CIRCULAR 73

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WATER *resources of Illinois*

by Shirley Miller Bartell

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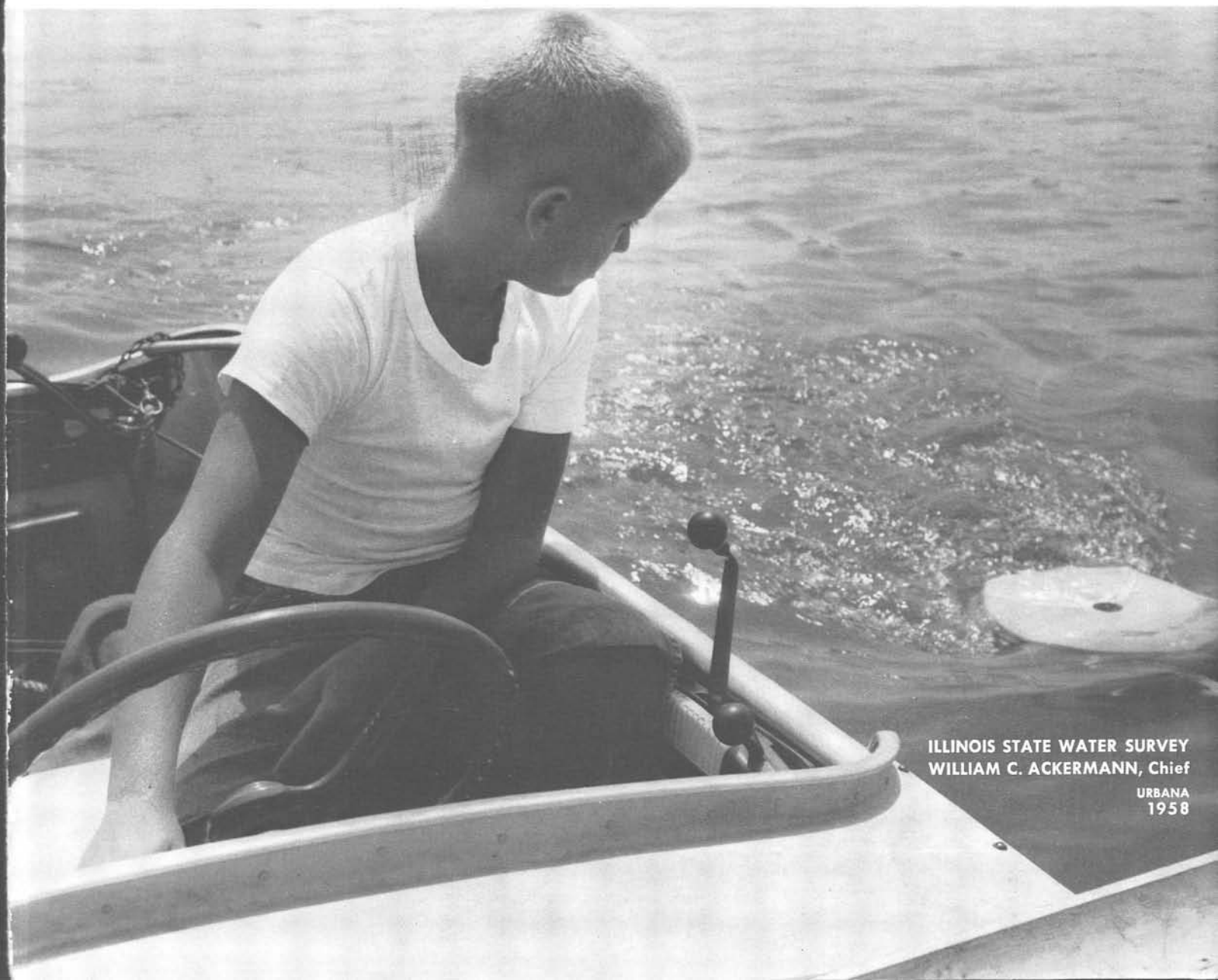


ILLINOIS STATE WATER SURVEY
WILLIAM C. ACKERMANN, Chief
URBANA
1958

WATER is so common in our everyday life that we sometimes forget how necessary it is to our existence.

Scientists believe that life itself originated in water, that is, the seas of long ago. We know that without water, just as without air or sunlight, we could not live. Our bodies are composed largely of water that must be continuously replenished. Our food is mostly water, and it is in the air we breath. As a cleansing agent and a carrier of wastes, water helps keep us healthy.

