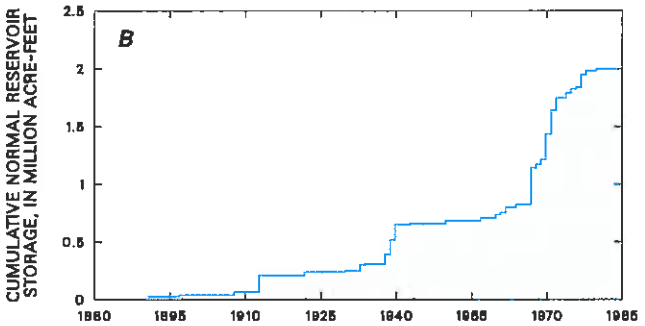
ILLINOIS
Water Supply and Use

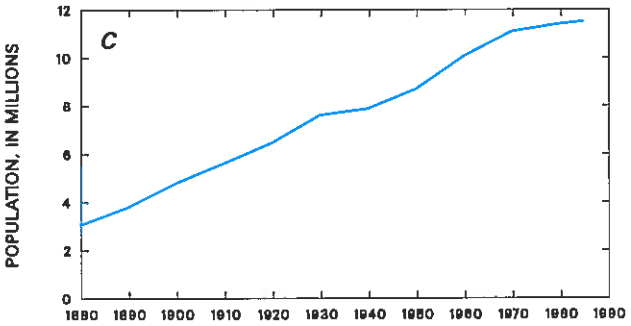
Illinois has an abundant supply of freshwater available from surface- and ground-water sources. In 1985, long-term average precipitation was 30 inches per year, or 101,000 Mgal/d (million gallons per day), and surface-water inflow was 9,900 Mgal/d (fig. 1A). The total amount of ground water potentially available for use is 7,000 Mgal/d (Illinois Technical Advisory Committee on Water Resources, 1967, p. 74). In 1985, withdrawals from rivers, lakes, and aquifers were about 14,400 Mgal/d, and consumptive use was 686 Mgal/d. Of the total amount of water withdrawn, 93.6 percent (13,500 Mgal/d) was from surface-water sources, and 6.4 percent (930 Mgal/d) was from ground-water sources; 95.2 percent was returned to the hydrologic system for reuse.

The largest offstream water users in Illinois are thermoelectric power facilities, which withdrew 80.9 percent (11,700 Mgal/d) of total withdrawals; 1.0 percent of this water was consumed. The amount of water withdrawn for industrial and mining use was 5.9 percent (857 Mgal/d) of total withdrawals; however, industrial and mining consumptive use accounted for 41.3 percent of total consumptive use.

The largest withdrawals are in the northeastern part of Illinois. Withdrawals in the Chicago area (Lake, Cook, and Will Counties) amount to 6,070 Mgal/d and supply more than one-half of the population in Illinois. Withdrawals from Lake Michigan, the second largest freshwater lake in the world, provided 97 percent of the water used in the Chicago area. Increasing demands for Lake Michigan water were a result of declining ground-water levels, although ground water still is used in some areas because of its favorable quality.

Instream water use for hydroelectric power generation in 1985 was 23,300 Mgal/d, which surpasses all other water uses. This use is not included in any of the figures because it would mask the importance of offstream use. Intensive reuse of water in densely pop-





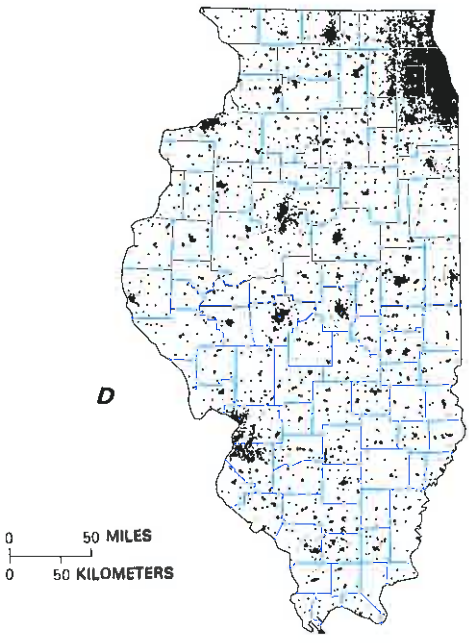


Figure 1. Water supply and population in Illinois. *A*, Water budget, in million gallons per day. *B*, Cumulative normal storage of reservoirs with at least 5,000 acre-feet capacity, 1880 to 1985. *C*, Population trend, 1880 to 1985. *D*, Population distribution, 1985; each dot on the map represents 1,000 people within a census tract. Abbreviations: BRF, boundary-river flow; CU, consumptive use; ET, evapotranspiration; P, precipitation; SWI, surface-water inflow; SWO, surface-water outflow. (Sources: *A*, Compiled from U.S. Geological Survey data; J.R. Kirk, Illinois State Water Survey, written commun., 1987; U.S. Environmental Protection Agency, 1975; Healy, 1979a; Healy, 1979a; 1979b; Healy and others, 1987; and U.S. Department of Commerce, 1951–85. *B*, U.S. Army Corps of Engineers, 1981. *C*, *D*, Compiled by U.S. Geological Survey from U.S. Bureau of the Census data.)

ulated and industrialized areas has degraded the quality of many surface-water sources. Contamination of streams and lakes by sediment as a result of soil erosion is considered to be the most serious water problem in the State.

