



ILLINOIS WATER RESOURCES AND USES

Special Report No. 1
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Introduction

To plan the wise use of our water and to solve and anticipate our future water problems, it is necessary to know the quality and quantity of the water resources available to Illinois and what uses are presently being made of them. This special report is intended to give a brief summary of these resources and uses to serve as a basis for resource management. Far more detailed information is available in published reports, in libraries and data banks, and in the files of water agencies. This report contains sections on precipitation, surface supplies, groundwater, water quality, and present uses.

Illinois Water Resources

Water is not uniformly distributed over Illinois, and furthermore, its distribution is constantly changing. It may be available from surface streams and lakes or from groundwater sources. The extremes of flood and drought are of particular concern in water planning.

Precipitation

Precipitation is the original source of all our water and includes both rainfall and snowfall. Snowfall produces about 10% of the average annual precipitation in northern Illinois and only 2% to 3% in southern Illinois.

Variability is the most significant characteristic of annual precipitation in Illinois. The average ranges from a low of 32 inches in the northeast to more than 46 inches in the extreme south. It also varies from year to year, and the 32- and 46-inch averages may vary by as much as 40% in 50 years.

Heavy rainstorms that produce floods may occur at any time, but the frequency of floods is greatest from late spring to early fall. Winter storms of flood proportions are restricted mostly to the southern part of the State. Historically, the most severe rainstorms have occurred in the south-central or southeast portions of the State. Observed heavy storms, for example, on a 1,000 square mile area have ranged from 7 inches in 6 hours to 15 inches in 5 days.

Droughts are difficult to define because critical precipitation deficits and durations vary with such water uses as agriculture or public water supply. However, it can be said that droughts have been observed in all sections of the State and are most frequent in the southern and southwest regions. Usual drought periods vary from 2 to 36 months. Three of the four worst droughts of

record occurred from 1930 to 1936. The droughts of 1953-1954, 1976-1977, and 1980-1981 were the most severe in more recent times. The 12-month drought period that ended in May 1934 affected the entire state, and only 50%-70% of normal precipitation occurred. The 12-month drought period that ended in July 1954 affected only portions of south-central Illinois, which experienced only half of normal precipitation, while the north-central part of the state had normal or above normal conditions.

Illinois's long record of measuring and recording precipitation is valuable because this record is the best guide to what the future will be. However, only about 5% of the moisture flowing over us in the atmosphere results in precipitation, and the possibility exists that through weather modification (cloud seeding) we may some day be able to increase the supply.

Surface Supplies of Illinois Water

Streamflow - In order to predict how much water is available for navigation, withdrawal, and recreation or for carrying treated wastes, it is important to know how much water flows in Illinois streams at various times. Streamflow is recorded at about 150 locations in the State.

The average discharge of streams is equivalent to about 9 inches of water depth over the land surface per year in northern Illinois and about 15 inches in southern Illinois. In many instances, water can be taken directly from a stream, in which case the measurement program is important in indicating the amounts available at various times.

Although water quality is discussed in another section of this report, it should be noted that streamflow is particularly important in determining water quality standards. In issuing treated-waste discharge permits, the lowest flow that occurs in a particular stream on the average of once in ten years (averaged over a week) is used as a measure of the dilution available for treated-waste discharge.

Lakes and Reservoirs - Lakes and reservoirs collect water for subsequent use, and thus, represent an important means of conserving water, while also reducing floods, reducing the impact of droughts, and serving other purposes.

Illinois has a number of large man-made reservoirs--including Rend, Carlyle, Shelbyville, and Crab Orchard--which were constructed for flood control, navigation, and regional development. There also are numerous lakes of intermediate size such as lakes Springfield and Decatur, which are used primarily for municipal water supply. The number of small lakes and farm ponds total more than 80,000. Natural lakes are confined to the northeastern portion of the State and are the result of the last glacial period. Most of these are in the Fox Chain of Lakes region in Lake and McHenry counties.

There are more than 800 sites for additional man-made lakes of more than 40 acres in size. If they were built, they would create the water storage equivalent of a depth of 2.85 inches over the State, in comparison to existing lakes that have an equivalent storage of about 0.5 inches. However, for environmental and other reasons the creation of major lakes has come to a virtual halt. It is probable that additional dams and lakes will be required in the future, but their design will involve constraints that were generally not considered in the past.

A major problem occurring with reservoirs and lakes is an excessive rate of sedimentation resulting from erosion on the watersheds. Sedimentation reduces storage capacity and also contributes to other problems such as eutrophication, which is the over-enrichment of nutrients in water that gives rise to growth of algae and other aquatic weeds.

Lake Michigan - Lake Michigan is the single most important water body available to the State. It supplies water to Chicago and numerous suburbs, as well as providing navigation and recreation. The amount of water that Illinois can withdraw from Lake Michigan is limited by a U.S. Supreme Court decree that is open to review by the Court as circumstances may change.

