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BEDROCK AQUIFERS OF NORTHEASTERN ILLINOIS

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ABSTRACT

Ground water is obtained from four aquifer systems in northeastern Illinois—glacial drift, shallow bedrock, and two divisions of the deep bedrock. The main water-yielding unit of the shallow bedrock aquifer system is the Silurian dolomite; the main water-yielding units of the deep bedrock aquifer systems are the Glenwood-St. Peter (Ordovician), Ironton-Galesville (Cambrian), and Mt. Simon (Cambrian) Sandstones.

This report presents data on the thickness and distribution of the main water-yielding units in the shallow and deep bedrock aquifer systems. The maps and data are intended for use by well drillers and engineers concerned with ground-water development from the various aquifers and by local and regional organizations concerned with planning the use of the area's ground-water resources.

INTRODUCTION

This is the first of two reports on the aquifers of the Chicago metropolitan area, consisting of Cook, DuPage, Kane, Lake, McHenry, and Will Counties in northeastern Illinois (fig. 1).

Four major aquifer systems, separated on the basis of hydrogeologic properties and source of recharge, are present in the area (fig. 2). They are the glacial drift aquifer system, the shallow bedrock aquifer system, and two deep bedrock aquifer systems—the Cambrian-Ordovician and the Mt. Simon. The latter were previously defined as the Cambrian-Ordovician and Mt. Simon Aquifers (Suter et al., 1959, p. 19 and 40).

The glacial drift aquifer system is restricted to the unconsolidated materials overlying the bedrock. This system is the subject of a report now in preparation.

The shallow bedrock aquifer system consists of those bedrock units that commonly directly underlie the glacial drift and are recharged locally from precipitation. The major units in this system are the Silurian age dolomite, which yields most of the water, and the Maquoketa Group, which underlies the Silurian dolomite and separates the shallow bedrock aquifer system from underlying deep bedrock aquifer systems.

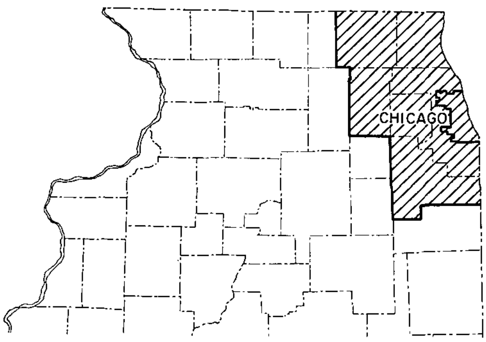


Figure 1 - Study area of northeastern Illinois.

The deep bedrock aquifer systems—Cambrian-Ordovician and Mt. Simon—receive recharge where they crop out at the surface or where they immediately underlie the glacial drift to the west and north. In addition, they gain some water from downward leakage through the Maquoketa Group (Walton and Csallany, 1962, p. 12). The upper unit of the deep bedrock aquifer systems is the Galena-Platteville Dolomite; the base of the lower unit is the top of Precambrian crystalline rock. Rocks of lower permeability in the upper and middle parts of the Eau Claire Formation separate the two deep bedrock aquifer systems. Three major sandstone aquifers are present in the two deep bedrock aquifer systems—the Glenwood-St. Peter, the Ironton-Galesville, and the Mt. Simon.

In northeastern Illinois, ground water is obtained from three major sources (Sasman, 1965, p. 1): glacial drift aquifers, shallow dolomite aquifers (corresponding to the shallow bedrock aquifer system), and deep sandstone aquifers (corresponding to the deep bedrock aquifer systems). Based on the total pumpage in 1962, the contribution of each source is 11 percent from glacial drift wells, 37 percent from shallow dolomite wells, and 52 percent from deep sandstone wells. Leakage from the shallow dolomite aquifers constitutes approximately one-fourth of the pumpage from deep sandstone wells (Sasman, 1965, p. 1).

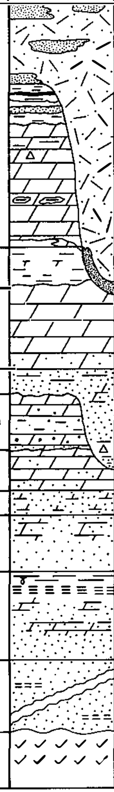
Wells finished in shallow dolomite aquifers furnished water for 79 municipalities in 1962, with Chicago Heights, Downers Grove, Glen Ellyn, Hinsdale, Homewood, LaGrange, Park Forest, and Wheaton (fig. 3) each pumping more than one million gallons per day (mgd) (Sasman, 1965, p. 15). Deep sandstone wells supplied—at least in part—60 municipalities in 1962, 16 of which pumped more than 1 mgd, with the largest production in the cities of Aurora, Des Plaines, Elgin, and Joliet (Sasman, 1965, p. 25).

Surface-water supplies in northeastern Illinois are limited entirely to those pumped from Lake Michigan. In 1963, Lake Michigan served 90 and 54 percent of the population of Cook and Lake Counties, respectively, which constitutes 76 percent of the population of northeastern Illinois (Sheaffer and Zeizel, 1966, table 13). DuPage, Kane, McHenry, and Will Counties, however, do not use Lake Michigan water and are wholly dependent on ground-water supplies.

Ground-water pumpage has increased from an average rate of 9.2 mgd to 202.2 mgd from 1880 through 1962. This is an average annual rate of increase of 2.3 mgd. Between 1950 and 1962, the average annual rate of increase was 5.8 mgd (Sasman, 1965, p. 1).

