ALABAMA GROUND-WATER QUALITY

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FOREWORD

This report contains summary information on ground-water quality in one of the 50 States, Puerto Rico, the Virgin Islands, or the Trust Territories of the Pacific Islands, Saipan, Guam, and American Samoa. The material is extracted from the manuscript of the *1986 National Water Summary*, and with the exception of the illustrations, which will be reproduced in multi-color in the *1986 National Water Summary*, the format and content of this report is identical to the State ground-water-quality descriptions to be published in the *1986 National Water Summary*. Release of this information before formal publication in the *1986 National Water Summary* permits the earliest access by the public.

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In Alabama, ground water is the major source for public supply—about 52 percent of the population depends on ground water (see population distribution, fig. 1). The principal area for ground-water withdrawal is the Coastal Plain of Alabama. All principal aquifers (fig. 2) generally produce water that does not exceed the U.S. Environmental Protection Agency (EPA) national primary drinking-water standards for dissolved nitrate (as nitrogen) and fluoride, and secondary drinking-water standards for dissolved solids, sulfate, and fluoride. The principal aquifers contain water that is soft to moderately hard. Dissolved solids, nitrate, fluoride, sulfate, and hardness are important indicators for the acceptability of water for public supply.

Forty-three hazardous-waste sites require monitoring of ground-water quality under the Alabama Hazardous Waste Management Act and the Federal Resource Conservation and Recovery Act (RCRA) of 1976. In addition to these RCRA sites, six sites have been placed on the National Priorities List (NPL) of hazardous-waste sites by the U.S. Environmental Protection Agency (1986c), and two other sites have been proposed for the list. These six Superfund sites require additional evaluation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. At 28 of the RCRA sites and 4 of the CERCLA sites, contamination has been detected in the shallow ground-water system (fig. 3*A*). An additional 475 sites are on the EPA Emergency and Remedial Response Information System (ERRIS) list. In addition, the U.S. Department of Defense has identified 89 sites at 3 facilities where contamination has warranted remedial action.

In 1981, the U.S. Geological Survey in cooperation with the Geological Survey of Alabama began a ground-water-quality monitoring program to determine background water quality in the aquifers. Initially, 50 wells were chosen; by 1985, the number had increased to 96. The analyses primarily are for the major inorganic constituents and the more common trace elements. Determinations of organic contamination in Alabama's aquifers have been limited to specific sites under projects directed by State and county agencies and private industry.

WATER QUALITY IN PRINCIPAL AQUIFERS

Principal aquifers in Alabama (fig. 2*A1*) are grouped into two types—those within the Coastal Plain and those north of the Coastal Plain (fig. 2*A2*). The aquifers within the Coastal Plain consist primarily of a sequence of unconsolidated sediments, whereas those outside the Coastal Plain consist of consolidated sediments, carbonate rocks, and igneous and metamorphic rocks (U.S. Geological Survey, 1985, p. 123). More than 62 percent of the State's ground-water withdrawals are from the Coastal Plain aquifers (Baker, 1983).

The freshest ground water in Alabama, commonly containing less than 100 mg/L (milligrams per liter) of dissolved solids, occurs in the recharge areas of all the principal aquifers. Downdip in Coastal Plain aquifers, the dissolved-solids concentrations become as large as 30,000 mg/L. Within the area of the non-Coastal Plain aquifers, the primary sources for public supply are surface water, spring flow, and a few deep wells. Iron concentrations larger than 300 μg/L (micrograms per liter) and corrosive waters (pH less than 5) are the common water-quality problems in the non-Coastal Plain aquifers. Iron also is a local problem in the Coastal Plain aquifers.

Naturally impaired water quality in southwestern Alabama (fig. 3*B*) resulted from connate, highly mineralized water migrating upward along faults. Information is not available to determine if the water quality is continuing to change. All major aquifers in the area are affected, and the only sources of fresh ground water are discontinuous terrace deposits and alluvium along the rivers.