Water has played an important role in shaping the land we know and love today. It helps level mountains into hills and plains; pushes rock and debris before it to form valleys, rivers, and lakes; and then works unceasingly to modify these changes. It helps grow the trees, flowers, and plants which beautify our land and provide our food. It makes possible most of our forms of recreation from skiing and ice skating to boating, swimming, and fishing.

Man has turned this natural resource into power to light our homes and cook our food. He has used it for power to run trains and great factories and mills, as well as for transportation on rivers, lakes, and oceans. In many parts of the West, where there is very little rainfall, arid land has been changed by irrigation water into splendid green fields and farms.

All living things begin with water and are constantly being renewed by water.

water cycle in Illinois

Among all the states, Illinois enjoys an enviable position with regard to its natural, fresh water resources. Any ordinary map of Illinois will show that the state is almost an island surrounded by fresh water. Along the western border flows the nearly inexhaustible Mississippi River which carries enough water to supply the needs of the entire country. To the south is the Ohio River which is the second largest in the country in terms of stream flow, that is, the amount of water it carries. To the east is the Wabash River and along the northeast border is Lake Michigan which supplies Chicago, the second largest city in the country. Illinois normally enjoys an abundant rainfall, and underlying much of the state is a vast supply of ground water.

Where does our water come from and why does it not become depleted? Primarily, the source of all water is the large amount of moisture in the atmosphere. The great mass of this moisture is constantly forming from the oceans and being carried upward and out over the land areas. When this water-laden air is lifted, either by colder air or by hills or mountains, the moisture condenses, forming water drops. When the drops are big enough, they fall as precipitation. Precipitation can be in the form of rain, dew, snow, or hail which will evaporate once more into the atmosphere or renew water resources on the earth. This series of processes is known as the water cycle. Scientists call it the hydrologic cycle.

A diagram of the water cycle, as it applies to Illinois, appears on this page. It shows what happens to water that falls as precipitation. This water may soak into the ground to become well water, may be used by growing crops, may be utilized by man for his various needs, or may run off into rivers and streams. A very large amount evaporates directly back into the atmosphere from vegetation as well as lakes and streams.

To understand the water cycle, it is helpful to begin at one stage in the cycle and follow the several processes until we return once more to the same stage.

Each day vast quantities of moisture pass over the United States. In Illinois, it is estimated that 2,000