The basic geologic data for this report have been gathered over a period of years by the Illinois State Geological Survey. Additional data were gathered during

SYSTEM	SERIES	MEGA-GROUP	GROUP OR FORMATION	GRAPHIC LOG	THICKNESS (FEET)	DESCRIPTION	AQUIFER SYSTEMS	
QUATERNARY	PLEISTOCENE				0 - 400 +	Unconsolidated ice- and water-laid deposits, pebbly clay (till), silt, sand and gravel, generally discontinuous and interbedded; alluvial silts and sands commonly present along streams.	Glacial drift aquifer system	Sand and gravel beds serve as aquifers. Some wells yield more than 1000 gpm. Large supplies of water available from thick, relatively continuous sand and gravel deposits.
PENNSYLVANIAN					0 - 175	Shale; sandstones, fine grained; limestones; coal; clay.	Shallow bedrock aquifer system	Fractured beds yield small supplies locally.
MISSISSIPPIAN* DEVONIAN; SILURIAN	NIAGARAN				0 - 400 +	Dolomite, very pure to very silty, cherty; shale partings; thin shales and argillaceous beds frequently present in lower parts of Silurian dolomite.		Not consistent; some wells yield more than 1000 gpm. Crevices and solution channels more abundant near bedrock surface.
	ALEXANDRIAN				0 - 165	Upper and middle units—shale, light gray to green, plastic to brittle, some dolomite, silty; dolomite, mostly silty, argillaceous; minor limestone. Lower unit—shale, dark gray, black, brown, plastic to brittle; some dolomite in upper part; silty, argillaceous.		Yields water from fractured beds. Shales, particularly in lower unit, act as confining beds at the base of the shallow bedrock aquifer system.
ORDOVICIAN	CINCINNATIAN		Maquoketa		0 - 250 +			
	CHAMPLAINIAN	OTTAWA	Galena Platteville		150 - 350+	Dolomite, cherty; sandy at base; limestone; shale partings.	Deep bedrock aquifer systems: Cambrian-Ordovician aquifer system	Where below shales, development and yields of crevices are small; where not capped by shales, dolomites are fairly permeable.
			Glenwood St. Peter		75 - 650	Sandstone, fine to coarse grained; shale at top; locally cherty red shale at base.		Glenwood-St. Peter Sandstone. Small to moderate quantities of water. T probably about 15% of that of Cambrian-Ordovician aquifer system.
	CANADIAN	KNOX	Prairie du Chien		0 - 340	Dolomite, sandy, cherty, interbedded with sandstone.		Crevices in dolomite and sandstone generally yield small amounts of water. Potosi dolomite locally well creviced and partly responsible for exceptionally high yields of several deep wells. T probably about 35% of that of Cambrian-Ordovician aquifer system.
CAMBRIAN	CROIXAN		Eminence Potosi		0 - 225	Dolomite, white, fine grained, sandy at base; drusy quartz.		
			Franconia		45 - 175	Sandstone, dolomite, and shale, glauconitic, green to red, micaceous.		
			Ironton Galesville		103 - 275	Sandstone, fine to medium grained, well sorted, upper part dolomitic.		Ironton-Galesville Sandstone. Most productive part of Cambrian-Ordovician aquifer system. T probably about 50% of entire system.
			Eau Claire		235 - 450	Shale and siltstone, dolomitic, glauconitic; sandstone, dolomitic, glauconitic; dolomite, sandy.		Shales generally not water yielding; act as confining bed at the base of the Cambrian-Ordovician aquifer system.
		POTSDAM	Mt. Simon		2000 ±	Sandstone, coarse grained, white, red in lower half; lenses of shale and siltstone, red, micaceous.	Mt. Simon aquifer system	Mt. Simon Sandstone. Data sparse; probably less permeable than Ironton-Galesville; quality of water deteriorates with depth.
PRECAMBRIAN						Not penetrated by wells in Chicago area. Nearby wells encounter red or gray granite or similar rocks.		



* Mississippian rocks present in Des Plaines Disturbance.
Devonian rocks present as crevice fillings in Silurian rocks.

Modified from Suter et al., 1959, p. 24; Zeizel et al., 1962, p. 14; Walton and Csallany, 1962, p. 9.

Figure 2 - Stratigraphy and aquifer systems of northeastern Illinois, with hydrologic properties of main water-yielding units of the bedrock.