Official water-use forecasts are not available for Illinois. However, use of water for irrigation and nuclear power has increased during the past 10 years. Irrigation use has nearly doubled during that period—a trend that may lead to significant declines in ground-water levels in areas of intensive irrigation and that may affect neighboring areas that depend on ground-water supplies. Two nuclear powerplants are scheduled to begin operation in 1987; thus, the total consumptive water use is expected to increase significantly.

HISTORY OF WATER DEVELOPMENT

The surface-water resources of Illinois were important to early settlement and growth. The Ohio River was the navigation route of the first settlers at the beginning of the 19th century. In 1848, the Illinois and Michigan Canal (which is no longer being used) was completed to provide a navigable waterway from the Great Lakes to the Mississippi River. The city of Galena was established along the Mississippi River in the 1820's as the center for lead mining and, through the use of paddle-wheel steamers, contributed to the growth of navigation of the upper Mississippi River. In the 1930's, locks and dams converted the Ohio, the Mississippi, and the Illinois Rivers into modern, busy transportation arteries. Thus, navigable waterways determined the patterns of settlement and commerce.

Settlement in some areas required drainage of wetlands. Most of this drainage was accomplished after the Civil War and was essentially completed by 1920. Open ditches and, later, field tiles lowered the water table to allow the tough, but rich, prairie sod to be cultivated. Conversion of the wetlands led to the development of mechanized, large-yield crop production.

Development of water resources can range from a shallow well to a sophisticated multipurpose reservoir system. The State has many large-capacity wells. Large multipurpose reservoirs, such as Shelbyville Lake (Moultrie and Shelby Counties), Carlyle Lake (Clinton, Bond, and Fayette Counties), and Rend Lake (Franklin and Jefferson Counties) in the central and southern parts of the State, provide storage for water supply. Since construction of the first reservoir in 1891, storage has increased seventyfold (fig. 1*B*) to help meet the needs of the steadily growing population (fig. 1*C*). In 1985, Illinois' population totaled 11.5 million, which ranks fourth in the United States (U.S. Bureau of the Census, 1985a); most of the population is in the northeastern part of the State (fig. 1*D*).

In the late 1950's, impoundments were constructed for water-based recreation. More recently, recreational development usually was incorporated into the multiple purposes of large water projects. Emphasis, however, has shifted gradually to recreation associated with natural streams. Recreational activities include fishing, boating, and enjoyment of scenic rivers.

Development of water resources has been most significant in the Chicago area. Water-supply intakes have been increased in size and have been extended farther into Lake Michigan. Throughout the 1890's, increasing amounts of untreated waste were discharged into Lake Michigan and its tributaries. In 1900, the flow in the Chicago River was reversed so that wastes diluted by lake water were diverted into the Illinois River basin. Over time, methods of treating the wastewater have improved. The Metropolitan Sanitary District of Greater Chicago is constructing a tunnel and reservoir system designed to capture storm runoff in a combined sewer system that would virtually eliminate the occasional overflow into the lake during storms.

WATER USE

Water use in Illinois generally has not been restricted because surface- and ground-water supplies are abundant. The largest fresh surface-water resources are the Illinois River, which flows through central Illinois, Lake Michigan to the northeast, and the Mississippi, the Wabash, and the Ohio Rivers on the western, eastern, and southern borders, respectively. Even though supplies currently are sufficient, the Illinois Department of Transportation evaluated public-water supplies, which resulted in 20 of 99 surface-water distribution systems and 26 of 60 ground-water distribution systems being insufficient to meet demands by the year 2000 (Illinois Department of Transportation, 1982, p. 1–6; 1983, p. 4–7). In southwestern Illinois, all surface-water distribution systems are reported to be potentially deficient, although surface-water resources are adequate.

Most water withdrawals are in densely populated areas, along navigational routes, or at thermoelectric power and industrial facilities. The largest withdrawals are in the northeastern part of the State (fig. 2*A*), where the city of Chicago leads all other cities in Illinois in population and manufacturing (R.A. Tobias, Northern Illinois University, Governmental Studies Center, oral commun., 1987). Lake, Cook, and Will Counties account for 42 percent of total offstream withdrawals and 52 percent of the total population in Illinois. Withdrawals are also large along the Illinois River. For example, the city of Peoria is the third leading manufacturing area in the State and the third largest thermoelectric power user. Large withdrawals in southwestern and southern Illinois reflect the concentrated population in the East St. Louis area and the scattered thermoelectric power use. Withdrawals for thermoelectric use in the 15 largest water using counties account for 85 percent of total withdrawals.

The distribution of surface-water withdrawals by county (fig. 2*B*) is similar to total withdrawals by county (fig. 2*A*) because surface water is the source of 93.6 percent of total withdrawals. The largest surface-water withdrawals (5,900 Mgal/d) are from Lake Michigan. Since 1982, these withdrawals have increased 24 percent (Kirk and others, 1984, p. 32; 1985, p. 32). Ground-water withdrawals by county (fig. 2*C*) are largest in the northern one-third and parts of central Illinois.