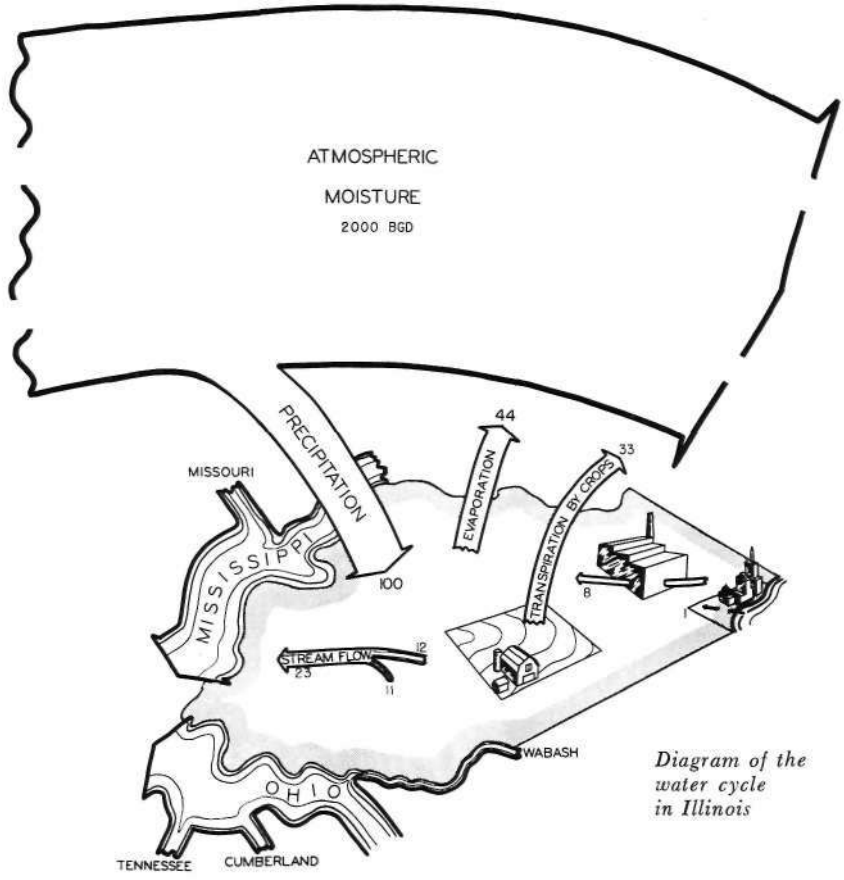
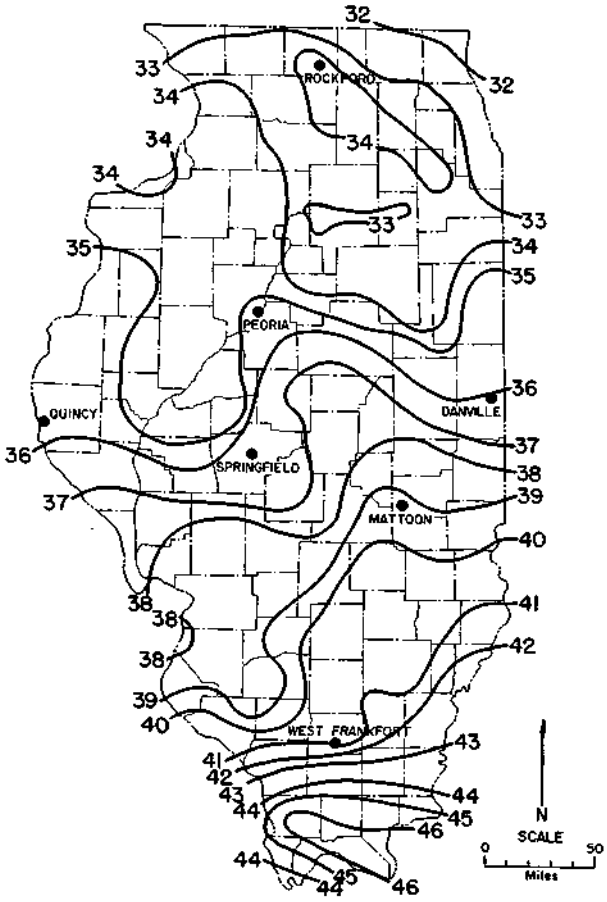


Diagram of the water cycle in Illinois



Average annual precipitation in Illinois, based on U. S. Weather Bureau records

billion gallons of moisture on the average flow daily over the state. Of this amount, about 5 per cent or 100 billion gallons per day reach the earth as precipitation.

Of the total daily precipitation, it is estimated that nearly one-half or 44 billion gallons return directly to the atmosphere from the land and the streams and reservoirs. This process is called evaporation.

About one-third of the total daily amount or 33 billion gallons are used in the growing of crops, that is, water is absorbed by the roots after which it passes into the atmosphere through the leaves. This process is known as transpiration.

Of the remainder or about 23 billion gallons daily, the greater part flows out of the state in the Mississippi, Wabash, and Ohio Rivers. This water, which leaves the state in streams and rivers, is called surface runoff or stream flow, and eventually it reaches the Gulf of Mexico where once again it will evaporate and become precipitation.

The amount of water used by the citizens of Illinois for their household and industrial needs, about 9 billion gallons daily, is included with stream flow, as most of this water is not consumed but only used and then returned to rivers and streams.

The amounts of water which are stated on the diagram of the water cycle in Illinois are approximate. Evaporation from the land, for example, cannot be measured exactly, but it is estimated on the basis of rainfall and stream flow which can be measured. Moreover, the amounts of water which occur at different stages in the water cycle affect one another, that is, if heavy rainfall occurs the stream flow will be greater.

Each process also varies in degree with the seasons. For example, in Illinois during the six months beginning in April, transpiration plus evaporation is greater, mainly because this is the season when more rain occurs, temperatures are higher, and crops are growing. From about mid-September until the end of March, crops are not growing and more water can soak into the ground to restore the soil moisture and replenish the ground-water storage.

precipitation

The immediate sources of water supply — the streams and reservoirs and most of the water from wells and springs — are constantly renewed by rain and snow. In Illinois the precipitation, in yearly amounts, averages from about 46 inches in the south to about 32 inches in the north.

On this same page is a special map showing average yearly precipitation in Illinois. The lines, which are called isohyetal lines, were determined by studying weather records over a long period of time. For this particular map, 50 years of records from U. S. Weather Bureau stations in Illinois and bordering states were used.

