standard definitions for terms like "spring water," which is water collected as it flows naturally to the surface or when pumped through a borehole from the spring source. “Mineral water” must come from a protected underground source and contain a minimum of 250 ppm total dissolved solids (AWWA, 1996b). However, a recent study found contaminants in one-third of bottled water samples; contaminants in one sample exceeded applicable health standards. Further, much bottled water is exempted from testing and purity rules that apply to tap water (WaterWorld, 1999b).

WATER USE

In 1997, an estimated 6.148 bgd of water was withdrawn from surface- and ground-water sources for use in Alabama. This figure represents about 1,474 gallons per day (gpd) for each person in the state. These estimates are based on data from ADECA. Figure 14 compares 1980, 1985, 1990, and 1997 withdrawals. Amounts of water used in Alabama in the categories listed below are intermediate or low when compared to other states (Solley and others, 1998).

Despite some differences in how water-use information has been collected in different years, some interesting conclusions can be drawn. Water use in Alabama and also nationwide has decreased significantly since 1980, according to data collected by the U.S. Geological Survey (Mooty and Richardson, 1998; Solley and others, 1998). This decrease in water use has been accompanied by significant population growth, and therefore must result from a combination of conservation and reuse. Corroborating this conclusion is a decrease in per capita freshwater use nationwide that parallels the decrease in overall water use. In addition, the use of reclaimed wastewater was 36 percent higher in 1995 than in 1990, according to the U.S. Geological Survey national study. No wastewater reclamation was reported for Alabama in 1995. The report on the latest nationwide study (for 1995) is available free on the web at http://water.usgs.gov/public/watuse or by mail from U.S. Geological Survey Information Services, Box 25286, Denver Federal Center, Denver CO 80225 (single copy only).

Water use is divided into two categories: withdrawal or offstream use, where water is withdrawn from its natural setting in streams, lakes, or aquifers prior to being used, and nonwithdrawal or instream use, where water is used without being withdrawn from its natural setting. Data were estimated for 10 categories of use in Alabama, 6 of which were withdrawal uses and 4 of which were nonwithdrawal uses. Figure 15 shows the percentages of withdrawal use by category for 1980 and 1997.

WITHDRAWAL USE

The six withdrawal-use categories are public water systems, self-supplied industrial/commercial, agricultural, self-supplied domestic, power generation, and mining. Figure 14 shows comparative amounts of withdrawal use in million gallons per day (mgd) for selected years. Figure 15 shows the percentages of total withdrawals of water. Withdrawal water use in 1997 is estimated at 6.148 bgd, which is a substantial increase over the 1996 value of 5.035 bgd. At least part of this increase results from improved reporting of water use data according to ADECA.

PUBLIC WATER SYSTEMS

Public water systems served an estimated 3.97 million people in Alabama in 1997. Estimated water use by public supply systems increased from 776.82 mgd in 1996 to 787 mgd in 1997, an increase of about 1.3 percent. During this same time period the state's population increased by about 0.63 percent. Population and water-use data for both years were obtained from records supplied by the Office of Water Resources of ADECA.

SELF-SUPPLIED INDUSTRIAL/COMMERCIAL

Self-supplied industrial/commercial water use during 1997 was estimated to be 878 mgd, based on data supplied by the Office of Water Resources of ADECA. The equivalent estimate in 1996 was 746.65 mgd.

AGRICULTURAL

Agricultural uses are divided into irrigation and nonirrigation uses. Nonirrigation uses include water for livestock operations and for catfish farming. Irrigation agricultural water use was estimated at 102.13 mgd in 1996 and 178 mgd in 1997, using data supplied by the Office of Water Resources of ADECA. Irrigation has increased in recent years, indicating that farmers are using irrigation as a method of crop insurance, particularly during dry periods. However, the value for 1997 is much higher than the equivalent value for 1996. The magnitude of the increase may reflect increased reporting of irrigation water use to ADECA. As 1997 was not a particularly dry year, the large increase in reported irrigation is not thought to correspond to a large increase in actual irrigation in the state. Nonirrigation agricultural water use was not estimated for 1997, and the value estimated for 1995 (128.73 mgd) is used for 1997. Total agricultural use was estimated at 306 mgd, which is about 32 percent greater than the estimate of 230.86 mgd for 1996. However, the 1997 value is about 17 percent greater than the estimate for 1995. Fluctuation in the

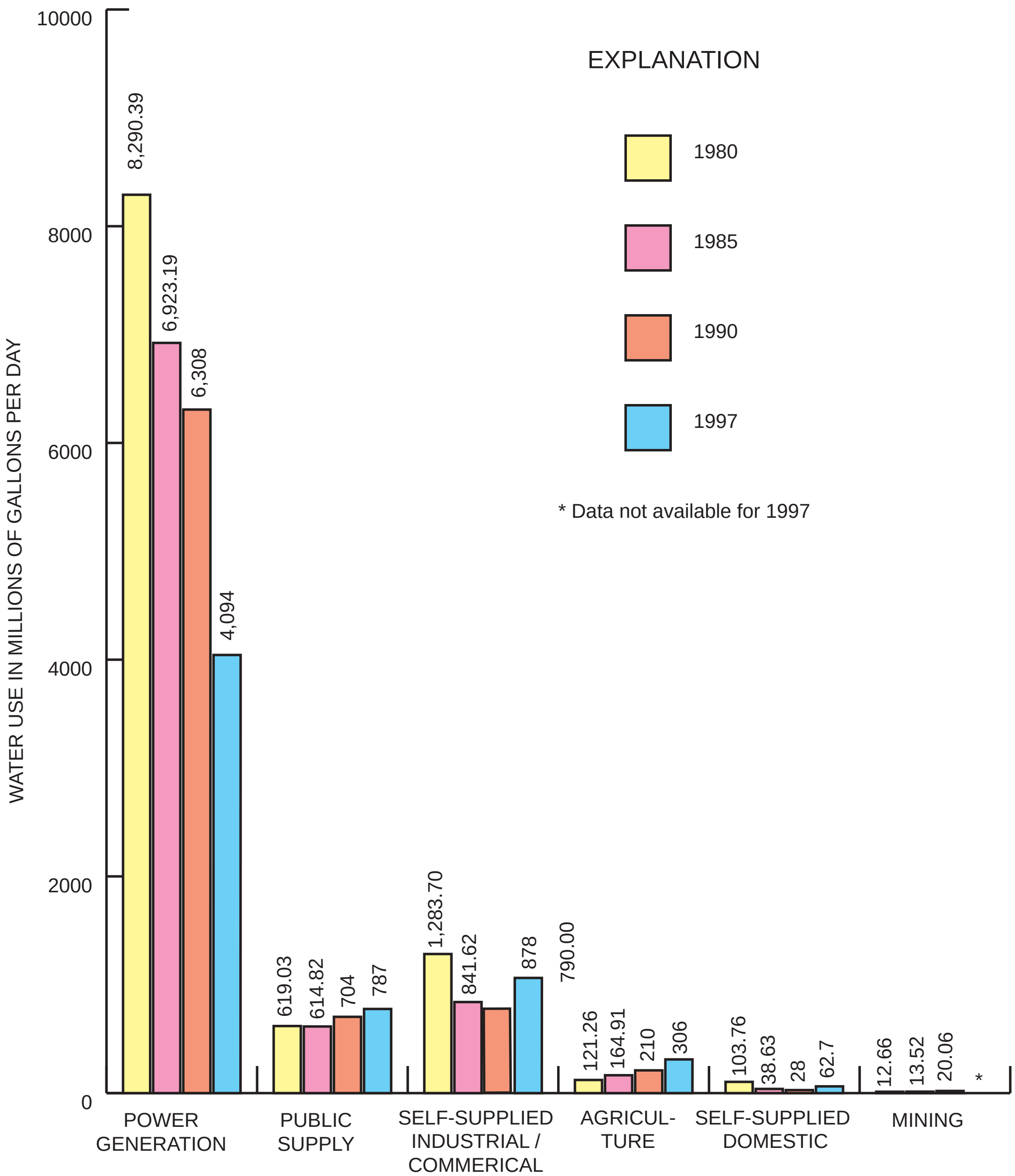


Figure 14.—Comparative withdrawal water use for selected years.