BACKGROUND WATER QUALITY

A graphic summary of selected water-quality variables compiled from the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE) is shown in figure 2*C*. The summary is based on dissolved-solids, hardness, nitrate (as nitrogen), sulfate, and fluoride analyses of water samples collected from 1940 to 1986 from the principal aquifers in Alabama. Percentiles of these variables are compared to national standards that specify the maximum concentration or level of a contaminant in drinking-water supply as established by the U.S. Environmental Protection Agency (1986a,b). The primary maximum contaminant level standards are health related and are legally enforceable. The secondary maximum contaminant level standards apply to esthetic qualities and are recommended guidelines. The primary drinking-water standards include maximum concentrations of 10 mg/L nitrate (as nitrogen) and 4.0 mg/L fluoride, and the secondary drinking-water standards include maximum concentrations of 500 mg/L dissolved solids, 250 mg/L sulfate, and 2.0 mg/L fluoride.

Coastal Plain Aquifers

The Coastal Plain aquifers consist of, from youngest to oldest, the Citronelle-Miocene aquifer, the Floridan aquifer, the Tertiary sedimentary aquifer system, and the Cretaceous aquifer system (fig. 2*A1*, 2*B*). Overall, the quality of water produced from these aquifers is very good for most uses, because most water is produced from the shallowest available aquifer. In the downdip sections of the aquifers, the water becomes progressively more mineralized. A shallow aquifer producing relatively unmineralized water usually is available for development, except in the southwestern section of the Coastal Plain in parts of Choctaw, Clarke, Marengo, Monroe, and Sumter Counties. This area contains faults, many caused by the upward migration of salt; the domes of salt have pierced the overlying sediments, providing an avenue for movement of very mineralized water from below.

The Citronelle-Miocene aquifer has the widest range for values of dissolved solids and hardness (fig. 2*C*) in the principal aquifers. Because it is the uppermost available of the Coastal Plain aquifers, the Citronelle-Miocene aquifer is used even when the water approaches objectionable quality. Although the range of dissolved-solids concentrations for the Citronelle-Miocene aquifer and the Cretaceous aquifer system is similar, the maximum concentration in a potential water well in the Citronelle-Miocene aquifer is about 20,000 mg/L, almost four times the maximum for water in the Cretaceous aquifer system. The values for dissolved-solids concentrations in the Cretaceous aquifer system are large, however, because the aquifer is tapped farther downdip and at a deeper interval than most of the other Coastal Plain aquifers.

Figure 2*C* shows that the 90th-percentile value for dissolved-solids concentration in three Coastal Plain aquifers—the Citronelle-Miocene, the Tertiary, and the Cretaceous—exceeded the national drinking-water standard of 500 mg/L. The only Coastal Plain aquifer leaching of minerals from spoils produced by the surface mining of coal, leaking underground storage tanks, or downward migration of leachates from surface impoundments and landfills. Long-term data are not available to document most changes in water quality in Alabama. A monitoring network of wells was established in Alabama in 1981 under a joint program between the U.S. Geological Survey and the Geological Survey of Alabama. The deterioration of ground-water quality generally is documented by the large concentrations of constituents in affected wells (fig. 3*B*) compared with the background water quality of unaffected wells.

Intensive Pumping

Coastal areas are the most susceptible to migration of extremely mineralized water caused by intensive pumping. Water from a well tapping the Citronelle-Miocene aquifer, located on an offshore island in southern Mobile County, has had chloride concentrations increase from about 100 mg/L during 1955 to about 800 mg/L during 1976 (Chandler and Moore, 1983). Water from another well located farther inland had chloride concentrations increase from about 250 mg/L during 1967 to about 400 mg/L during 1976. Chandler and others (1985) reported that intensive pumping has caused saltwater encroachment in the Citronelle-Miocene aquifer in a small area of southern Baldwin County.

Leaching of Mine Spoils

Several coal seams are present in the Pottsville Formation, which contains the Pennsylvanian sandstone aquifer. The Pottsville Formation contains many soluble minerals that become exposed to oxidation and precipitation and produce leachates during widespread excavation associated with surface coal mining. Leachates commonly contain increased concentrations of dissolved solids, sulfate, iron, and manganese. Contamination of the ground water generally is localized and depends upon the presence of the soluble minerals (Puente and others, 1982, p. 9).

Leaking Underground Storage Tanks

The Alabama Department of Environmental Management has information on more than 13,000 sites, with an average of 3 underground storage tanks per site (John Poole, Alabama Department of Environmental Management, oral commun., 1986). However, the Department believes that their information is incomplete and estimates that more than 40,000 underground storage tanks are present in the State. The State has not developed a regulatory program requiring leak detection but has received 20 reports of ground-water contamination in 1986 caused by leaking tanks.

