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A Comparison of Potentiometric Surfaces for the Cambrian-Ordovician Aquifers of Northeastern Illinois, 1995 and 2000

by
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A Division of the Illinois Department of Natural Resources

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Abstract

In response to expanding urban development, the use of Lake Michigan and other sources for public water supplies, and a growing interest in regional water resources development, this report provides a detailed discussion of groundwater withdrawals and water levels in northeastern Illinois. The water-level portion of this report covers a 15-county area from Lake Michigan to north-central Illinois and from the Wisconsin border south to Kankakee County. Particular emphasis, however, has been given to deep well pumpage in the eight counties of the Chicago region because of the significant shift in the late twentieth century from groundwater supplies of the deep bedrock aquifers to Lake Michigan and other sources.

This report details the fall 2000 water-level measurement of wells reaching to the St. Peter and Ironton-Galesville sandstones (deep bedrock aquifers), provides a map illustrating the slope of groundwater levels, and compares the fall 2000 levels to the fall 1995 observations. The rapid decrease in groundwater pumpage from the deep bedrock aquifers during the 1980s initially resulted in a rapid recovery of groundwater levels. However, the rate of water-level change has slowed since the mid-1990s. The greatest recovery during the past five years occurred in Cook County. Groundwater levels in several wells were observed to have risen more than 50 feet since 1995.

Where the deep bedrock aquifers of Cambrian-Ordovician age continue to be used, declines in groundwater levels were observed. Most notable declines were in southeastern Kane and northern Kendall Counties, southwestern Lake County, and southeastern McHenry County. Outside the Chicago region, water-level declines were observed in deep wells at Loves Park in Winnebago County and in the vicinity of DeKalb and Sycamore in DeKalb County.

Introduction

In May 1959, the Illinois State Water Survey (ISWS) and the Illinois State Geological Survey (ISGS) published a cooperative report (Suter et al., 1959) that discussed the geology and hydrology of the groundwater resources of the eight-county Chicago region, aquifer yields, and the possible consequences of future groundwater development. Special emphasis was placed on deep bedrock aquifers that had been widely used to obtain large groundwater supplies. The report indicated that pumpage from deep wells during 1958 approached the amount that could be continuously withdrawn without eventually dewatering the most productive formation of the deep bedrock aquifers. Future water-level declines (1958-1980) were predicted, ranging from 190 feet at Elgin to 300 feet at Chicago and Des Plaines. Suter et al. (1959) recognized that actual water-level declines would vary from predicted declines if future distribution and pumpage rates deviated from extrapolations of past groundwater use patterns.

In 1959, as a result of the findings of Suter et al. (1959), the ISWS expanded its program of collecting and reporting water-level and pumpage data for deep wells in the Chicago region. Program objectives were: 1) to provide long-term records of pumpage and water-level fluctuations, 2) to delineate problem areas, and 3) to report hydrologic information to facilitate the planning and development of water resources from the deep bedrock aquifers in the Chicago region. The importance of the program became apparent during the ensuing years as water demands increased and groundwater levels continued to decline.

This report provides an update to the first objective listed in the preceding paragraph. That is, it adds to the long-term record of pumpage and water-level information. The water-level portion of this report covers a 15-county area from Lake Michigan to north-central Illinois and from the Wisconsin border south to Kankakee County as shown in Figure 1. The pumpage portion of the report summarizes groundwater withdrawals from the deep bedrock aquifers in a smaller area, the eight counties of the Chicago region as described by previous reports.

The eight counties of the Chicago region are:

Cook	Kendall
DuPage	Lake
Grundy	McHenry
Kane	Will

The seven northern counties outside of the Chicago region included in this report are:

Boone	Lee
DeKalb	Ogle
Kankakee	Winnebago
LaSalle	

Pumpage figures for the 1995-1999 period (2000 figures were incomplete) used in this report were taken from the Illinois Water Inventory Program (IWIP) maintained by the ISWS.

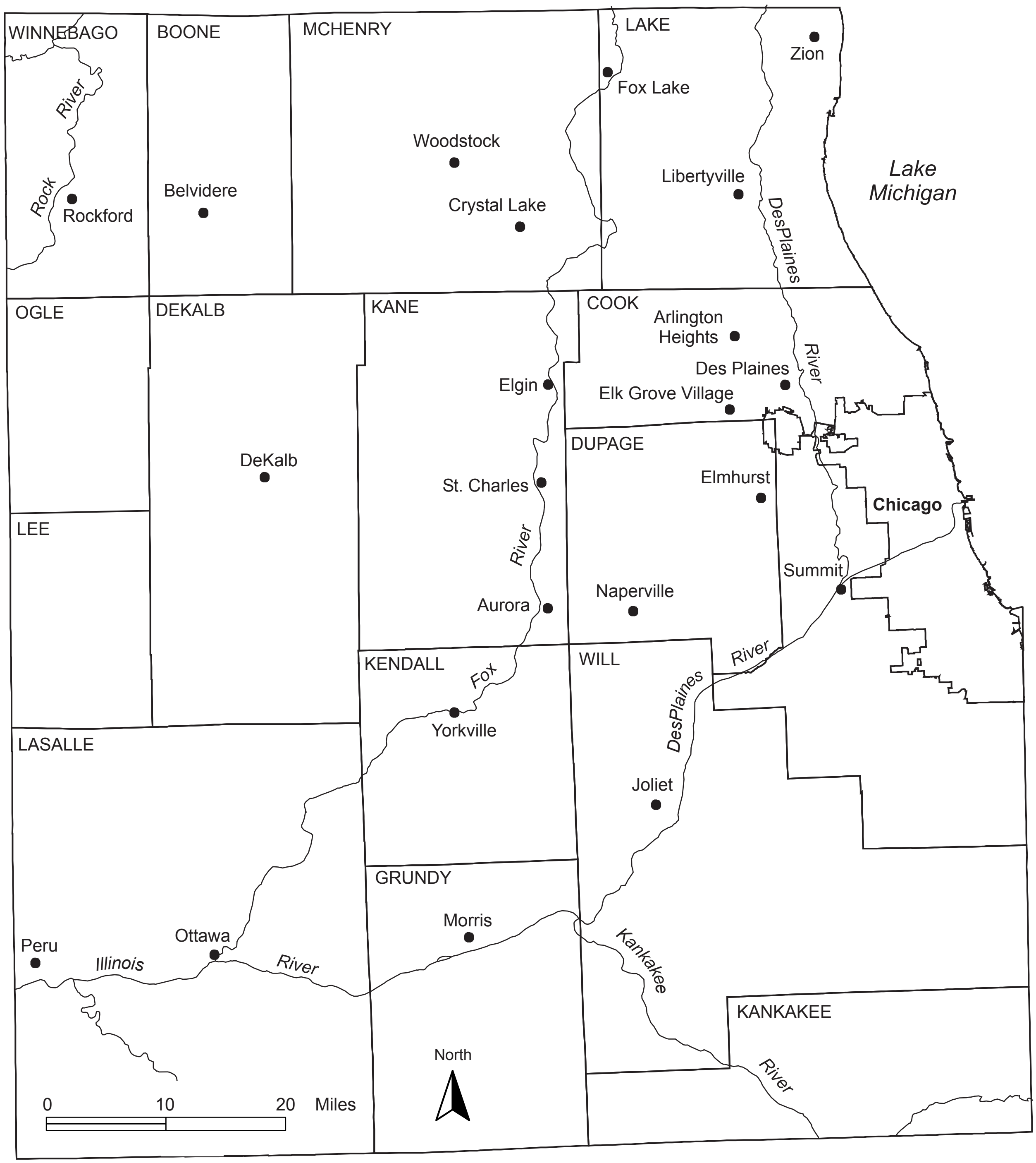


Figure 1. The northeastern Illinois study area

The program annually gathers water-use information from public water-supply operators and self-supplied industries through voluntary questionnaires. Because the response rate is not perfect, the author estimated probable pumpage to supply missing values. Consequently, the preliminary data are subject to final revisions.

Pumpage for public use includes use by municipalities, subdivisions, mobile home parks, and institutions. No attempt has been made to determine the final use of water within these categories. Pumpage for self-supplied industries also is shown but excludes pumpage for country clubs.

This report does not include pumpage from deep wells for individual domestic and rural residences or for farm supplies. Few wells serve these uses in the Chicago region, and total estimated pumpage for these uses in northeastern Illinois is extremely limited.

Water levels in deep wells were measured by various methods under a wide range of operating conditions and reliability. Most measurements were obtained from altitude gages attached to air lines permanently suspended in the wells. Other measurements were obtained with electric droplines that set off light or sound signals when the probe touched water. A few open wells can be measured very accurately with a dropline. Most wells, however, are equipped with pumps that limit or prevent access for measurement. Water levels are affected by recent pumpage of the well or by pumpage of adjacent wells. Other important considerations are the reliability of the water-level-measuring equipment and the experience of the person taking measurements.

Previous Reports

The ISWS has issued many reports on water levels and pumpage from deep wells in the Chicago region since the benchmark publication by Suter et al. (1959). Walton et al. (1960), Sasman et al. (1961, 1962, 1967, 1973, 1977, 1982, 1986) and Visocky (1993, 1997) summarized data for 1959, 1960, 1961, 1962-1966, 1966-1971, 1971-1975, 1971-1980, 1980-1985, 1985-1991, and 1991-1995, respectively.

Reports broader in scope by Sasman (1965) and Sasman and Baker (1966) summarized data on groundwater pumpage in 17 northern Illinois counties through 1962 and 1963, respectively. Sasman et al. (1974) discussed groundwater pumpage in 20 northern Illinois counties during the 1960-1970 period.

Schicht et al. (1976) and Singh and Adams (1980) described available groundwater and surface water resources for the Chicago region, predicted water shortages depending on various water-use scenarios, and offered alternatives for meeting projected water-supply needs to the year 2010.

Prickett and Lonnquist (1971) did the first computer simulation of groundwater decline in the Chicago region. Visocky (1982) and Burch (1991) subsequently described the impact of substituting Lake Michigan water for groundwater pumpage from deep wells. Young (1992) incorporated the Chicago region in a groundwater flow model of Illinois, Wisconsin, Minnesota, Iowa, and Missouri.

A cooperative effort by the U.S. Geological Survey, Illinois State Water Survey, and the Illinois State Geological Survey resulted in an updated hydrogeologic evaluation of the water resources of the deep bedrock aquifers in northern Illinois (Visocky et al., 1985). This report used previously collected and reported data.

Acknowledgments

The principal sponsor of this report was the Illinois Department of Natural Resources (Division of Water Resource Management, http://dnr.state.il.us/waterresources/). Their support was made available to the ISWS through the Grants and Contracts Office at the University of Illinois (Standard Research Agreement No. 99-282). Additional support was provided by ISWS General Revenue Funds. The views expressed in this report are those of the author and do not necessarily reflect the views of the sponsors or the ISWS.

The author wishes to acknowledge numerous individuals at water-supply systems in various communities and in corporations who generously granted access to their wells so water levels could be measured. Staff at these systems voluntarily report their annual pumpage in response to mailed questionnaires from the Illinois Water Inventory Program (IWIP) at the ISWS. Andrew (Andy) Buck, Layne-Western Company (Aurora, Illinois), deserves special recognition for the many details he provided about air line lengths in wells constructed and serviced by that company.

The author is especially grateful to the various Fire Chiefs at municipalities across the Chicago region who responded favorably to the request by Northbrook Chief James Reardon, President of the Mutual Aid Box Alarm System, to assist the ISWS by refilling compressed air tanks. In particular, these services were used at Libertyville, Aurora, Elmhurst, Arlington Heights, and Lemont. Barry Wagner, at the Fire Service Institute in Champaign, also refilled air tanks and provided valuable insights on the use of the air tanks.

Water-level data were largely obtained during ISWS personnel visits to system operators. Special acknowledgment is extended to Mark Anliker, ISWS, who collected water-level data in McHenry County and parts of Kane and DuPage Counties during October 2000. Ken Hlinka, ISWS, helped the field effort by collecting water-level data at several Cook County facilities. He was also the key person responsible for obtaining pumpage information compiled by the IWIP.

Several other current and former ISWS staff members worked on this project. Sean Sinclair generated base maps and digitized hand-drawn contours of water-level data. Review comments of Douglas D. Walker, Scott Meyer, H. Allen Wehrmann, and Derek Winstanley were incorporated into the text. Eva Kingston provided editorial review, Linda Hascall provided graphical support, and Patti Hill and Sandie Osterbur provided clerical support throughout the project. Pamela Lovett did final word processing and assembled the report. Adrian Visocky and Robert Sasman, ISWS retirees, provided encouragement, counsel, and historical perspective.

Geology and Hydrology

Groundwater resources in the Chicago region are developed mainly from three aquifer systems: 1) sand-and-gravel deposits of the glacial drift; 2) shallow dolomite formations, mainly of Silurian age; and 3) deep sandstone and dolomite formations of Cambrian and Ordovician age. Figure 2 shows the general stratigraphic relationships that wells in northeastern Illinois encounter.

The sequence of rocks that comprises the Cambrian and Ordovician units described in this report were first defined by Suter et al. (1959, p. 48) as the "Cambrian-Ordovician Aquifer" and has been referred to by this name in most subsequent reports. A local term, "deep sandstone aquifers," is often used informally in northeastern Illinois in reference to the two major sandstone aquifers within the deep bedrock system, the St. Peter and the Ironton-Galesville. Of the two, the Ironton-Galesville sandstone is the most productive, but supplemental yields are obtained from the overlying St. Peter sandstone.

The shallower St. Peter sandstone is part of the Ancell Group (composed of the Glenwood Formation and St. Peter sandstone). It is present throughout northeastern Illinois and frequently exceeds 200 feet in thickness. The St. Peter is an unusually extensive, very pure, uniformly fine-grained, and well-sorted quartz sandstone. The Galena-Platteville dolomite and the Maquoketa shale overlay the St. Peter sandstone in most of the Chicago region. The majority of public and industrial wells finished in the St. Peter sandstone in the Chicago region each produce less than 200 gallons per minute (gpm). In north-central Illinois, however, the St. Peter sandstone yields several hundred gallons per minute to wells and is the primary source of groundwater for some municipal and industrial supplies.

Strata of low permeability comprised mainly of dolomite and shale with some sandstone separate the St. Peter and Ironton-Galesville. This interval, comprised of the Prairie du Chien, Eminence-Potosi, and Franconia Formations, constitutes the "confining unit" between the St. Peter and Ironton-Galesville aquifers. The Prairie du Chien is important because it thins in the northern two tiers of Illinois counties, while the other formations are uniformly thick throughout much of northern Illinois.

The Ironton-Galesville sandstone underlying the strata of low permeability is the most consistently permeable and productive aquifer of the deep bedrock aquifers on a regional scale. The Ironton-Galesville sandstone dips to the east at a rate of about 10 feet per mile and is generally 175 to 200 feet thick (Suter et. al., 1959). Most high-capacity, deep municipal and industrial wells in the Chicago region obtain a major part of their yields from this aquifer.

The hydraulic properties of an aquifer are determined by means of a pumping test. That is, a well is pumped at a known, constant rate, and the drawdown of the groundwater levels around the well versus time is used to solve equations that express the relationship between transmissivity (T) and storage coefficient (S). Tests run in the Chicago region have led to a simplistic conceptual model of the Cambrian-Ordovician aquifer, which is loosely described as a confined aquifer with T approximately equal to 17,000 gallons per day/foot (gpd/ft) and with S approximately equal to 0.0003.

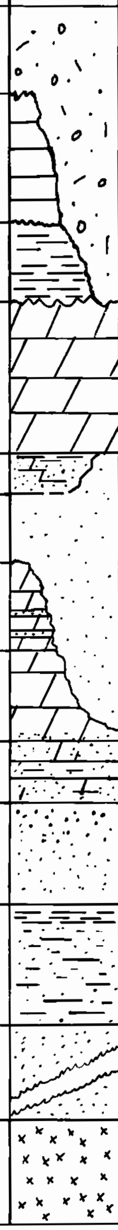
SYSTEM	FORMATION OR GROUP	LOG	DESCRIPTION
Quaternary			Unconsolidated glacial deposits. Commonly pebbly clay, but with silt, sand, and gravel. Some glacial deposits consist of very permeable bodies of sand and gravel.
Silurian			Dolomite, very pure to very silty. Upper part frequently creviced and broken. Lower part contains thin shale layers and tends to be silty.
Ordovician	Maquoketa		Shale, gray or brown.
	Galena-Platteville		Dolomite, commonly creviced when not underlying the Maquoketa Shale. Some limestone layers and thin shale partings.
	Glenwood		Sandstone and dolomite, shale at the top.
	St. Peter		Sandstone, fine to medium texture, well sorted and poorly cemented. Exceptionally pure quartz sand.
	Prairie du Chien		Interbedded dolomites and sandstones.
Cambrian	Eminence-Potosi		Dolomite, white, fine-grained, but typically sandy at its base. (Lower unit known as St. Lawrence in Wisconsin.)
	Franconia		Sandstone, dolomitic with thin shale partings.
	Ironton-Galesville		Sandstone, coarse to fine-grained, well sorted. May be dolomitic in the upper part.
	Eau Claire		Shale and siltstone. Contains a sandy dolomite member in northeastern Illinois. Entire formation becomes essentially a fine-grained sandstone in Milwaukee.
	Mt. Simon		Sandstone, coarse-grained. Thickness estimated at 2,000 feet in Illinois.
Precambrian			Crystalline rock, probably granite.

Figure 2. Stratigraphic column showing typical sequence of formations encountered in deep bedrock wells of northeastern Illinois

Although Suter et al. (1959) illustrated structure contour and thickness maps for both sandstones in the Cambrian-Ordovician, they did not discuss differences in hydraulic head between the two sandstones. For all practical purposes, since development of the deep bedrock aquifers began, artesian pressures in the St. Peter and Ironton-Galesville have been regarded as nearly equal. Closer examination during this field effort, however, has recognized a range of artesian head differences exists between the sandstones. For example, two wells in central Lake County (Wildwood #4 and #8) at nearly the same location have almost identical water levels. However, in the Joliet area it appears that 60 feet of head difference exists between the sandstones.