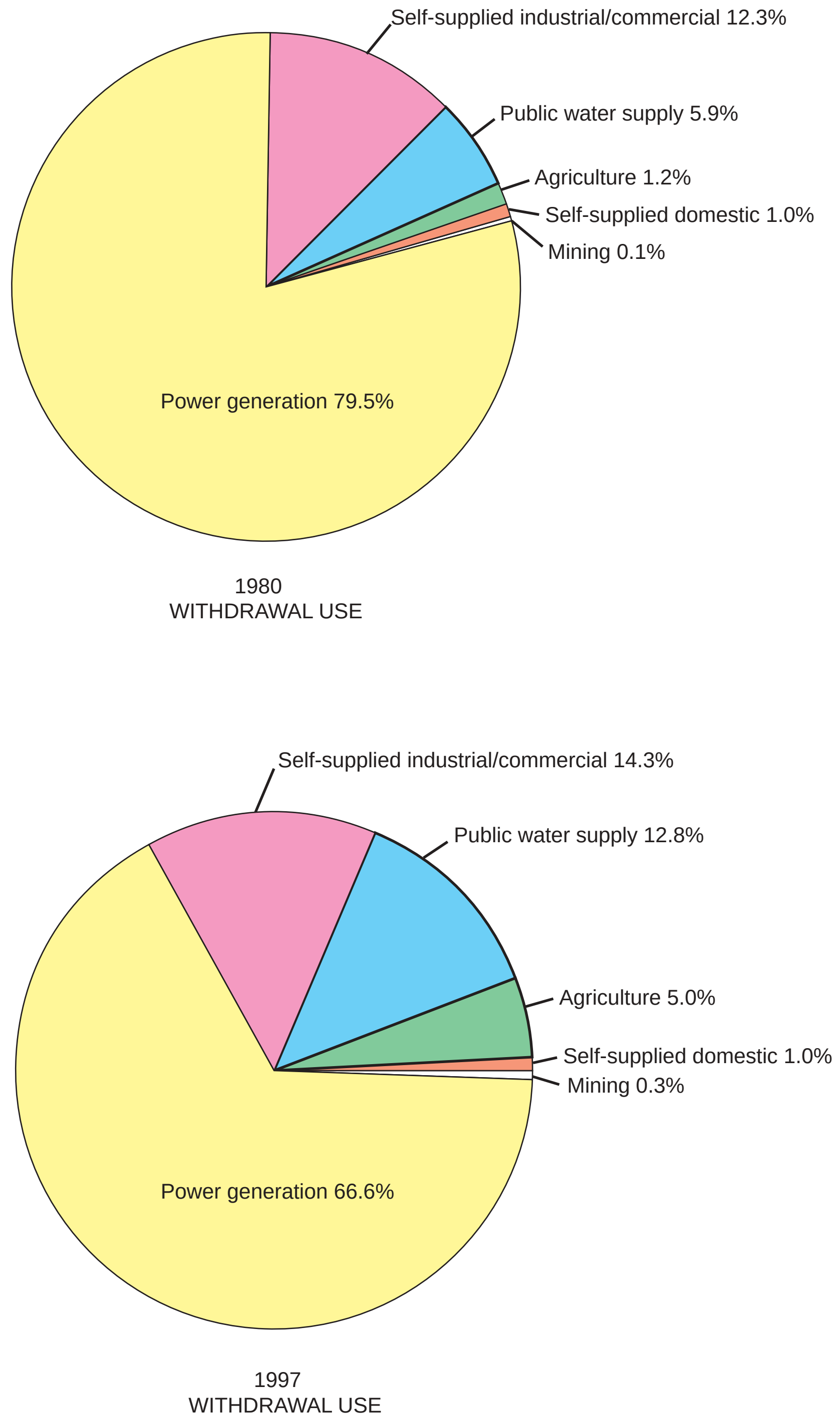


Figure 15.—Percentages of total withdrawal water use, 1980 and 1997.

estimates from year to year probably results in part from variation in reporting and in the method used to derive the estimates. Nationwide, irrigation water use has been decreasing since 1980 (Solley and others, 1998).

SELF-SUPPLIED DOMESTIC

Self-supplied domestic water use is estimated at 62.7 mgd for 1997, which was calculated using the 1996 value and the increase in population from 1996 to 1997.

POWER GENERATION

Water use by nuclear and fossil fuel power generation plants in Alabama accounted for 4,094 mgd, or about 67 percent of the entire 1997 withdrawal water use (fig. 14). This value and percentage are higher than the equivalent numbers for 1996 (3,198.5 mgd, or about 63.5 percent of the entire 1996 withdrawal water use). Because the 1996 values were considerably lower than the equivalent numbers for 1995, and because ADECA reports that some facilities reported water use in 1997 but not in 1996, the large increase in reported water use may represent improved accuracy and not an increase in actual water use. Power production in 1997 was estimated to be 84 million megawatt hours.

MINING

The amount of water withdrawn for mining was insufficient to constitute a major water use. About 20 mgd was withdrawn in 1997 for washing coal, sand, and gravel, and for enhanced recovery of hydrocarbons. Much of this water was recycled. Also, water produced by coalbed methane production wells has increased the mining water use value in recent years.

NONWITHDRAWAL USE

Nonwithdrawal or instream uses of water comprised 4 of the 10 categories inventoried. These categories are hydroelectric power generation, sewage treatment, navigation, and recreation/preservation. Water for these uses is not removed from its natural setting and is often reused many times while it moves downstream.

HYDROELECTRIC POWER GENERATION

The 21 hydroelectric power generating facilities operating in Alabama in 1996 used about 160,000 mgd of water to produce about 9.4 million megawatt hours of electricity. These numbers are the estimates for 1995, which are considered valid for

1997. There is virtually no consumptive use of water by hydroelectric generating plants; water used at a plant is available for other uses downstream.

SEWAGE TREATMENT

The total discharge by sewage treatment facilities in Alabama for 1997 was not estimated. The estimate of 450 mgd during 1992 is used for 1997. Discharge data from ADEM records were used to estimate the 1992 discharge value. The actual value may be higher than the estimate indicates, however, because many discharges are not metered.

NAVIGATION

Fourteen locks are located on four waterways in Alabama. These locks have inside dimensions ranging from 84 x 100 feet to 110 x 600 feet. Water requirements for a single lockage range from 13.8 million gallons (mg) at the new (July 1991) Oliver Lock on the Black Warrior River to 50 mg at Wilson Lock on the Tennessee River. The combined volume of all locks in Alabama is approximately 301 mg. The number of lockages for 1997 is not available; however, during 1991, an estimated 41,000 lockages required about 1,200 billion gallons of water. Lockage is a sequential use of water, which means that the same water is used downstream.

RECREATION/PRESERVATION

Although not considered a major water-use category, recreation/preservation is important to the state’s economy. Alabama has no natural large lakes, but many impoundments developed for navigation and hydroelectric power generation provide habitats for fish and wildlife and are used as recreational areas. They support a significant part of the state’s economy by providing a basis for the tourist industry, sales of recreation equipment, and habitats and spawning areas for commercial game and fish.

Recreation/preservation use is usually estimated by the number of annual visits per facility. The Tennessee Valley Authority estimates annual recreational use at its Guntersville, Wheeler, Wilson, Pickwick, and Bear Creek Lakes and associated property to be about 21 million visits. The number of annual visits to state-operated parks and recreational areas is estimated to be 8 million, and to the U.S. Army Corps of Engineers’ facilities about 20 million.

WATER PROBLEMS

DROUGHTS

A drought is defined as a deficiency in precipitation for an extended period of time. The severity of a drought depends on the duration and geographical extent of the precipitation deficiency, on the amount of the rainfall deficiency, and on the effects the drought has on human activities. The effects of a drought vary with different water users. Water users who rely on water supplies with limited storage may be severely affected by rainfall deficiencies of only a few weeks. Also, lack of rain for a few weeks during the growing season may reduce crop yields and possibly destroy crops. However, lack of precipitation for a few weeks, or even months, may have no appreciable effect on water users who obtain water supplies from large streams or large ground-water reservoirs.

Major droughts affected Alabama in 1954, 1968, 1980-81, 1986, and 1988. The drought of 1986, which affected much of the southeastern United States, is considered to be the most severe drought in the area in more than 100 years of record.

The Palmer Drought Severity Index (Palmer, 1965) can be used to indicate prolonged abnormal conditions of dryness or wetness. Index values depend upon amounts of precipitation, soil moisture, recharge, runoff, and evapotranspiration. Figure 16, which is based on the long-term Drought Severity Index, shows the changes in moisture conditions in Alabama during 1997. Most of Alabama was under near normal or moist conditions throughout the year and there was no drought anywhere in the state during 1997. With regard to drought conditions, 1996 and 1997 were quite similar, in contrast to 1995, when much of the state experienced drought conditions during substantial portions of the growing season.