Of the major river basins, the Upper Illinois and the Lower Illinois basins had the largest surface-water withdrawals (fig. 3*A*). Thermoelectric power generation accounted for most of these withdrawals. Surface-water withdrawals by public suppliers also were substantial in the Northeastern Lake Michigan–Lake Michigan region.

Surface-water quality is a major concern in Illinois. The quality of surface water is being degraded by sewage wastewater and industrial wastewater discharges in densely urbanized areas. Because of advancements in water-treatment technology, the use of surface water has not yet been limited. The Illinois Environmental Protection Agency, however, assessed the quality of many public-supply lakes and reported that nearly 50 percent did not meet State water-quality standards, mainly because of sediment contamination (Illinois Environmental Protection Agency, 1986, p. 67).

Instream uses of water, such as hydroelectric power generation, require large amounts of water. The 23,300 Mgal/d of water passing through Illinois' six hydroelectric powerplants during 1985 is nearly twice the amount withdrawn for offstream uses. The largest instream water user is a hydroelectric powerplant on the Mississippi River near Hamilton. This plant accounted for 82 percent of all hydroelectric water use in the State and used about 80 percent of the flow in the river. Hydroelectric power generation contributed 1,100 GWh (gigawatthours) of electricity, or about 1 percent of the electricity produced in Illinois. Since 1981, hydroelectric power generation has declined 10 percent because of decreases in electrical demand and increases in nuclear power generation. The quantities of water needed for other instream uses, such as navigation and recreation, are difficult to measure and were not assessed.

Of the four principal aquifers (fig. 3*B*), the sand and gravel aquifers supplied 49 percent of the total ground-water withdrawals.

These aquifers are dispersed throughout the State and generally yield water that is suitable for most uses. The deep Cambrian–Ordovician aquifer provides 54 percent of the water in the northern one-third of Illinois—mainly the Chicago and Rockford areas—and accounts for about 33 percent of the total ground-water withdrawals. Pumping from deep aquifers in the Chicago area has increased from 0.2 Mgal/d during 1864 to 199.3 Mgal/d during 1984 (Kirk and others, 1979, p. 2; 1985, p. 30). As a result of these increases, water levels have declined more than 850 feet (Kirk and others, 1982, p. 2). State authorities have been allocating Lake Michigan water to communities that compete for ground water (Illinois State Water Plan Task Force, 1983, p. 50) to allow recovery of ground-water levels. In 1985, ground-water withdrawals decreased to 174 Mgal/d as a result of these allocations. Southern Chicago suburbs that compete for ground water and are isolated from Chicago's water-supply system are allocated Lake Michigan water from public suppliers in northwestern Indiana.

The overall quality of ground water in Illinois is considered to be suitable for most uses, according to a study by the Illinois Environmental Protection Agency (1986, p. 132), which noted pollution problems in 1.5 percent of the 3,427 wells sampled. Ground-water quality in the East St. Louis area has deteriorated as a result of urbanization and industrialization (U.S. Geological Survey, 1988). Consequently, industry has decreased its use of ground water and has increased its use of Mississippi River water. This change has caused a rise in ground-water levels; however, the rise has resulted in widespread sewer-system damage and flooded basements (Voelker, 1984, p. 1–2).

The source, use, and disposition of freshwater are diagrammatically shown in figure 4. The quantities of water given in this figure and elsewhere in this report may not add to the totals indicated because of independent rounding. The source data indicate that 93.6 percent (13,500 Mgal/d) of all withdrawals was from surface water. Of this total, 86.5 percent was withdrawn for thermoelectric power generation, and 9.7 percent was withdrawn for public supply. Public suppliers delivered a total of 1,530 Mgal/d to domestic and commercial users, 255 Mgal/d to industrial and mining facilities, and 0.9 Mgal/d to thermoelectric powerplants. The use data indicate that thermoelectric power accounted for 80.9 percent (11,700 Mgal/d) of all the freshwater used during 1985. Of this total, 1.0 percent (121 Mgal/d) was consumed, and the remaining 99.0 percent (11,600 Mgal/d) was returned to surface- or ground-water sources. The disposition data indicate that, of all the freshwater withdrawn, 4.8 percent (686 Mgal/d) was consumed and 95.2 percent (13,700 Mgal/d) was returned to the hydrologic system for reuse. About 16 percent of the return flow was treated by sewage-treatment facilities.