Pumpage from Deep Bedrock Wells

The Chicago region has been one of the most favorable areas for development of deep bedrock wells because of widespread sandstones that underlie the area. Potential users could drill anywhere with confidence that they would find a reliable groundwater source of excellent quality. Suter et al. (1959) reported steady increase of withdrawals since the 1800s. Because early ISWS reports vary in how they combined wells by usage and source, it is not always clear which aquifer was being used. It seems that terms were not defined precisely in early groundwater studies. When referring to pumpage from "deep wells," early studies (Sasman et al., 1961, p. 8; Sasman et al., 1967, p. 5; Sasman et al., 1973, p. 7; Sasman et al., 1977, p. 5; Walton et al., 1960, p. 8) included all bedrock pumpage. The Mt. Simon aquifer was largely abandoned by the mid-1970s due to salinity problems and became inconsequential in the accounting system. The Silurian aquifer continued to be used extensively until the availability of Lake Michigan water, so it may have remained part of the pumpage numbers. With the advent of a computerized database at ISWS beginning in 1980, it became easier to include aquifer information in usage tallies.

Further complicating identification of the groundwater source is the fact that some wells were open to multiple aquifers. That is, a well casing may have been set through the Quaternary-age deposits and rested on solid rock of Silurian age. Another length of casing may have been placed on a ledge of the Galena-Platteville at some interval to block off the Maquoketa shale and keep it from sloughing off into the open hole. Groundwater entered the hole drilled through the sandstones (St. Peter and the Ironton-Galesville), which occurs several hundred feet below the Silurian. In time, this practice was abandoned because of differences in hydrostatic pressures among aquifers. Still it occurred and makes it very difficult to assign aquifer withdrawals.

For example, Suter et al. (1959) reported that pumpage increased from about 200,000 gallons per day (gpd) in 1864 to 76.1 million gallons per day (mgd) in 1958 in the eight-county Chicago region. However, Walton et al. (1960) revised the 1958 pumpage figures upward. They noted that total pumpage from the deep wells was 78.3 mgd in 1958 and 88 mgd in 1959, and that "50.0 mgd came from the Cambrian-Ordovician aquifer, and 38.0 mgd came from the Silurian-age dolomite and Mt. Simon aquifer in the Chicago region" (p. 10).

The water-use accounting system used by Sasman et al. (1961) blurred the distinction between source (Cambrian-Ordovician versus Silurian and Mt. Simon) and usage type (public versus industrial). Consequently, it is difficult to tell whether the goal was to report pumpage by aquifer, by usage type, or both. The data are unclear for the next two decades, especially after 1966. Fortunately, it was reported that "... of the 91.7 mgd pumped from deep wells during 1960, 52.3 mgd came from the Cambrian-Ordovician" aquifer in the eight-county Chicago region (Sasman et al., 1961, p. 10). The accounting system becomes even more muddled when Sasman et al. (1967) reported "... that of the 145.8 mgd pumped from deep wells during 1966, 83 mgd came from the Cambrian-Ordovician aquifer and 62.8 mgd from the Silurian age dolomite and Mt. Simon aquifer" (p. 5). The problem with this statement is the 145.8 mgd refers to both the Chicago region and an outlying area. While one could use the 57 percent estimate of previous reports (Suter et. al., 1959, p. 62; Sasman et. al., 1961, p. 10) to calculate the Cambrian-Ordovician aquifer's portion of the total, that would be inappropriate because the Silurian is absent in the pumping centers west of the Chicago region (Belvidere, DeKalb, and Morris) and therefore contributes nothing. Thus, reported pumpage data must be used cautiously, especially reports of data prior to 1980.

To correct the focus of Sasman et al. (1967), one need only consider the 126.4 mgd reported for the Chicago region in Table 1 of that report (p. 7), add 4.3 mgd of pumpage for the Waukegan and Woodstock pumping centers, and then multiply by 57 percent to determine Cambrian-Ordovician pumpage. Doing so yields 74.5 mgd for Cambrian-Ordovician pumpage in the Chicago region, which seems reasonable given the scale of pumpage in 1960. Careful examination of Figure 2 in Sasman et al. (1967, p. 6) reveals another error that likely was repeated in other reports: The figure clearly uses the 83 mgd pumpage described in the text (page 5) rather than the 74.5 mgd, which the present author calculated should apply to the Chicago region. Errors seem probable in the 1967-1979 pumpage data. It is not clear if Silurian aquifer pumpage is separated from that of the Cambrian-Ordovician, although the title of Table 1 (Sasman et al., 1973, p. 8) claims it tallies "Pumpage from Sandstone Wells." Although this is different than the table caption used in previous reports, the present author doubts its validity because the pumpage trend is consistent with the errors of Sasman et al. (1967). Consequently, it would be prudent to be skeptical of the pumpage amounts and illustrations of the early years.

Figure 3 represents a new way of looking at historic groundwater development and was constructed especially for this report to better illustrate the history of pumpage from the deep bedrock aquifers of the Chicago region. It does not include the Silurian aquifer, which is now known as the "shallow bedrock" or "shallow dolomite." Because data from the 1800s are rare and few data from the early part of the twentieth century are available, Figure 3 was constructed by digitizing the Cambrian-Ordovician line shown in Figure 2 of Walton et al. (1960, p. 9). Then Cambrian-Ordovician pumpage numbers either reported in Walton et al. (1960) or calculated from Sasman et al. (1961, 1967) were used to develop better characterizations of the 1958-1966 period.

If the data in Sasman et al. (1982) are accurate, then groundwater withdrawals from the deep bedrock reached an all-time high in 1979. The sum of "Public and Industrial Use" for that year is the highest ever reported: 182.88 mgd. The title of Table 1 in that report (p. 11) states that these figures are from Cambrian-Ordovician wells. If the 1979 pumpage report is accepted, then development since 1966 [pumpage equal to 74.5 mgd based on calculation above using Sasman et al. (1967) and the 57 percent apportionment] occurred at a rapid rate.

Figure 3 also shows that the 1980-1985 period saw the first overall pumpage decline in the eight-county Chicago region. Sasman et al. (1986) noted four reasons for this decrease.

- Water from Lake Michigan was available to municipalities.
- A decline in the number of high-volume water-consuming industries lessened demand on the Cambrian-Ordovician aquifer.
- Elgin began using water from the Fox River.
- The number of shallow wells, which are cheaper to construct, operate, and easily meet radium and barium drinking water standards increased. Consequently, blending sources of water (for example, groundwater and surface water) became an essential strategy for public water systems in the Chicago region without access to Lake Michigan.

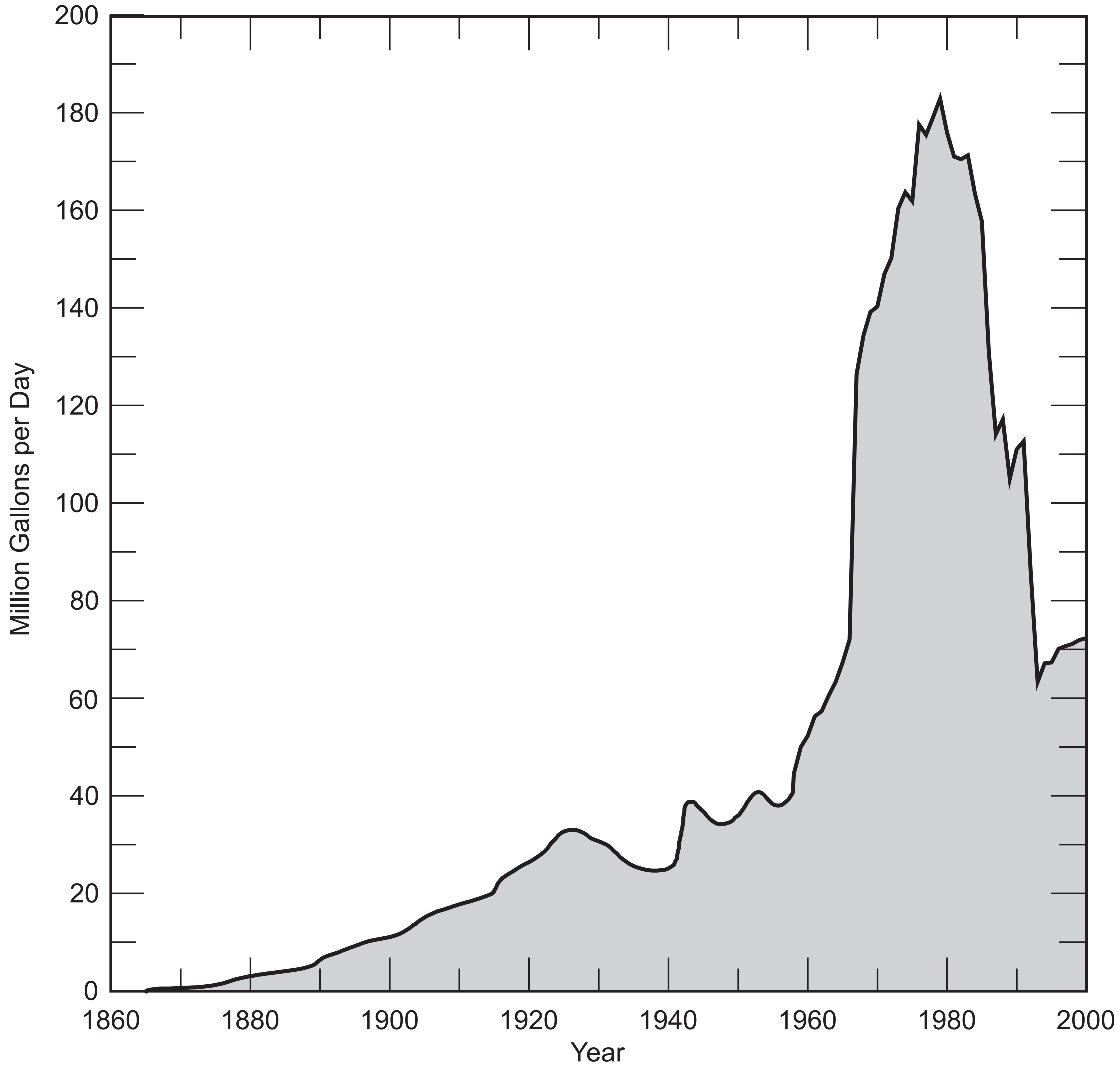


Figure 3. Estimates of historical pumpage from the Cambrian-Ordovician aquifers in the eight-county Chicago region

Table 1. Distribution of Pumpage from Deep Bedrock Wells in Northeastern Illinois, 1995-1999 (mgd)

Year	*County*	*Public*	*Industrial*	*Total*
1995	Cook	4.97	6.20	11.17
	DuPage	2.02	0.30	2.32
	Grundy	2.59	6.36	8.95
	Kane	13.77	0.40	14.17
	Kendall	1.58	0.31	1.89
	Lake	2.46	1.07	3.53
	McHenry	2.68	1.53	4.21
	Will	15.18	5.91	21.09
	Total	**45.25**	**22.08**	**67.33**
1996	Cook	4.42	6.58	11.00
	DuPage	2.27	0.25	2.52
	Grundy	2.58	6.98	9.56
	Kane	15.50	0.50	16.00
	Kendall	1.65	0.29	1.94
	Lake	2.51	1.03	3.54
	McHenry	2.36	1.92	4.28
	Will	15.23	6.06	21.29
	Total	**46.52**	**23.61**	**70.13**
1997	Cook	3.80	6.43	10.23
	DuPage	2.28	0.25	2.53
	Grundy	2.56	6.78	9.34
	Kane	15.57	0.32	15.89
	Kendall	1.75	0.30	2.05
	Lake	2.71	0.93	3.64
	McHenry	3.20	2.35	5.55
	Will	15.62	5.82	21.44
	Total	**47.49**	**23.18**	**70.67**
1998	Cook	4.43	6.74	11.17
	DuPage	1.52	0.25	1.77
	Grundy	2.66	6.96	9.62
	Kane	16.10	0.30	16.40
	Kendall	2.03	0.30	2.33
	Lake	2.89	0.94	3.83
	McHenry	3.00	2.40	5.40
	Will	15.33	5.27	20.60
	Total	**47.96**	**23.16**	**71.12**
1999	Cook	4.17	7.04	11.21
	DuPage	1.80	0.25	2.05
	Grundy	2.76	7.12	9.88
	Kane	16.12	0.34	16.46
	Kendall	2.15	0.30	2.45
	Lake	3.07	0.83	3.90
	McHenry	3.53	2.09	5.62
	Will	15.14	5.23	20.37
	Total	**48.74**	**23.20**	**71.94**

Groundwater withdrawals from the deep bedrock aquifers declined and then steadied briefly at the end of the twentieth century, as public water supplies in Cook, DuPage, and Lake Counties switched to Lake Michigan water. Demand on the deep bedrock aquifers increased slowly in the southwest counties (Lake, McHenry, and Kane). During the 1995-1999 period, pumpage for public and industrial supplies from deep bedrock wells (Cambrian-Ordovician) rose slightly from 67.3 to about 72 mgd. Table 1 shows the distribution of pumpage in the eight-county Chicago region between 1995 and 1999, subdivided by public and industrial use categories, and by counties.

The Chicago region has about 150 public water-supply facilities and another 100 industrial facilities. Most of these facilities are small users and are not especially important when considered individually. Consequently, it has been found convenient to examine the membership of those public water-supply facilities pumping more than 1.0 mgd from the deep bedrock aquifers in 1999. The number of facilities is the same as in the last report (Visocky, 1997). The composition of the group has changed to include the communities of Lemont, Oswego, Romeoville, and Plainfield, however. Bartlett, Bellwood, Elgin, and Lockport dropped off the list because their daily pumping rates decreased to less than 1.0 mgd. Pumpage at the other facilities ranged from 1.15 to 10.05 mgd, as shown in Table 2. Joliet and Aurora are decidedly the largest deep bedrock public water supplies in the Chicago region.

Table 2. Public Water-Supply Facilities in the Chicago Region Pumping More than 1.0 mgd from Deep Bedrock Aquifers, 1999

Community	*Pumpage (mgd)*
Joliet*	10.05
Aurora	5.80
Crystal Lake	2.25
Lake Zurich	1.95
Morris	1.81
Batavia	1.60
West Chicago	1.58
Montgomery	1.46
North Aurora	1.40
Geneva	1.33
St. Charles	1.32
Lemont	1.27
Oswego	1.26
Western Springs	1.23
Romeoville	1.15
Plainfield	1.15

Note:
*This number reflects the last report from Joliet for 1995 pumpage.

Water Levels in Deep Bedrock Wells

As described earlier, the ISWS has issued many reports on water levels and pumpage from deep wells since 1959. The ISWS has made routine mass measurements of water levels in deep bedrock wells about every five years since 1966. During the 1985 measurement, it was observed that water levels rose in a significant number of deep bedrock wells in the Chicago region since detailed water-level information was first recorded. These rises were attributed to major shifts in the sources of water and to local reductions in pumpage between 1980 and 1985.

Pumpage continued to decline between 1985 and 1991, again primarily due to a shift to Lake Michigan water. As a result, water levels in many deep wells rose, particularly in northwestern Cook and southern Lake Counties. Visocky (1993) reported that average annual water-level changes were upward in five of the eight counties and varied from a rise of 12 feet in Cook County to a decline of 8 feet in Will County, with an overall average rise in the Chicago region of about 3 feet during this six-year period. "This marked the first time that the average change was upward since detailed record-keeping began in the 1950s" (Visocky, 1997, p. 16).

Method Used to Collect Water-Level Data

Water levels were measured during fall 2000 in 367 deep wells in 15 counties of northeastern Illinois (see Appendix A for data). Attempts were made to measure water levels in other wells but were unsuccessful due to air line leaks, plugged air lines, or well operation affecting our ability to take a static measurement. Table 3 breaks down the number of wells measured by county. As Figure 4 illustrates, these wells are concentrated in the western suburbs of Chicago. Water-level changes were calculated for 298 wells that were measured in 1995 and 2000. Obviously, no prior data existed for new wells constructed since 1996. Conversely, a few wells that no longer existed could not be measured in 2000.