The averages of the amounts of precipitation were plotted on the map at the location of the station at which the record was taken. Next, lines were drawn connecting adjacent stations having the same amounts. In this way, lines were formed which show generally the amount of rain and snow to be expected in an average year at any certain location.

Precipitation maps, such as this one, are important to engineers who design culverts, bridges, and municipal water-supply systems as well as to farmers and others interested in agriculture. Maps similar to this one often appear in daily newspapers. Usually these maps are more inclusive, providing additional weather information, and often they represent records from a shorter period.

streams

The Illinois River is the largest within the state. Other main rivers, as shown by the map on this page, are the Rock, the Fox, the Kaskaskia, the Sangamon, the Embarrass, and the Big Muddy.

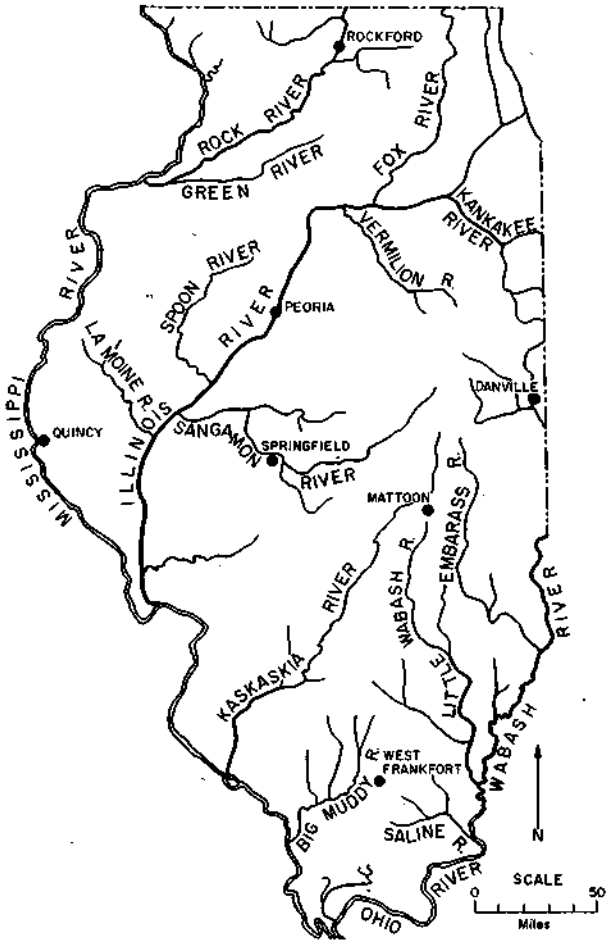
A larger and more detailed map of all surface water resources of Illinois would reveal that the state is veritably webbed like a leaf with its many rivers and streams. Some of these streams are large enough that towns can pump water directly for their use. Some vary in the amount of water they carry to the extent that reservoirs must be built to store water for use during dry periods when stream flow is low. Other streams do not carry enough water to serve to any degree as a source of public water supply.

underground water

Not shown on ordinary maps are important underground supplies. The special map of Illinois on the next page shows generally where underground water may be found.

From earth science lessons, it may be recalled that beneath the surface of the earth, rock and soil material occur in strata, that is, layers like a sandwich. These layers are not the same everywhere. Owing to tremendous physical changes on the earth's surface, partly due to forces inside the earth, the layers have at times been made to sink or to rise or to fold, thus helping to form valleys and hills and mountains. In many places where the earth has been eroded, the layers are exposed for examination. From studying these strata where they have been exposed naturally or where deep wells have been drilled, scientists have learned a great deal about the history of the earth and also what happens to water when it is absorbed into the ground.

It has been found, for example, that water penetrates the ground, seeping between soil particles or into porous rock until it reaches impervious or solid