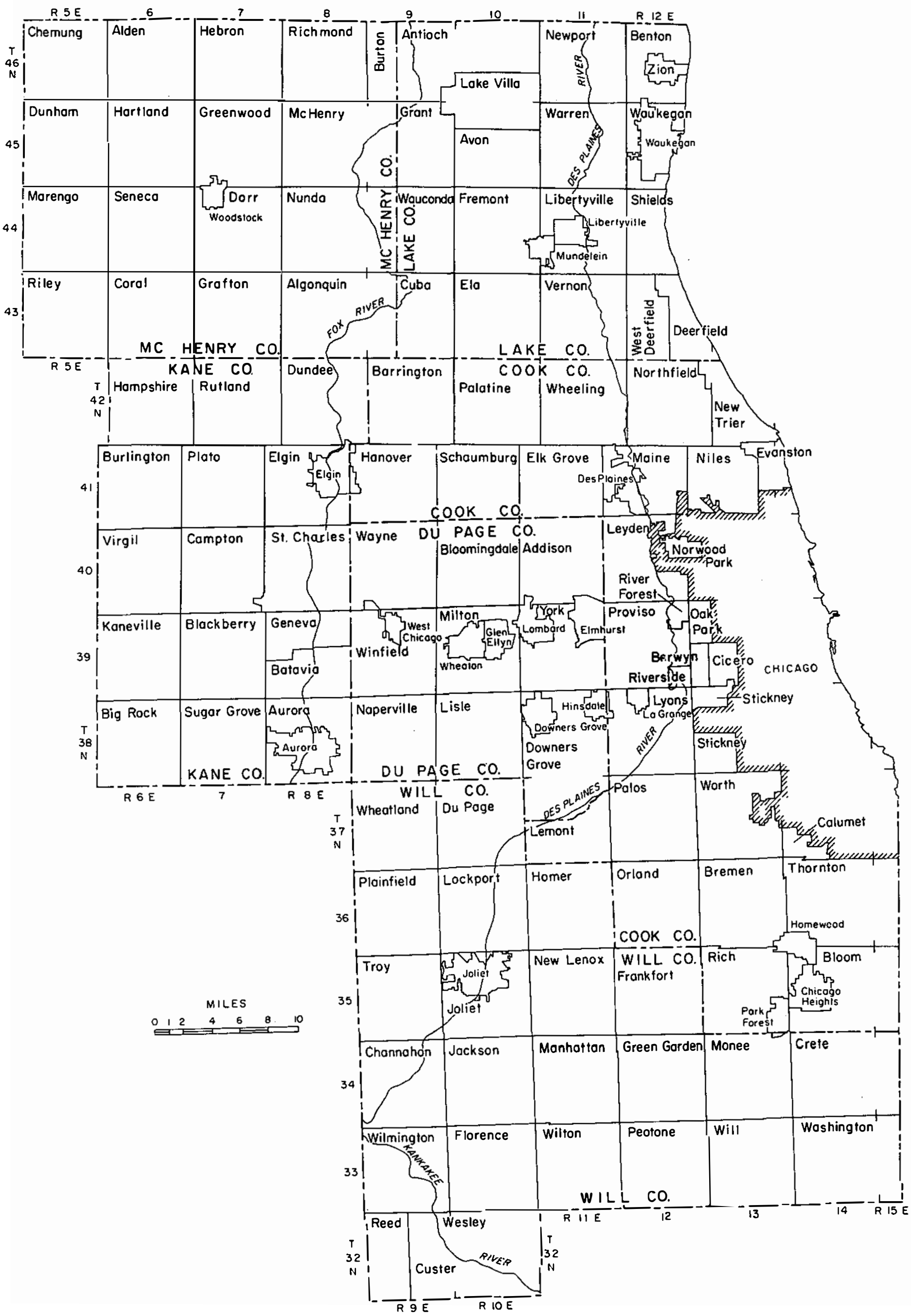


Figure 3 - Political townships and principal cities of northeastern Illinois using ground water from bedrock aquifers. (Modified from base map prepared by Northeastern Illinois Planning Commission)

the preparation of the State Geological and State Water Surveys' Cooperative Ground-Water Reports 1 and 2 (Suter et al., 1959; Zeizel et al., 1962). Further geologic investigations were conducted in the course of a water resources planning study of the northeastern Illinois metropolitan area, financed in part through an urban planning grant from the Federal Housing and Home Finance Agency and coordinated by the Northeastern Illinois Planning Commission. Later revision was undertaken as a result of well location and elevation changes provided by R. T. Sasman of the Illinois State Water Survey.

This report and the accompanying maps are designed for well drillers, engineers, planning groups, and all others concerned with developing ground-water supplies in the northeastern Illinois area. Maps and data pertaining to geologic units, gathered in the course of the water resources study but not treated in detail in this report, are on open file at the Illinois State Geological Survey offices in Urbana and Naperville.

GEOLOGY

In the eastern three-fourths of the study area the Silurian dolomite forms the bedrock surface beneath the glacial drift. In the western quarter of the area, the bedrock surface is predominantly shales and dolomites of the Maquoketa Group, with minor areas of Galena-Platteville Dolomite in the extreme west and minor areas of Pennsylvanian rocks in the southwest.

Erosion of the bedrock surface before glaciation produced deep valleys, many of which now are filled with glacial drift. Because of this erosion, the thickness of the upper unit of the bedrock may change abruptly over short distances. The existence of solution features in the upper part of the Silurian dolomite has been noted by Ekblaw (1924, p. 208), Fisher (1925, p. 52-61), Athy (1928, p. 61-62), Bretz (1940, p. 338), and Otto (1963, p. 3-4). Samples of drill cuttings from several wells studied in this investigation indicated 20 feet or more of green clay in the upper part of the Silurian dolomite. This has been interpreted as solution cavity deposits. Solution effects, which have increased the permeability of the rock, also have been noted in the Galena-Platteville Dolomite where it directly underlies the drift (Suter et al., 1959, p. 40).

Beneath the Maquoketa Group are the sandstones and dolomites of the deep bedrock aquifer systems. To the west and northwest of the Chicago metropolitan area, however, these deeper units are present immediately beneath the glacial drift.

The structural geology of northeastern Illinois is relatively simple. Generally, the rocks dip eastward at 10 to 15 feet per mile, with minor east-west-trending flexures. However, two major structural features are present in the area—the Des Plaines Disturbance in northern Cook County and the Sandwich Fault Zone in southwestern Will County. The Des Plaines Disturbance is an area of complex faulting and has been described in detail by Emrich and Bergstrom (1962). Disturbed rocks also are present in the Sandwich Fault Zone, which is described in more detail in Suter et al. (1959, p. 36). Ground-water circulation may be restricted in these areas and local effects may be difficult to predict.

The following descriptions of the various rock units present in the shallow and deep bedrock aquifer systems (fig. 2) are taken from more detailed descriptions presented by Suter et al. (1959), Willman (1962), Templeton and Willman (1963), and Buschbach (1964). For the purpose of this study, some of the stratigraphic units currently recognized in the region (Buschbach, 1964) are combined (e.g. Glenwood-St. Peter Sandstone).