FLOODING

Flooding is one of the most severe water-related problems. Construction of buildings in flood-prone areas can be avoided to reduce the destruction by floods. Flat, open flood plains appear to be attractive, easily developed sites for building, but these areas are particularly susceptible to flooding. In many cases, flooding cannot be controlled; in other cases, construction of dams and flood-control impoundments may alleviate some flooding problems. Although properly constructed and maintained dams can mitigate flood damage, Alabama does not require that dams be inspected or maintained. Neglected dams can fail under stress, causing property damage or loss of life. While all major dams in Alabama, such as power-generation structures, are closely monitored, small private dams may not receive adequate inspection.

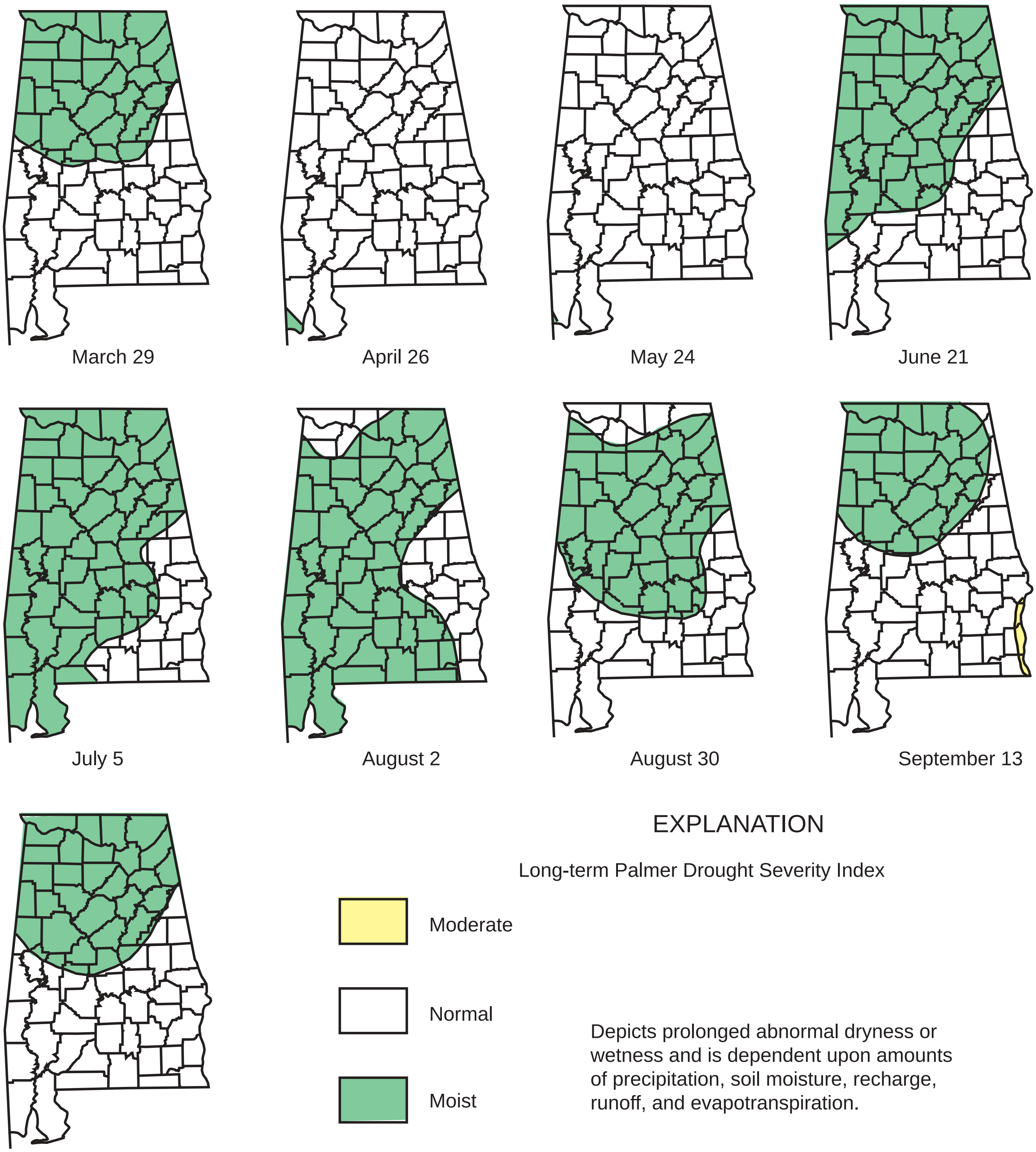


Figure 16.—Changes in drought severity during 1997.

Olin (1984) provided methods and equations for estimating the magnitude and frequency of floods for streams in Alabama with drainage areas of 1 to 22,000 square miles. Also, the relationship of maximum floods of record to drainage areas for different streams in Alabama is given as a guide in estimating potential maximum floods.

Olin and Atkins (1988) used computer programs to estimate flood hydrographs for ungaged rural and urban streams in Alabama with drainage areas less than 500 square miles. Their report also provides equations for estimating basin lag time and flood volume for the ungaged streams.

Flood information can be obtained from the U.S. Army Corps of Engineers, the Tennessee Valley Authority, and the U.S. Geological Survey. Flood easement information also can be obtained from the Alabama Power Company. The Federal Emergency Management Agency has prepared flood-insurance rate maps as part of the National Flood Insurance Program for several areas in the state. These maps, although prepared for flood-insurance purposes, show 100-year and 500-year flood boundaries and other flood-prone areas but not necessarily all areas subject to flooding. Flood-insurance rate maps are available from the Federal Emergency Management Agency's Map Service Center (http://msc.fema.gov/MSC/toc.htm) at Map Service Center, P.O. Box 1038, Jessup, Maryland 20794-1038; Tel: (800)358-9616; Fax: (800)358-9620. Many flood-hazard maps are available online from ESRI at http://www.esri.com/hazards/makemap.html.

The chief cause of flooding in Alabama is heavy spring rain falling on soil saturated by previous rainfall events. Consequently, most of Alabama's floods occur in the spring. However, there were no major floods in Alabama during 1997. Information about water levels in Alabama's rivers is collected by the U.S. Geological Survey and published in an annual report (Pearman and others, 1998).

A lesser but significant cause of flooding in Alabama is tropical cyclones (tropical storms and hurricanes). During 1997 Hurricane Danny brought record amounts of rainfall to coastal Alabama causing widespread flooding and coastal erosion. Danny reached the mouth of Mobile Bay, near Fort Morgan, Alabama, just before dawn on July 19, 1997. The eyewall and western edge of the eye passed over Dauphin Island, where sustained hurricane-force winds and torrential rains were experienced. After drifting over extreme southern Mobile Bay, the center moved eastward, practically stalled, and finally crossed the coast on the southeast shore of the bay near Mullet Point, Alabama, around midday on the 19th. Danny continued to move erratically over extreme southeast Alabama and the adjacent Florida panhandle, while weakening to a tropical depression by late on the 20th (Richard J. Pasch, National Hurricane Center, written commun., 1997). Doppler radar estimates suggested maximum storm total precipitation of about 43 inches near Dauphin Island. A total of 36.71 inches of rainfall was measured at the Dauphin Island Sea Lab. This is the largest hurricane-related rainfall ever recorded in Alabama. Fortunately, most of the extreme precipitation amounts occurred in areas near the coast or over water (Richard J. Pasch, National Hurricane Center, written commun., 1997).

In addition to destruction of life and property, flooding can cause other kinds of environmental damage. For instance, more than 30 inches of rain in Mobile and Baldwin Counties resulting from Hurricane Danny caused widespread destruction of erosion control measures at construction sites throughout the area (John Carlton, ADEM's Mobile field office, written commun., 1997). This resulted in harmful sediment input to water bodies, which would have been prevented by the erosion control measures had they not been destroyed.

Information about tropical storms and hurricanes is most readily available from the National Hurricane Center web site (http://www.nhc.noaa.gov).