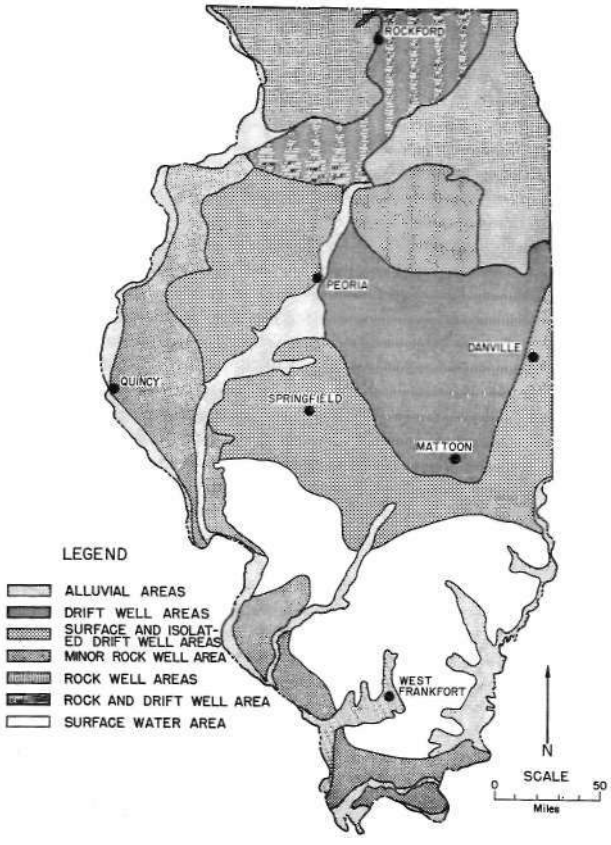


Major streams in Illinois

rock and can go no farther. It then collects and fills in between the soil particles above the solid rock. The top of the zone where water has collected underground is known as the water table, and this level may be at the surface or many feet below the surface of the ground. If the water level rises to the surface of the ground or above, we have a marsh or swamp.

Sometimes water may find its way into a layer of sand or porous rock beneath the surface, and it may travel through this subterranean layer for many miles. If the layer is exposed to the surface, the water may emerge as a spring or flow into a stream. In this case, the underground source plays an important role in the water cycle by contributing some of its water to streams.

Where the layer is not exposed to the surface, it is possible for large amounts of water to collect. If the



Sources of underground water in Illinois

water collects under great pressure and a well is drilled, it may be forced up without pumping, thus making an artesian well. If a well is drilled into an extended layer of soil material that is also inclined, it may produce water that once fell as rain many miles away and, sometimes, many hundreds of years ago.

From the map of underground sources of water, it can be seen that in large areas of northern and central Illinois water is obtained from sources which do not appear to occur in southern Illinois.

Actually, similar rock and soil material is beneath the surface throughout Illinois. But the rock layers which produce large quantities of good water in the northern part of the state are too deep in southern Illinois to be useful and the water they contain is highly mineralized.

Drift is glacial material or sand and gravel which were deposited in the state during the Ice Ages. These sand and gravel deposits are thick in northern Illinois, as more glaciers advanced across this part of the state. Because they easily absorb and yield water, they are the source of many wells producing very large amounts of water.

The drift or glacial deposits are thinner in southern Illinois or, in many areas, are absent. Therefore, the soil is less capable of storing water underground. As a result, in this part of Illinois there are fewer water wells generally, and the amount of ground water that finds its ways into streams is also less.

wells

Water wells are usually named according to the type of soil or rock into which they are drilled. The type of soil or rock determines also the amount of water a well can produce. Sand-and-gravel or drift wells, the type constructed into glacial deposits, sometimes yield water in quantities exceeding 1000 gallons per minute.

Rock wells are those drilled into rock that is pervious or capable of receiving and storing water. They are often high capacity wells producing as much as 1500 gallons of water per minute. The rock is either sandstone, which is porous having water within like a sponge, or non-porous limestone which contains cracks or "solution" channels that hold the water. Ordinarily, wells drilled into sand and gravel and some rock wells require special construction, including a screen that will keep out small soil particles, allowing the water to seep through and be pumped out for use.

It can be seen readily by comparing the maps of streams and underground sources of water that the so-called "alluvial areas" occur along the courses of major streams. As the name implies, for it comes from the Latin word meaning "to overflow," alluvium is a type of soil that was deposited by running water, either many years ago by glacial meltwater or by flood water. These alluvial deposits may also be extremely productive of water since, like the glacial outwash deposits, they may be highly permeable and often absorb water from the stream nearby.

Another source of ground water is the buried valleys, which contain sand and gravel and are to be found at many locations in the state. For example, the water supplies at Paxton, Urbana-Champaign, and Mahomet are obtained from deep wells, some to a depth of 300 feet, drilled into an ancient buried river valley known as the Mahomet-Teays Valley. At one time, before it was covered by glacial deposits, this ancient river had its source approximately in

West Virginia and flowed westward into Illinois. Today, along its former course, are a number of wells that yield extremely large amounts of water from the buried sand and gravel deposits.

reservoirs and lakes

The areas in southern and western Illinois, indicated as "minor rock" on the map of underground sources, produce water usually in amounts sufficient only for household or domestic use. In these areas and the so-called "surface water areas," it has been necessary generally to develop storage reservoirs for obtaining large supplies of water. Fortunately, the hilliness of southern Illinois and the greater amount of rainfall that occurs are especially favorable for the construction of reservoirs.