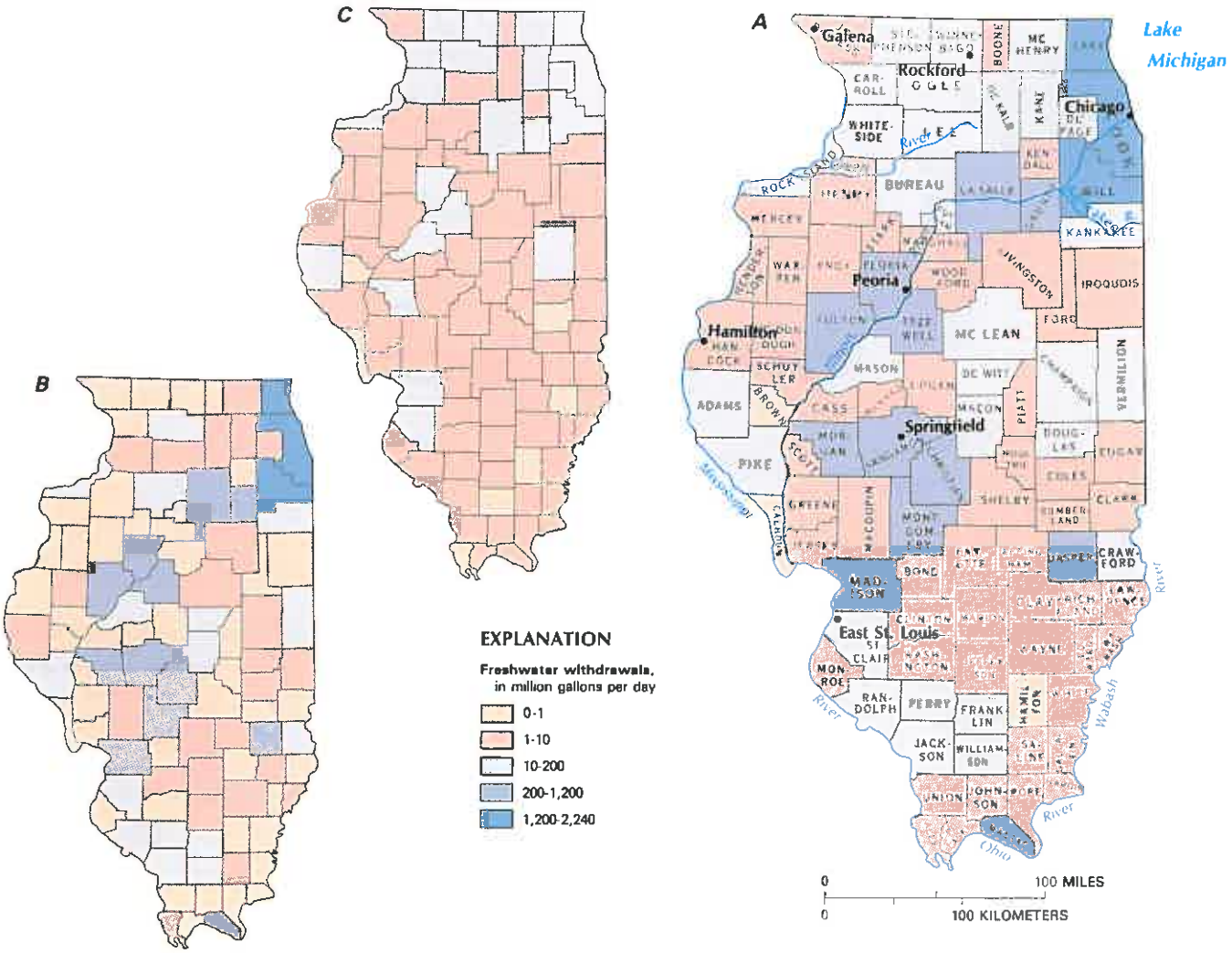
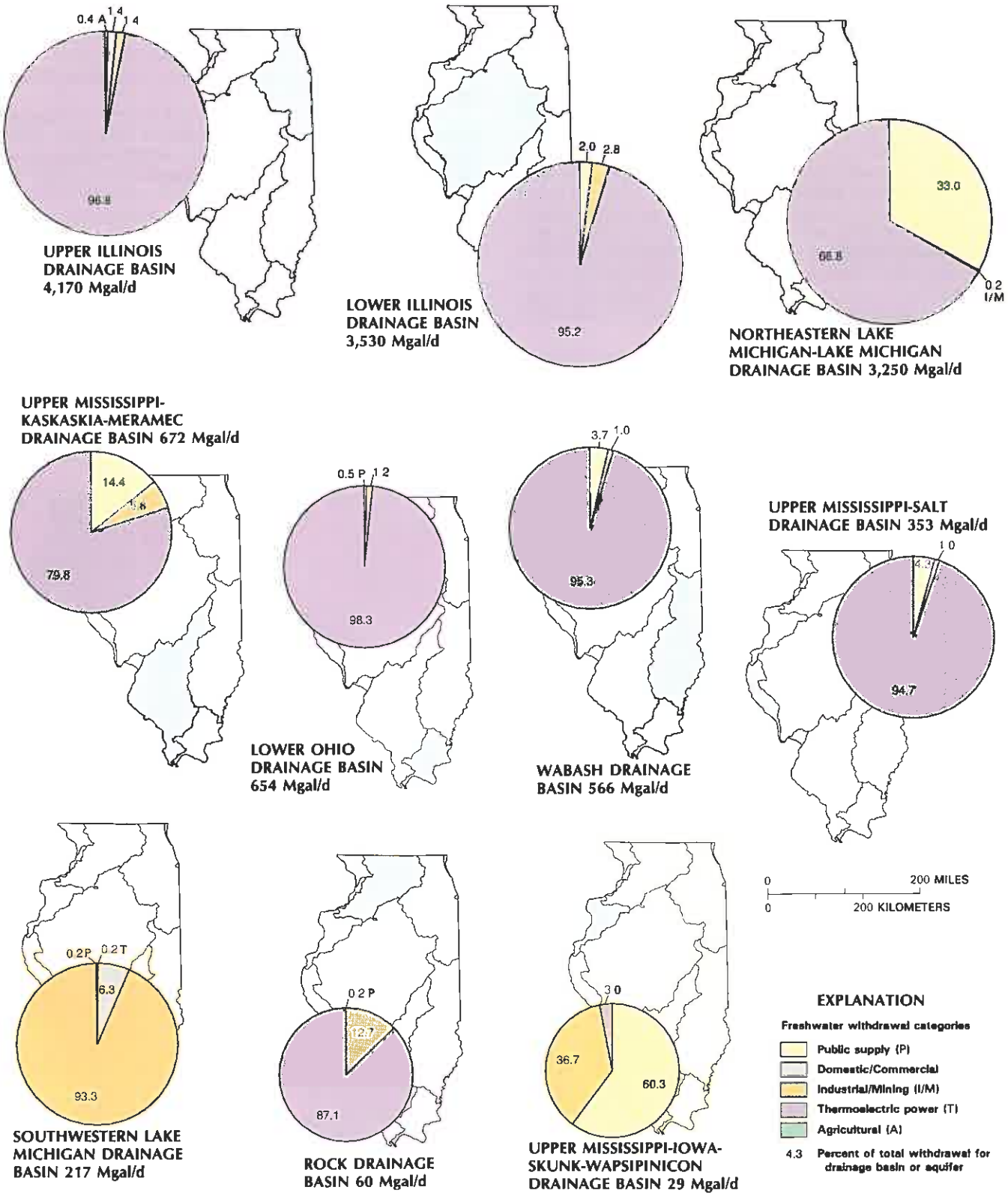