Rocks of Pennsylvanian age occur beneath the glacial drift and overlie rocks of Silurian age or rocks of the Maquoketa Group in the southwestern part of the area. These Pennsylvanian rocks reach approximately 175 feet in thickness and consist largely of plastic or soft to brittle shale, fine-grained sandstone, argillaceous limestone, and some coal.

The Silurian dolomite lies uncomformably on rocks of the Maquoketa Group and underlies the glacial drift over the eastern three-fourths of the area. Fracturing is common in these rocks, particularly in the upper part where some solution activity also has been noted. The Silurian dolomite is subdivided into the Niagaran Series and the underlying Alexandrian Series. The Niagaran Series consists of light buff, very fine crystalline to granular, relatively pure to argillaceous and silty, compact to porous dolomite, with some dolomitic siltstone. Marked variations in lithology within short horizontal or vertical distances are very common in the area of reef development in southeastern Cook and eastern Will Counties. Thin, gray, pink, red, or green shale and shaly dolomite beds are often present near the base of the Niagaran Series. The argillaceous zone in which these beds occur seldom exceeds 20 feet in thickness and the shales in this zone are commonly less than two feet thick.

The rocks of the Alexandrian Series consist of 40 to 50 feet of light gray to yellowish tan, very finely crystalline, slightly silty, slightly porous to compact dolomite (Kankakee Dolomite) overlying gray to brown, very fine, granular, silty to very silty, cherty, compact dolomite and sometimes dolomitic siltstone (Edgewood Dolomite). The Edgewood Dolomite is absent in some areas, whereas in others it is as much as 100 feet thick.

The Maquoketa Group underlies the glacial drift over the western quarter of the area, and is up to 250 feet thick. Where the overlying Edgewood Dolomite is thick, however, the Maquoketa is thinner and averages 150 to 200 feet thick. The Maquoketa Group consists of plastic or soft shale interbedded with dolomite, brittle dolomitic shale, and siltstone. The materials comprising the upper part are quite variable, but the beds near the base are more consistent, with relatively impermeable shales, generally more than 30 feet thick.

In parts of western Kane and McHenry Counties, the Galena-Platteville Dolomite underlies the glacial drift. This unit averages approximately 350 feet in thickness and consists mostly of fine- to medium-grained, buff to brown dolomite.

Throughout the study area, the Glenwood-St. Peter Sandstone underlies the Galena-Platteville Dolomite. It consists of fine- and coarse-grained dolomitic sandstone, fine-grained dolomite, and some light green shale in the upper part (Glenwood) and a white, pink, or buff, medium- and fine-grained, well sorted and well rounded, friable sandstone in the lower part (St. Peter). A major unconformity is present at the base. The great variation in the thickness of the Glenwood-St. Peter is caused by deposition in steep-walled channels and solution cavities. Shale, chert, and dolomite fragments are common at the base of the sandstone.

The Prairie du Chien Group, Eminence-Potosi Dolomite, and Franconia Formation consist primarily of argillaceous and glauconitic sandstone and dolomite, dolomite with drusy quartz, and cherty dolomite. They are present throughout the study area and contain some joints and crevices in the upper part. The Potosi Dolomite was formerly called the Trempealeau Dolomite. The sandy dolomite and sandstone now called Eminence have been previously assigned to the Prairie du Chien and to the Trempealeau.

The Ironton-Galesville is approximately 100 to 275 feet thick and consists of clean, medium- to coarse-grained, partly dolomitic, moderately to poorly sorted sandstone in the upper part (Ironton) and white to light buff, clean to slightly silty, fine-grained, moderately well sorted, and largely nondolomitic sandstone in the lower part (Galesville).

The Eau Claire Formation is composed of a variety of rock types including sandstone, siltstone, dolomite, and shale in its upper and middle parts. The lower part is composed of sands similar to those in the underlying Mt. Simon Sandstone and is included with the Mt. Simon in the Potsdam Megagroup. The Potsdam Megagroup, therefore, corresponds to what has been called the Mt. Simon aquifer in recent ground-water reports. The Eau Claire is present throughout the area.

The Mt. Simon Sandstone, present throughout the study area, is approximately 2000 feet thick and consists of fine- to coarse-grained friable sandstone that commonly is poorly sorted and contains occasional small pebbles.

HYDROGEOLOGY

Shallow Bedrock Aquifer System

The shallow bedrock aquifer system (pl. 1A, in pocket) is formed by those bedrock units that are recharged locally from precipitation. In northeastern Illinois this system consists predominantly of Silurian dolomite (pl. 1B) and shales and dolomites of the Maquoketa Group (pl. 1C). In some areas, Pennsylvanian rocks and the upper part of the Galena-Platteville Dolomite are also a part of this system.

The upper boundary of the shallow bedrock aquifer system is the top of bedrock. The lower boundary is the top of the Galena-Platteville Dolomite, except where the Galena-Platteville Dolomite is the uppermost bedrock and subject to local recharge. In these areas, the upper part of the Galena-Platteville Dolomite (the Galena) is more permeable (Walton and Csallany, 1962, p. 12), and the lower boundary of the shallow bedrock aquifer system lies within this dolomite.

Data suggest that "there is a good hydraulic connection between Silurian rocks and overlying glacial drift and that the productivity of Silurian rocks is primarily controlled by solution openings in the upper part of the aquifer" (Csallany and Walton, 1963, p. 18). There is also appreciable downward leakage through the Maquoketa Group to the deep bedrock aquifer system (Walton and Csallany, 1962, p. 12; Walton, 1965, p. 3 and 5).