Within the eight-county Chicago region, 288 deep bedrock wells were measured, or static water-level information for new wells was provided by the drilling contractor. Head change was calculated for 246 wells in the Chicago region that also were measured in 1995. The greatest

Table 3. Number of Wells Measured, 1995 and 2000

County	*2000*	*1995*	*County*	*2000*	*1995*
Boone	7	10	Lake	51	50
Cook	66	92	La Salle	12	58
DeKalb	23	31	Lee	4	7
DuPage	35	43	McHenry	27	16
Grundy	13	29	Ogle	2	18
Kane	52	54	Will	34	63
Kankakee	0	8	Winnebago	31	49
Kendall	10	14	**Totals**	**367**	**542**

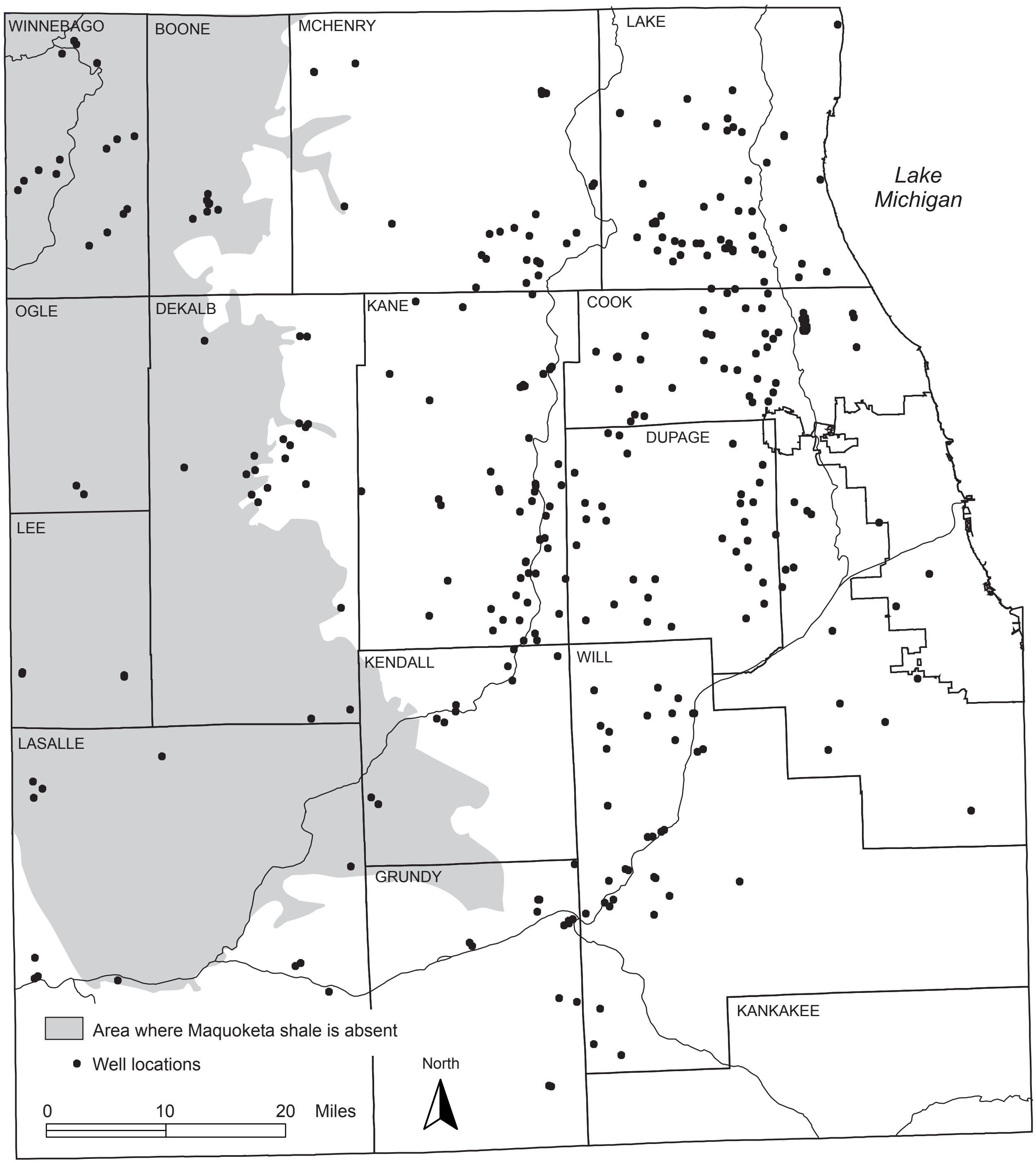


Figure 4. Distribution map of wells used in 2000 measurement

numbers of wells measured in 1995 and again in 2000 were in Cook (62), Kane (49), Lake (42), and DuPage (35) Counties.

Figure 5 shows groundwater-level recovery in a hypothetical deep bedrock well similar to that found in northeastern Illinois. The hydrograph illustrates the rapid recovery that occurs immediately after a pump is switched off. As time progresses, the rate of recovery slows, and the water level in the well approaches some static level. Consequently, it was desirable that a pump be turned off for more than 30 minutes prior to measuring the water level in the well. Most readings were collected from wells that had not operated for weeks or even years prior to measurements.

Measuring groundwater levels in deep wells requires a different method than typically used. Instead of electric droplines or steel tapes with chalked ends to directly determine the depth to water, air lines fitted with pressure gages are used. Although the air-line method is generally less accurate than electrical droplines, it offers the most practical means for measuring water levels in a pumped well (Driscoll, 1986). The air-line method is also useful because pump motors and casing tops on active wells are sealed. Production wells, unlike observation wells, do not provide direct access to water levels. The air-line method is noninvasive and offers a way to work around this difficulty by using the principle that air pressure is proportional to water pressure: that is, 1 pound per square inch (psi) of air is equivalent to 2.31 feet of water in a vertical column. The air line consists of small-diameter tubing of stainless steel, plastic, and/or copper that extends from the top of the well down to a point usually near the pump. Air lines in the Chicago region are frequently 600 to 1,100 feet long. The exact length of the air line must be measured (usually when the pump is installed or serviced) to determine the depth to water.

The submerged portion of the air line fills with groundwater. Measuring the depth to water requires injecting 200 to 300 psi of compressed air through a valve at the upper end of the air line to clear it. Once the line is cleared, the application of pressure is suspended. Groundwater then rushes back into the empty air line and compresses the air space above the static water level. The observer monitors the pressure gage (attached to the air line) until it stabilizes and then records the reading. The gage reading corresponds with the amount of water above the bottom of the air line, usually in feet. By subtracting this amount from the total length of the air line, one can calculate the depth to water below the land surface (the upper end of the air line).

For example, suppose the length of an air line inside a well is 1,000 feet. Compressed air is forced into the air line and clears it of water. When the pressure is released, groundwater refills the submerged portion of the air line and deflects the needle on an altimeter gage at the surface. A reading is taken when the gage steadies. If the water pressure above the bottom of the air line equals 250 feet, then the depth to water equals 750 feet (1000 - 250 = 750). Pressure maximums for gages of this type (used in the Chicago region) are typically 100 psi (230 feet), 200 psi (460 feet), or even 300 psi (690 feet). Gages are usually accurate to within one percent in the center portion of their ranges (2.3 to 6.9 feet in 100 to 300 psi gages, respectively), and accurate to within 2 percent at full deflection (4.6 to 13.8 feet in 100 to 300 psi gages, respectively). Since the majority of wells use 200 psi gages, it is estimated that most readings are accurate to within 10 feet.

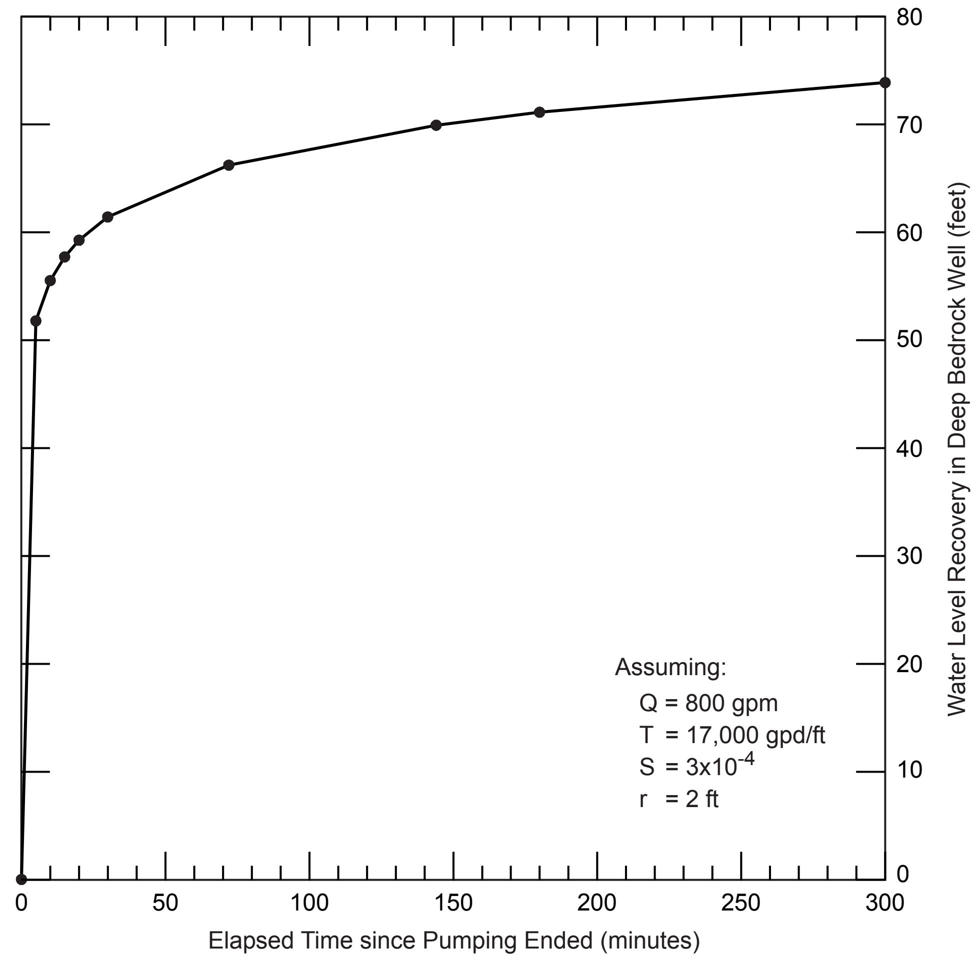


Figure 5. Time necessary for water-level recovery in a hypothetical deep bedrock well

Historical Observation Wells

Past reports include hydrographs based upon direct measurements of depth to water. Generally, these monthly measurements were made with an electric dropline in wells where pumps had been removed. With the closure of the ISWS Batavia office and subsequent retirement of Curt Benson in 1994, these measurements have ceased. However, during the 2000 mass measurement, four former observation sites were visited at Lake Bluff, Lincolnshire, Des Plaines, and Hickory Hills. Unsuccessful attempts were made to locate other historically measured wells, especially the Maywood #3 well for which the observation history dates back to the early 1940s.

Other wells were not measured because they could not be located easily or were covered with snow. These included one well at the Metropolitan Water Reclamation District (Calumet) and two wells at the former Joliet Army Ammunition Plant. Outside the Chicago region, wells such as Morris #4 have been abandoned and sealed. The well at the Metropolitan Water Reclamation District (COK 37N-14E-27.5e) is one of the furthest southeast locations and was very useful in previous contouring efforts of groundwater levels in the deep bedrock. Likewise, the Joliet Army Ammunition Plant wells are in a strategic location (WIL 34N-09E-25) in the southern extent of the eight-county Chicago region. Fortunately, a deep bedrock well at the Abraham Lincoln National Cemetery (WIL 34N-10E-30.6a) has been recently constructed and served as a viable substitute when contouring groundwater levels in southern Will County.

Potentiometric Surface of Deep Bedrock Aquifers

Groundwater will rise to some height above the top of an artesian aquifer in tightly cased wells. It does so in response to the potentiometric pressures that exist within confined (artesian) aquifers such as those found in the deep bedrock of northeastern Illinois. The potentiometric pressures of a number of wells, shown in feet of elevation above the National Geodetic Vertical Datum (NGVD), commonly referred to as mean sea level can be plotted on a map and contoured. The resulting map of the potentiometric surface is important because the general direction of groundwater flow can be inferred from the pattern of contour lines drawn on the potentiometric map. The potentiometric map also illustrates where cones of depression have developed in response to pumping. The contour map, in effect, depicts a three-dimensional surface of potentiometric pressures and is often referred to as a potentiometric map.

A potentiometric map for each aquifer can be constructed. One common mistake in preparing potentiometric maps is the "failure to distinguish between water levels of different aquifers and to identify which wells have contact with more than one aquifer" (Davis and DeWeist, 1966, p. 51). As was stated previously, Suter et al. (1959) did not discuss differences in hydraulic head between the St. Peter and Ironton-Galesville sandstones in northeastern Illinois. Previous studies have regarded these sandstones as having one potentiometric pressure for two reasons, and this report continues that assumption because at most locations the wells are open to both aquifers and hydraulic communication occurs freely within the well. Another reason has to do with scale. Potentiometric maps of the study area have been and continue to be drawn at a scale of 1:250,000 and with a contour interval of 50 feet. Consequently, the groundwater-level differential between the aquifers, which may range from 4 feet in Wildwood (Lake County) to 60 feet near Joliet (Will County), is insignificant considering the distances and contour interval involved in a regional study of northeastern Illinois.

The predevelopment potentiometric surface (mid-1860s) in Wisconsin was characterized by Weidman and Schultz (1915) and in Illinois by Anderson (1919). Both reports provided maps illustrating that the surface in southeastern Wisconsin and northeastern Illinois was featureless and sloped gently away from a groundwater divide located between Chicago and the Rock River. The natural equilibrium of groundwater flow in the St. Peter and Ironton-Galesville sandstones was: 1) southeast (down dip) and into the geologic basins, 2) west to the bedrock valley of the Rock River, and 3) south to the outcrop areas along the Illinois River in La Salle County. Figure 6 illustrates the approximate potentiometric surface in 1865 and the likely directions of groundwater flow within the deep bedrock aquifers.

Since then, cones of depression have formed around each well as the groundwater level was drawn down. Individual pumping centers have grown under the influence of continued withdrawals until they eventually overlapped and formed regional pumping centers at Milwaukee and Chicago. For example, by 1915, groundwater withdrawals at Chicago and Joliet had lowered the potentiometric surface by 300 feet, and the resulting cones were clearly visible on the potentiometric map (Suter et al., 1959). Other cones formed on the potentiometric surface as pumpage increased during the ensuing years. By 1958, depressions on the potentiometric surface also were recognized at Aurora, Elgin, Des Plaines, and Elmhurst. Suter et al. (1959) reported the

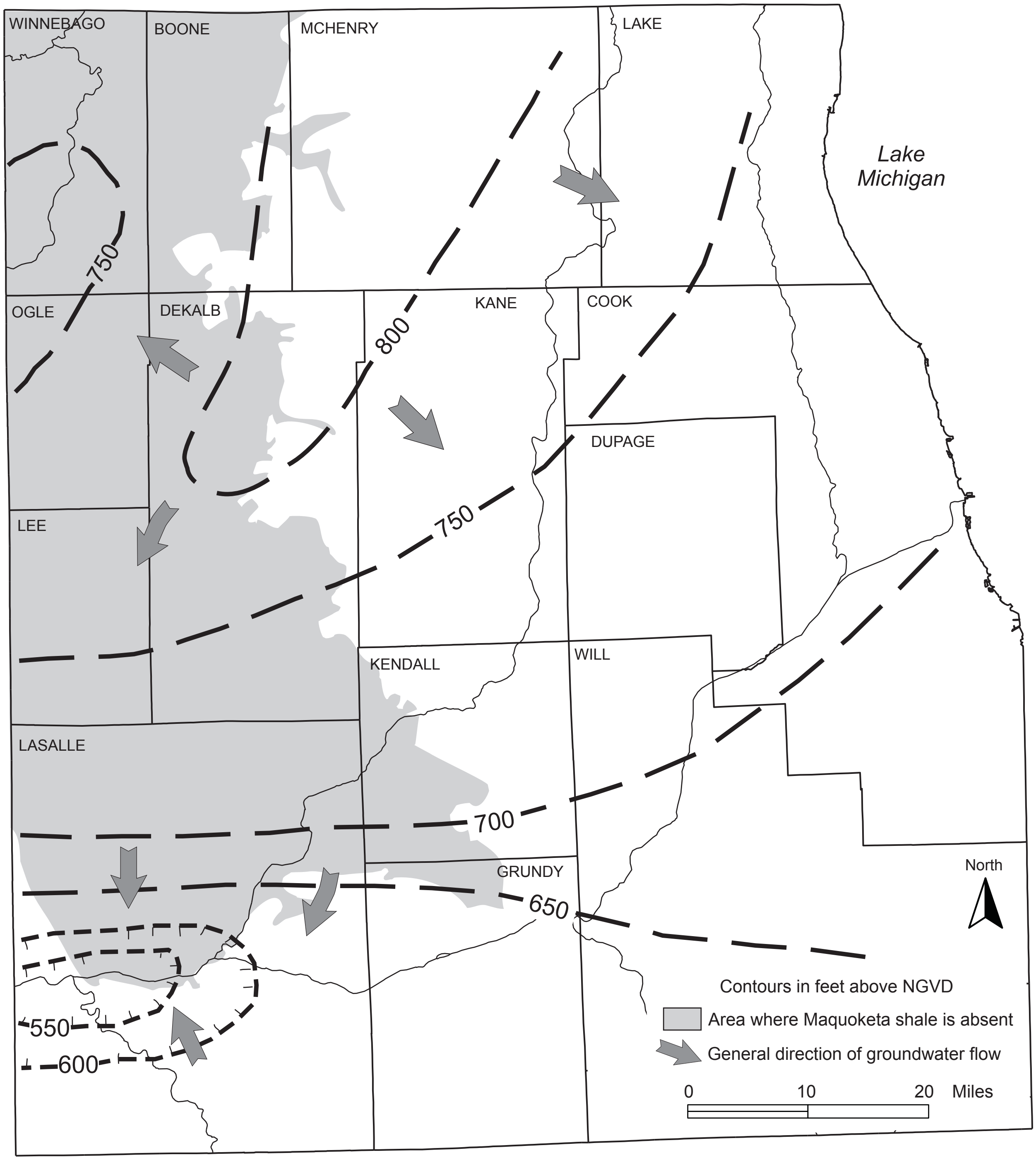


Figure 6. Approximate potentiometric surface of deep bedrock aquifers in 1865 (after Weidman and Schultz, 1915; Anderson, 1919)

cone at Summit, just southwest of Chicago, had declined another 350 feet by 1958, making it the deepest cone in Cook County.

Groundwater levels in wells reaching to the deep sandstones have been checked periodically since 1958. Annual measurements of the depths to water and pumpage summaries were made from 1959 until 1962. The scope of reporting was broadened to include Belvidere, DeKalb, Morris, Waukegan, and Woodstock pumping centers, and the publication interval for reports expanded to approximately every five years. The last "mass measurement," as they came to be known at the ISWS, was made at the end of 1995.

Potentiometric Surface, 1995

Figure 7 shows the potentiometric surface of the deep bedrock aquifers in fall 1995. Water-level data used to prepare the map appear in Appendix A. General features of the 1995 potentiometric surface map resemble those of the 1985 and 1991 maps, despite differences in details around former pumping centers.