There are more than 500 man-made lakes or reservoirs throughout the state which serve as the source of a public water supply, and there are many hundreds of smaller lakes and farm ponds. The largest of these artificial lakes is Crab Orchard Lake near Carterville in southern Illinois. Completed in 1940, this lake, which is a recreation and conservation lake as well as source of public water supply, is approximately nine miles long. It averages a mile in width and holds nearly 21 billion gallons of water.

Because the city of Chicago represents about one-half the population of the state and its water supply comes from Lake Michigan, this natural lake supplies a greater number of people than any other source in Illinois. However, on the basis of the number of water systems, approximately five out of six or about 80 per cent of the public water systems in the state obtain water from the ground.

composition of water

Water is unlike any other liquid in its behavior and properties. Pure water has a faint blue tint; it has no taste or smell and is transparent. At 32 degrees Fahrenheit, water becomes a solid called ice, and at 212 degrees it becomes a gas called steam.

Water is unique in that it is lighter as a solid than as a liquid, and therefore ice floats on top of water. If water did not have this property, lakes would freeze from the bottom up and fish life could not survive from one season to the next.

As a chemical compound, one molecule of water is composed generally of two atoms of hydrogen and one atom of oxygen. In recent years, scientists have learned that water contains minute quantities of other atoms. These atoms are similar to hydrogen but differ in certain of their properties. They are known as tritium and deuterium. Water containing deuterium is known as "heavy water," although it weighs scarcely more than ordinary water.

Heavy water is used in special chemical processes. Tritium is believed to be formed in the atmosphere from cosmic rays and is present in rain or snow in extremely small amounts, but after a number of years it disappears. Therefore, the absence or presence of tritium has become a valuable means of determining the age of water or of substances containing water. Water from a well at Champaign, tested by this method, was found to be more than 50 years in age, that is, it had been more than 50 years since the water fell as rain.

water treatment

Water as it is taken from a natural source, that is, a river or lake or well, is called "raw" water. Raw water may sometimes be suitable for human use, but

Water-level recorder measures amount of water that a reservoir contains

Highly sensitive instruments are used to measure natural radioactivity in Illinois waters

ordinarily it must be treated to remove any harmful bacteria or unwanted minerals.

Among the undesirable minerals are those causing water hardness. Everyone has noticed that in some water a grey scum forms when soap is used. When this kind of water is boiled in the same pan a number of times, it leaves a scale or deposit. The scum and the deposit are caused by certain minerals, and water that contains these minerals is known as "hard" water. When they are removed or made inactive, the water is "softened."

Some minerals in water can result in costly repair bills. They are the ones that take part in causing clogged water pipes, "rusty" water, stained clothes in laundering, or stained porcelain fixtures. Proper treatment of the water can eliminate these difficulties.

The type of treatment that is necessary for any raw water depends upon the intended use of the water. Treatment of water for drinking or household use, for example, can differ greatly from treatment for use by an industry.

Sometimes the word "quality" is used to describe a water source, and it refers to the kinds of minerals and substances that the water contains. When water is treated, its quality is changed or improved.

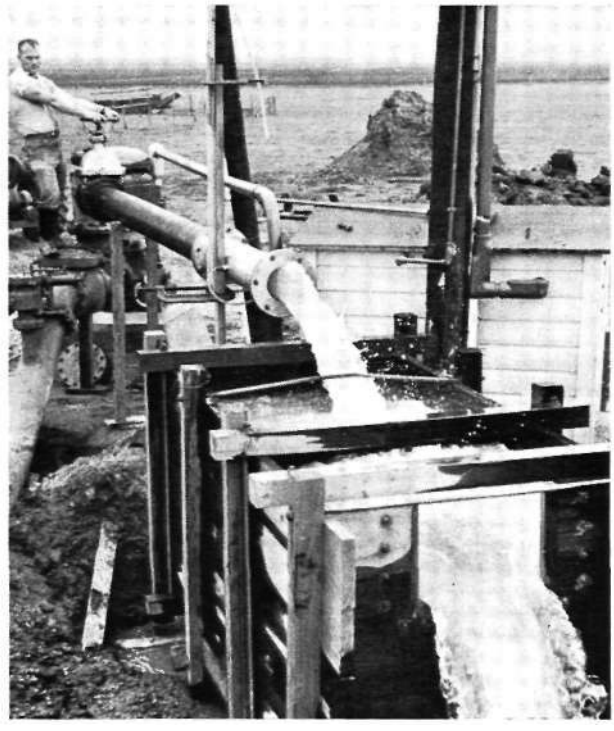
For the public water supply of one town in Illinois, raw water is pumped from a river into a treatment plant where the solid materials are first removed. Lime and soda ash are next added to soften the water, and activated carbon is added to remove any undesirable color or odor. The water is then allowed to settle before being filtered, and it is next chlorinated to destroy disease germs. Finally, it is pumped into a clean storage reservoir and from there into the public water-supply system.