Extent of Surface Waters - There also are measures of surface waters, other than quality and quantity, which are of particular interest to recreation. These measures are the number of miles of streams and the surface areas of ponds, lakes, and reservoirs. Such information is shown in the following table, which was taken from the Department of Conservation report "1978 Inventory of Illinois Surface Water Resources," dated September 1979.

ILLINOIS SURFACE WATERS

Water Resource Type	Classification	Number	Acres	Total Acres
Lake Michigan (Ill. portion only)		1	976,640	976,640
Reservoir ¹		3	54,580	54,580
Impoundment ²	State	211	29,876	
	Public	631	76,570	
	Organization	1,974	24,808	
	Commercial	505	3,037	
	Private	79,599	107,887	
	TOTAL	82,920	242,181	242,181

Miles

Streams	0-20 ft. wide	4,915	7,195	
	21-100 ft. wide	5,916	29,885	
	101-300 ft. wide	992	17,753	
	301 plus ft. wide	1,379	201,778	
	TOTAL	13,204	256,574	256,574

GRAND TOTAL SURFACE WATER ACREAGE-----1,529,975

¹ The three Corps of Engineers reservoirs - Carlyle, Rend, and Shelbyville.

² Includes all natural lakes except Lake Michigan and all man-made lakes except Carlyle, Rend, and Shelbyville.

Groundwater in Illinois

The topography and the nature of earth and rock materials largely determine the availability of groundwater. The more permeable earth and rock formations serve as aquifers - formations that store and transmit water and allow it to flow into wells.

The northern third of Illinois is more fortunate than the rest of the State with regard to the extent of aquifers of sand and gravel in the shallow glacial material. The northern part of the State also has more aquifers of sandstone and limestone in deeper-lying rock formations.

In the remainder of the State, the only aquifers of high potential water yield are sand and gravel deposits along the Mississippi, Illinois, Ohio, Wabash, Kaskaskia, and Embarras Rivers, as well as the buried Mahomet valley that partially crosses the State just north of Champaign.

In portions of the State that are not underlaid by principal sand and gravel or bedrock aquifers only small yields are available to wells. These yields, however, may be adequate for domestic and livestock purposes and for small communities.

Groundwater is an extremely important resource in the State. Hundreds of municipal and industrial wells take large quantities from aquifers in the northern half of the State. Groundwater also is the predominant source for medium and small communities and is virtually the exclusive source for rural supplies.

The potential for the development of groundwater supplies in Illinois is huge--in the order of 7 billion gallons per day as compared to the approximate one billion gallons per day that was withdrawn in 1980. However, even though present withdrawals are far below their potential for the State as a whole, in the Chicago region the rate of withdrawals from deep sandstone wells is in excess of the rate of water recharge, which means that groundwater levels in these deep sandstone aquifers are declining at the rate of ten feet or more per year. Cost-effective means must be found to shift a portion of this Chicago-area demand to shallow aquifers, where additional supplies exist, or the State must seek further allocations from Lake Michigan. It also may be possible to artificially recharge aquifers in the Chicago region with treated waste water as has been practiced at Peoria with river water for about 30 years. This recharge option is currently under study.

Finally, it is important to realize that we must protect our aquifers from pollution, which is recognized as a growing problem.

Water Quality

Most of the previous discussion of precipitation, surface supplies, and groundwater has been directed to the quantity of available Illinois water. However, water quality is of equal importance. In considering water quality, it is useful to consider natural causes of minerals and trace organics in water apart from man-made pollution - although both are important.

Natural Effects Upon Water Quality - Natural effects upon water quality can be thought of primarily in terms of geologic processes. Water is a solvent and, therefore, as it passes through soil and rock it dissolves mineral matter.

The most common form of dissolved minerals in Illinois waters is referred to by the term "hardness," which results from dissolved calcium and magnesium. Hardness affects the use of soap in cleaning and causes scale to form in plumbing and boilers. Some 88% of public groundwater supplies would be considered hard, with levels of dissolved minerals about 200 parts per million (ppm). In some instances, the hardness is extreme. Fortunately, hardness can be eliminated or reduced in either municipal or home systems at relatively modest cost.

Iron at levels sufficiently high to cause staining is also frequently present in water supplies, particularly in groundwaters. Fortunately, iron also can be removed by methods in general use.

Excessive nitrate levels in water can also be a natural health problem. However, excessive nitrate levels have been increasing, especially in water from shallow rural wells, due to man-made nitrate sources - such as fertilizers. This form of mineralization, however, is not as readily treated. If nitrate levels are present in excess of the drinking water standard of 45 ppm, an advanced treatment process or change to another water source is required.

Less common troublesome, natural constituents are methane gas, fluoride, and radioactivity. Methane gas can be explosive; and health problems can result from excessive levels of fluorides, which occur in about 1% of public supplies, and radioactivity, which is present in a few deep wells.