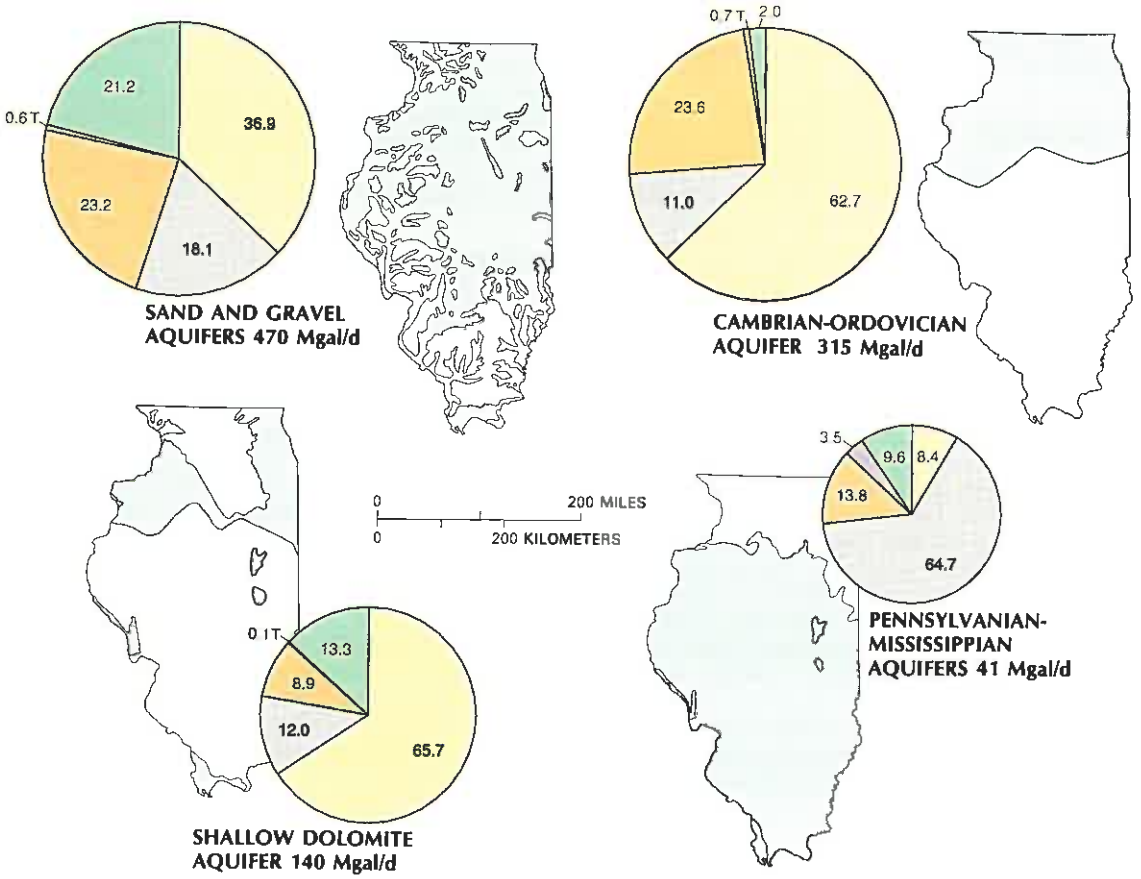