Although potentiometric levels have declined by 500 feet or more over a broad area of the Chicago region since 1865, some levels in the Joliet area have declined 850 to 900 feet. The deepest cones of depression in the Chicago region in 1995 were in Joliet and Western Springs, where levels were as much as 246 feet and 78 feet below mean sea level, respectively. The cone observed at Elmhurst in 1991 shrank in size and depth by 1995, but noticeable cones were present in Western Springs, Elk Grove, Rolling Meadows, Wheeling-Mt. Prospect, and Northbrook-Glenview (western and northern Cook County); Geneva-St. Charles (Kane County); Lake Zurich (southern Lake County); and Crystal Lake and Ringwood (McHenry County).

The 0-foot (ft) contour line centered around the Joliet area of northwestern Will County and southern Cook County and was present in small areas of western, central, and northern Cook County (Visocky, 1997). The 200-ft contour surrounded and effectively defined major pumping centers in northeastern Illinois.

The general pattern of groundwater flow in the deep bedrock aquifers continued to originate in north-central Illinois and move east and southeast. Locally, deviations from this pattern occurred, especially in northern Cook County and near Joliet. West of the groundwater divide, groundwater flowed into cones of depression at Rockford and Belvidere.

Potentiometric Surface, 2000

Figure 8 shows the potentiometric surface of the deep bedrock aquifers in fall 2000. Water-level data used to prepare the map appear in Appendix A. The major feature of the 2000 potentiometric surface map is the pumping cone at and around Joliet, the largest public water supply using the deep bedrock aquifers. Some potentiometric levels continue to be 850 to 900 feet lower than in 1865, and growth in demand at Plainfield, continued pumpage in the industrial corridor along the Des Plaines River and I-55, and increases in pumpage at Romeoville all contribute to maintaining the Joliet cone.

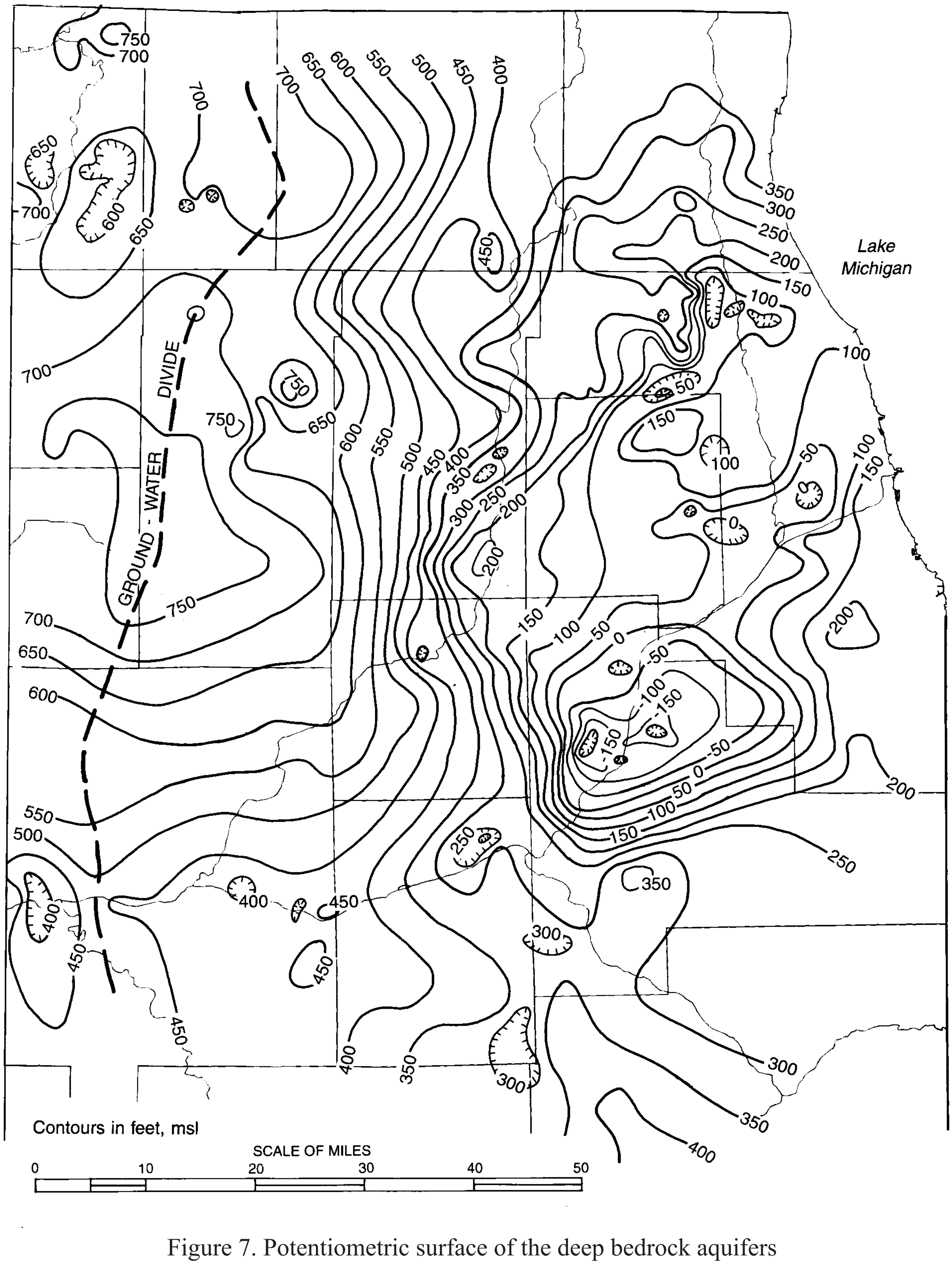


Figure 7. Potentiometric surface of the deep bedrock aquifers in northeastern Illinois, fall 1995 (after Visocky, 1997)

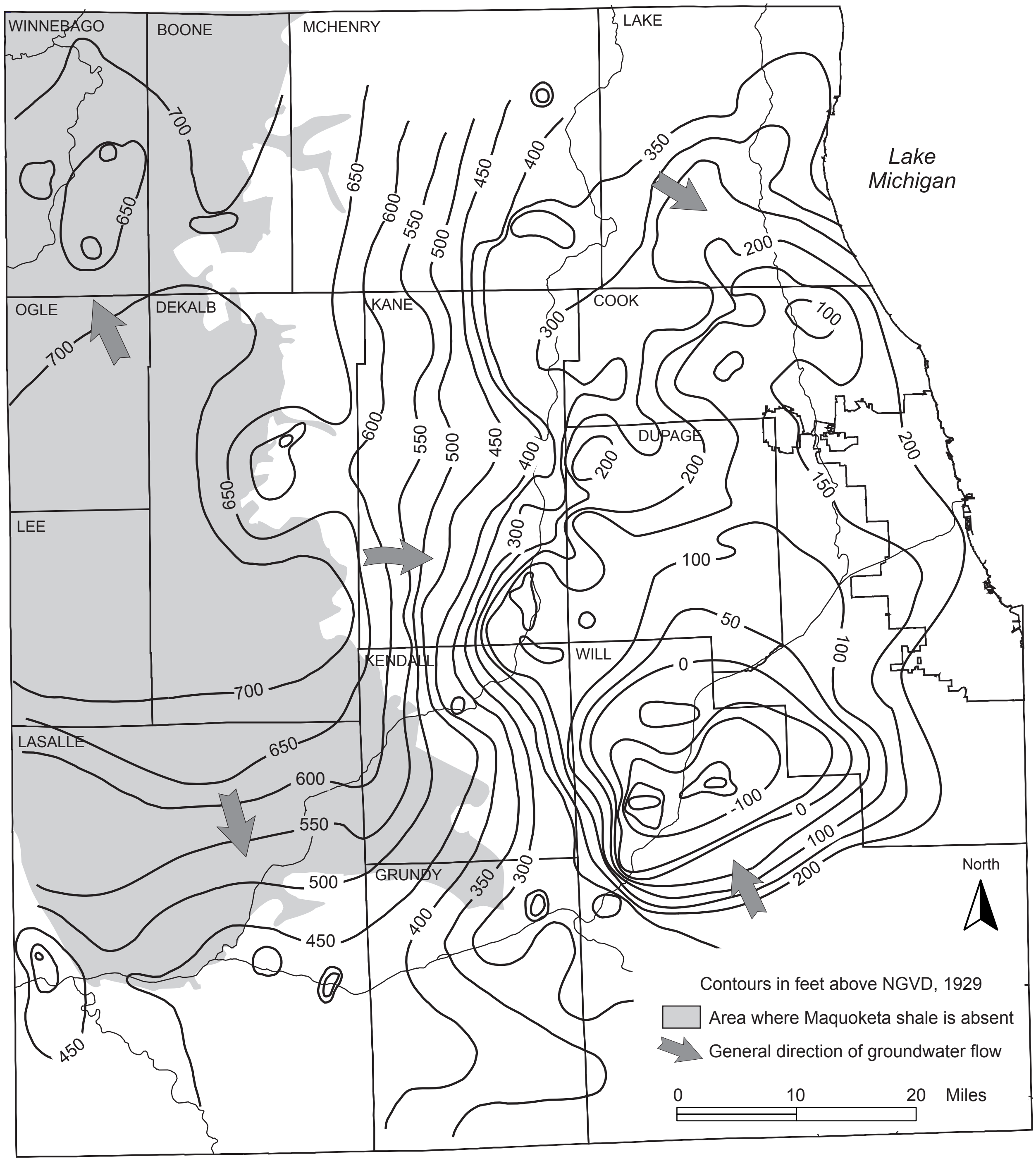


Figure 8. Potentiometric surface of the deep bedrock aquifers in northeastern Illinois, fall 2000

The major cone of depression observed at Elmhurst in 1991 has disappeared. In fact, the potentiometric surface in DuPage and western Cook Counties appears fairly smooth and several hundred feet higher than in 1980. Cones are present in West Chicago (DuPage County), Northbrook-Glenview (northern Cook County), the Aurora-Oswego (Kane/Kendall Counties), and Crystal Lake and Ringwood (McHenry County).

Beyond the Chicago region, cones of depression still exist at DeKalb-Sycamore and at Rockford, with smaller cones at Belvidere, LaSalle-Peru, and Ottawa. Industrial pumpage in a corridor along the Illinois River in eastern Grundy and western Will Counties has maintained a notable depression on the potentiometric surface just beyond the Joliet cone.

The 100-ft contour line now cuts east-west across the middle of DuPage County rather than north-south through the county. The Elmhurst-Elk Grove Village-Des Plaines cone has all but disappeared with the conversion of public water supplies to Lake Michigan water. The change in the trend of the water-level contours signifies the dominance of the Joliet cone on the hydrogeologic system.

In eastern Cook County, the 150- and 200-ft contours have closed with corresponding contours in Lake County. They have not been illustrated in this manner since before 1958. The observation of this occurrence also is the result of shrinkage of the Chicago and Elmhurst pumping centers. A case in point is Well #2 at the Froedtert Malt Company (formerly Fleischmann Malting Co.) at 38N-14E-07.6d, where the groundwater level has recovered 150 feet since 1980.

Selected water-level observations were intentionally ignored or not considered when contouring the 2000 potentiometric surface. Table 4 identifies wells that were excluded. Information about air line lengths was unavailable for Joliet wells, the Briarwood Country Club well, and the Rose Packing well. Consequently, the water-level elevations for these points could not be calculated even though they were measured in 1995 and 2000. One well reading (Manhattan #6–Will County) was rejected because the pump had not been off 30 minutes. Several other wells seem unusually high (in terms of elevation) and were excluded from the contouring. The well construction reports suggest these wells may be open to the Mt. Simon Formation and therefore are beyond the scope of this report.

Table 4. Wells Excluded from 2000 Potentiometric Surface Map

Well	*Reason omitted*	*Comments*
Aurora #16	Anomalously high level	Mt. Simon Formation?
Aurora #17	Anomalously high level	Mt. Simon Formation?
Aurora #18	Anomalously high level	Mt. Simon Formation?
Peru #5	Anomalously high level	Mt. Simon Formation?
Sycamore #1	Anomalously high level	
Manhattan #6	Anomalously low level	Not enough recovery time

Changes in Groundwater Levels, 1995-2000

Groundwater levels at 298 wells were measured in both 1995 and 2000. Differences in the levels were plotted on a working map and examined. It was apparent the 50-ft contour interval used to illustrate the recovery in the 1991 and 1995 measurements would be inappropriate because the magnitude of change was smaller than in previous measurements (1985, 1991, and 1995). Consequently, it was judged that a decrease to a 25-ft interval would be more illustrative. Figure 9 is the resulting map.

Although the pattern of water-level change was consistent with the knowledge of the pumping history in DuPage and Cook Counties, some previous observations seemed in error. Consequently, the 1991 and 1995 observations were reviewed for about a dozen wells because their 1995 readings appeared to be too high. For example, some of the groundwater levels observed in 2000 in Arlington Heights, Schaumburg, and Rolling Meadows were lower than reported by the 1995 measurement, despite the fact that the wells have not been pumped. Wells with questionable data points listed in Table 5 were not used in the preparation of Figure 9.

Extra care was taken to examine the changes in water levels observed at Bellwood (62 feet), Western Springs (152 feet), R.M.L. Speciality Hospital (13 feet), West Chicago (95 feet), and Aurora (-122 feet). Although the values were viewed with skepticism because of the large change, they appeared to be consistent with nearby pumpage patterns and were included in the preparation of Figure 9.

Figure 9 shows large portions of the study area with water-level changes ±25 feet. This is in contrast to previously reported changes of 50 or 100 feet (Visocky, 1993, 1997); hence the

Table 5. Well Heads with Questionable Head Change

	Water-level elevation (ft)		
Well name	*1991*	*1995*	*2000*
Rolling Meadows #6	82	245	186
Rolling Meadows #5	140	—	196
Arlington Heights #11	144	287	226
Arlington Heights #12	—	304	164
Arlington Heights #13	140	300	220
Schaumburg #20	—	190	153
Schaumburg #21	60	130	99
Wood Dale #7	42	315	25
Kropp Forge	-102	-45	178
Crystal Lake #6	310	429	321
Wheeling #7	71	-6	154
Lake Barrington Shores #2	200	210	356
Alcoa Engineered Products #2	223	277	164
Bellwood #4	-110	152	140

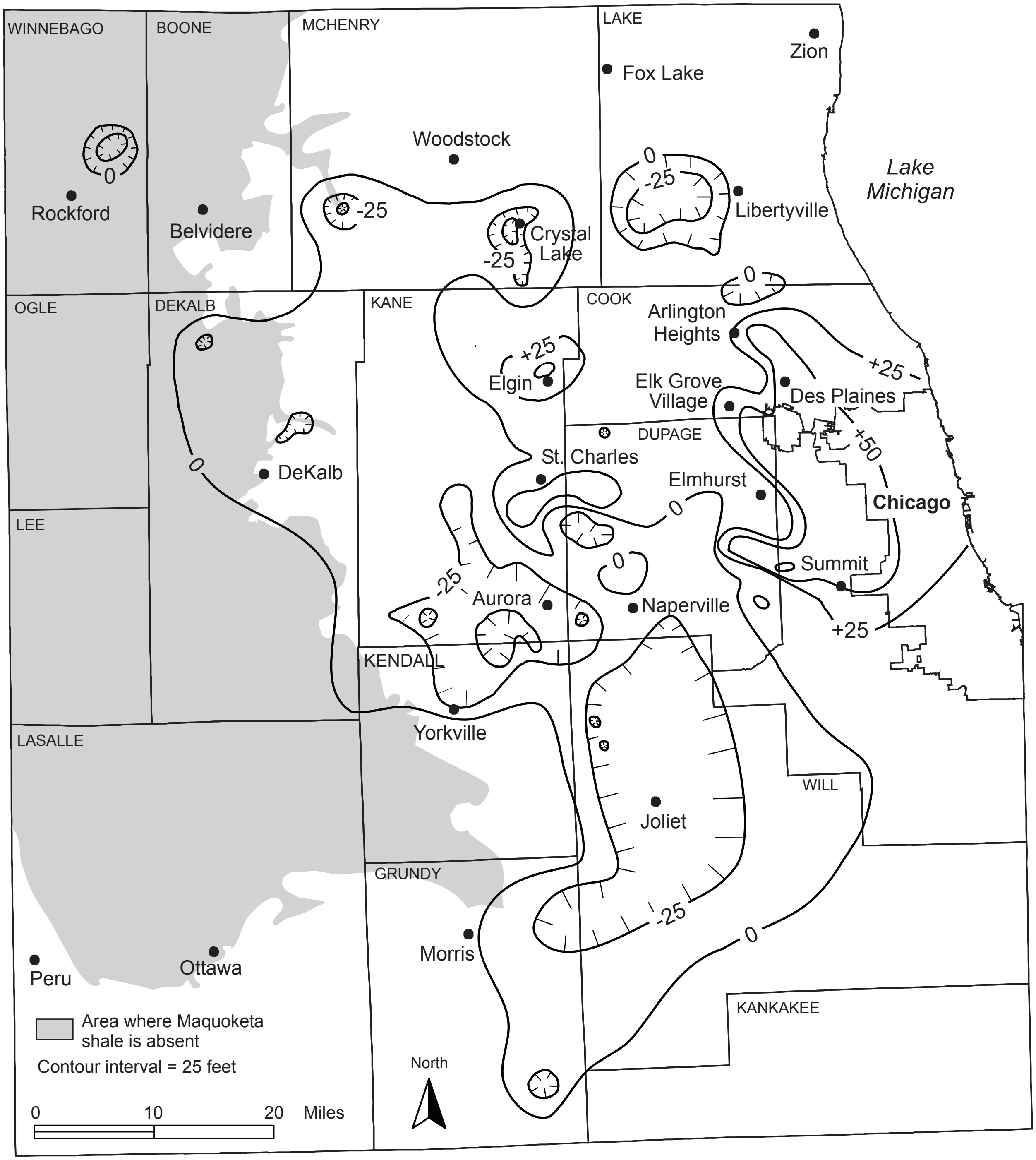


Figure 9. Changes in groundwater level in deep bedrock wells in northeastern Illinois between 1995 and 2000

contour interval on the head change map had to be smaller than used previously. The primary area of groundwater recovery during the 1995-2000 period was in the west-central half of Cook County. Levels rose by more than 50 feet at Des Plaines, Bellwood, Western Springs, and Prospect Heights. The Cook County changes are due to a switch from groundwater to Lake Michigan water. Water-level recoveries also were observed in northeastern Kane County around Elgin, where groundwater levels rose about 40 feet in response to the increased use of Fox River water.