From this one example, one can appreciate that considerable care is taken to assure pure water of good quality for public use. An interesting trip might be a visit to the water works company in one's own town to learn how the water supply is treated.

After learning the many steps involved in operating a public water-supply system, one can better understand that when people pay for water they are paying for a service rather than a product. In other words, they pay for the cost of having clean, pure water delivered to faucets in their homes day and night and for the upkeep of the water delivery system, rather than for the water itself. A public water-supply system makes possible fire protection and this is one of its most important services.

water use

The water resources of Illinois were described earlier — the generous rainfall and underground sup-



An engineering well test indicates the amount of water a well can produce

ply and the many reservoirs, rivers and streams. From this description one would surmise that there is adequate water in Illinois for all needs. But having sufficient water when and where it is needed sometimes depends upon factors over which we have very little control.

Rainfall in Illinois, for example, varies greatly throughout the state, from north to south and from year to year. The underground supply is not the same everywhere. Having an adequate water supply is affected also by changing patterns of use of water in homes. There are more households today than formerly, and in each of them more water-using appliances are being installed.

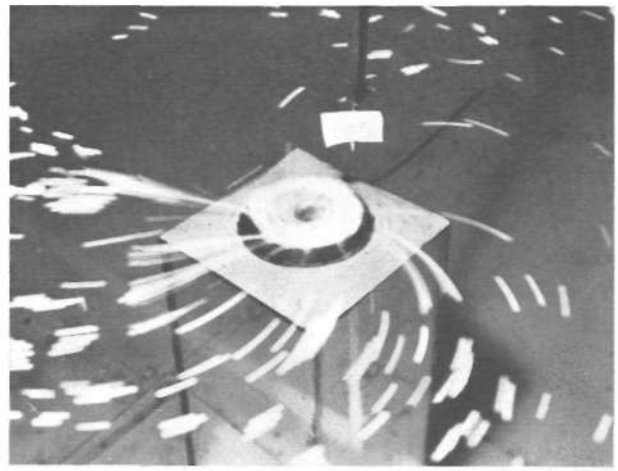
New industries have been developed, requiring large amounts of water. Often water of a certain quality or mineral content may be needed at a location where it is not available. Other factors relating to the problem of adequate water supply are increase in population, growth of industries, and concentrated use of water at some locations in the state such as East St. Louis, Peoria, and Chicago.

For all these reasons, therefore, water may not always be where it is most needed or wanted. In recent years, due mainly to a large increase in population since 1940 and to the greater number of uses of water, there has been considerable discussion of the need for water conservation.

Measuring amount of sediment at the bottom of a water-supply reservoir

water conservation

One ordinarily thinks of conservation as guarding what one has, using it sparingly and eliminating waste. This definition applies as well to water resources. It is highly important to guard and protect the amount and the quality of the water resources we now enjoy so that they will not become less useful.



Bits of paper are used to study surface flow of water into model spillway

Every citizen can assist in safeguarding our precious water resources. Everyone, young and old, can help in keeping our streams, lakes, reservoirs, or underground water clean and pure. Adults can cooperate with local governments when new supplies are to be developed or when waste waters should be treated to prevent stream pollution.

Because the water cycle exists, water is one of the few natural resources which can be renewed. Conservation of water may therefore have the additional meaning to seek ways to increase the usefulness of our water resources. To discover these new ways, the most valuable tool has been scientific research.

Knowledge that is gained from research can be applied in many ways to assist in the renewal of water resources. It can be used in constructing reservoirs, locating or replacing ground water storage, improving the quality of ground and surface supplies, and learning new methods to develop sources of water or improve the present ones.