WATER QUALITY

The quality of surface waters in Alabama is considered "generally good." Most Alabama surface waters meet applicable water-quality standards or support designated water uses. ADEM reported that 99.5 percent of Alabama's 77,274 stream miles now meet the fishable/swimmable goals of the 1972 Clean Water Act; of these only 1.2 percent fail to meet one or more criteria necessary to support designated usages (ADEM, 1996b). One hundred eleven segments of rivers, streams, lakes, reservoirs, and estuaries in Alabama did not support designated uses in 1998, according to a draft list released by ADEM (ADEM, 1998). The list of impaired water bodies is available from ADEM (see "Selected Contact Information") or on the web at http://www.adem.state.al.us/othpubno.html. Causes for nonsupportive status include excessive organic enrichment, which depletes dissolved oxygen, bacterial contamination, and siltation from agricultural and silvicultural practices. The 1998 list of impaired water bodies is slightly shorter than the 1996 list; 31 water bodies were removed, and 27 added to the list. Nine Alabama streams have been upgraded to higher use categories by the USEPA because of improvements or anticipated improvements in water quality. Upgraded streams include all or part of Buck Creek, Lost Creek, Cane Creek (Oakman segment), Flint Creek, Cane and Town Creeks (Jasper segments), Mobile River, Chickasaw Creek, and Three Mile Creek (Alabama Water Watch, 1998).

Water quality testing by ADEM at five locations on Alabama's beaches in the summer of 1999 turned up no violations of water-quality regulations for fecal coliform bacteria. These bacteria indicate the possible presence of disease-causing microorganisms (The Tuscaloosa News, Monday, August 9, 1999).

Water quality in Alabama is better than the national average. According to a report from the USEPA, 40 percent of waters surveyed nationwide remain too polluted for swimming, fishing, and other recreational activities. On a national basis runoff from agricultural land is the largest source of pollution. The USEPA report (*The Quality of Our Nation's Water: 1996*, document EPA 841-S-97-001, 197 pages or Report Brochure: *National Water Quality Inventory 1996 Report to Congress*, document EPA 841-F-97-003, 12 pages) is available online at http://www.epa.gov/305b/, or from the National Center for Environmental Publications and Information at 1-800-490-9198. Despite the relatively large number of contaminated surface water bodies in the U.S., 86 percent of the population served by community water systems drinks from water systems that reported no violations of health-based drinking-water standards in 1996. This information was published in USEPA's 1996 National Public Water System Annual Compliance Report and Update on Implementation of the 1996 Safe Drinking Water Act Amendments, available online at http://www.epa.gov/ogwdw/annual.

The USEPA's first comprehensive nationwide assessment of watersheds rated 16 percent as having good water quality, but 38 percent of Alabama's watersheds were rated as having good water quality (Tuscaloosa News, October 7, 1997, p. A-1). Fewer than 6 percent of Alabama's watersheds were rated as having serious water-quality problems, versus 21 percent nationally. Only two Alabama watersheds received a rank score of 5 (on a 1-6 scale, with 1 being best), and both of these (the Lower Chickasawhay and Noxubee watersheds) are located chiefly in Mississippi. For 7 of Alabama's 52 watersheds, data were insufficient to complete the assessment. The USEPA's watershed assessment can be viewed on the internet at http://www.epa.gov/surf.

USEPA initiated in August 1999 a new online database of water quality information. This database is called the National Drinking Water Contaminant Occurrence Database, or NCOD. NCOD is a convenient source for information about the occurrence of both regulated and unregulated contaminants in water in the U.S. NCOD includes data derived from analyses of two sample sets. One set consists of water samples from public water systems; the other set consists of samples collected from rivers by the U.S. Geological Survey for the National Water Information System database. The NCOD is an excellent source of basic information about the occurrence of a wide range of contaminants in water in the U.S., and may be accessed online at http://www.epa.gov/ncod/. At that web site, the use and limitations of the database are explained, and alternate sources of water-quality information are described. NCOD will be updated with new information quarterly.

Alabama had an average of 770 active public water systems in 1997. Of the 770 systems, 588 were community systems, 56 were nontransient noncommunity systems, and 126 were transient noncommunity systems. Very few systems exceeded the chemical or bacteriological contaminant levels during 1997. The typical system that exceeded the contaminant level is either a small transient noncommunity system or a small community system. During this period, 79 percent of the water systems in Alabama were in compliance with all provisions of federal and state drinking water regulations.

A copy of a report listing all violations in 1997 can be obtained by written request to ADEM, Water Supply Branch, P.O. Box 301463, Montgomery, Alabama 36130-1463 or at e-mail address tsd@adem.state.al.us. The report is also available through the ADEM home page at http://www.adem.state.al.us/viorep97.html (Tom DeLoach, ADEM, written commun., 1999).

Of the state's 272 municipal waste-water treatment facilities, 14 did not comply with federal guidelines in December 1996 (Michael Barilone, ADEM, oral commun., 1999). However, the number of facilities not in compliance has decreased from 115 since 1985. As of December 31, 1996, the state had 279 semipublic and private waste-water treatment plants of which 5 were under Administrative Order for noncompliance (Michael Barilone, ADEM, oral commun., 1999). The total number of plants has decreased in recent years, but the number of plants under Administrative Order for noncompliance has not changed significantly since 1993.

In 1999 there were 30 permitted municipal solid-waste landfills in Alabama, of which only 25 were operating (R. A. Kelly, ADEM, written commun., 1999). This compares to 104 municipal landfills operating in 1989. Closures were the result of implementation of subtitle D, which governs installation of liners to prevent water pollution and ground-water monitoring to detect water pollution. As of 1999 there were 171 operating construction and demolition or industrial landfills and 240 closed landfills (R. A. Kelly, ADEM, written commun., 1999). Ground-water quality is being monitored for a wide variety of potential contaminants in the vicinity of many of these landfills, and ground-water contamination has been detected at a small number of old facilities. Leachate from landfills also can contaminate surface-water bodies. Common contaminants include lead, chromium, and organic chemicals.

Ground-water contamination has been detected at several hazardous-waste treatment, storage, or disposal facilities in Alabama. As of August 1999, 62 facilities had ground-water monitoring systems. Contamination had been detected at 52 of those facilities. Corrective action is being taken at 33 facilities (Kathy Keller, ADEM, written commun., 1999).

More than 600 abandoned or inactive hazardous-substance sites have been identified and are being evaluated under the provisions of the Federal Comprehensive Environmental Response, Compensation and Liabilities Act. ADEM and the U.S. Environmental Protection Agency rank sites according to their potential to affect adversely human health or the environment. Sites with a Hazard Ranking System score of 28.5 or greater are eligible for inclusion on the National Priorities List. Currently, 15 sites in Alabama are part of the National Priorities List. One site has been delisted and undergoes an effectiveness review every five years. Another site has been removed from the list entirely. Ground-water contamination has been detected at 11 of the 13 remaining sites (Larry Bryant, ADEM, written commun., 1999).

The Department of Defense, as a part of its Environmental Restoration Program, has identified more than 350 solid-waste sites at 19 active or former military installations in Alabama. Ground-water contamination is known to exist at a majority of the sites. Assessment and/or corrective actions are underway at most of these sites (Larry Bryant, ADEM, written commun., 1999).

Bioaccumulative contaminants in fish were evaluated at 141 sites in 84 water bodies in 1996. At 17 of these sites bioaccumulative contaminants were found in excess of levels recommended by the Food and Drug Administration as being safe for human consumption. Fish consumption advisories were in effect for seven water bodies: two segments of the Coosa River (between Logan Martin Dam and Riverside and between Riverside and the Alabama-Georgia state line), Huntsville Spring Branch and Indian Creek (from Redstone Arsenal to the Tennessee River), West Point Lake to Lake Harding, Cold Creek Swamp, Tombigbee River (Olin Basin), Choccolocco Creek (south of Oxford downstream to Logan Martin Lake), and Fish River (ADEM, 1996b). The contaminants analyzed for were PCBs, chlordane, toxaphene, mercury, mirex, DDT, DDD, DDE, dieldrin, dursban, endrin, heptachlor, heptachlor-epoxide and certain heavy metals. Followup monitoring at 26 sites in 15 water bodies in 1998 found elevated levels of PCBs in fish in Lay, Mitchell, and Jordan reservoirs and elevated levels of mercury in Fowl River and Chickasaw Creek. The origin of the mercury is not known because there are no known sources of mercury in these watersheds. The 1998 monitoring program targeted areas of known fish contamination problems (ADEM web site: http://www.adem.state.al.us/6fishti.html), which may be why the percentage of water bodies exhibiting problems appears to be higher than in 1996. Evidence suggests that the content of bioaccumulative contaminants in fish in Alabama is relatively stable–there were 13 fish consumption advisories in Alabama in 1997 versus 11 in 1996 (USEPA web site: http://www.epa.gov/OST/fishadvice). The number of advisories nationwide increased 5 percent from 1996 to 1997 (USEPA press release dated July 31, 1998, “EPA has released annual listing of state fish advisories; appeals to states for greater consistency in advisory programs”).