Groundwater levels continued to decline at the Aurora pumping center. Water levels in deep wells in southeastern Kane and northern Kendall Counties declined 30 to 70 feet during the 1995-2000 period. The pumping cone, centered from Aurora to Oswego, reflects the increased pumpage in the area.

To a lesser extent, a pumping center is developing in Lake Zurich and Wauconda in southwestern Lake County. It is unusual because the greatest drawdowns (approximately 30 feet) are seen in wells finished in the St. Peter sandstone, whereas nearly steady water levels occur in deeper wells into the Ironton-Galesville sandstone.

Another area of measured groundwater decline is located in southeastern McHenry County and includes drawdowns at Lake-in-the-Hills, Huntley, and Cary. The observation at Crystal Lake Well #6 suggests a large drawdown (108 feet), but this may be suspect because the water level elevation (321 feet) is nearly the same as reported in 1985 and 1991. The 25-ft contour shown on Figure 9 more likely approximates the decline in southeastern McHenry County during the past five years.

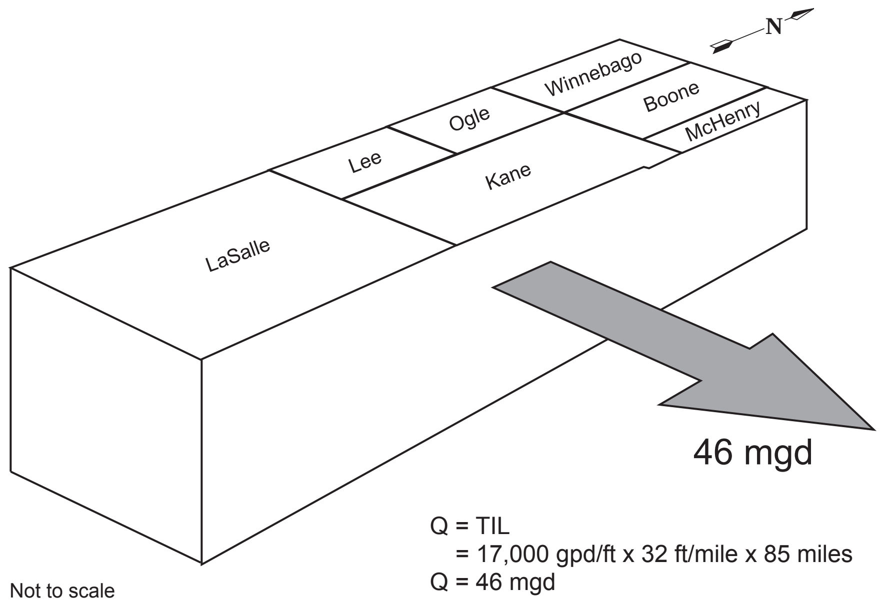
Outside the Chicago region, water-level declines were observed in deep wells at Loves Park (Winnebago County) where levels went down about 40 feet, although water levels rose in nearby wells owned by the City of Rockford. Groundwater levels in the deep bedrock wells declined another 25 to 50 feet in the immediate vicinity of the DeKalb-Sycamore pumping center (DeKalb County).

Discussion

The maximum amount of groundwater that can be continually withdrawn from the deep bedrock aquifer (Cambrian-Ordovician) was estimated to be about 46 mgd (Suter et al., 1959). That evaluation was subsequently modified to about 65 mgd (Walton, 1964; Schicht et al., 1976). The calculations sought to estimate a practical sustained yield, the maximum that could be pumped from existing pumping centers without eventually dewatering the Ironton-Galesville sandstone or exceeding recharge.

Initial estimates of the sustained yield for the deep bedrock were based on very little information about the quantity of water that could enter the aquifer in the recharge area (Suter et al., 1959). It was reported that "about 10 to 12 percent of the annual precipitation" reached the groundwater reservoirs in Illinois (Suter et al., 1959, p. 14). Using a conservative estimate that only 5 percent of the annual precipitation (about 34 inches) infiltrated the aquifer in the 1,200 square miles thought to contribute recharge, Suter et al. (1959) initially estimated that "the total available water would be about 100 mgd" (p. 66). They recognized that the transmissivity of the Cambrian-Ordovician aquifer is low and that the cross-sectional width (in Illinois) is about 85 miles; thus, they lowered their estimate of the maximum water available from 100 mgd to about 65 mgd. Further examination of the distribution of pumping in 1958 prompted them to lower their estimate of the practical sustained yield to the deep bedrock aquifer to about 46 mgd. Their calculation, shown as Figure 10, was based on a transmissivity of 17,000 gpd/ft and a hydraulic gradient of about 32 feet per mile (calculated) through an 85-mile-long, north-south trending cross section from the Wisconsin state line south through Township 33 North. Walton (1962, 1964) seems to have located this cross section as being 47 miles west of Chicago, approximately at the western border of Kane County. Although the location was not given explicitly by Walton, it was inferred from his conceptual model of the Cambrian-Ordovician aquifer being overlain by a 200-foot-thick confining layer (which does not exist in DeKalb County along the groundwater divide). Walton (1964) attempted to refine the estimates of the sustained yield and eventually concluded that the practical sustained yield of the deep bedrock aquifer was about 65 mgd. That estimate was based on the following: 50 mgd contributed from the recharge area in north-central Illinois, west of the border of the Maquoketa Formation (i.e., where recharge is estimated at 42,000 gpd/sq mi); 12 mgd of vertical leakage down through the Maquoketa shale; and 3 mgd of upward leakage through the Eau Claire Formation. Walton speculated that the maximum practical sustained yield "could be obtained by shifting the Elmhurst pumping center about 10 miles west and by adding 2 new pumping centers, one near the center of Lake County and one near the center of McHenry County" (p. 18).

It has long been discussed informally whether the 65-mgd estimate of practical sustained yield for the Chicago region is valid. Burch (1991) used a lower value of recharge (30,000 gpd/sq mi) as the recharge rate in the area west of the Maquoketa Formation border. Scott Meyer (personal communication, August 8, 2000) studied the position of the groundwater divide and boundary of the Maquoketa in an attempt to reconstruct the location of the 1,200-square-mile recharge area used by Suter et al. (1959). Meyer encountered difficulties in delineating such a large area in north-central Illinois and speculated that the recharge area might be less than the 1,200 sq mi used to estimate the practical sustained yield.



Q = TIL
= 17,000 gpd/ft x 32 ft/mile x 85 miles
Q = 46 mgd

where:
T = Transmissivity
I = Hydraulic gradient
L = Length of cross section

Figure 10. Estimate of potential recharge from area west of Maquoketa shale confining layer (after calculation of Suter et al., 1959)

There is the additional problem that not all of groundwater moves eastward through the calculated cross-sectional area. The direction of movement along the southern edge of the 85-mile length (southern Kendall and Grundy Counties) is to the south, not east as was assumed. Consequently, the lateral inflow of groundwater cannot be captured by the eight-county Chicago region. Offsetting this misgiving, however, are the observations that a favorable hydraulic gradient from Will County existed in 1958 and still does in 2000.

Finally there is the variability of transmissivity to consider. It was reported (Suter et al., 1959, p. 48) that 63 pumping tests were made between 1922 and 1954 in northeastern Illinois to determine the hydraulic properties of the "Cambrian-Ordovician Aquifer" (deep bedrock aquifers). The results indicated the average transmissivity was 17,400 gpd/ft, but that values ranged from 10,800 to 26,900 gpd/ft. Furthermore, transmissivity was observed to decrease in a southerly direction.

This means that if the cross section shown as Figure 10 were divided into thirds, three scenarios might be observed. First, that the northern segment most likely has groundwater flow through the area of highest transmissivity but at a hydraulic gradient that is not at its maximum. In the middle segment, however, where average transmissivity occurs, the hydraulic gradient is steepest. Finally, in the third segment where the lowest transmissivity is likely, there may not be any groundwater flow (gradient) to the east.

The 65 mgd estimate of the practical sustained yield also has other shortcomings. During the past 40 years, the ISWS periodically has measured groundwater levels and has never seen the elevation in the deep bedrock aquifers drop to -650 feet below sea level (as speculated by Suter et al., 1959, p. 66). Consequently, the hydraulic gradient was never as steep as hypothesized. The deepest part of any pumping center in the region was observed during the 1985 measurement (i.e., the -200-ft contour) in Elk Grove Village; and at selected wells at Elmhurst and near Joliet. Based on these observations, the resulting gradient may have been as much as 25 feet per mile (calculated from the 650-ft contour in western Kane County to the -150-ft contour in DuPage County).

If the 1985 gradient is used in computations as was done previously (Suter et al., 1959, pp. 60 and 66), then perhaps only 36 mgd was induced into the Chicago region from the recharge area. Assuming Walton's estimates of vertical leakage are unchanged, then perhaps only 51 mgd is entering the deep bedrock aquifers in the Chicago region. Despite attempts to shift the usage of water to Lake Michigan during the past two decades, users are still removing groundwater from the deep bedrock aquifers faster than scientists' best estimate of the rate at which nature can recharge them. The great storage capacity of the aquifers allows deficit spending, which is frequently termed "mining." Although mining is a slight misnomer since the resource is renewable, it makes the point that one of the groundwater resources serving the Chicago region is being reduced.

Since Walton (1964), the 65 mgd practical sustained yield has been a widely cited estimate for the deep bedrock aquifers. As reviewed in the preceding paragraphs, there are problems with all of the estimates, yet it is generally accepted that the deep bedrock aquifers (Cambrian-Ordovician) have been overdeveloped since the 1950s or 1960s. The exact number, either 46 or 50 or 65 mgd, has not been particularly important because the pumpage from the aquifers (Figure 3) greatly exceeded all of these estimates.

Implementation of Surface Water Alternatives

Schicht et al. (1976) noted that there are several water-supply alternatives to using groundwater from the deep bedrock aquifers. These included purchasing Lake Michigan water from the City of Chicago, using Kankakee River water in Will and southern Cook Counties, and using Fox River water in Kane County, among others. On August 11, 1980, the Special Master (Judge Albert B. Maris) made his report to the U.S. Supreme Court, which in effect forced the State of Illinois to formally recognize the need to reduce pumpage from the Cambrian-Ordovician aquifers (Fetter, 1981).

The ensuing “Level of Lake Michigan Act” [615 ILCS 50] directed the State of Illinois to devise and develop a continuing program for the apportionment of water to be diverted from Lake Michigan. As a result, a water allocation program now exists and implements the U.S. Supreme Court Order regarding the amount of water that can be withdrawn from Lake Michigan for use in Illinois. These allocations are based on past, existing, and future water use and trends. All allocations are subject to public hearings with extensive coordination among allocation permittees; federal, state, and local water agencies and authorities; other Great Lakes states; and the federal Department of Justice.

One large request for a Lake Michigan allocation came in March 1984, when the DuPage County Commission signed a 40-year agreement to buy water from the City of Chicago for redistribution in DuPage County. The Water Commission Act of 1985 [70 ILCS 3720] authorized the Commission to finance, design, construct, and operate a Lake Michigan-to-DuPage County water-supply system. In 1986, the Commission entered into "wholesale" Water Purchase Agreements with 23 DuPage County municipalities and began constructing the second largest water-supply system in the State of Illinois (http://www.dpwc.org/history.html accessed September 15, 2000). The Commission finally went into full operation on May 1, 1992, and lessened DuPage County deep bedrock use by 20 mgd (Visocky, 1997).

Likewise, the Central Lake County Joint Action Water Agency (CLCJAWA), representing 12 communities in Lake County, Illinois, decided to use Lake Michigan as its water source rather than groundwater. Historically, the communities of Grayslake, Gurnee, Lake Bluff, Libertyville, Mundelein, Round Lake, Round Lake Beach, Round Lake Heights, Round Lake Park, and the Lake County Public Works Department, representing the communities of Knollwood/Rondout, Vernon Hills, and Wildwood, had obtained water supplies from aquifers or purchased Lake Michigan water from other communities. However, faced with diminishing quantity and quality of groundwater, as well as rising costs of lake water, these communities joined together to organize the CLCJAWA in 1986. Delivery of Lake Michigan water to central Lake County reduced demand on the deep bedrock aquifers, and groundwater levels began to recover.

The Fox River also has been developed as a water supply as communities have lessened their dependence on the deep bedrock aquifers. For example, approximately 94 percent of Elgin's raw water is from the Fox River, with the remaining 6 percent drawn from deep wells. Elgin decided in 1979 to build a new treatment facility that could process 16 mgd of Fox River water after Elgin officials began exploring alternate sources of raw water and even considered buying Lake Michigan water from the City of Chicago. Aurora also has developed an elaborate water treatment facility for using both Fox River water and groundwater. This strategy has allowed Aurora to meet its rapidly increasing demand (16.1 mgd in 1999) for more water, while attempting to minimize deep bedrock aquifer pumpage. The Aurora Water Department now obtains about 55 percent of its supply from the Fox River and about 10 percent from shallow wells tapping sand-and-gravel aquifers.

Response of Groundwater Levels to Pumpage Reductions

Groundwater levels have risen in response to the lessening of groundwater withdrawals by deep bedrock wells. A comparison of water elevations for wells measured in 1980 and 2000 was made for this study in an attempt to determine the impact of Lake Michigan deliveries. About 150 wells were measured in both years, and the change in groundwater levels for each well was calculated (see Appendix B). Although in some cases the levels went down even below the 1980 levels before they started to recover, this exercise illustrates the impact of Lake Michigan allocations to the suburbs.

Figure 11 illustrates the change in groundwater levels since 1980 and the impact of the Lake Michigan allocation program. Groundwater levels in 2000 are about 300 feet higher at Villa Park and Elmhurst than they were in 1980. Recoveries of 225 to 275 feet were measured at Arlington Heights and Bellwood; 140 to 170 feet at Hanover Park; and 130 to 185 feet at Oak Brook. All of these observed recoveries are attributed to the switch from the deep bedrock aquifers to Lake Michigan and the Fox River as sources of water. Where the State's water allocation program did not receive or approve permits for lake water, groundwater levels continued to decline in Will, DeKalb, and Kane Counties where the comparison of 1980 and 2000 water levels often found declines of 50 feet or more.

The rise in groundwater levels (or recovery) comes despite the fact that withdrawals from the deep bedrock continue to exceed all aquifer yield estimates. Much of the observed recovery is simply a function of how many gallons per minute were pumped from the well and for how long, assuming a uniform transmissivity and storage. That is, the recovery proceeds in accordance with the Theis nonequilibrium formula (Ferris et al., 1962). Where pumpage from the deep bedrock has been reduced sharply at long-term pumping centers, such as in Cook, DuPage, and Lake Counties, groundwater level recoveries of more than 100 feet over large areas have been observed.

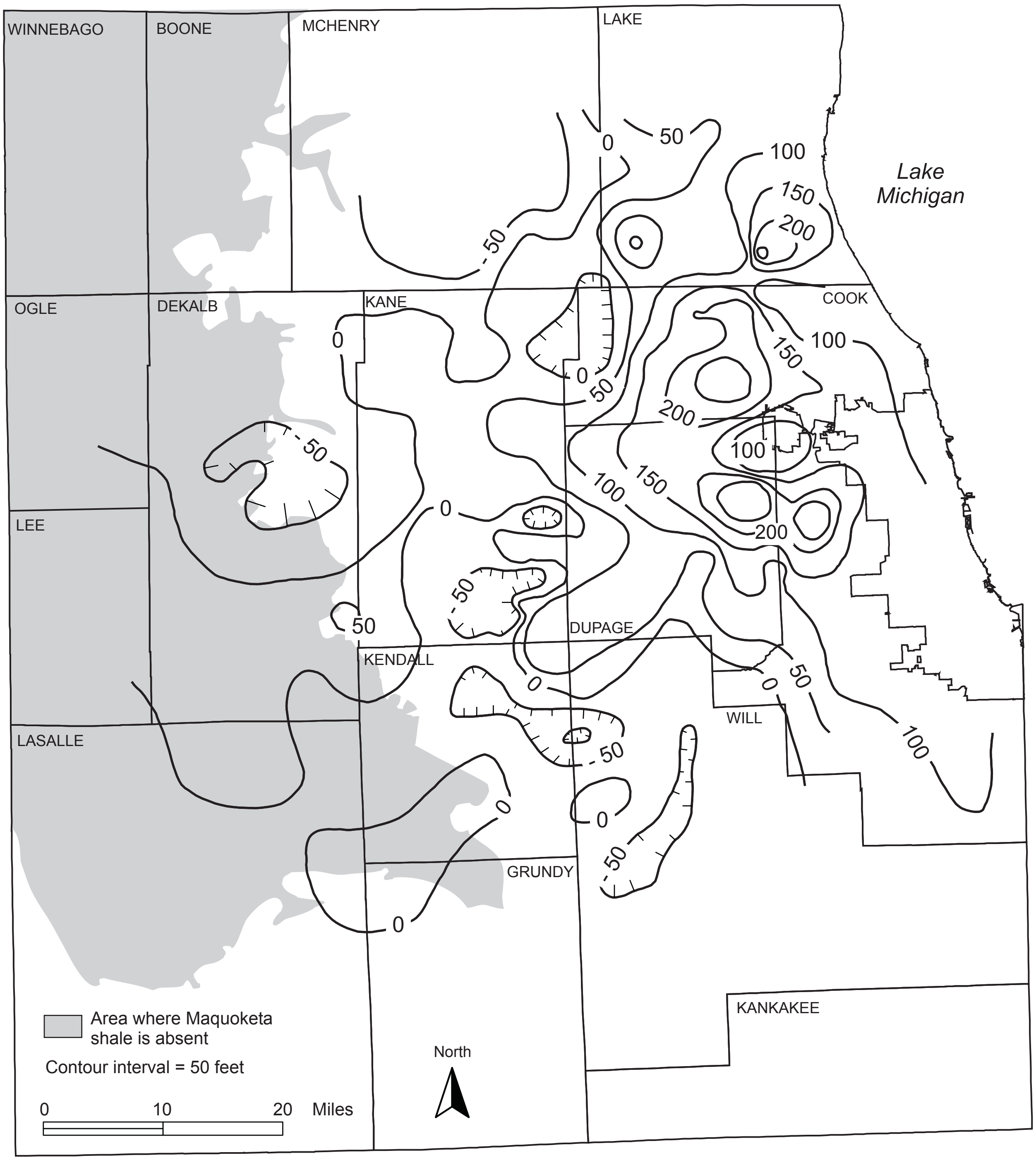


Figure 11. Changes in groundwater level in deep bedrock wells in northeastern Illinois between 1980 and 2000

Summary and Conclusion

In response to expanding urban development, the use of Lake Michigan water and other sources for public supplies, and a growing interest in regional water resources development, this report provides a detailed discussion of groundwater withdrawals and water levels in northeastern Illinois. The water-level portion of this report covers a 15-county area from Lake Michigan to north-central Illinois and from the Wisconsin border south to Kankakee County. Groundwater levels were measured in 367 deep bedrock wells during fall 2000 and were compared with previous measurements.