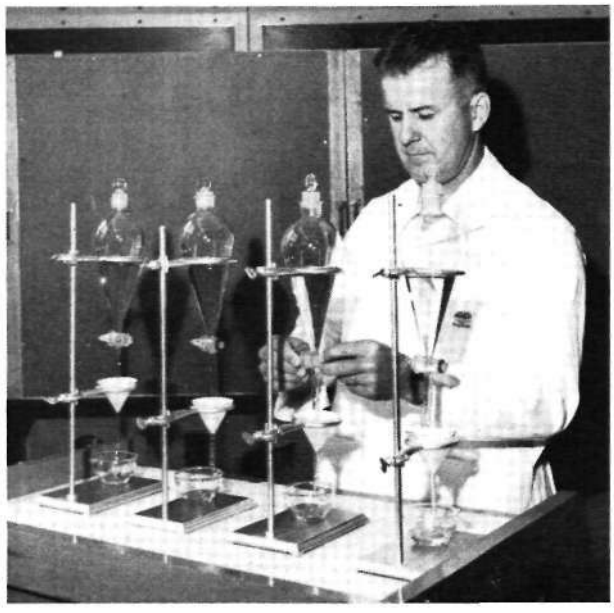
water resources research

It was early acknowledged in Illinois that water resources might not always be ample in all parts of the state in view of growing population and industry. For this reason, gathering scientific facts about the quality and amount of water resources was recognized as an important factor in the growth of the state. To serve this need, the Illinois State Water Survey was established. As a result of investigations by the Water Survey since 1895, Illinois probably has better records of its water resources than any comparable area in the world.

Upon request, the Water Survey provides mineral analyses of samples of water from any location in the state. Individual reports on the amount and quality of ground water that may be available at any location are prepared for the use of consulting engineers, well drillers, municipal officials, and private citizens. This service is also provided without charge.

Besides these services, the Water Survey conducts research into many aspects of water supply, so that scientific knowledge of our water resources may be used in solving water-supply problems. Following are some current research projects.

Each year, as a result of water corrosion or rusting, many miles of water pipes in homes and public supply systems deteriorate, and this problem is currently under study. Other research in chemistry is concerned with finding improved ways to treat or analyze water.



Testing water for minerals in chemistry laboratory

Radar is newest tool used to study rainfall

At Peoria, the Water Survey is studying ways to replace ground water where it is being used in amounts too great to be replenished naturally by rainfall. This research is concerned with filtering treated water through pits into the ground and studying the results.

Eroded soil material called sediment is the principal contaminant of many streams today. Sediment costs millions of dollars when it must be removed from dirty water to make it usable or when it settles at the bottom of reservoirs, reducing the storage space for water. Measuring and studying sediment is an important research activity.

Another investigation is devoted to finding an economical design for drop-inlet spillways on dams. These structures are used on the many hundreds of small reservoirs and farm ponds which are constructed each year in Illinois.

Earlier, it was mentioned that a vast quantity of water falls each day in Illinois, about 100,000,000,000 gallons on an average. The fact that this large sum is only about five per cent of the amount drifting past in the atmosphere represents a real challenge to research. And some day, if the demand for water becomes great enough, studies in meteorology at the Water Survey may possibly lead to "tapping" this great reservoir of moisture in the sky.

Cover shows James Keating of Lakewood, Illinois, who assisted Water Survey engineers and local officials and made available his boat for an experiment in reducing evaporation at Crystal Lake. Frequently, more water evaporates from a water-supply reservoir than is used for human needs. For this reason, the Water Survey is investigating ways to reduce evaporation by means of a non-toxic chemical film spread over the water surface.

Illustrations were obtained from:

Robert Heller: p. 10 lower left
Bob McCandless, Urbana Courier: p. 8 lower right
Ed McCauley: p. 10 upper right
Joe Stocks: p. 2, p. 8 upper left
Wyndham Robert: cover, p. 7
John Stall: p. 9 lower left

The technical information was obtained largely from staff members of the Water Survey. Appreciation is expressed to them for their cooperation and to William C. Ackermann for his review of the manuscript. This brochure was designed and written by Mrs. Shirley Miller Bartell, Technical Editor of the Water Survey, in response to numerous requests from school children and others for information on the water resources of Illinois.

Other state agencies concerned with the water resources of Illinois are: State Department of Public Health, Springfield, for sanitary drinking water and water pollution; State Division of Waterways, Springfield, for levees, flood control, and drainage districts; and State Geological Survey, Urbana, for geology of well water sources.

Additional individual copies of this brochure are available upon request to the State Water Survey Division, Box 232, Urbana, Illinois.

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