Waste Sites

Hazardous waste is treated, stored, or disposed at 75 RCRA facilities that are at various stages of permitting or closure in Alabama. Forty-three of these facilities have ground-water monitoring systems (fig. 3*A*), and some level of ground-water contamination has been detected at 28 of the facilities (Fred Mason, Alabama Department of Environmental Management, oral commun., 1986). Six priority sites are related to CERCLA and four of those sites have reported ground-water contamination (fig. 3*A*). Also, two proposed CERCLA sites have reported ground-water contamination. An additional 475 sites are on CERCLA's ERRIS list (Fred Mason, oral commun., 1986) and, of these sites, preliminary assessments have been completed at 442. Monitoring programs are designed to detect ground-water contamination, which includes increased concentrations of trace metals, acidity, volatile organic constituents, and priority pollutants. Operations that may contribute to ground-water contamination include: metal plating operations, plating wastes (metals), wood treating, solvent disposal (degreasing operations), pesticide production, battery processing and disposal (metals and acids), and industrial chemical production.

As of September 1985, 175 hazardous-waste sites at 5 facilities in Alabama had been identified by the U.S. Department of Defense (1986) as part of their Installation Restoration Program (IRP) as having potential for contamination. The IRP, established in 1976, parallels the EPA Superfund program. EPA presently ranks these sites under a hazard ranking system and may include them in the NPL. Of the 175 sites evaluated under the program, 72 sites contained contaminants but did not present a hazard to people or the environment. Eighty-nine sites at 3 facilities (fig. 3*A*) were considered to present a hazard significant enough to warrant response action in accordance with CERCLA. Remedial action at 63 of these sites has been completed under the program.

Waste-disposal sites not categorized as RCRA, CERCLA, or IRP sites are identified as "other" in figure 3*A*. These other sites include 56 disposal sites associated with manufacturing, coal mining, oil and gas production, electric power generation, and miscellaneous other industrial activities. (Some of these sites are too close to be plotted with separate symbols in fig. 3*A*.)

In addition to the sites described above, Alabama has 137 county and municipal landfill sites (fig. 3*C*). Each landfill is monitored with a minimum of three wells. One well is positioned upgradient in the natural ground-water flow pattern to establish background ground-water quality. At least two wells are positioned downgradient to evaluate potential effects from the landfill on ground-water quality. Leachate sampled from the landfills may contain increased concentrations of contaminants including iron, manganese, chromium, lead, and organic chemicals.

POTENTIAL FOR WATER-QUALITY CHANGES

The aquifers most susceptible to contamination are the non-Coastal Plain aquifers. In these aquifers the normal avenues for water movement are fractures, bedding planes, and solution features that collect flow and could permit relatively rapid transport of contaminants. These aquifers are recharged over their entire extent, allowing the whole aquifer to be susceptible to direct contamination from the surface. Susceptibility is also increased by the aquifers either being exposed at the land surface or being recharged through a relatively thin (usually less than 100 feet) mantle of residuum, which provides an easy avenue for downward contaminant migration.

An example of contamination to one of these aquifers is Coldwater Spring in Calhoun County, which receives water from the Paleozoic carbonate aquifer system. Concentrations of organic chemicals, which did not exceed the national drinking-water standards, were detected in 1982. The source of contamination has not been identified. Several point sources located in the area could be sources of contamination. As of 1986, no increase in the organic chemicals has been detected at the spring.

The Coastal Plain aquifers also are susceptible to contamination from the surface in their recharge areas. Wells that tap Coastal Plain aquifers in their recharge areas could become directly contaminated. However, most large-yield wells in these aquifers are farther downdip in the confined zones and, therefore, are less susceptible to direct contamination from the surface. Even in the outcrop areas of the Coastal Plain aquifers, flow through the porous unconsolidated sediments aids in faster dispersion of contaminants than would occur in the non-Coastal Plain aquifers.

GROUND-WATER-QUALITY MANAGEMENT

Alabama has existing and pending legislation pertaining to ground-water-quality management. All programs not under RCRA are managed under standards prescribed by the Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub. L. 92-500, as amended by Pub. L. 95-217, Pub. L. 95-576, Pub. L. 96-483 and Pub. L. 97-117, 33 U.S.C. 1251 et seq.