Dolomites of the shallow bedrock aquifer system yield water primarily from fractures and solution openings rather than from between individual grains as in sand and gravel in the glacial drift aquifer system or sandstones in the deep bedrock aquifer systems. Brittle siltstones and dolomitic shales in the shallow bedrock aquifer system, which are also susceptible to fracturing, have been included with the dolomite on the accompanying maps. Shale or plastic shale in the shallow bedrock aquifer system, as used in this report, refers to soft, weak, or caving rock, consisting predominantly of clay and silt, which is susceptible to permanent deformation when wet. This material would tend to seal fractures in itself and in more brittle beds lying immediately below it, and thus would present a barrier to ground-water movement.

Yields of wells in the shallow bedrock aquifers show wide variation. Data on specific capacity (the yield of a well in gallons per minute divided by the drawdown in the well measured in feet) for shallow dolomite wells in northeastern Illinois have been collected and statistically analyzed (Csallany and Walton, 1963) and are summarized in table 1. Fifty percent of the wells analyzed in each category had specific capacities equal to or greater than the figure given. These data were compiled from geologic maps published in earlier reports and are useful with the maps presented in this report in outlining areas in which productivity is likely to be highest. However, these data and the accompanying maps should not be used to predict precise yields at any specific location.

As can be seen from table 1, production is highest from the Silurian dolomite and the Galena-Platteville Dolomite and lowest from the Maquoketa Group. Factors favoring higher production are, in the case of the Silurian dolomite and Galena-Platteville Dolomite, the absence of overlying bedrock and, in the case of the Silurian dolomite, the presence of bedrock upland. These data also show that in McHenry County the upper third of the Silurian dolomite is likely to be more productive than the lower two-thirds.

Although not noted on table 1, Csallany and Walton (1963, p. 16) concluded that production from the Silurian dolomite is "greater in areas where sand and gravel directly overlie and are in hydraulic connection with the dolomite than it is in areas where relatively impermeable till directly overlies the dolomite." Maps showing sand and gravel will be presented in a forthcoming circular on glacial drift aquifers. More specific information regarding productivity of the various units and methods used to calculate this productivity can be obtained from reports by Csallany and Walton (1963) and Walton and Neill (1963).

Zeizel et al. (1962, p. 66) present a map showing recharge rates in DuPage County. The areas having low recharge rates are those in which less than 25 feet of dolomite overlies the shaly beds in the base of the Niagaran Series and where

TABLE 1 - SPECIFIC CAPACITIES OF THE SILURIAN DOLOMITE, GALENA-PLATTEVILLE DOLOMITE, AND MAQUOKETA GROUP UNDER VARIOUS GEOLOGIC CONDITIONS[1]

Unit	Conditions		Specific capacity[2]
Silurian dolomite	Directly underlies glacial drift		0.1
	Underlies bedrock		0.012
	Silurian in bedrock upland		0.23
	Silurian in bedrock valley		0.067
	Upper 33% of aquifer	McHenry County	0.20
	Lower 67% of aquifer	McHenry County	0.039
Galena-Platteville Dolomite	Directly underlies glacial drift		0.071
	Directly underlies bedrock (not uppermost bedrock)		0.018
Maquoketa Group	Overlain by bedrock - DuPage County		0.015

1 Compiled from data presented by Csallany and Walton (1963).

2 Values represent specific capacities per foot of penetration measured in 50 percent of the wells and adjusted to a well radius of 0.5 foot and a pumping period of 12 hours.

less than 25 feet of Alexandrian Series underlies these beds (Walton, 1965, p. 8). Plate 1B shows those areas where soft or plastic shales are present at the base of the Niagaran Series. However, the regional hydrologic significance of these shales is not known.

Conditions in the shallow bedrock aquifer system are summarized in figure 4, which consolidates the most significant features of plate 1A, B, and C, based on the data in table 1. It can be seen that the most favorable areas for development of the shallow bedrock aquifer system are mainly to the east where thick sections of Silurian dolomite are present. The 50-foot thickness line from the Silurian dolomite thickness map was arbitrarily chosen as the boundary for the favorable area. The least favorable areas are in the west where shales of the Maquoketa Group are present immediately beneath the glacial drift. In these areas, the deeper aquifers should be considered if high capacity wells are desired.

The shallow bedrock aquifer system is presently receiving more emphasis as a source of ground water due to concern over the possibility that pumpage is exceeding the sustained yield of the deep bedrock aquifer systems. The shallow bedrock aquifer system has the advantage of local and rapid recharge, particularly in areas where the overlying drift is thin or absent, and where there are permeable materials within the drift sequence that are in direct hydrologic connection with the bedrock, or will permit leakage into the bedrock.

Ease of drilling and lower drilling and operating costs are also advantages of the shallow bedrock aquifer system. Minor limitations include erratic yields, because of the irregular permeability of the system, and susceptibility to contamination from waste disposal operations at some places, because shallow aquifers are at or near ground surface. Variability in quality of water also may limit the use of this system.

Deep Bedrock Aquifer Systems

The deep bedrock aquifer systems include the Cambrian-Ordovician aquifer system and the Mt. Simon aquifer system. The major aquifers in the deep systems are the Glenwood-St. Peter, Ironton-Galesville, and Mt. Simon Sandstones. However, other beds in the systems also contribute water at some locations. Recharge to the deep units is mostly from west and north of the six-county metropolitan area, where the rocks crop out at the surface or lie immediately below the glacial drift (Suter et al., 1959, p. 59). Other recharge is contributed by leakage downward through the shallow bedrock aquifer system.