Figure 2. Freshwater withdrawals by county in Illinois, 1985. *A,* Total withdrawals *B,* Surface-water withdrawals *C,* Ground-water withdrawals. (Source: Data from U.S. Geological Survey National Water Data Storage and Retrieval System.)



A. SURFACE WATER

Figure 3. Freshwater withdrawals by category of use and hydrologic unit in Illinois, 1985. *A*, Surface-water withdrawals by principal drainage basin. *B*, Ground-water withdrawals by principal aquifer. Abbreviation: Mgal/d is million gallons per day. (Sources: *A*, Drainage basins from Seaber and others, 1987; data from U.S. Geological Survey National Water Data Storage and Retrieval System. *B*, Compiled by J.R. Kirk, Illinois State Water Survey, written commun., 1987; Illinois Technical Advisory Committee on Water Resources, 1967, p. 70–77).



B. GROUND WATER

Figure 3. Freshwater withdrawals by category of use and hydrologic unit in Illinois, 1985—Continued.

PUBLIC SUPPLY

Public-supply systems deliver water for domestic, commercial, industrial, mining, and thermoelectric power uses (fig. 4). In 1985, about 1,900 systems delivered water to 9.8 million people, or 85 percent of the population. Illinois currently ranks fourth in withdrawals for public supply in the United States (Solley and others, 1988).

A total of 1,780 Mgal/d of water was delivered to users by public-supply systems. Of that amount, 73.8 percent (1,320 Mgal/d) was from surface water, and 26.2 percent (467 Mgal/d) was from ground water. In 1985, about 61 percent of the population was delivered water from surface-water sources compared to 58 percent in 1980. An increase in the population using surface water is a result of declining ground-water levels and degraded ground-water quality in densely populated areas.

Withdrawals by public suppliers in the Chicago and the East St. Louis areas are significant. The Chicago Department of Water supplied 1,040 Mgal/d from Lake Michigan to nearly one-half of the population in Illinois. Domestic and commercial use received 78 percent of this supply. Another 18 percent was delivered to industries primarily for the production of machinery, electrical equipment, and fabricated metals. The East St. Louis area has 25 public-supply systems that provided 76 Mgal/d to 439,000 people. Industries in this area are predominantly oil and ore refineries, chemical plants, and steel plants, which used 27 percent of public-supply withdrawals in East St. Louis.

Conveyance losses from public-supply systems account for 14 percent of the total water distributed (modified from American Water Works Association, 1981, p. 152–153). This amount of water equals that publicly supplied to all industries and mining operations during 1985. Conveyance losses are included in the domestic and commercial use data in figure 4.

DOMESTIC AND COMMERCIAL

In 1985, domestic water use was 980 Mgal/d, of which 850 Mgal/d was publicly supplied (87 percent) and 130 Mgal/d was self-supplied from privately owned wells that obtain water solely from ground-water sources. Public-supplied domestic use was estimated to be 86 gal/d (gallons per day) per capita, whereas self-supplied domestic use was estimated to be 74 gal/d per capita. Self-supplied domestic use ranged from 69 gal/d per capita in western Illinois to 92 gal/d per capita in northeastern Illinois (Kirk and others, 1985, p. 7). Self-supplied domestic use in northeastern Illinois generally is larger than in other parts of the State. Domestic consumptive use in Illinois was estimated to be 97 Mgal/d, which is 10 percent of the total domestic use. The majority of domestic consumptive use is evaporation from outdoor uses, such as lawn watering. Outdoor uses are small because precipitation is adequate; therefore, domestic consumptive use is small.

In 1985, commercial water use was about 578 Mgal/d, of which 107 Mgal/d was self-supplied and 471 Mgal/d was public supply. Consumptive use was 64 Mgal/d, or 11 percent of the total

commercial use. Conveyance losses (205 Mgal/d) in public-supply distribution systems and some public water uses, such as fire fighting, are included in the domestic and commercial use total (1,760 Mgal/d) in figure 4.

Industrial and Mining

Freshwater withdrawals and deliveries for industrial and mining use were 5.9 percent (857 Mgal/d) of total withdrawals (fig. 4). Industries used 790 Mgal/d, and mining operations used the remaining 67 Mgal/d. Of the total industrial use, 535 Mgal/d of freshwater was self-supplied, and 255 Mgal/d was public supply. Self-supplied industries withdrew 385 Mgal/d of surface water and 150 Mgal/d of ground water, whereas mining operations withdrew 53 Mgal/d of surface water and 14 Mgal/d of ground water.

Water used for mining was mostly for oil-field operations. Oil-field operations in southern Illinois withdrew 38 Mgal/d of saltwater. In most instances, the ground water was returned directly to the producing geologic unit. The only known withdrawals of saltwater in the State are in southern Illinois. Freshwater for mining is used primarily to flush oil from oil-bearing strata.

About 47 percent of the total water used by industry and mining (321 Mgal/d of fresh and saline water) was consumed. Industrial and mining freshwater use accounted for 41.3 percent of Illinois' total consumptive use. About 95 percent of industrial withdrawals is used for cooling, which is the largest industrial consumptive use (Illinois Technical Advisory Committee on Water Resources, 1967, p. 99).

The number of industrial facilities in Illinois is larger than in any other State and reflects the importance of industrial activity to the Illinois economy (R.A. Tobias, Northern Illinois University, Governmental Studies Center, oral commun., 1987). Three-quarters of the water withdrawn for industrial use is in the Chicago, the Rockford, the Peoria, and the East St. Louis areas where primary metal, machinery, and chemical industries predominate. The primary metal industries used approximately one-half (249 Mgal/d) of the self-supplied industrial withdrawals, and the chemical industries used 23 percent (J.R. Kirk, Illinois State Water Survey, written commun., 1987).