The Alabama Department of Environmental Management has developed a comprehensive ground-water protection law for consideration by the 1988 State legislature. The law addresses the requirements of the EPA's ground-water protection strategy and underground storage-tank program. The legislation also will provide the Alabama Department of Environmental Management with the authority to protect all aquifers and recharge areas in Alabama that are extremely vulnerable to contamination and are irreplaceable because of no reasonable alternative source of drinking water. The Alabama Surface Mining Commission has regulatory powers to minimize ground-water contamination due to surface mining. The Geological Survey of Alabama has regulatory responsibility for the protection of ground-water quality related to the disposal of brines generated by the exploration and production of oil and gas. The Alabama Farm Bureau has recently proposed legislation that would regulate agricultural ground-water use.

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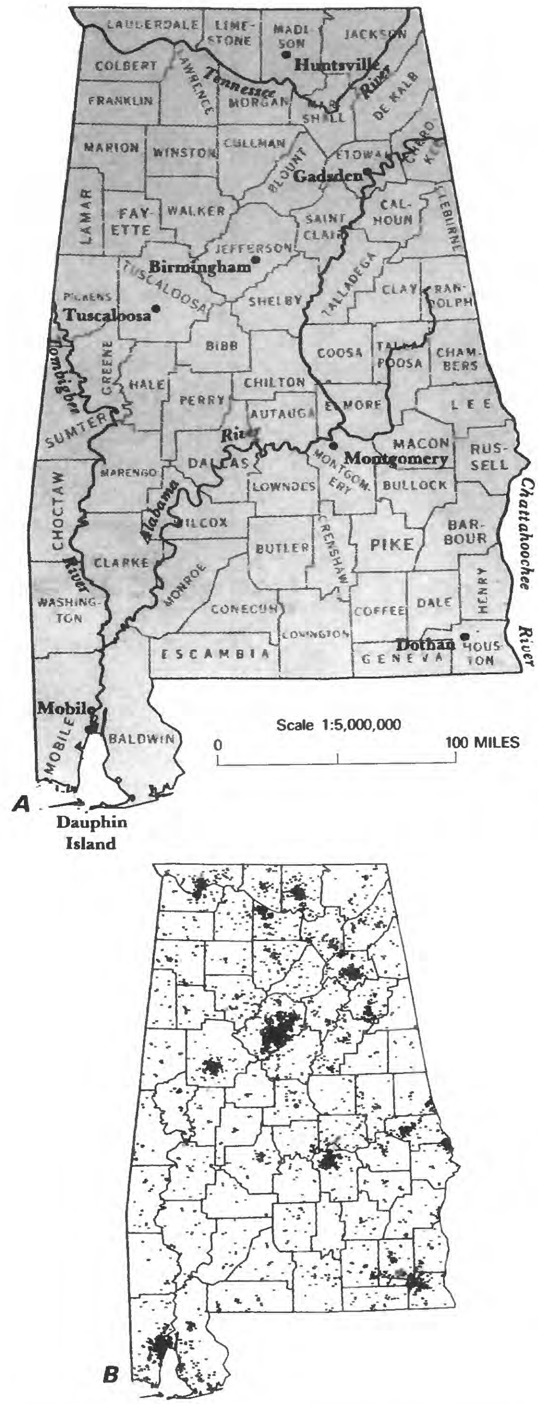

Figure 1. **Selected geographic features and 1985 population distribution in Alabama.** *A*, Counties, selected cities, and major drainages. *B*, Population distribution, 1985; each dot on the map represents 1,000 people. (Source: *B*, Data from U.S. Bureau of the Census 1980 decennial census files, adjusted to the 1985 U.S. Bureau of the Census data for county populations.)