Major sources of stream pollution include industrial waste discharges, discharges from waste-water-treatment plants, and nonpoint discharge from urban areas, mining operations, and agricultural areas. Of the more than 1,000 complaints regarding water-quality problems received by ADEM in 1993-94, 44 percent were nonpoint-source related (ADEM, 1994a). Nonpoint-source pollution is also a problem for Alabama’s lakes, many of which contain high and rising levels of nitrogen and phosphorus (The Tuscaloosa News, Wednesday, February 26, 1997). For Alabama, as for most states, nonpoint-source organic enrichment, particularly with nitrogen compounds from animal waste and fertilizers, is one of the most ubiquitous water-quality problems. The amount of nitrogen now entering natural systems is about twice what it would be without the influence of humans (Tuscaloosa News, Sunday, September 21, 1997).

A new class of water pollutants has been discovered in recent years. Pharmaceutical chemicals given to people and to domestic animals–including antibiotics, hormones, pain killers, tranquilizers, and chemotherapy chemicals given to cancer patients–have been measured in surface water, in ground water, and in drinking water at the tap. Drugs are excreted by humans and domestic animals, and are distributed into the environment by flushing toilets and by spreading manure and sewage sludge onto and into soil. The concentrations of some drugs in water are comparable to levels at which pesticides are commonly found (near 1 part per billion; Peter Montague, written commun., 1998). The occurrence of pharmaceutical chemicals in Alabama ground water and surface water is not known.

Leaking underground storage tanks (UST) continue to be one of the major sources of ground-water contamination. As of September 1998, there were about 21,500 regulated underground storage tanks registered in Alabama. Since 1987, more than 9,000 releases have been reported from underground storage tank systems. Of these, 2,884 were significant enough to warrant further assessment and remediation efforts after the release was reported. The Alabama Tank Trust Fund continues to provide reimbursement to eligible owners and operators of tanks for site assessment and remediation costs at UST sites in Alabama (Dorothy Malaier, ADEM, written commun., 1999).

In 1992, ADEM initiated copper and lead testing of large- and medium-sized public water-supply systems in Alabama. Results of the initial round of testing indicated that only 5 of more than 200 systems exceeded the action levels, where a system is determined to have exceeded an action level if 10 percent or more of the samples taken from throughout the system exceed 15 parts per billion (ppb) of lead or 1,300 ppb of copper. These five systems are now in compliance.

A water quality problem that has been recognized only in the past few years is the occurrence in drinking water supplies of the protozoan cyst *Cryptosporidium* and similar microbes. Some of these organisms are highly resistant to standard disinfection techniques and can be deadly. No *Cryptosporidium* outbreaks have been recognized in Alabama. Nevertheless, progress in controlling *Cryptosporidium* is of interest to Alabamians for the purpose of prevention. USEPA and Phoenix Water Systems Inc. (PWS) are testing a new approach to water disinfection using a combination of ultrasonic vibrations, electromagnetic fields, and ultraviolet light (Laughlin, 1997a). Initial laboratory tests show greater than 99.99 percent destruction of *Cryptosporidium* as well as other kinds of harmful microbes. Current research by USEPA and PWS aims to determine whether the procedure is economical and effective at the scale needed for small drinking water systems (Laughlin, 1997a). For more information contact James Goodrich at USEPA (513) 569-7605.

On October 2, 1997, a warehouse fire in Birmingham resulted in a spill of 4,700 gallons of the pesticide Dursban into Village Creek and Bayview Lake (Tuscaloosa News, October 22, 1997, p. A1). The concentrated pesticide mixed with the millions of gallons of water used to fight the fire and killed hundreds of thousands of fish in Bayview Lake and Village Creek. By the time the contaminant plume reached the Locust Fork of the Warrior River around October 20, 1997, the pesticide had been considerably diluted. The chemical killed only a small number of shad, a sensitive species of fish, in Locust Fork. By the spring of 1998, levels of Dursban in sediment in Village Creek and Bayview Lake were found to be declining (Georgia and Southeast Environmental News, 1998). By August 1999, fish had been restored to the affected areas. After the spill, dursban was detected in 9 of 13 monitoring wells. However, by August 1999, the chemical was detected only in one well, and dursban levels were declining there (The Tuscaloosa News, August 4, 1999, p. 3B).

Excessive naturally occurring chloride, iron, and hardness are common water-quality problems for ground-water supplies in Alabama. High chloride content makes water unfit for most uses. A high concentration of chloride in drinking water imparts a salty taste and can cause physiological damage. Excessive hardness inhibits the action of cleaning agents, causes scum in bathtubs, scale in hot-water tanks and lines, and problems in the processing of food and in some industrial processes. Excessive iron in water causes staining of plumbing fixtures and laundry, an objectionable taste, and may form scale or sludge in pipes, pumps, and water heaters. Some aquifers produce water with a rotten-egg odor caused by hydrogen sulfide. Naturally occurring trace metals such as arsenic have been detected in water in Alabama.

A potential water-quality problem in coastal areas is salt-water encroachment. Excessive pumpage of ground water in areas where the salt water/freshwater interface is very close to the surface may draw salt water into freshwater aquifers, effectively destroying them for many years.

OVERDEVELOPMENT OF GROUND WATER

Water shortages induced or enhanced by human activities commonly are only locally severe. The most common is the decline in ground-water levels caused by overpumping. Several cities in Alabama, especially in the southern part of the state, derive their water supplies from wells. Increased pumpage to keep pace with demand from an increasing number of water users and water uses has caused water-level declines in the immediate vicinity of these cities. Figure 10, hydrograph 3 (well Hal-1) is an example of long-term water-level decline in a well. Most of the cities generally use more than one well to supply water needs. Therefore, pumpage from the wells may have resulted in well interference, where the drawdown in each well is increased as a result of pumpage at other wells. In such cases, large depressions in the potentiometric surface and decreased well yields occur in the vicinity of large pumping centers. Some cities that have been rapidly depleting ground-water supplies in certain aquifers have begun to seek alternate sources of water or modified aquifer-development strategies to mitigate this problem.

SPECIAL PROJECTS

The Hydrogeology Division of the GSA initiated, continued, or completed a variety of special projects in 1997. These projects, along with ongoing annual ground-water level monitoring, provide water-resources data useful for many different applications.

AQUIFER VULNERABILITY

In the late 1980s the U.S. Geological Survey, in cooperation with ADEM, conducted a series of 13 studies to describe the vulnerability of Alabama's aquifers to contamination from the surface. The GSA is currently revising, updating, and expanding these reports, again in cooperation with ADEM. The reports focus on aquifer characteristics and distribution, and classify aquifers as having low, moderate, or high vulnerability to contamination. The new report series will be produced on CD-ROM and will include text, maps, and a GIS dataset. The first CD-ROM, covering Mobile and Baldwin Counties, is now available. Five other CD-ROMs are in various stages of preparation.

CHARACTERIZATION OF THE WATER RESOURCES OF THE CHOCTAWHATCHEE-PEA-YELLOW RIVERS WATERSHED

GSA initiated a project in 1994 to characterize and evaluate the water resources of the Choctawhatchee-Pea Rivers watershed. The Yellow River watershed is now included in the water-resources assessment. The major objective of the first phase of the project was to identify, locate, and assemble into a data base all available, relevant surface-water data, including runoff, streamflow, water-quality, and water-use information; relevant ground-water data, including aquifer characteristics, stratigraphic and structural data, water levels, recharge rates, water-quality, and water-use information; and rainfall data, including precipitation rates, amounts, and distribution. Currently, new data are being collected on surface-water quality and availability, and a detailed evaluation of the aquifers underlying the watershed is being conducted.

CHOCCOLOCCO CREEK WATERSHED

In November 1996, GSA initiated a study of surface water in the Choccolocco Creek Watershed to document impacts of using best management practices (BMPs) to control polluted water runoff and to provide data for developing a holistic approach to water management for the watershed. This multi-year monitoring effort, partly funded through section 319 of the Federal Clean Water Act, and conducted in cooperation with ADEM, is to be completed in November 2001.

In November 1996, water, habitat, fish, and macroinvertebrate sampling was initiated at six sites in the middle Choccolocco Creek watershed. This effort was expanded in September 1999 to include two additional sites in the lower part of the watershed. Water-analysis parameters include discharge, nutrients, specific conductance, pH, turbidity, total suspended solids, dissolved oxygen content, and biochemical oxygen demand. Water sampling is conducted at all but one site on a monthly basis; biological sampling is conducted at all sites seasonally.