The top of the Cambrian-Ordovician aquifer system is at the top of or within the Galena-Platteville Dolomite. The Cambrian-Ordovician and the Mt. Simon aquifer systems are separated by relatively impermeable shales and dolomites of the upper and middle parts of the Eau Claire Formation. The permeable sands of the lower part of the Eau Claire are included with the Mt. Simon Sandstone as the Mt. Simon aquifer system (Potsdam Megagroup). Water in the Mt. Simon aquifer system occurs under leaky artesian conditions because of confining beds of the Eau Claire Formation (Walton and Csallany, 1962, p. 8).

The deep bedrock aquifer systems have been utilized for many years because of an assurance of relatively large supplies of water of predictable quality. Wells with yields exceeding 700 gallons per minute (gpm) are not uncommon (Walton and Csallany, 1962, p. 7). However, drilling, pumping, and maintenance costs are appreciably higher for wells drilled to the deep bedrock aquifer systems than for those drilled to the shallow bedrock systems.

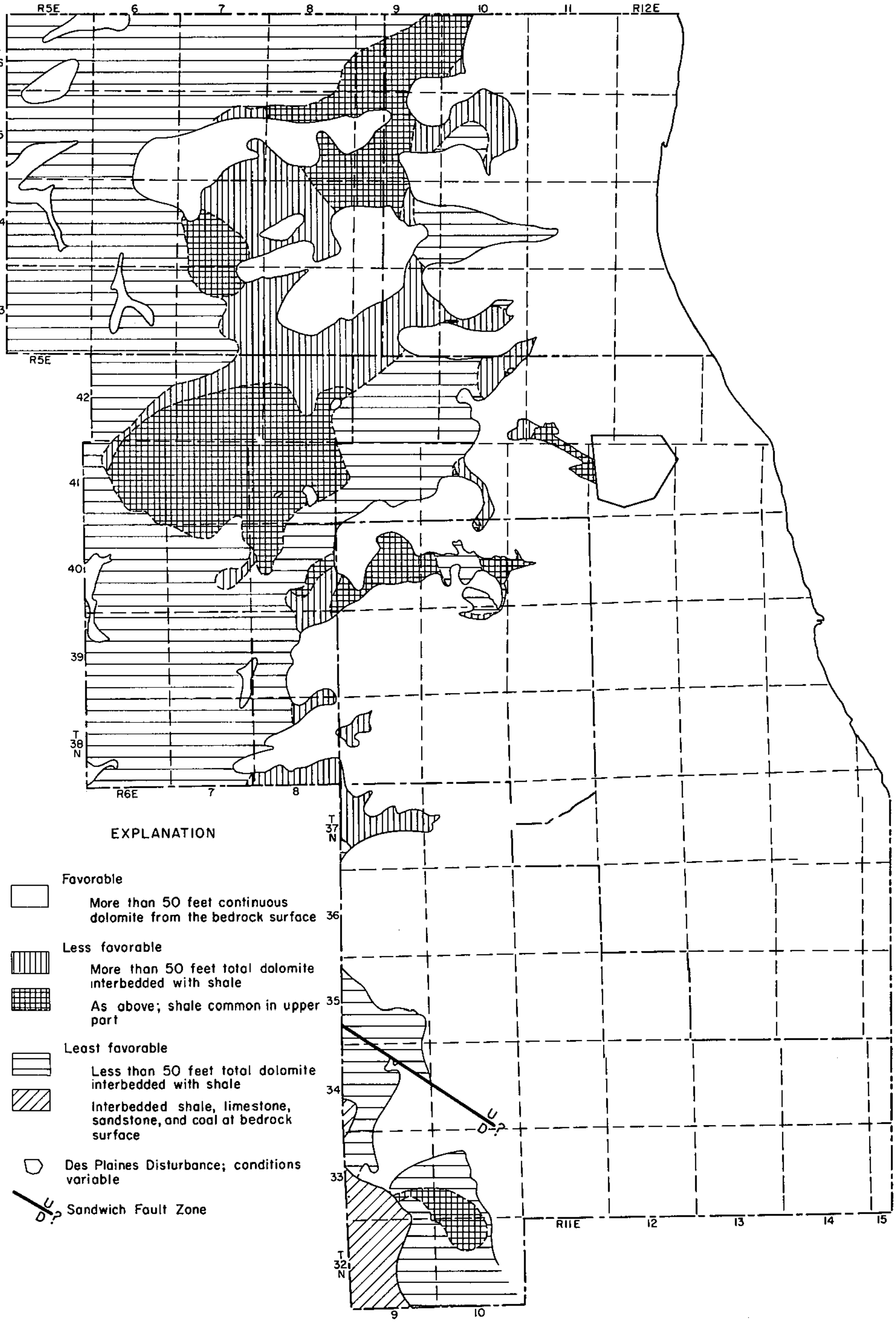


Figure 4 - Aquifer conditions of the shallow bedrock system.

Cambrian-Ordovician Aquifer System

The coefficient of transmissibility (T) and the coefficient of storage (S) of the Cambrian-Ordovician aquifer system average 17,000 gpd/ft and 0.00035, respectively, but for periods of pumpage involving several years or more, a coefficient of storage of 0.0006 is believed to be more realistic (Suter et al., 1959, p. 50). The coefficient of transmissibility decreases rapidly south of Joliet and east of Chicago. Wells drilled into this system generally penetrate to one of the major sandstone aquifers and are often left uncased or open to overlying aquifers.

The Galena-Platteville Dolomite, where overlain by shales of the Maquoketa Group, is the uppermost unit of the Cambrian-Ordovician aquifer system. Because of low permeability, it contributes very little water to wells in this system.