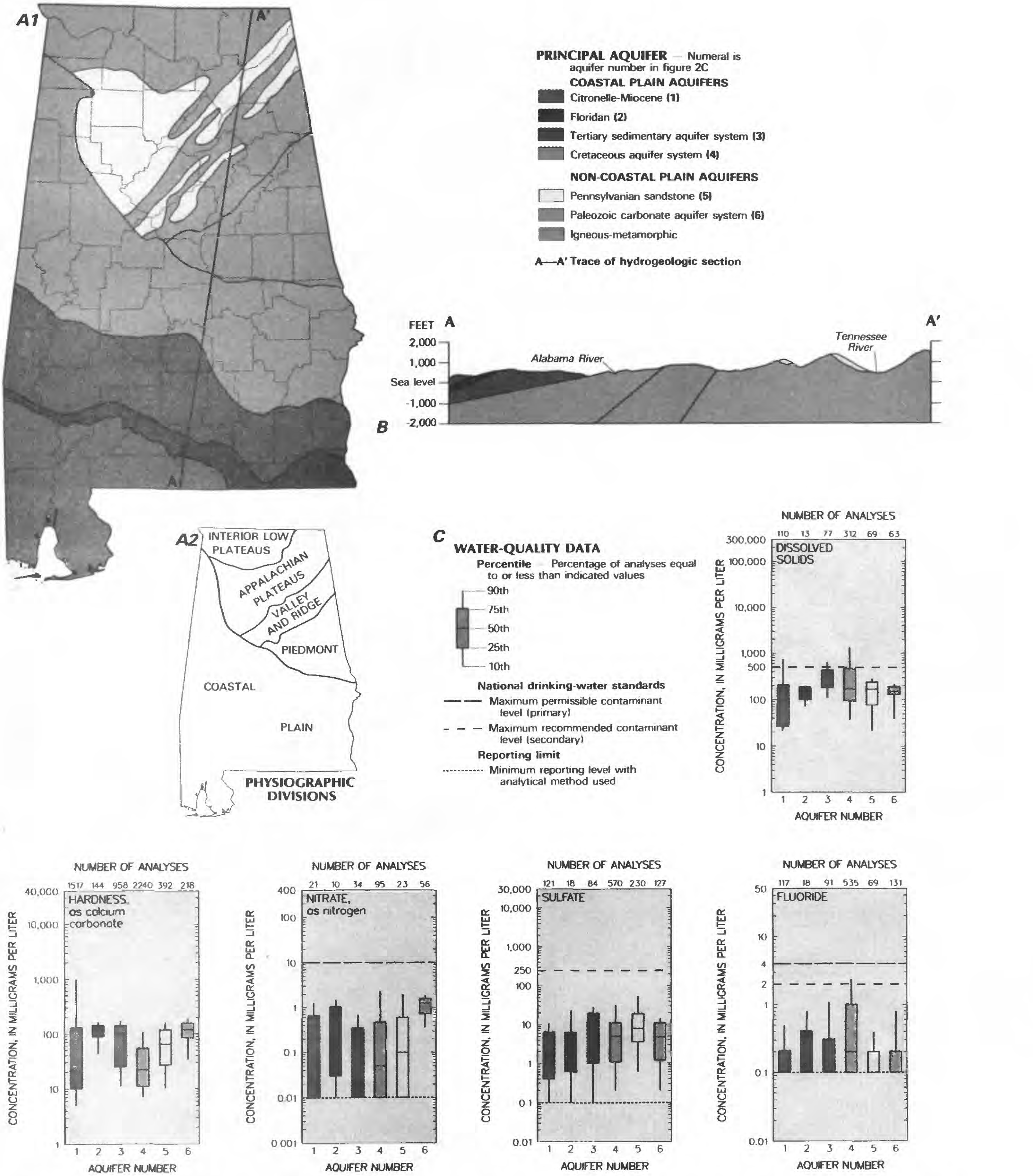

Figure 2. Principal aquifers and related water-quality data in Alabama. *A*1, Principal aquifers; *A*2, Physiographic provinces. *B*, Generalized hydrogeologic section. *C*, Selected water-quality constituents and properties, as of 1940–86. (Sources: *A*1, Johnston, 1933; Carlston, 1942. *A*2, Fenneman, 1938; Raisz, 1954. *B*, Copeland, 1968; Barksdale and Moore, 1976. *C*, Analyses compiled from U.S. Geological Survey files; national drinking-water standards from U.S. Environmental Protection Agency, 1986a,b.)