Causes of water-quality problems in the watershed include agricultural wastes, sediment loading, and runoff from urban areas and construction sites. Land use has a major impact. Principal land uses include residential, agriculture, forestry, pasture, and turf/sod farming. In the upper and middle reaches of the watershed, agricultural activities appear to affect water quality, whereas in the lower reaches, impacts of urban runoff are noted. Major water-quality problems in the watershed are caused by erosion, bacteria in storm water (fecal coliform counts exceed 2,000 colonies per 100 milliliters, at times, after rainfall), and toxic chemicals.

The Choccolocco Creek watershed includes parts of the cities of Anniston and Oxford, the Talladega National Forest, and the Anniston Army Depot, a Superfund site, as well as rural, agricultural areas. Discharge is to the Coosa River.

GSA's study of water quality in the Choccolocco Creek watershed is part of the Choccolocco Creek Watershed Project, a local-based, multi-agency initiative headquartered at the Natural Resources Conservation Service office at Anniston. The principal objective of that project is to restore 75 percent of damaged riparian zones in the Choccolocco Creek watershed.

DELINEATION OF WELLHEAD PROTECTION AREAS

Section 1428 of the 1986 Amendments to the Safe Drinking Water Act of 1974 required states to develop and submit a program to USEPA designed to protect wellhead areas of public water supply systems. A committee comprised of several state, federal, and local organizations prepared Alabama's Wellhead Protection Program, which was administered by ADEM. Public water systems that use ground water were required (until 1998) to prepare a Wellhead Protection Plan (WHPP). As part of the plan, the water systems must delineate recharge areas and identify sources of potential contamination in the recharge areas.

GSA, in cooperation with ADEM and public water supply systems, conducted many wellhead protection projects. During 1997 and 1998, 16 studies were conducted in Beatrice, Dothan, Douglas, Greenhill, Hawk Pride, Hurtsboro, Lawson's Trailer Park, Leighton, Limestone County, Luverne, Monrovia-Chastain-Bucks, Rogersville, Sylacauga, Tuscumbia, West Dallas County, and Wilsonville. These cities and public water supply systems can develop and implement controls through a management plan for potential contamination sources and prepare contingency plans for emergency and long range water supply needs. Guidebooks and an instructional video are available through GSA to assist other public water supply systems in developing wellhead protection plans.

In 1998 the Wellhead Protection Program was replaced by the Source Water Protection Program, but the requirements for hydrogeological studies have not changed.

GIS PROJECTS

GSA is completing a land use/land cover classification for approximately one-half of the State of Alabama. For this classification, the project team is using recent LandSat Thematic Mapper multispectral satellite imagery processed through an image analysis software package. The resulting raster data will be further processed and will ultimately result in a vector geographic information systems (GIS) thematic data layer for land use/land cover. These data will have wide application for various purposes including land use planning, economic development, and environmental management and protection.

In cooperation with ADEM, GSA has developed a GIS database for information collected for assessment of pesticides in ground water for four north Alabama counties (Limestone, Lauderdale, Madison, and Lawrence). A thematic layer of data collected from water wells has been compiled, as well as layers for various other themes. These include roads, streams, geology, public water supply wells, and wellhead protection areas. In addition, a land use/land cover classification from LandSat Thematic Mapper satellite imagery is being developed. All data will be distributed on CD-ROM.

GROUND-WATER BOOKLET

GSA and ADEM initiated a cooperative project in 1995 to produce an informative booklet about ground water (*Water Down Under*). This booklet is intended to provide information about ground-water resources, use, contamination, and protection in Alabama. The booklet is a nontechnical distillation of up-to-date technical information and should be useful to adults, high-school students, and middle-school students. The book is available from GSA and ADEM.

LIGHTWOOD KNOT CREEK WATER-QUALITY EVALUATION

A seven-year project to evaluate the effects of best management practices (BMPs) on tributaries of Lightwood Knot Creek in Covington County was initiated in 1995. This case study will evaluate the effectiveness of BMPs to improve water quality related to poultry production facilities and other agricultural practices in the study area. Automatic sampling stations at four sites collect water quality data every 15 minutes, and water samples are collected every 24 hours. Additional water samples are collected during storms. The amounts of sediment transported by the streams are measured weekly. This unprecedented level of monitoring will facilitate interpretation of the causes of long-term and transient changes in water quality. The BMPs being evaluated include the composting of dead chickens and waste products, sediment retention, erosion control, and other practices intended to reduce contaminant runoff into streams. If the BMPs prove effective, then the results of this study can provide a paradigm for water-quality improvement in areas of poultry production throughout Alabama and elsewhere.

SELECTED CONTACT INFORMATION

The following list, though not exhaustive, includes contact information for many state and federal agencies and other organizations that can provide information and assistance pertaining to water in Alabama.

GEOLOGICAL SURVEY OF ALABAMA

Mailing Address: P.O. Box 869999, Tuscaloosa AL 35486-6999

Street Address: 420 Hackberry Lane, Tuscaloosa.

Telephone: (205) 349-2852 FAX: (205) 349-2861

E-mail: info@gsa.state.al.us

Web site: http://www.gsa.state.al.us

U.S. ENVIRONMENTAL PROTECTION AGENCY

National Agriculture Compliance Assistance Center (Ag Center), toll-free, automatic "fax-back" system for fact sheets and other publications. Telephone: 1-888-663-2155 (new telephone number). The list includes information on pesticides, underground storage tanks, animal feeding operations, and other subjects.

American Heritage Rivers initiative Web site: http://www.epa.gov/docs/owowwtr1/heritage/index.html

American Heritage Rivers toll-free hotline. Telephone: 1-888-40-RIVER

Clean Water Initiative Web site: http://www.cleanwater.gov/

Conservation guidelines Web site: http://www.epa.gov/owm/genwave.htm or contact Safe Drinking Water Act Hotline.

Drinking water information Web site (data from local systems): http://www.epa.gov/safewater/dwinfo.htm

Hardship Grants Program for Rural Communities Web site: http://www.epa.gov/OWM/wm042002.htm

Hardship Grants Program for Rural Communities. Telephone: (202) 260-2268

National Center for Environmental Publications and Information, P.O. Box 42419, Cincinnati OH 45242. Telephone: (800) 490-9198. Web site: http://www.epa.gov/ncepihom

Nonpoint Source e-mail discussion list (NPSINFO) Web site: send message "subscribe NPSINFO (your first name, last name)" to listserver@unixmail.rtpnc.epa.gov

Nonpoint Source Water Pollution Control. The USEPA has published a study on state laws and regulations that can be used to address nonpoint-source pollution. Web site: http://www.epa.gov/OWOW/NPS/elistudy

Nonpoint Source success stories Web site: http://www.epa.gov/OWOW/NPS/Success319

Pollution Prevention Information Clearinghouse. Telephone: (202) 260-1023. E-mail to ppic@epamail.epa.gov

Safe Drinking Water Act Hotline. Telephone: (800) 426-4791

Safe Drinking Water Act information Web site: http://www.epa.gov/OGWDW/ or http://www.epa.gov/OGWDW/SDWAsumm.html

Source water protection Web site: http://www.epa.gov/OGWDW/swp/swapes.html

Superfund Web site: http://www.epa.gov/superfund/index.htm

Superfund, RCRA, UST, oil pollution, and community right-to-know hotline. Telephone: (800) 424-9346

Superfund, RCRA, UST, oil pollution, and community right-to-know hotline Web site: http://www.epa.gov/epaoswer/hotline/index.htm

Surface Water Treatment Rule, guidance for small systems. Telephone: (800) 426-4791 or on the Web: http://www.epa.gov/ogwdw/regs/swtrlist.html

Total Maximum Daily Load (TMDL) program of the Clean Water Act Web site: http://www.epa.gov/owowwtr1/tmdl/index.html . Telephone: (202) 260-7074

Underground Storage Tank upgrade/replacement/closure costs Web site: http://www.epa.gov/swerust1/1998/urccosts.htm

USEPA Web site: http://www.epa.gov

Wastewater (National Small Flows Clearinghouse) hotline. Telephone: (800) 624-8301. Web site: http://www.nsfc.wvu.edu