Thermoelectric Power

In 1985, thermoelectric powerplants withdrew 80.9 percent (11,700 Mgal/d) of the total offstream withdrawals (fig. 4). Of the total thermoelectric withdrawals, fossil-fueled plants used about 68 percent, and nuclear plants used about 32 percent. Most water used by these thermoelectric powerplants is returned to rivers or lakes; about 1 percent is lost through evaporation. Consumptive use amounted to 46 Mgal/d for fossil-fueled plants and 76 Mgal/d for nuclear plants. All the water used for power generation and cooling was from surface-water sources. A small amount of ground water (less than 0.1 percent) was used for employee needs.

The State has 38 thermoelectric powerplants—33 are fossil fueled, and 5 are nuclear powered (J.R. Kirk, Illinois State Water Survey, oral commun., 1987). These plants produced 107,000 GWh of electricity, or 99 percent of the electric power produced in Illinois.

Illinois has been decreasing its dependence on fossil fuels by converting to nuclear power. Consequently, water use by nuclear powerplants is expected to increase significantly as a result of two new reactors scheduled to begin production in 1987. A nuclear powerplant in Lake County is the largest thermoelectric water user

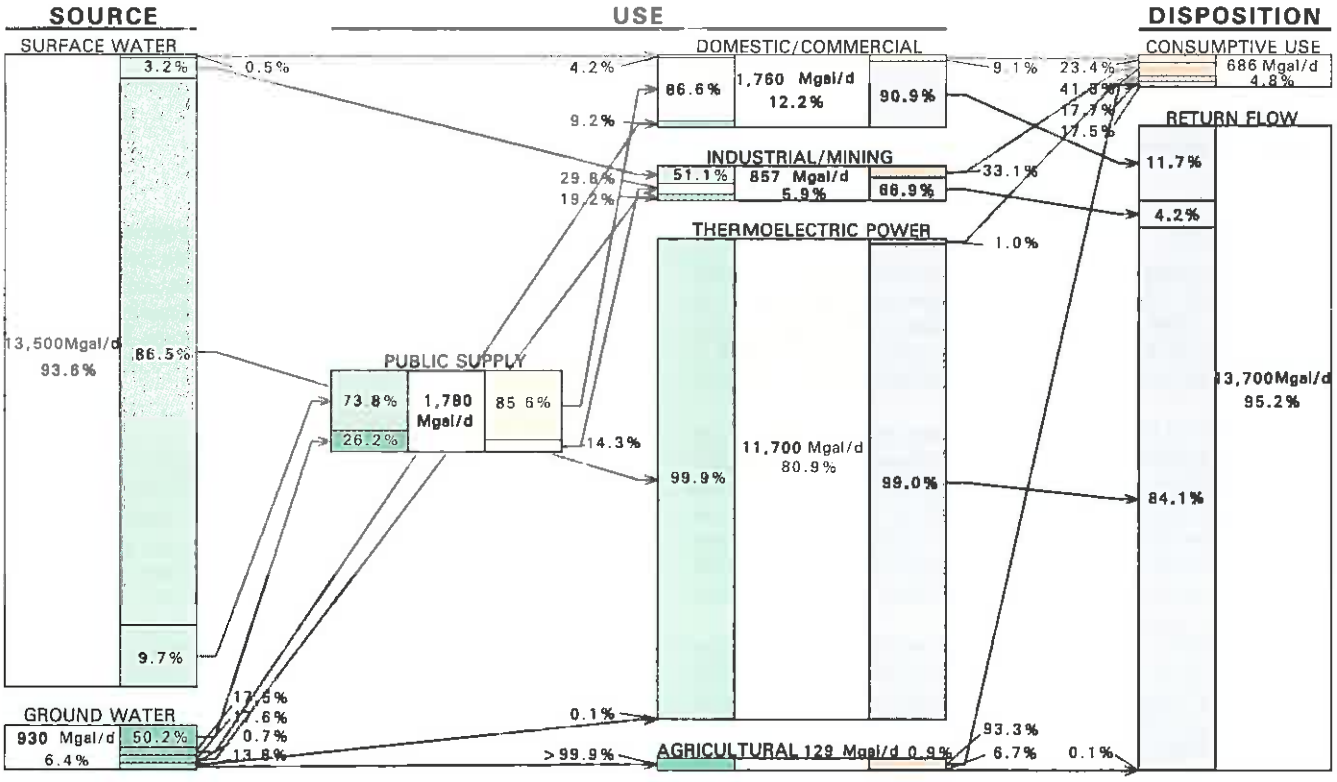


Figure 4. Source, use, and disposition of an estimated 14,400 Mgal/d (million gallons per day) of freshwater in Illinois, 1985. Conveyance losses in public-supply distribution systems and some public water uses, such as fire fighting, are included in the total shown for domestic and commercial use; losses in irrigation distribution systems are included in the total shown for agricultural return flow. All numbers have been rounded and values may not add to totals. Percentages are rounded to the nearest one-tenth of 1 percent (0.1%) between 0.1 and 99.9 percent. Symbol: > means greater than. (Source: Data from U.S. Geological Survey National Water Data Storage and Retrieval System.)

and the third largest water user in the State. Cooling-tower evaporation in Illinois' nuclear powerplants is three times as great as in the fossil-fueled powerplants; therefore, total thermoelectric consumptive use in Illinois also is expected to increase.