Particular emphasis was given to deep well pumpage in the eight counties of the Chicago region because of the significant shift in the late twentieth century from groundwater supplies of the deep bedrock aquifers to water from Lake Michigan and other sources. Between 1995 and 1999, pumpage rose slightly for public and industrial supplies from deep bedrock wells (Cambrian-Ordovician) in the Chicago region from 67.34 mgd in 1995 to 71.93 mgd in 1999. Public water supplies in Will and Kane Counties constitute the greatest demand, followed by industrial use in Cook and Grundy Counties.

Depths to groundwater levels in deep wells can be measured by using compressed air and pressure gages. These data can be converted so that the groundwater level can be plotted on a map as an elevation above or below the National Geodetic Vertical Datum, commonly referred to as “mean sea level.” By contouring points of equal elevation, the groundwater surface can be mapped. Such a potentiometric map is important because the general direction of groundwater flow can be inferred from the contour pattern.

The 2000 potentiometric surface shows a pattern of flow east and west from a small groundwater divide in northeastern Illinois and southeastern Wisconsin. Deviations from this pattern occur in Illinois, especially in northern Cook County, near Joliet, and near DeKalb. Groundwater also flows south in LaSalle County and discharges to the Illinois River.

Comparison of the 1995 and 2000 potentiometric surface maps indicates a groundwater recovery slowdown in the eight-county Chicago region. Large portions of the study area have water-level changes ranging from increases of 25 feet to decreases of 25 feet. This contrasts with the 1985, 1991, and 1995 measurements when observed changes generally were increases on the order of 50 or 100 feet. The largest recoveries since 1995 were observed at Des Plaines, Bellwood, Western Springs, Prospect Heights, and Elgin. Declines continued at the Aurora pumping center and at the developing pumping center in northern Kendall County.

About 40 years ago, the maximum amount of groundwater for continual withdrawal from the deep bedrock was estimated to range from 46 to 65 mgd, and pumpage in 1979 greatly exceeded all estimates. In 1980, the U.S. Supreme Court, in effect, forced the State of Illinois to formally recognize the need to reduce pumpage from the deep bedrock (Cambrian-Ordovician) aquifers.

The ensuing water allocation program allowed the diversion of Lake Michigan water for use in Illinois, lessening groundwater withdrawals from the deep bedrock. A comparison of water elevations in 1980 and 2000 found groundwater levels about 300 feet higher at Villa Park and Elmhurst (DuPage County) than they were in 1980. Meaningful recoveries of more than 100 feet were observed over a large area of Cook, DuPage, and Lake Counties.

An examination of the widely cited 65-mgd estimate of practical sustained yield from the deep bedrock aquifers has some shortcomings. These include difficulties in delineating a 1,200-square-mile recharge area that is east of the groundwater divide in north-central Illinois, transmissivity variability, direction of lateral flow, and improbably steep hydraulic gradients. Despite the difficulties of precisely determining the practical sustained yield, and despite the groundwater-level recoveries documented in this and other reports, the aquifers continue to be pumped in excess of all yield estimates.

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Appendix A. Water-Level Elevations of the Deep Bedrock Aquifers in Northern Illinois, 1995-2000

Appendix A. Water-Level Elevations of the Deep Bedrock Aquifers in Northern Illinois, 1995 and 2000

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
Boone							
44N03E24.8a	6	Belvidere	868	784	712	726	14
44N03E25.3d	1	Pillsbury-Green Giant Pkg Co.	627	770	716		
44N03E25.4d	2	Pillsbury-Green Giant Pkg Co.	550	770	717		
44N03E25.6d	2	Dean Foods Co.	868	770	670		
44N03E25.7c	2	Belvidere	1861	763		743	
44N03E25.8b	3	Belvidere	1803	765	753	759	6
44N03E26.1e	4	Belvidere	1801	778	710	721	11
44N03E34.2a	8	Belvidere	1393	780	599	640	41
44N03E35.1f	5	Belvidere	610	800	736	734	-2
44N03E36.2g	7	Belvidere	969	840	625	620	-5
45N03E27.4c	3	Consumers Ill. Water Co. -Candlewick Lk.	917	885	675		
Cook							
35N14E19.4c	22	Chicago Heights	1800	677	239		
35N14E21.2h	2	Rhodia Co.	1979	640	168	172	4
36N12E02.5h	11	Orland Park	1683	712	84	100.5	16.5
36N12E22.6b	3	Citizens Fernway Utilities	1712	720	-54	-65	-11
36N13E09.8b	1	Oak Forest	1701	672	116	132	16
37N11E14.7c	1	IMTT	1501	585	20		
37N11E29.1g	4	Lemont	1685	737	51		
37N11E29.4a	3	Lemont	1723	743	-84		
37N11E31.2e	5	Lemont	1675	752			
37N12E02.8h	2	Hickory Hills	1608	685	66	86	20
37N13E26.1g	3	Oak Hill Cemetery	1637	617	235	223	-12
37N14E27.5e	1118	Met. Water Recl. Dist.	1683	590	183		
38N12E05.8d	3	Western Springs	1600	673	-19	63	82
38N12E06.6b	4	Western Springs	1913	642	-78	74	152
38N12E18.8g	3	R.M.L. Speciality Hospital	1540	685	25	38	13
38N12E23.2g	13	CPC Intl., Inc.	1525	600			
38N12E24.7h	14	CPC Intl., Inc.	1481	597			
38N12E24.8g	12	CPC Intl., Inc.	1507	597	31		
38N13E08.1f	4	Rose Packing Co.	1590	594	108		
38N13E19.4f	3	Viskase Corporation	1665	621			
38N13E19.6f	2	Viskase Corporation	1590	619	14		
38N13E27.5g	1	Tootsie Roll Industries	1565	617	97	132	35
38N14E07.6c	1	Froedtert Malt Co.	1583	594	139		
38N14E07.6d	2	Froedtert Malt Co.	1523	594	115	155	40
39N12E08.5g	4	Bellwood	1965	645	152	140	-12
39N12E09.5a	3	Bellwood	1480	624		133	
39N12E11.7f	3	Maywood	1640	630	141		
39N12E16.2f	5	Bellwood	1845	627	101	163	62
39N13E21.6g	1	Kropp Forge Co.	1636	608	-45	178	223
39N14E21.7b	1	Industrial Coatings Group, Inc.	1610	593	129		
39N14E21.7b	2	Industrial Coatings Group, Inc.	1603	593	267		
40N12E31.4c	2	Centerpoint Properties	1468	655			
40N12E31.4d	1	Centerpoint Properties	1470	655	75		
41N09E23.5g	3	Streamwood	1410	820	310	315	5
41N09E36.3f	2	Hanover Park	1429	828	229	247	18
41N09E36.6b	4	Hanover Park	1434	820	291	282	-9
41N10E06.5b	10	Hoffman Estates	1357	810	250	262	12
41N10E12.3g	21	Schaumburg	1355	735	130	99	-31
41N10E21.1f	20	Schaumburg	1440	800	190	153	-37
41N10E31.3e	3	Hanover Park	1952	798	263	281	18

Appendix A. (continued)

County location	Well no.	Owner	Depth ft.	Surface elev.	Water-level elevation 1995	Water-level elevation 2000	Water-level change, ft.
Cook (cont'd)							
41N10E34.8h	15	Schaumburg	1350	810	190		
41N10E36.8b	11	Elk Grove Village	1367	725	48	>119	>71
41N11E08.3a	6	Rolling Meadows	1602	694	245	186	-59
41N11E14.5b	3	Citizens Waycinden Division	1382	672	32	-11	-43
41N11E16.2h	12	Arlington Heights	1780	714	304	164	-140
41N11E23.7f	16	Mt. Prospect	1961	675	85		
41N11E24.1f	2	Citizens Waycinden Division	1652	660	74	143	69
41N11E25.2h	7	Des Plaines	1815	655	239	270	31
41N11E25.6b	4	Touhy Mobile Homes	1515	657	7	32	25
41N11E26.8a	2	Elk Grove Village	1395	682		153	
41N11E27.3f	9	Elk Grove Village	1403	681	26	91	65
41N11E31.3a	14	Elk Grove Village	1390	702	-108		
41N12E12.8b	1	North Suburban Public Util.	1414	662	99		
41N13E22.4g	2	Evanston Country Club	1465	608	76		
42N09E25.5g	4	Willow Creek Church	947	840	251	252	1
42N09E32.6e	1	Sears Roebuck & Co.	1380	845	225	245	20
42N09E34.7a	1	Allstate Insurance Co.	1250	850	264	299	35
42N09E34.8a	3	Allstate Insurance Co.	1370	850	298	316	18
42N10E01.8f	15	Palatine	1603	750	225	252	27
42N10E14.6h	10	Palatine	1995	750	247	273	26
42N10E15.3f	7	Palatine	1350	750	290	>300	>10
42N10E24.8a	1	Arlington Park Jockey Club	1825	724	149		
42N10E25.8g	4	Arlington Park Jockey Club	1906	728	52	68	16
42N10E26.4h	5	Rolling Meadows	1555	733	293	196	-97
42N11E03.3b	5	Wheeling	1355	650	32	7	-25
42N11E05.8e	1	Buffalo Grove	1335	725	149	135	-14
42N11E06.6c	13	Arlington Heights	1795	730	300	220	-80
42N11E08.1a	11	Arlington Heights	1647	689	287	226	-61
42N11E10.7a	7	Wheeling	1350	661	-6	154	160
42N11E12.8b	2	Plum Creek Condominiums	1323	645	95		
42N11E17.7e	9	Arlington Heights	1532	691	221		
42N11E24.4d	4	Citizens Chicago Suburban Division	1323	642	0		
42N11E26.4h	2	Prospect Heights	1318	648	58	118	60
42N11E26.7d	2	Citizens Chicago Suburban Division	1468	661	73	143	70
42N11E27.5h	17	Mt. Prospect	1282	663	13	113	100
42N11E30.3b	17	Arlington Heights	1323	708	308		
42N11E31.7a	16	Arlington Heights	1810	698	270		
42N11E33.3b	4	Mt. Prospect	1950	693	123	148	25
42N11E34.4g	5	Mt. Prospect	1822	670	80	130	50
42N12E14.2a	3	Sunset Ridge Country Club	1396	655	106	133	27
42N12E14.2c	2	Sunset Ridge Country Club	1247	655		161	
42N12E18.1e	1	Mission Brook Sanitary Dist.	1399	685	110		
42N12E18.2b	1	Ameritech	1380	660	79	89	10
42N12E18.3a	1	Culligan U.S.A.	1380	652	79	57	-22
42N12E18.3e	3	Mission Hills Country Club (1)	1400	660	75	105	30
42N12E18.4a	1	Donlen Corp.	1330	660		40	
42N12E19.1b	3	Allstate Ins. Co.	1401	662	67	83	16
42N12E19.1c	1	Allstate Ins. Co.	1400	663	32	90	58
42N12E19.1d	2	Allstate Ins. Co.	1404	663	43	15	-28
42N12E19.2a	4	Allstate Ins. Co. (G)	1400	655	63	105	42
42N12E19.2e	2	Accenture	1400	657	130	88	-42
42N12E19.2h	2	Culligan U.S.A.	1380	655	84	85	1
42N12E19.3a	1	Allstate Ins. Co. - West Plaza	1352	640	94	103	9
42N12E19.3f	1	Accenture	1400	655	75	73	-2

Appendix A. (continued)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
Cook (cont'd)							
42N12E19.4b	2	Allstate Ins. Co. - West Plaza	1328	650	78	115	37
42N12E23.6b	1	Sunset Village	1415	626	54		
42N12E32.6f	2	Zenith Radio Corp.	1400	662	108		
42N12E36.8f	3	North Shore Country Club	1444	640	106	130	24
42N13E32.1a	2	Westmoreland Country Club	1477	630	125		
DeKalb							
37N05E32.1c	1	Somonauk	190	685	657	660	3
37N05E32.1c	2	Somonauk	502	685	648	661	13
37N05E36.7g	3	Sandwich	610	655	633		
37N05E36.7h	1	Sandwich	600	667	649	646	-3
38N04E15.8d	3	Waterman	400	813	771		
38N04E16.2d	2	Waterman	400	825	789		
38N05E14.4d	3	Hinckley	605	740	719	719	0
38N05E15.2d	2	Hinckley	708	740	723		
38N05E15.2d2	4	Hinckley		740		664	
40N03E15.7c	2	Kishwaukee College	920	910	716	717	1
40N03E23.6e	2	Malta	1254	915	739		
40N03E23.7e	1	Malta	853	915	769		
40N04E01.4e	7	Sycamore	1233	835	559	512	-47
40N04E10.7b	14	DeKalb	1313	890	605	589	-16
40N04E13.2h	11	DeKalb		885		580	
40N04E15.7a	6	DeKalb	1291	855	585	597	12
40N04E16.1g	1	Suburban Apts. & Estates	805	880	791	801	10
40N04E21.4f	10	DeKalb	1310	880	625	616	-9
40N04E23.5d	4	DeKalb	1325	885	602		
40N04E26.3g	1	Del Monte Corp.	1324	890	622		
40N04E26.6e	7	DeKalb	1328	885		544	
40N04E33.1h	12	DeKalb	1200	862	588	612	24
40N04E34.5c	13	DeKalb	1222	865	646	635	-11
40N05E05.5e	5	Sycamore	1270	872	683		
40N05E06.7a	8	Sycamore	1300	880	657	651	-6
40N05E29.3g	3	Cortland	1307	892	622	620	-2
41N05E32.1g	3	Sycamore	1002	845	815	759	-56
41N05E32.3e	1	Sycamore	902	870	820	800	-20
41N05E32.7g	6	Sycamore	1214	845	665	600	-65
42N03E26.3h	0	Kirkland	737	767	763	731	-32
42N03E26.3h	1	Kirkland	636	764	756		
42N04E22.7a	2	Kingston	755	830	675		
42N05E19.4b	3	Genoa	732	830	699	685	-14
42N05E20.7a	4	Genoa	770	847	645	626	-19
DuPage							
38N09E01.5a	28	Naperville	1490	730	105	120	15
38N09E22.2h	26	Naperville	1500	700	118	103	-15
38N09E29.5f	22	Aurora	1420	684	170	74	-96
38N10E08.5h	24	Naperville	1560	772	97	92	-5
38N10E18.3d	25	Naperville	1491	695	113	100	-13
38N10E30.4d	16	Naperville	1478	690	110	95	-15
38N10E33.4h	20	Naperville	1572	748	76	46	-30
38N11E03.7e	13	Westmont	1578	740	50	70	20
38N11E10.7e	11	Westmont	1604	751	64		
38N11E11.5c	7	Clarendon Hills	1585	722	60	72	12
38N11E23.5e	3	Willowbrook	1620	734	50	87	37

Appendix A. (continued)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
DuPage (cont'd)							
38N11E28.1c	4	Darien	1612	767	69	65	-4
39N09E04.1b	3	West Chicago	1378	762	146	241	95
39N09E05.4d	5	West Chicago	1376	751	210	221	11
39N09E08.4b	9	West Chicago	1424	751	117	79	-38
39N09E15.7h	4	West Chicago	1465	746	155	145	-10
39N09E19.6c	4	Fermi Nat. Accelerator Lab.	1432	756	439	203	-236
39N10E01.5e	1	Midwest Generation - Lombard Station	1565	740			
39N11E04.1e	7	Villa Park	1420	702	107	107	0
39N11E09.2h	2	Villa Park	1605	699	138	149	11
39N11E10.1h	4	Elmhurst	1400	669	119	136	17
39N11E10.3g	11	Ovaltine Food Products	1897	670	222		
39N11E15.8d	10	Villa Park	1458	685	103	113	10
39N11E17.8d	7	Lombard	1520	730	72		
39N11E20.7a	8	Lombard	1590	775	106	92	-14
39N11E24.3b	5	Oak Brook	1503	680	80	75	-5
39N11E26.5h	2	Oak Brook (Well #1)	1521	685	75		
39N11E26.8h	1	Oak Brook (Well #2)	1458	690	45		
39N11E27.6g	7	Oak Brook	1513	715	-30	33	63
39N11E33.6h	6	Oak Brook	1522	695	24	101	77
40N09E03.5b	7	Bartlett	1996	812	229	202	-27
40N09E11.6h	4	Bartlett	1985	770	5	235	230
40N09E13.8d	8	Bartlett	1445	793	233	234	1
40N09E19.3a	10	West Chicago	1425	750		186	
40N10E09.3h	5	Roselle	1423	805	67		
40N10E20.4g	8	Bloomingdale	1415	765	42	>122	>80
40N11E10.4h	5	Wood Dale	1400	695	105	>145	>40
40N11E11.4d	7	Bensenville	1900	680	145	>210	>65
40N11E14.4e	3	Bensenville	1445	670	130	>170	>40
40N11E16.6g	7	Wood Dale	1356	693	315	25	-290
40N11E26.2h	6	Bensenville	1900	684	89	144	55
40N11E35.5e	6	Elmhurst	1476	703	83	90	7
Grundy							
31N06E06.2e	2	Kinsman	785	658	416		
31N08E04.1a	4	Gardner	1933	588	360	332	-28
31N08E04.2a	5	Gardner	1929	587	397	360	-37
31N08E04.2b	3	Gardner	972	586	373		
31N08E11.6a	4	South Wilmington	970	585	279		
31N08E11.6b	3	South Wilmington	994	586	281		
32N08E03.1e	4	Coal City	793	567	301		
32N08E26.1f	1	Braceville	868	580	301		
33N06E29.3d	2	Explosives Technologies Intl.	1433	502	418		
33N07E04.2a	3	Morris	1485	523	323	327	4
33N07E04.4c	5	Morris	1462	506	306	293	-13
33N07E04.6c	6	Morris	1450	525	339		
33N07E09.3h	4	Morris	1501	519	291		
33N08E07.4c	3	Midwest Generation - Collins Station	1513	525	289		
33N08E34.1d	5	Coal City	1785	560	316	299	-17
33N08E35.3f	1	Coal City	805	560	330		
33N08E36.5a	1	Diamond	723	562		462	
34N08E01.3e	3	Minooka	1508	610	251		
34N08E01.3e	4	Minooka	725	610	340	342	2
34N08E20.2e	1	Equistar	1453	524	127		
34N08E21.3f	2	Alcoa Engineered Products	1515	525	277	164	-113