Wastewater (small systems) Web site: http://www.epa.gov/OWM/smcomm.htm

Watersheds (Surf Your Watershed Program) Web site: http://www.epa.gov/surf or call (202) 260-7087. Water-quality and other information about watersheds throughout the U.S. is available on this web page. In addition, USEPA's Office of Water has recently published a new document entitled "Catalog of Federal Funding Sources for Watershed Protection," which is available by telephone at (513) 489-8190 or (800)490-9198 and FAX (513)489-8695. Please include the document number (EPA841-B-97-008) in requests. A new service of the USEPA, the Index of Watershed Indicators (IWI), is available on the Web at: http://www.epa.gov/surf/iwi/ . The IWI summarizes available water-quality information and other environmental information for every watershed in the country. A related page is the watershed information network, Web site: http://www.cleanwater.gov/win

Wellhead Protection Document List Web site: http://www.epa.gov/OGWDW

OTHER FEDERAL AGENCIES

U.S. Agricultural Statistics Service Web site: http://www.usda.gov/nass

U. S. Department of Agriculture Water Quality report Web site: http://www.nal.usda.gov/wqic/wgwq/progress.html

National Agricultural Library, Water Quality Information Center, annotated listing of funding sources related to water resources, Web site at: http://www.nal.usda.gov/wqic/funding.html

U.S. Geological Survey Water Resources Division. The USGS is the lead federal agency in all areas of water research. Telephone: (800) 426-9000. E-mail: h2oinfo@usgs.gov; Web site: http://water.usgs.gov

U.S. Government Printing Office (for any federal reports). Telephone: (202) 512-1808. FAX: (202) 512-2250

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

Mailing Address: P.O. Box 301463, Montgomery AL 36130-1463

Street Address: 1400 Coliseum Blvd., Montgomery AL 36110-2059

Telephone: (334) 271-7700

Alabama Tank Trust Fund telephone: (334) 271-7844

Water Division telephone: (334) 271-7823

Water Division FAX: (334) 279-3051

Web site: http://www.adem.state.al.us

OTHER STATE AGENCIES

Alabama Web site: http://alaweb.asc.edu/

Alabama Agricultural Statistics Service, Web site: http://www.acenet.auburn.edu/department/nass

Alabama Department of Conservation and Natural Resources, Web site: http://www.dcnr.state.al.us/agfd

Alabama Department of Economic and Community Affairs, Office of Water Resources, P.O. Box 5690 Montgomery AL 36103-5690. General telephone: (334) 242-5525. General FAX: (334) 242-5515. Office of Water Resources telephone: (334) 242-5499. Web site: http://www.adeca.state.al.us/AOWR/index-water.html

Alabama Department of Public Health. Telephone: (334) 206-5300. Web site: http://www.alapubhealth.org/index.htm

Alabama Surface Mining Commission, Web site: http://www.surface-mining.state.al.us/

State Oil and Gas Board, P.O. Box 869999, Tuscaloosa AL 35486-6999. Telephone: (205) 349-2852. Web site: http://www.ogb.state.al.us

OTHER SOURCES OF INFORMATION AND ASSISTANCE

Alabama Water Watch. Telephone: (334) 670-3624; e-mail (Michael William Mullen): mmullen@trojan.troyst.edu

Legacy, Inc.: Telephone: (334) 270-5921; e-mail at legacypartners@mindspring.com; Web site: http://legacypartners.home.mindspring.com

Groundwater Guardian program, City of Tuscumbia affiliate. Telephone: (256) 383-0321; Web site: http://home.hiwaay.net/~dbt

Mobile Bay National Estuary Program, 440 Fairhope Ave., Fairhope AL 36532. Telephone: (334) 990-3565. FAX: (334) 990-3609. Web site: http://www.mobilebaynep.com

National Drinking Water Clearinghouse (information about source water protection). Telephone: (800) 624-8301, ext. 4

Bama Environmental News is a weekly e-mail newsletter produced by Pat Byington. Telephone: (205) 226-7739. E-mail: pkbyington@aol.com. Web site : http://www.BamaNews.com

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GLOSSARY

ACRE-FOOT - A unit of measurement of water volume, the quantity of water required to cover 1 acre to a depth of 1 foot.

AQUICLUDE - Relatively impermeable rock that acts as the upper or lower boundary of an aquifer. It can slowly absorb water but does not readily transmit water to wells or springs.

AQUIFER - A formation, part of a formation, or a group of formations that is saturated and will yield useful amounts of water to wells and springs.

ARTESIAN WATER - Ground water that is in an aquifer confined by an impermeable bed or beds and under sufficient pressure to cause the water levels in wells to rise above the base of the overlying confining bed.

ARTESIAN WELL - Well deriving water from an artesian or confined water body.

AVERAGE DISCHARGE - The arithmetic average of the average annual discharges for all complete water years of record.

BASE FLOW - The sustained flow of a stream during fair weather conditions. Generally the base flow is composed of effluent ground water.

BASIC HYDROLOGIC DATA - Data collected during inventories of water and related land features, and records on water-related processes. The data include records of precipitation, streamflow, ground-water levels, and water quality.

CFS - The volume of water flowing in one second through a cross section with an area of 1 square foot.

CONDENSATION - The process by which a substance changes from the vapor state into the liquid or solid state.

CONE OF DEPRESSION - The depression in the water level or potentiometric surface of ground water caused by pumping a well or pit. The greatest amount of depression occurs near the discharge well or pit. The cone defines the area of influence of pumpage.

CONFINED WATER - Ground water occurring under pressure greater than atmospheric pressure. The boundary of the upper surface of the water is an impermeable bed or a bed with a permeability significantly less than the permeability of the bed in which the water occurs.

CONFINING BED - A relatively impermeable bed adjacent to and confining water in an aquifer.

DAILY DISCHARGE - The volume of water flowing past a point within a 24-hour period. Daily discharge is normally reported as the mean discharge for 24 hours.

DAILY GAGE HEIGHT- Gage height is the mean gage height for 24 hours or the value that occurs at a specified time during the day.

DEPLETION - The removal of ground water from an aquifer at a rate greater than that of recharge.

DISCHARGE - The volume of water passing a specified point within a specified period of time. Frequently discharge is reported in cubic feet per second (ft^3/s).

DRAINAGE BASIN - The area around a surface-water drainage system that contributes runoff from precipitation to the system.

DRAINAGE DIVIDE - The boundary or rim separating two drainage basins.

DRAWDOWN - The amount of decline in the water level or the reduction in pressure in a well caused by ground-water discharge.

EVAPORATION - The process by which a substance passes from a liquid or solid state to a vapor state.

EVAPOTRANSPIRATION - The combined processes by which water is lost from the land area by evaporation from water surfaces and moist soil and by transpiration of plants.

FRESHWATER - Water with a low salinity or with a low dissolved-solids content.

GAGE HEIGHT OR STAGE - The height of a water surface above an arbitrarily established datum plane. Gage height and stage are synonymous terms.

GROUND WATER - The part of subsurface water that is in the zone of saturation. However, the term is used by some to refer to all water beneath the surface.

GROUND-WATER DISCHARGE - The removal of water by any means from the zone of saturation.

GROUND-WATER RECHARGE - The process by which water is added to the zone of saturation.

HARDNESS - The property of water that prevents lathering of soaps and causes the formation of insoluble residues when soap is used. It causes scale to form in vessels in which water has evaporated and is caused by the presence of some cations, primarily calcium and magnesium.

HEAD - The pressure of a fluid on an area at a given point caused by the height of the fluid surface above that point.

HYDROGRAPH - A graph that shows the change in ground-water level or other characteristics of water with time.

HYDROLOGIC BUDGET - An accounting of the inflow to, outflow from, and storage in a hydrologic unit such as an aquifer, drainage basin, or reservoir.

HYDROLOGIC CYCLE - A term to denote the sequence of events in the circulation of water from the sea, through the atmosphere, to the land, and back to the sea.

HYDROLOGY - The science that deals with the properties, circulation, and distribution of water on and under the earth's surface and in the atmosphere.

HYDROSTATIC HEAD - The height of a vertical column of water with a unit cross-sectional area having a weight equal to the hydrostatic pressure at a point.

HYDROSTATIC LEVEL - The level to which water will rise in a well under a full pressure head. This level defines the potentiometric surface. Same as STATIC LEVEL.

HYDROSTATIC PRESSURE - The pressure caused by the weight of the ground water at higher levels in the zone of saturation.

INFILTRATION - The movement of water into soils or into interstices or cracks in rocks.

INFILTRATION RATE - The rate at which soils or interstices in rocks under specified conditions can absorb water. It is expressed as depth of water per unit of time.

IMPERMEABLE - A term used in describing a substance that does not allow the transmittal of fluids under pressure. Also used to describe substances that allow little fluid transmittal under pressure.

MAXIMUM DISCHARGE - The instantaneous maximum streamflow. These values are commonly determined from records of surface-water elevation (stage, gage height) and the use of streamflow rating charts.