AGRICULTURAL

Irrigated acreage has been increasing rapidly but remains insignificant compared to Illinois' total cropland. Since 1978, irrigation withdrawals and irrigated acreage have nearly doubled. Irrigated acreage increased from about 9,000 acres in 1950 to 256,000 acres in 1984 (Kirk and others, 1985, p. 7), yet only 1 percent of the total cropland is irrigated. Crops grown on irrigated acreage include corn (73 percent), soybeans (19 percent), other vegetables (4 percent), and hay (2 percent) (Irrigation Journal, 1987, p. 20–26). Illinois currently ranks third in value of overall crop production (U.S. Bureau of the Census, 1985b).

In 1985, withdrawals for agricultural use, primarily irrigation and livestock watering, totaled 129 Mgal/d and were solely from ground water (fig. 4). As of 1987, about 1,170 irrigation wells obtain water primarily from shallow sand and gravel aquifers (Jean Bowman, Illinois State Water Survey, oral commun., 1987). Seasonal irrigation water use was 56 percent (72 Mgal/d) of the total agricultural use and is an average for the entire year; however, most land is irrigated during the summer. Sprinkler systems are used for most irrigating, and almost one-half are large-volume center-pivot systems.

Irrigation is practiced mainly in the sandy soil regions along the Illinois, the Green, and the Kankakee Rivers. Most irrigation is in Mason County, in central Illinois, which accounted for 34 percent of the total withdrawals for irrigation. Other withdrawals for irrigation were in areas where truck crops, such as melons, tomatoes, and onions, are grown. Consumptive use was estimated to be 100 percent of total withdrawals for irrigation.

Livestock watering was a small part of the total water use and is expected to remain small. In fact, withdrawals for livestock watering (57.2 Mgal/d) have decreased 16 percent since 1980 (Kirk and others, 1982, p. 13). Consumptive water use for livestock watering was estimated to be 85 percent, or 48.7 Mgal/d.

WATER MANAGEMENT

An understanding of water management in Illinois requires recognition of two major factors—water law and the decentralized nature of government. With respect to water law, Illinois is typical of the Eastern States. Surface water is governed by the doctrine of absolute ownership that grants the use of a water body to landowners adjacent to that water body. Although there is no modern test of the law, it is probable that a "reasonable use" of the water also may warrant a water right. Ground-water withdrawals are governed by the same laws. Laws for surface- and ground-water uses are modified and limited by a variety of Federal, State, and local agencies. Despite multiple jurisdictions, few conflicts have arisen, probably because of the abundance of water in the State.

Water management by the State involves all three branches of government, but the Executive Branch, headed by the Governor, is responsible for most enforcement actions. Under the direction of the Governor, programs are integrated by a Cabinet and a Subcabinet on Natural Resources and by the Bureau of the Budget. Two ad hoc committees appointed by the Governor have been important to water-resources management during the past 20 years. The first of these was the interagency Technical Advisory Committee on Water Resources that operated from 1966 to 1968. In 1967, this committee produced the report "Water for Illinois, A Plan of Action." In 1980, the second committee, a State Water Plan Task Force, was appointed to provide policy and program guidance in water-resources management to State and local agencies and to nongovernmental organizations. The Task Force produced annual progress reports and a final report titled "Illinois State Water Plan" in January 1984. Since 1984, the Task Force has produced annual reports dealing with implementation of the State water plan.

Water management is the responsibility of one-half of the State agencies engaged in aspects of water resources. The roles of agencies directly involved in water resources are summarized below.

The Illinois State Water Survey in the Illinois Department of Energy and Natural Resources is the primary State agency concerned with water research, data collection, and data requests. It shares responsibility for ground-water activities with the Illinois State Geological Survey.

The Division of Water Resources in the Illinois Department of Transportation is responsible for protective jurisdiction over public water and regulates construction in rivers, lakes, and streams. The Division allocates and regulates all water diverted from Lake Michigan for Illinois' use and also regulates the sale of water from State-owned multipurpose reservoirs.

The Illinois Environmental Protection Agency, which has a broad mandate to protect the State's environment, protects and regulates public-water supplies. It administers the Federal Clean Water Act, the Resource Conservation and Recovery Act, and the Safe Drinking Water Act. The Division of Public Water Supply within the Illinois Environmental Protection Agency is responsible for protecting the quality and the quantity of public water supplies.

An agency closely allied to the Illinois Environmental Protection Agency is the Illinois Department of Public Health, which regulates activities related to plumbing, well-pump installations, bathing beaches, and private and semiprivate water supplies, such as schools, restaurants, and hospitals.

The Illinois Department of Mines and Minerals acts to prevent pollution of freshwater supplies by oil production, gas production, or saltwater-disposal activities. Permits for drilling water wells and for plugging abandoned wells are required from this Department.

The Illinois Department of Commerce and Community Affairs is the principal State agency dealing with business and local community affairs. It administers various grant and loan programs including those for water-supply facilities. This department also has initiated a program promoting water conservation, particularly at the local level.

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