Appendix A. (continued)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
Grundy (cont'd)							
34N08E21.3g	1	Alcoa Engineered Products	1540	525	268		
34N08E21.4f	3	Alcoa Engineered Products	1540	528		168	
34N08E21.9a	3	Equistar	1463	523			
34N08E21.9c	2	Equistar	1470	526	99		
34N08E22.6e	2	Northern Ill. Gas Co. SNG Plant	1519	523	225		
34N08E22.8e	1	Northern Ill. Gas Co. SNG Plant	1511	522	209		
34N08E28.5f	5	Equistar	1455	502		103	
34N08E34.7h	1	Reichhold Chemicals, Inc.	706	510	410		
34N08E34.7h	2	Reichhold Chemicals, Inc.	710	518	418		
34N08E35.1e	2	Exelon - Dresden Station	1500	515	257	281	24
34N08E35.1g	1	Exelon - Dresden Station	1499	519	241	304	63
34N08E35.4d	2	General Electric Co.	788	533	313	305	-8
Kane							
38N07E05.2d	1	Waubonsee College	1323	703	455	438	-17
38N07E19.7e	4	Sugar Grove	1475	705	499	427	-72
38N07E24.6h	21	Aurora	1447	670		199	
38N07E25.5b	23	Aurora	1420	670	223	127	-96
38N08E01.2c	20	Aurora	1400	715	171	168	-3
38N08E03.6g	5	North Aurora	1330	700	166	148	-18
38N08E04.3g	3	North Aurora	1305	675	190	67	-123
38N08E04.8d	4	North Aurora	1325	689	140	126	-14
38N08E08.3a	25	Aurora	1460	695	195	73	-122
38N08E13.7b	2	Rock-Tenn Co. (formerly Davey Co.)	1787	696			
38N08E13.8b	1	Rock-Tenn Co. (formerly Davey Co.)	1397	696	176		
38N08E15.6f	1	Oberweiss Dairy	875	660	155		
38N08E16.4d	17	Aurora	2152	685	275	226	-49
38N08E19.5a	19	Aurora	1424	685	168	138	-30
38N08E24.7c	18	Aurora	1486	715	172	226	54
38N08E29.2h	15	Aurora	1719	665	191	108	-83
38N08E32.4f	4	Montgomery	1333	641			
38N08E33.7c	3	Montgomery	1336	635	125	92	-33
38N08E34.6b	8	Montgomery	1378	665	151	76	-75
38N08E34.8g	16	Aurora	2139	660	178	280	102
39N07E05.7f	4	Elburn	1353	840	480	454	-26
39N08E02.4c	5	Geneva	2292	753	299	319	20
39N08E03.5e	1	Burgess Norton Mfg. Co.	1308	760	355	362	7
39N08E03.8g	3	Geneva	2300	759	269	299	30
39N08E09.8h	6	Geneva	1350	758	215	280	65
39N08E11.7e	7	Geneva	2001	730	249	249	0
39N08E22.3e	2	Batavia	2200	667	234	238	4
39N08E22.3e	3	Batavia	2200	667	406	423	17
39N08E23.8f	4	Batavia	1357	721	233	237	4
39N08E26.6g	5	Batavia	1440	780	186	190	4
39N08E33.5g	2	Mooseheart Home	1508	704	208	209	1
39N08E33.5g	3	Mooseheart Home	1386	713	243	254	11
40N06E30.5a	4	Maple Park	960	862	606	600	-6
40N07E03.3h	1	Glenwood School	780	900		317	
40N07E03.3h	2	Glenwood School	790	890		380	
40N07E24.5d	1	Wasco Sanitary Dist. Water System	875	800	459	439	-20
40N07E32.8b	3	Elburn	1393	900	502	492	-10
40N08E04.1a	2	Silver Glen Estates (north well)	705	755			
40N08E09.1h	1	Silver Glen Estates (south well)	700	735	423	432	9
40N08E24.6g	1	Royal Fox Golf Course	1345	760	332	332	0

Appendix A. (continued)

County location	Well no.	Owner	Depth ft.	Surface elev.	Water-level elevation 1995	Water-level elevation 2000	Water-level change, ft.
Kane (cont'd)							
40N08E25.4a	8	St. Charles	1368	761	340	391	51
40N08E27.5a	3	St. Charles	1191	690	281	282	1
40N08E27.6b	4	St. Charles	1647	692	291	289	-2
40N08E31.6f	5	Illinois Youth Center	1292	763	374	420	46
40N08E31.6h	4	Illinois Youth Center	1322	790	384	384	0
40N08E34.6e	5	St. Charles	1713	764	309	336	27
41N06E09.1g	2	Burlington	1105	922	570		
41N06E09.1g	3	Burlington	1105	925	580	567	-13
41N07E19.4d	3	Central Community School	1035	1040		525	
41N08E11.1h	2	Elgin (Slade Ave. #2)	1965	723	240	290	50
41N08E11.1h	3	Elgin (Slade Ave. #3)	1960	725	303	298	-5
41N08E11.2g	1	Elgin (Slade Ave. #1)	2000	721	264	345	81
41N08E11.2g	5	Elgin (Slade Ave. #5)	1225	720	246	310	64
41N08E11.3f	6	Elgin (Slade Ave. #6)	1300	720	206	277	71
41N08E16.2d	704	Elgin (4A)	1345	831	80	137	57
41N08E16.4c	701	Elgin (1A)	1305	858	252	275	23
41N08E16.4d	702	Elgin (2A)	1353	861	308	335	27
41N08E16.4d	703	Elgin (3A)	1320	866	286	335	49
41N08E16.7c	705	Elgin (5A)	1310	815	273	286	13
42N06E03.1e	7	Ill. Toll Highway Comm. (M6)	962	910			
42N06E21.2b	5	Hampshire	818	878	452	>384	
42N06E11.6h	7	Hampshire	997	955		550	
Kankakee							
29N10E04.2a	1	Nat. Gas Ppl. (Holtman #1)	1837	690	418		
30N09E03.8g	1	Nat. Gas Ppl. (P. Cook #G-1)	1815	613	394		
30N09E06.8a	1	Reddick	1188	612	252		
30N10E08.5a	1	Nat. Gas Ppl. (Heimburger #1)	2582	628	380		
30N10E16.8c	1	Nat. Gas Ppl. (J. Karcher #1)	1825	635	403		
30N10E29.2h	5	Herscher	789	648	413		
30N10E30.1h	1	Nat. Gas Ppl. (Saffer #1)	1788	649	418		
30N10E34.8f	1	Nat. Gas Ppl. (G. Clodi #1)	1881	670	412		
Kendall							
35N06E05.6a	3	Newark	336	690	608	601	-7
35N06E06.2e	2	Newark	287	663	571	577	6
36N07E06.1g	1	Fox Lawn Subdivision	715	665	479	478	-1
36N07E16.5g	1	Ill. Division of Highways	750	725	489		
37N06E22.7b	1	Sparkling Spring Water Co.	550	650	581		
37N07E27.2b	1	Hide-A-Way Lakes Inc.	550	590	396		
37N07E28.8b	4	Yorkville	1393	628	338	305	-33
37N07E31.5b	1	Hoover Outdoor Ed. Center	850	640	465	451	-14
37N07E32.1e	3	Yorkville	1335	584	334	311	-23
37N08E05.5i	1	AT&T	1332	640	252		
37N08E05.6e	2	Fox Metro Water Reclam. Dist.	1325	628	184	129	-55
37N08E05.9f	1	Caterpillar Tractor Co.	1384	661			
37N08E06.2d	3	Caterpillar Tractor Co.	1352	661			
37N08E06.2f	2	Caterpillar Tractor Co.	1346	660			
37N08E11.1h	7	Oswego	1535	735		75	
37N08E07.2b	6	Oswego	1392	652	202	132	-70
37N08E17.2e	4	Oswego	1396	658	210		
37N08E20.8h	3	Oswego	1378	640	219	200	-19

Appendix A. (continued)

County location	Well no.	Owner	Depth ft.	Surface elev.	Water-level elevation 1995	Water-level elevation 2000	Water-level change, ft.
Lake							
43N09E11.2a	2	Lake Barrington Shores	1305	815	210	356	146
43N10E06.5b	1	Wynstone Water Co.	1001	850	244	215	-29
43N10E06.5b	3	Wynstone Water Co.	1000	850	341	306	-35
43N10E06.5c	2	Wynstone Water Co.	1000	860	317	270	-47
43N10E06.7b	4	Wynstone Water Co.	1321	830	235	205	-30
43N10E07.1a	11	Lake Zurich	1358	838	235	233	-2
43N10E13.2g	3	Fields of Long Grove	980	741	183	161	-22
43N10E14.7d	1	Kemper Insurance	1400	796	293	230	-63
43N10E15.2d	2	Kemper Insurance	1402	796	160	216	56
43N10E16.4d	8	Lake Zurich	1373	868	216	217	1
43N10E16.8f	12	Lake Zurich		860		210	
43N10E19.4h	10	Lake Zurich	1340	850	212	210	-2
43N10E21.5e	7	Lake Zurich	1333	846	201	198	-3
43N10E23.2b	1	Glenstone Subdivision	980	750	188	198	10
43N10E29.2h	9	Lake Zurich	1365	875	183	211	28
43N11E09.4a	8	Vernon Hills (Well 3)	1265	700	220	233	13
43N11E12		Lincolnshire Park Dist.	940	680		210	
43N11E18.4d	1	Royal Melbourne Golf Course	1300	740	169	197	28
43N11E18.5a	3	Royal Melbourne Homeowner Assn.	925	725	165	156	-9
43N11E18.6a	2	Royal Melbourne Homeowner Assn.	958	725	172	159	-13
43N11E18.7a	1	Royal Melbourne Homeowner Assn.	945	725	181	176	-5
43N11E19.1d	1	Briarcrest Subd. Homeowner Assn.	960	690	196	243	47
43N11E19.1d	3	Briarcrest Subd. Homeowner Assn.	940	695	190	193	3
43N11E21.3g	1	Powernail Co.	1258	685		165	
43N11E22.6d	3	Lincolnshire	1300	667	196	217	21
43N11E32.8f	2	Buffalo Grove	1355	703	173		
43N11E34.2g	6	Pekara Subdivision	980	642	107	124	17
43N12E30.4f	1	Deerfield Park Dist.	1375	660	157	177	20
43N12E31.6e	1	Baxter Corp. Headquarters	1456	685	153	156	3
43N12E33.3h	1	Briarwood Country Club	1333	680		178	
44N09E20.6e	9	Island Lake	1337	740		340	
44N09E24.5d	4	Wauconda	1264	792	348	322	-26
44N10E12.8a	9	Mundelein	1380	830	265		
44N10E25.1c	10	Mundelein	1421	760	245	220	-25
44N10E35.5b	4	Countryside Lakes	1085	780		243	
44N11E10.3b	3	Countryside Manor Subdivision	1040	672	262	259	-3
44N11E21.7f	11	Libertyville	1490	703	278	288	10
44N11E28.4e	12	Libertyville	1926	700	275		
44N11E32.6a	6	Vernon Hills	1912	725	425	430	5
44N11E33.3g	1	Cuneo Museum Gardens	1290	690	262		
44N11E33.5a	7	Vernon Hills	1870	685	220	230	10
44N12E21.8f	4	Lake Bluff #2	1804	680	377	385	8
45N09E22.4c	1	Volo	975	790		345	
45N09E22.4c2	2	Volo	1012	790		371	
45N10E15.7e	6	Round Lake Beach	1287	790	405	410	5
45N10E20.4h	7	Round Lake Beach	1250	760	380		
45N10E26.2b	4	Grayslake	1354	780	315	328	13
45N10E30.3d	3	Round Lake	1241	791	365	372	7
45N11E07.1b	7	Grandwood Park	1020	772	297	356	59
45N11E14.5a	1	Gurnee	1517	667	360		
45N11E30.1a	2	Wildwood	1845	785	335	345	10
45N11E30.4g	4	Wildwood	1320	795	326	337	11
45N11E30.4g	8	Wildwood	1088	795		342	
45N11E31.5g	7	Wildwood	1320	813	321	298	-23

Appendix A. (continued)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
Lake (cont'd)							
45N11E32.3f	1	Merit Club	1367	755	313	305	-8
45N11E36.7c	3	Allegiance (formerly Baxter Healthcare)	1415	710	305	274	-31
45N11E36.7d	1	Allegiance (formerly Baxter Healthcare)	1421	710	273	273	0
46N12E14.6g	1	U.S. Geological Survey	1203	585	372	375	3
46N12E21.1b	1	Zion	1100	633	364		
LaSalle							
31N01E24.6e	4	Lostant	1881	700	455		
31N03E22.8h	1	Kangley	542	632	451		
32N02E05.4h	2	Matthiesen State Park	304	640	485		
32N05E17.1a	2	Midwest Generation - LaSalle Station	1620	711	479		
32N05E17.2f	1	Midwest Generation - LaSalle Station	1629	712	430		
33N01E08.2f	8	Peru	2764	638	385	340	-45
33N01E16.8a	4	Peru	1506	460	458		
33N01E16.8a	6	Peru	2665	540	299	348	49
33N01E20.1h	7	Peru	2591	460	367		
33N01E20.2h	5	Peru	2601	465	381	414	33
33N01E20.8h	1	American Nickeloid Co.	1632	595	464		
33N01E36.6g	3	Oglesby	2821	630	413		
33N01E36.6g	4	Oglesby	2795	630	429		
33N02E09.7b	2	North Utica	1078	470	496		
33N02E09.8b	1	North Utica	618	480	494		
33N02E21.2g	3	Starved Rock State Park	401	470	454	460	6
33N02E21.3g	2	Starved Rock State Park	475	470	446		
33N03E01.6b	7	Ottawa	1187	489	432		
33N03E01.7c	11	Ottawa	1203	488	428		
33N03E03.2b	1	Lavico Polymers (USA), Inc.	1225	490	457		
33N03E03.5a	2	Lavico Polymers (USA), Inc.	1255	490	442		
33N03E12.2h	12	Ottawa	1200	492	429		
33N03E16.2f	1	Naplate	420	485	423		
33N03E17.7c	1	Buffalo Rock State Park	480	542	454		
33N04E13.2f	5	Marseilles	1450	670	417	406	-11
33N04E13.3c	3	Marseilles	850	498	455		
33N04E15.7e	2	General Electric Plastic Plant	1292	480	309		
33N04E15.7h	4	General Electric Plastic Plant	444	485	356		
33N04E15.8f	3	General Electric Plastic Plant	1243	490	362		
33N04E16.3g	1	Ottawa Steel & Wire	442	480	386		
33N04E16.6g	1	Garvey International	440	480	400		
33N05E07.6a	4	Marseilles	1466	688	405	412	7
33N05E20.4e	1	Vigoro Industries, Inc.	360	496	441		
33N05E21.5c	1	PCS Phosphate	410	490	389		
33N05E23.1g	3	Seneca	1445	635	425		
33N05E24.8c	1	Seneca	700	510	465		
33N05E28.4e	6	Marseilles		507		300	
34N01E05.1h	15	Northern Ill. Gas Co. (Weldon 15)	1007	678	581		
34N01E05.2h	9	Northern Ill. Gas Co. (Weldon 9)	1022	681	578		
34N03E35.4a	2	Oak Lane Subdivision	504	610	450		
34N04E09.4g	1	Wedron Silica Co. (Housing 1)	261	545	500		
34N04E25.2b	1	Illinois Prairie Estates	681	760	488		
34N05E02.2h	3	AT&T	377	770	569	567	-2
34N05E02.2i	1	AT&T	1348	770	483		
34N05E02.3h	2	AT&T	1353	770	480		
35N01E34.8g	1	Northern Ill. Gas Co. (A. Engel #1)	1292	675	587		
35N05E08.6b	1	Sheridan Correctional Center	885	591	573		