Considerable data are available to characterize the natural constituents in both surface water and groundwater, and the technology is available to treat most waters to a satisfactory quality for the various uses.

Man-Made Sources of Pollution - In addition to the natural constituents in water, a considerable burden is added from man-made sources. These sources are often thought of as point sources, which originate from municipal and industrial discharges, and as non-point sources, which originate from agriculture, mining, construction, and urban runoff.

Illinois has long had a program of pollution control, and this activity was greatly accelerated in 1970 by the creation of a Pollution Control Board and the Illinois Environmental Protection Agency. National programs have continued to accelerate also, particularly as a result of legislation in 1972. Both the Illinois and national programs reflected a public resolve to improve the quality of our streams, and, at this time, it can be said that an improvement in quality has been achieved in most respects.

The Illinois program for water quality improvement is aimed at achieving water quality that will (1) sustain ecologically balanced streams and lakes, (2) support desirable aquatic life, and (3) protect human health with respect to both public water supplies and water recreation.

Pollution control during the past decade has been directed to point sources through massive waste treatment programs. More recently, we have come to realize that the extent of rural and urban non-point sources of pollution is sufficient to prevent our reaching desirable goals of stream and lake water quality, and this problem is being addressed.

A number of biological, chemical, and physical problems caused by pollution have been of major concern. Among these are bacteria and viruses resulting from inadequate treatment of water following human and animal use. Another major problem has been excessive amounts of organic material, which in the process of decomposing can lower dissolved oxygen levels in streams and lakes to the point that desirable life cannot exist in them. A third problem is the result of large discharges of heated water, largely from electric generating plants, that cause problems by elevating the water temperature and lowering the dissolved oxygen level. More recently, concern has increased with respect to a spectrum of toxic chemicals from industrial and agricultural discharges.

A major remaining, and perhaps increasing, pollutant is sediment carried by our streams. Although erosion and resulting sediment are natural processes, these processes have been greatly accelerated by row-crop farming, mining, construction, and urban runoff. The problem is now well-recognized, and programs are being increased and restructured to address the problem.

Illinois Water Use

To efficiently plan and manage Illinois's water resources, it is necessary to document current water uses. For this reason, the Illinois State Water Survey in cooperation with the U.S. Geological Survey has expanded water use inventory activities to include all water resources in all areas of the State. This data collection system is intended to (1) document the State's total water use; (2) assist in coordinating the management of groundwater resources in the northeastern part of the State, where a major groundwater resource system is currently being "mined" (withdrawn faster than recharged); (3) expedite the exchange of water use information to the benefit of other state agencies; (4) enable researchers to compile data necessary for identifying various regional water use patterns; and (5) facilitate planning the most effective use of Illinois water resources for the economic and social well-being of the people of Illinois and the rest of the nation.

Information on water use in this report is taken from the report "Water Withdrawals in Illinois, 1980," compiled by the Illinois State Water Survey. Reports similar to this 1980 study and another compiled in 1978 are expected to continue in a water use inventory program that will show changes in quantities of water used; indicate trends in use; and provide the basic data required for establishing water budgets, developing water use plans, and evaluating watershed and aquifer systems. (In the past, most reports on water use only have emphasized the regions where water resources are extensively developed or have surveyed withdrawal by a major user category.)

The following table summarizes water use in Illinois for 1980 according to various source and use categories. It can be noted that the total withdrawal is far greater for surface water uses and that these large

withdrawals are predominantly in the category of self-supplied industry. Much of this water was used for cooling of thermoelectric power generation.

SUMMARY OF TOTAL WATER WITHDRAWALS, 1980
IN MILLION GALLONS PER DAY

Category	Groundwater	Surface Water	Total
Public water supplies	475	1,313	1,788
Self-supplied Industry	226	40,314	40,540
Rural	312	0	312
Fish and Wildlife	4	26	31
Total	1,017	41,653	42,671

The term "water withdrawals" designates water that is taken from a groundwater or surface water source and conveyed to the place of use. Water that is used more than once through recycling is counted only once in the table. Nonwithdrawal uses are not included in the table.

In Illinois "public water supplies" are defined as systems or wells that furnish water for general domestic use in incorporated municipalities, in unincorporated communities where ten or more separate lots or properties are being served or are intended to be served, and for state-owned properties and institutions. Public water supplies serve domestic, commercial, and industrial users.

If a public supply is either not available or not used, the water is "self-supplied." Individual families and small communities not served by a public water supply system are categorized as "rural" with regard to water use. Industries and commercial establishments using their own water source facilities are categorized as "self-supplied industry."

Water used to generate hydroelectric power is also included as a withdrawal use in this report because of its diversion through powerplants.

Water use data are reported as the average daily quantities, usually derived from the annual use. The use is expressed in million gallons per day.

The report "Water Withdrawals in Illinois 1980" contains considerably more detail than is cited here, including categories by county, districts, river basins, and standard metropolitan statistical areas.

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