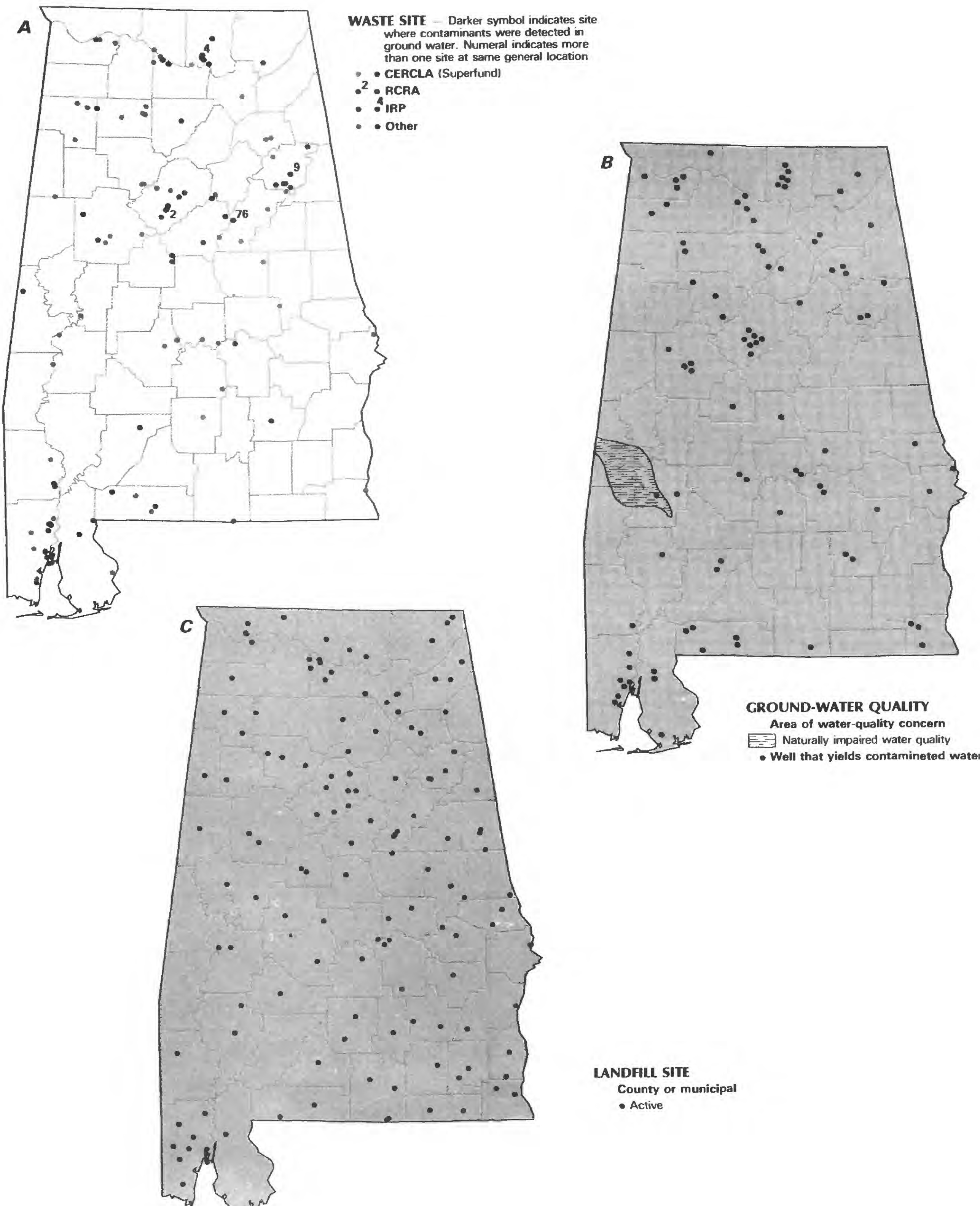

Figure 3. Selected waste sites and ground-water-quality information in Alabama. *A*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, as of 1986; Resource Conservation and Recovery Act (RCRA) sites, as of 1986; Department of Defense Installation Restoration Program (IRP) sites, as of 1985; and other selected waste sites, as of 1986. *B*, Areas of naturally impaired water quality and distribution of wells that yield contaminated water, as of 1986. *C*, County and municipal landfills, as of 1986. (Sources: *A*, Fred Mason, Alabama Department of Environmental Management, written commun., 1986; U.S. Department of Defense, 1986. *B*, *C*, Fred Mason, Alabama Department of Environmental Management, written commun., 1986.)