MAXIMUM GAGE HEIGHT - The maximum instantaneous gage height (stage).

MOISTURE - Water that is diffused in the atmosphere or in the ground.

PERCHED AQUIFER - An aquifer containing perched ground water.

PERCHED GROUND WATER - Ground water that is separated from an underlying main body of ground water by an unsaturated zone capped by an impermeable layer.

PERCHED WATER TABLE - The water table of a body of perched ground water. See PERCHED GROUND WATER.

PERCOLATION - The movement of water, generally downward, by the force of gravity or under hydrostatic pressure, through the interstices of rocks or soils, but not through large openings such as caves.

PERMEABILITY - The ability of a porous rock or soil to transmit fluids without impairment of the structure of the rock or soil.

POROSITY - The property of a rock or soil containing interstices. It is expressed as the ratio (as a percentage) of the volume of the interstices to the total volume of the rock or soil.

POTABLE WATER - Water that is safe and palatable for human consumption.

POTENTIOMETRIC MAP - A map showing the elevation of the potentiometric surface of an aquifer.

POTENTIOMETRIC SURFACE - The imaginary surface representing the static head of ground water in an aquifer. It is defined by the level to which water will rise in wells.

RECHARGE - The process by which water is added to the zone of saturation.

RECHARGE AREA - The area where water enters the soil and moves downward to the zone of saturation.

SALINITY - The quantity of dissolved salts in water measured by weight in parts per thousand with the qualifications that all carbonate has been converted to oxide, all bromide and iodide have been converted to chloride, and all organic matter has been oxidized.

SALTWATER ENCROACHMENT - The displacement of freshwater in an aquifer by saltwater because of the greater density of saltwater. The encroachment occurs when the total head of the saltwater exceeds that of the freshwater.

7-day Q_2 LOW FLOW - The lowest mean discharge during 7 consecutive days of a year that will be expected to occur once every 2 years.

7-day Q_{10} LOW FLOW - The lowest mean discharge during 7 consecutive days of a year that will be expected to occur once every 10 years.

SOIL MOISTURE - Water in the upper part of the zone of aeration, which is just beneath the land surface.

SPECIFIC CAPACITY - The rate of discharge of water from a well per unit of drawdown. It is generally expressed in gallons per minute per foot of drawdown.

SPECIFIC DISCHARGE - The rate of discharge of ground water through a unit cross-sectional area of the aquifer measured perpendicular to the direction of flow.

SPECIFIC YIELD - The ratio of the volume of water that a saturated soil or rock will yield by gravity to the volume of the rock or soil.

SPRING - A place where ground water flows naturally from a soil or rock onto the land surface or into a surface-water body.

STAGE - See GAGE HEIGHT.

STATIC HEAD - The height above a standard datum of the surface of a column of water that can be supported by the static pressure at a given point. It is the sum of the elevation head and the pressure head.

STATIC LEVEL - See HYDROSTATIC LEVEL. Also, static level refers to the water level in a well that is not affected by ground-water withdrawal.

SUBSURFACE WATER - All water occurring below the surface of the earth and within bodies of surface waters.

TRANSPIRATION - The process by which water is absorbed by roots of plants and then evaporated into the atmosphere at the surfaces of the plants.

UNCONFINED WATER - Ground water that is not confined under pressure by relatively impermeable rocks. It has a free-water surface.

UNSATURATED ZONE - The zone between the land surface and the water table. The water is under pressure less than atmospheric pressure.

WATER TABLE - The surface of a ground-water body at which pressure equals atmospheric pressure. It is the surface that separates the zone of saturation and the zone of aeration, and is defined by the level at which water will stand in a well completed in an unconfined aquifer.

WATER YEAR - October 1 to September 30.

WELL - A pit, hole, or tunnel constructed in the ground for the purpose of obtaining water or other fluids from soils or rocks or for the purpose of injecting fluids into soils or rocks.

APPENDIX A

Well Forms

NOTIFICATION OF INTENT TO DRILL A WATER WELL

DRILLING CONTRACTOR	License Number	Address	Zip Code	Date

PROPERTY OWNER	Address (mailing)	Zip Code

WELL LOCATION	County	Township	Range	Section	1/4 Section

Distance and direction from nearest town, community, road junction or other reference point

WELL TO BE USED FOR:

❑ Private supply ❑ Public supply ❑ Industrial supply ❑ Test well ❑ Monitoring well

❑ Irrigation Other: ______________________

Diameter of well ______ Estimated depth ______

Estimated starting date ______

Drilling Method:
- ❑ Cable tool
- ❑ Rotary
- ❑ Jetted
- ❑ Bored
- ❑ Other: ______________________

SIGNATURE of Drilling Contractor ______________________

Total Depth ______________________ **Completion Date** ______________________

Inter-val	Description of cuttings	Inter-val	Description of cuttings

Completion date: report depths below ground level

Pump

Type: ❑ Turb. ❑ Subm. ❑ Jet ❑ Cyl Other______

Intake depth__________ H.P. __________ Yield ______ gpm

Capacity

Tested by: ❑ pumping ❑ air lift ❑ bailer ❑ none

Measured Static Water Level ______________________ ft.

Measured pumping level ______________________ ft. after

__________ hrs. pumping ______________________ gpm

Development time prior to testing ______________________ hrs.

Finish

❑ Open hole ❑ Screened ❑ Slotted pipe ❑ Gravel pk.

Inerval(s) screened: ______________ to ______________ ft;

________ to ________; ____________ to ______________ ft.

Packer(s) set at ______________ and ______________ ft.

Screen: diam. ______________; Size openings ______________

Casing

Interval cased	Diam. (Inches)	*Type pipe	*Type couplings	Interval grouted

*Couplings: Threaded & Coupled (T&C) Welded (W)
Threaded & coupled & welded (TC&W)

Other: ______________________

*Pipe: Black; PCV; Galv.; Other: ______________________

Quality

Water analysis obtained? (check)
- ❑ No
- ❑ Bacteriological
- ❑ Chemical

Analysis by: ❑ Ala Geol. Surv. ❑ U.S. Geol. Surv. ❑ Ala Health Dept. ❑ Private lab.

Signed:

*For deeper well please attach continuation sheet.

Send WHITE copy to:
ALABAMA GEOLOGICAL SURVEY
P.O. BOX 869999
TUSCALOOSA, AL 35486

Send YELLOW and PINK copies to:
ADEM DRINKING WATER BRANCH
P.O. BOX 301463
MONTGOMERY, AL 36130-1463

Retain GOLD copy for Records

ADEM FORM 60 2/02

NOTIFICATION OF INTENT TO DRILL A WATER WELL

DRILLING CONTRACTOR	License Number	Address	Zip Code	Date

PROPERTY OWNER	Address (mailing)	Zip Code

WELL LOCATION	County	Township	Range	Section	1/4 Section

Distance and direction from nearest town, community, road junction or other reference point

WELL TO BE USED FOR:

- ❑ Private supply
- ❑ Public supply
- ❑ Industrial supply
- ❑ Test well
- ❑ Monitoring well
- ❑ Irrigation
- Other: ______________________

Diameter of well ____________ Estimated depth ____________

Estimated starting date ____________

Drilling Method:
- ❑ Cable tool
- ❑ Rotary
- ❑ Jetted
- ❑ Bored
- ❑ Other: ______________________

SIGNATURE of Drilling Contractor ______________________

ADEM FORM 60 2/02

(Tear here for mailing)

Mail this Postcard to ADEM Prior to Drilling

FIRST
CLASS
POSTAGE

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
DRINKING WATER BRANCH
PO BOX 301463
MONTGOMERY AL 36130-1463

APPENDIX B

Federal and State agencies responsible for water regulation and water use planning in Alabama

Appendix B.—Federal and state agencies responsible for water regulation and water use planning in Alabama

FEDERAL

U.S. Environmental Protection Agency
Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, Georgia 30303-8909

STATE

Alabama Department of Conservation and Natural Resources
P.O. Box 301456
64 North Union Street
Montgomery, Alabama 36130-1456

Alabama Department of Economic and Community Affairs
P.O. Box 5690
401 Adams Avenue
Montgomery, Alabama 36103-5690

Alabama Department of Environmental Management
P.O. Box 301463
Montgomery, AL 36130-1463

Alabama Surface Mining Commission
P.O. Box 1027
Jasper, Alabama 35501

State Oil and Gas Board
P.O. Box 869999
420 Hackberry Lane
Tuscaloosa, Alabama 35486-6999

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