The Glenwood-St. Peter Sandstone (pl. 1D), beneath the Galena-Platteville, is widely utilized as an aquifer where water requirements are less than 200 gpm (Walton and Csallany, 1962, p. 11). Normally, the permeability of the Glenwood-St. Peter is approximately 9 to 15 gpd/sq ft, being low south of Chicago and high to the north and west (Walton and Csallany, 1962, p. 21). Where the aquifer thickens appreciably (pl. 1D), the total yield of wells rises; however, the increase in yield is not directly proportional to the increase in thickness (Walton and Csallany, 1962, p. 20). This is because the permeability of the additional deposits is lower.

No wells are uncased only in the Prairie du Chien, Eminence-Potosi, or Franconia rocks, below the Glenwood-St. Peter, and therefore yields of these rocks are estimated from wells that also produce from other formations in the Cambrian-Ordovician aquifer system. It is estimated that up to 43 percent of the total yield of the Cambrian-Ordovician aquifer system in Kane County is from Prairie du Chien-Franconia rocks (Walton and Csallany, 1962, p. 22); however, this figure decreases to the north, south, and east. Available data indicate that production is mainly from joints and crevices in the upper dolomitic part, with minor amounts of water contributed by sandy units in the lower part. Yields from these rocks are much more erratic than from the Glenwood-St. Peter and Ironton-Galesville Sandstones.

The Ironton-Galesville Sandstone (pl. 1E), beneath the Franconia Formation, has the most consistent permeability of the aquifers in northeastern Illinois and is the major producing unit in the Cambrian-Ordovician aquifer system. Permeabilities in this aquifer range from 40 gpd/sq ft in Kane County to 25 gpd/sq ft in Kankakee County (Walton and Csallany, 1962, p. 20).

Beneath the Ironton-Galesville, the upper and middle units of the Eau Claire Formation function as an aquitard and separate the deep bedrock aquifer systems. The lower sandstone unit of the Eau Claire Formation is part of the Mt. Simon aquifer system.

Mt. Simon Aquifer System

Walton and Csallany (1962, p. 23) estimate that the average permeability of the Mt. Simon aquifer system (pl. 1F) is approximately 16 gpd/sq ft. Water wells rarely penetrate more than a few hundred feet into this system. The quality of the water deteriorates with depth, and below an elevation of approximately 1300 feet below sea level, water is too highly mineralized for most purposes (Suter et al., 1959, p. 74).

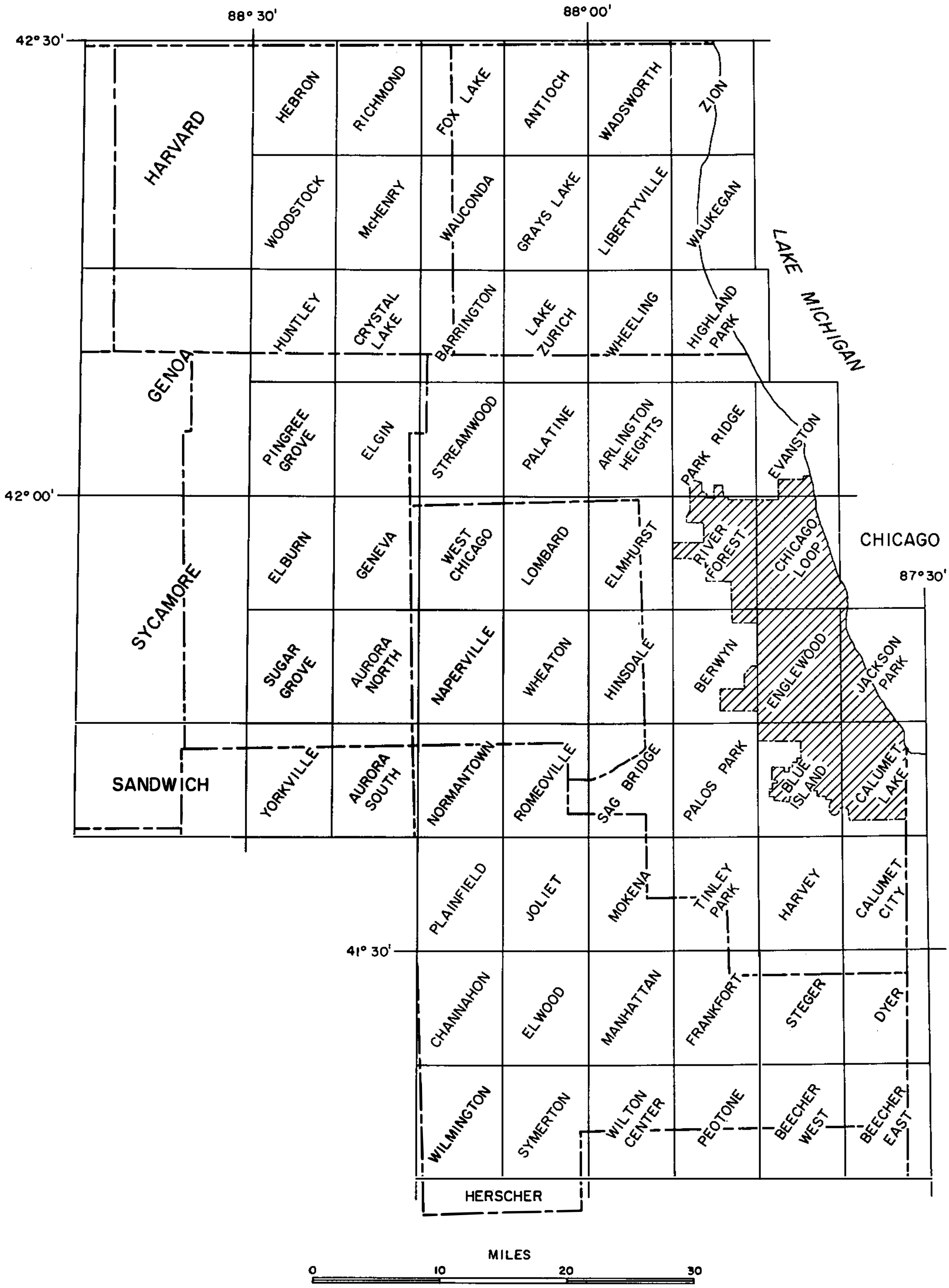


Figure 5 - Index of quadrangle topographic maps of northeastern Illinois.

MAPS

The maps on plate 1 are designed to aid in predicting depths to the various aquifers. They can also be used for a regional evaluation of possible yields. Where solid lines are used, accuracy on structure and isopach maps is believed to be within 25 feet. Where boundaries or contour lines are dashed, the mapping accuracy can be estimated, based on the density of control points.

Depths to all of the major units but the Maquoketa Group can be calculated by subtracting the elevation of the particular horizon from the elevation of the ground surface at that location. To obtain the depth of the Maquoketa Group, it is necessary to calculate the depth to the top of the shallow bedrock aquifer system from plate 1A, then add to this figure the thickness of the Silurian dolomite from plate 1B. The elevation of the ground surface is determined from quadrangle topographic maps (fig. 5) available at the Illinois State Geological Survey in Urbana, Illinois, or from the United States Geological Survey, Washington, D. C.

In addition to the uses noted above, plates 1A and B can be used to estimate the amount of casing likely to be needed to prevent shales in the Maquoketa Group from caving into the boring or to case out water from the glacial drift or shallow bedrock aquifer systems in wells penetrating to the deep bedrock aquifer systems. Plate 1C shows the total thickness of dolomite in the Maquoketa Group and outlines those areas where shales are likely to be found near the top. Estimates of variations in productivity within the Maquoketa Group have not, as yet, been made, and the significance of the lithologic subdivisions within the Maquoketa Group has not been established by hydrologic studies. It would seem, however, that production should be greatest in areas of thicker dolomite and in areas where plastic shale comprises less than 50 percent of the upper 30 feet of this unit.

The remaining three maps (pl. 1D, E, F) are for determining the depths and thicknesses of the Glenwood-St. Peter and Ironton-Galesville Sandstones and the depth to the Mt. Simon aquifer system. The 1300-foot elevation on plate 1F shows the approximate eastern edge of potable water in the Mt. Simon aquifer system (Suter et al., 1959, p. 74).

Assuming that a well is to be drilled in the northwest corner of sec. 6, T. 40 N., R. 12 E., Cook County (Elmhurst Quadrangle), these maps may be used as follows. Ground surface elevation at this site is shown as approximately 670 feet on the Elmhurst Quadrangle topographic map. The elevation of the upper surface of the shallow bedrock aquifer system is approximately 560 feet (pl. 1A). The depth to the top of the shallow bedrock is, therefore, approximately 110 feet (670 minus 560). The thickness of the Silurian dolomite is approximately 110 feet (pl. 1B), and, therefore, the top of the Maquoketa Group should be at a depth of approximately 220 feet (110 feet plus 110). The base of the shallow bedrock aquifer system is at an elevation of approximately 215 feet (pl. 1A), or at a depth of approximately 455 feet (670 minus 215). Approximately 455 feet of casing, therefore, would be necessary to shut out the glacial drift and shallow bedrock aquifers. The thickness of the Maquoketa Group is approximately 235 feet (455 minus 220). A string of casing through the shallow aquifers and the Maquoketa Group, therefore, would be 680 feet long (445 plus 235).

At this location, the highest yields would be expected within the upper part of the shallow bedrock aquifer system, and although additional yields might be obtained from this aquifer system with further drilling, it is probable that they would be small.

In the deep bedrock aquifer systems, the Glenwood-St. Peter Sandstone (pl. 1D) is at a depth of approximately 755 feet (670 minus -85) (negative numbers indicating depth below sea level) and is approximately 190 feet thick. The Ironton-Galesville Sandstone (pl. 1E) is at a depth of approximately 1210 feet (670 minus -540) and is slightly more than 200 feet thick. The Mt. Simon aquifer system is at a depth of approximately 1695 feet (670 minus -1025). Approximately 275 feet of fresh-water-bearing sandstone in the Mt. Simon aquifer system can be expected at this site.

SUMMARY

Aquifers capable of yielding small to large water supplies are present from near surface to great depths in much of northeastern Illinois. The shallow bedrock aquifer system, formed by those bedrock units that commonly directly underlie glacial drift and are recharged locally from precipitation, offers the most favorable areas for development where thick sections of Silurian dolomite are present. Ease of drilling and lower drilling and operating costs as well as the local and rapid recharge are advantages of the shallow aquifer system.

The deep bedrock aquifer systems, below the shallow bedrock system, offer greatest yields from the Glenwood-St. Peter, Ironton-Galesville, and Mt. Simon Sandstones. The Ironton-Galesville, with permeabilities from 25 gpd/sq ft in Kankakee County to 40 gpd/sq ft in Kane County, has the most consistent permeability of the aquifers in northeastern Illinois. Though drilling, pumping, and maintenance costs are appreciably higher for wells drilled to deep bedrock systems, users can be assured of relatively large water supplies of predictable quality. Wells with yields exceeding 700 gallons per minute are not uncommon (Walton and Csallany, 1962, p. 7).

Maps in this report showing distribution of the main bedrock aquifers, combined with well yield data, can be used to estimate the availability of ground water in various parts of the northeastern Illinois area, the depths to the major groundwater sources, and the length of surface casing likely to be required.

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