Appendix A. (continued)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
LaSalle (cont'd)							
35N05E17.7h	3	Sheridan Correctional Center	900	592	566		
35N05E20.1b	1	Girl Scouts - Camp Merrybrook	300	610	521		
36N01E27.4a	1	Del Monte Corp.	1384	730	560		
36N01E27.5b	2	Del Monte Corp.	1385	740	569		
36N01E29.2d	6	Mendota	1408	771	551	546	-5
36N01E32.1a	4	Mendota	1360	740	570	597	27
36N01E33.3g	3	Mendota	1377	740	577	583	6
36N01E36.6h	7	Mendota	508	715	689		
36N01E36.6h	8	Mendota	519	715	694		
36N03E18.4d	3	Earlville	625	703	663	678	15
36N05E08.4g	3	Lake Holiday Utilities	664	670	630		
36N05E08.5g	1	Lake Holiday Utilities	663	670	626		
Lee							
19N11E09.1a	2	Sublette	771	920	674		
37N01E08.7d	4	West Brooklyn	676	945	705	720	15
37N01E08.8c	5	West Brooklyn	680	945	687	675	-12
37N02E10.2b	1	Paw Paw	1018	928	729	728	-1
37N02E10.2c	2	Paw Paw	1053	945	763	732	-31
38N02E33.4e	1	Ill. Dept. of Transportation	1014	880	716		
38N02E33.5e	2	Ill. Dept. of Transportation	973	880	728		
McHenry							
42N07E09.7d	7	Huntley	1268	905		457	
42N08E04.8d	10	Algonquin	1315	880		305	
43N06E04.5d	4	Union	760	841		579	
43N07E11.6e	3	Lakewood	920	900		429	
43N07E12.5f	16	Crystal Lake	1293	900		422	
43N07E22.2f	11	Lake in the Hills	1256	875	364	360	-4
43N07E23.7d	8	Huntley	1260	880		372	
43N07E31.8h	2	Huntley School Dist.	915	880			
43N07E34.6a	10	Huntley	1330	888		470	
43N08E06.3a	6	Crystal Lake	1295	892	429	321	-108
43N08E08.2c	8	Crystal Lake	1300	900	422	406	-16
43N08E12.2d	4	Cary	1350	855	354	358	4
43N08E14.1e	6	Cary	1300	840	354	334	-20
43N08E20.4c	5	Lake in the Hills	910	870	494	455	-39
43N08E21.3a	1	Material Service Corp.	1262	835		437	
43N08E32.4c	1	The Golf Club of Illinois	1295	910	435	410	-25
43N08E33.4h	4	Algonquin	955	870	501	495	-6
44N05E35.5h	1	Arnold Engineering Co.	846	818	738	656	-82
44N08E33.5a	7	Crystal Lake	1400	930	377	341	-36
44N09E20.7d	8	Island Lake	950	740	365	372	7
45N08E10.7a	9	Rohm & Haas	1161	843	445	526	81
45N08E10.7c	8	Rohm & Haas	1160	835		283	
45N08E10.8a	2	Modine Mfg. Co. (owner #1)	1200	843	365	362	-3
45N08E10.8d	7	Rohm & Haas	1161	850		390	
45N08E15.8h	3	Modine Mfg. Co. (owner #2)	1220	835	347		
46N05E33.8b	2	Dean Foods Co. (owner #1)	1783	880	676	681	5
46N05E33.8b	4	Dean Foods Co.	825	880	658	745	87
46N05E36.5g	9	Harvard	1271	1040		657	

Appendix A. (continued)

County location	Well no.	Owner	Depth ft.	Surface elev.	Water-level elevation 1995	Water-level elevation 2000	Water-level change, ft.
Ogle							
24N10E24.2h	2	Midwest Generation - Byron Station	1500	875	627		
24N11E01.2b	1	Stillman Valley	300	733	697		
24N11E01.3a	2	Stillman Valley	460	747	693		
25N11E31.4e	2	Byron School District #226	250	718	668		
25N11E31.5h	3	Byron School District #226	418	728	682		
40N01E12.6a	2	Hillcrest	406	835	760		
40N01E12.6b	1	Hillcrest	387	825	765		
40N01E23.2d	5	Rochelle	502	810	751		
40N01E23.3b	1	Del Monte Corp., Plant 110	494	793	758		
40N01E24.5h	7	Rochelle	925	795	734		
40N01E24.7a	4	Rochelle	1450	793	716		
40N01E25.2h	9	Rochelle	888	785	730	736	6
40N01E25.3f	6	Rochelle	867	800	729		
40N01E26.5h	3	Del Monte Corp., Plant 109	420	778	755		
40N01E36.2h	10	Rochelle	920	785	710		
40N02E23.1f	2	Creston	737	905	796		
40N02E23.2f	3	Creston	724	905	806		
40N02E30.3b	8	Rochelle	935	793	690	696	6
Will							
32N09E01.6b	2	Lakewood Shores	700	561	322		
32N09E01.7f	1	Lakewood Shores	700	558	306		
32N09E05.6d	3	Braidwood	1733	560	303	293	-10
32N09E05.6d	4	Braidwood	795	560	294		
32N09E08.5d	2	Braidwood	846	572	280		
32N09E08.6g	5	Braidwood	805	567	267		
32N09E28.1d	2	Exelon Generation (Training Center)	1690	594	354	353	-1
32N10E36.2d	3	Illinois Youth Center	1700	610	273		
33N09E01.5e	5	Joliet Army Ammunition Plant	935	570	252		
33N09E36.7h	3	Wilmington	1578	530	289		
33N10E09.1f	902	Joliet Army Ammunition Plt Well 1 (East)	1672	646	360		
33N10E09.4h	901	Joliet Army Ammunition Plt Well 2 (West)	1645	641	364		
34N09E03.1a	4	BP Amoco	1415	570			
34N09E03	18	Joliet	1580				
34N09E09.4a	1	Channahon	765	570	266	255	-11
34N09E10.1h	2	BP Amoco	1405	568	-27	-86	-59
34N09E11.7g	1	BP Amoco	1422	569		-107	
34N09E11.8f	3	BP Amoco	1400	575			
34N09E21.2d	1	BASF Corp.	1573	545	219	188	-31
34N09E21.8a	2	Loders-Croklaan Co.	1555	530	240		
34N09E21.8b	1	Loders-Croklaan Co.	1555	530	264	192	-72
34N09E22.7d	1	Mobil Oil Corp.	1578	555	263		
34N09E34.7d	2	Hager Wood Preserving	1593	530	248		
34N10E07.5a	1	Peoples Gas SNG Plant	1581	609	52	52	0
34N10E07.6b	2	Peoples Gas SNG Plant	1597	609	29	7	-22
34N10E20.4e	6	Elmwood	1725	640		120	
34N10E30.6a	1	Abraham Lincoln Natl Cemetery	1665	620		220	
34N10E31.7a	12	Joliet Army Ammunition Plant	1709	625	244		
34N11E17.5d	6	Manhattan	1703	685	164	82	-82
35N09E01.3e	11	Joliet (11D, Gael Drive)	1623	619	-246		
35N09E09.3c	2	Shorewood	1499	605	100	65	-35
35N09E11.1b	10	Joliet (10D)	1572	610	-235		
35N09E25.1e	3	Caterpillar Tractor Co.	1556	547	-71	-88	-17
35N10E02.8b	4	Joliet (4D)	1608	558	-162		

Appendix A. (continued)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
Will (cont'd)							
35N10E03.4e	3	Joliet Correctional Center	1600	560	-150		
35N10E07.4b	9	Joliet (9D, Campbell St)	1671	647			
35N10E09.1d	1	Joliet (1D, Ottawa St)	1621	536	-154		
35N10E14.5d	3	Ivex Corp. Well #2	1639	593	-111		
35N10E14.6h	5	Joliet (5D)	1608	564	-91		
35N10E16.2h	604	Joliet (Des Plaines St)	1575	531	-87		
35N10E16.5c	3	Joliet (3D, Jasper St)	1565	537	-218		
35N10E19.2b	4	Midwest Generation - Sta. 29, Units 7,8	1525	523	-160		
35N10E19.6c	5	Johns-Manville	1525				
35N10E20.6a	2	Midwest Generation - Sta. 9, Unit 5	1487	536		-278	
35N10E20.7g	2	Rockdale	1586	556	-119		
35N10E22.8g	1	Joliet Equipment	1608	569	242		
35N10E29.8e	5	Olin Co.	1535	567	-114		
35N10E29.8h	5	Midwest Generation - Station 9, Units 7,8	1505	527		-2	
35N10E30.1c	4	Olin Co.	1555	583	-30		
35N10E30.1e	2	Olin Co.	1510	550	-178		
35N10E30.2h	3	Comm. Ed. - Sta. 29, Units 7,8	1525	510			
35N10E30.6e	2	Caterpillar Tractor Co.	1543	546	-134	-104	30
35N10E30.6e	4	Caterpillar Tractor Co.	1550	542		-85	
35N11E05.7h	8	Joliet (8D, Hadley Valley)	1660	648	-147		
35N11E08.8h	7	Joliet (7D, Hadley Valley)	1701	674	-171		
36N09E04.4a	4	Plainfield	1443	620	46	-9	-55
36N09E10.7d	3	Plainfield	1481	612	1	-21	-22
36N09E16.2a	5	Plainfield	1508	604	17	-56	-73
36N09E25.6d	12	Joliet (12D, Homart Site)	1557	602	-128		
36N09E31	17	Joliet					
36N10E02.7f	1	Midwest Generation - Station 18	1500	587	-52	-64	-12
36N10E02.8f	3	Midwest Generation - Station 18	1507	590	-39	-86	-47
36N10E02.8h	2	Midwest Generation - Station 18	1536	590	-26		
36N10E04.6g	4	Romeoville	1524	670	-60	-64	-4
36N10E06.6f	11	Romeoville	1555	650		-94	
36N10E16.4e	3	Joliet Regional Port Dist. Airport	1523	666	-33	-29	4
36N10E21.3a	6	Stateville Correctional Center	1611	642			
36N10E23.2f	4	Lockport	1572	650		-109	
36N10E23.6d	2	Lockport	1555	589	-91	-70	21
36N10E27.7b	1	Metropolitan Water Reclamation Dist.	852	547	-82		
36N10E28.6f	4	Stateville Correctional Center	1566	640	-131		
36N10E29.2g	5	Stateville Correctional Center	1653	645	-20		
36N10E33.6h	1	Hendrickson Stamping	1558	593	-98		
36N11E31.8a	6	Joliet (6D, Hadley Valley)	1656	642	-229		
37N09E13.5a	1	Naperville Golf Course	1485	638	83		
37N09E28.8h	6	Plainfield	1490	670		75	
37N10E29.7h	10	Romeoville	1505	640	8	-31	-39
37N10E33.1h	2	Romeoville	1520	640	-29	-35	-6
Winnebago							
43N01E03.7a	34	Rockford	1485	740	661		
43N02E04.3a	43	Rockford	1500	812	597	616	19
43N02E17.7h	36	Rockford (Unit Well 36)	1505	864	585	591	6
44N01E02.3b	3	Rockford (Unit Well 3)	1127	760	661	666	5
44N01E09.1c	20	Rockford (Unit Well 20)	1200	735		625	
44N01E12.6b	1	Ingersoll Milling Machine Co.	729	746	662		
44N01E14.5h	37	Rockford	1434	740	657	659	2

Appendix A. (concluded)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1995*	*Water-level elevation 2000*	*Water-level change, ft.*
Winnebago (cont'd)							
44N01E15.3c	1	Dean Foods Co.	1125	725	688		
44N01E17.2d	22	Rockford (Unit Well 22)	1381	760	625	635	10
44N01E20.7f	21	Rockford (Unit Well 21)	1205	820	650	690	40
44N01E21.1e	15	Rockford (Unit Well 15)	1355	810	623		
44N01E23.6d	801	Rockford (Beattie Pk/Obs Well)	1300	708	693		
44N01E27.1e	2	Reed Chatwood, Inc.	450	705	690		
44N01E28.5c	18	Rockford (Unit Well 18)	1380	820	649	670	21
44N01E33.8f	1	Muller Pinehurst Dairy	482	760	727		
44N01E34.6h	4	Rockford (Unit Well 4)	1219	730	665	672	7
44N02E03.4c	30	Rockford (Unit Well 30)	1325	905	568	558	-10
44N02E07.7e	1	Woodward Governor Co.	1227	725	659		
44N02E07.7e	2	Woodward Governor Co.	732	725	637		
44N02E08.2g	29	Rockford (Unit Well 29)	1357	845	576	593	17
44N02E09.3a	25	Rockford (Unit Well 25)	1290	878	583		
44N02E11.5g	39	Rockford (Unit Well 39)	1500	890	593	690	97
44N02E14.5d	31	Rockford (Unit Well 31)	1505	880	579		
44N02E16.2a	27	Rockford (Unit Well 27)	1280	840	554	573	19
44N02E17.6g	17	Rockford (Edgebrook #3)	1195	785	628		
44N02E18.7a	5	Rockford (Unit Well 5)	1312	792	565	633	68
44N02E20.4h	13	Rockford (Unit Well 13)	1457	835	557	583	26
44N02E23.1d	40	Rockford	1466	855	603	623	20
44N02E25.7g	1	Rockford Park Dist.	1185	793	613		
44N02E28.5h	26	Rockford (Unit Well 26)	1326	835	620	630	10
44N02E29.3a	10	Rockford (Unit Well 10)	1426	865	576	588	12
44N02E31.7f	6	Rockford (Unit Well 6)	1372	790	682	680	-2
44N02E32.4a	16	Rockford (Unit Well 16)	1310	840	566	540	-26
44N02E34.3h	42	Rockford	1500	830	549		
44N02E35.5e	3	Cherry Valley	682	800	657		
44N02E35.6h	2	Cherry Valley	1206	820	640	650	10
44N02E35.8e	1	Cherry Valley	1201	810	635	650	15
45N02E26.1a	5	Loves Park	1390	890	655	655	0
45N02E33.3a	4	Loves Park	1313	888	625	588	-37
45N02E34.4g	3	Loves Park	863	885	840	796	-44
46N01E12.5a	904	Beloit Corp. Welding & Res. Dept.	550	730	720		
46N01E24.8a	6	Rockton	728	828	728	714	-14
46N02E05.7d	3	Wis. Power & Light Co. (S Beloit)	1200	745	690		
46N02E15.5b	1	Colt Industries	301	820	775		
46N02E18.8a	1	Woodward Governor C. - Air	601	765	725	689	-36
46N02E18.8a	2	Woodward Governor C. - Air	600	765	703	686	-17
46N02E19.7g	7	Rockton	594	753	628	633	5
46N02E28.1b	6	North Park Public Water Dist.	780	750	686	693	7
46N02E29.1b	7	North Park Public Water Dist.	780	750	681	696	15

Appendix B. Water-Level Elevations of the Deep Bedrock Aquifers in Northern Illinois, 1980-2000

Appendix B. Water-Level Elevations of the Deep Bedrock Aquifers in Northern Illinois, 1980-2000

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1980*	*Water-level elevation 2000*	*Water-level change, ft.*
Boone							
44N03E25.8b	3	Belvidere	1803	765	754	759	5
44N03E36.2g	7	Belvidere	969	840	688	620	620
Cook							
35N14E21.2h	2	Rhodia Co.	1979	640	72	172	100
36N12E02.5h	11	Orland Park	1683	712	14	100.5	86.5
36N12E22.6b	3	Citizens Fernway Utilities	1712	720	38	-65	-103
36N13E09.8b	1	Oak Forest	1701	672	47	132	85
37N12E02.8h	2	Hickory Hills	1608	685	-28	86	114
38N12E05.8d	3	Western Springs	1600	673	-95	63	158
38N12E06.6b	4	Western Springs	1913	642	-8	74	82
38N14E07.6d	2	Froedtert Malt Co.	1523	594	6	155	149
39N12E08.5g	4	Bellwood	1965	645	-55	140	195
39N12E09.5a	3	Bellwood	1480	624	-137	133	270
39N12E16.2f	5	Bellwood	1845	627	-123	163	286
41N09E36.3f	2	Hanover Park	1429	828	98	247	149
41N09E36.6b	4	Hanover Park	1434	820	140	282	142
41N10E06.5b	10	Hoffman Estates	1357	810	138	262	124
41N10E31.3e	3	Hanover Park	1952	798	107	281	174
41N11E08.3a	6	Rolling Meadows	1602	694	-106	186	292
41N11E16.2h	12	Arlington Heights	1780	714	-91	164	255
41N11E27.3f	9	Elk Grove Village	1403	681	-153	91	244
42N09E34.7a	1	Allstate Ins. Co.	1250	850	300	299	-1
42N10E01.8f	15	Palatine	1603	750	79	252	173
42N10E14.6h	10	Palatine	1995	750	65	273	208
42N10E26.4h	5	Rolling Meadows	1555	733	51	196	145
42N11E03.3b	5	Wheeling	1355	650	-10	7	17
42N11E05.8e	1	Buffalo Grove	1335	725	-32	135	167
42N11E06.6c	13	Arlington Heights	1795	730	30	220	190
42N11E08.1a	11	Arlington Heights	1647	689	-6	226	232
42N11E10.7a	7	Wheeling	1350	661	1	154	153
42N12E19.1b	3	Allstate Ins. Co.	1401	662	31	83	52
42N12E19.1c	1	Allstate Ins. Co.	1400	663	-1	90	91
42N12E19.1c	1	Allstate Ins. Co.	1400	663	-1	90	91
42N12E19.1d	2	Allstate Ins. Co.	1404	663	-1	15	16
42N12E19.2a	4	Allstate Ins. Co. (G)	1400	655	7	105	98
42N12E19.2e	2	Accenture	1400	657	-12	88	100
42N12E19.3f	1	Accenture	1400	655	-35	73	108
DeKalb							
37N05E32.1c	2	Somonauk	502	685	665	661	-4
37N05E32.1c	1	Somonauk	190	685	665	660	-5
37N05E36.7h	1	Sandwich	600	667	649	646	-3
38N05E14.4d	3	Hinckley	605	740	663	719	56
40N03E15.7c	2	Kishwaukee College	920	910	727	717	-10
40N04E01.4e	7	Sycamore	1233	835	610	512	-98
40N04E15.7a	6	DeKalb	1291	855	605	597	-8
40N04E21.4f	10	DeKalb	1310	880	633	616	-17
40N04E26.6e	7	DeKalb	1328	885	629	544	-85
40N04E33.1h	12	DeKalb	1200	862	664	612	-52
41N05E32.1g	3	Sycamore	1002	845	805	759	-46
41N05E32.3e	1	Sycamore	902	870	826	800	-26
41N05E32.7g	6	Sycamore	1214	845	598	600	2

Appendix B. (continued)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1980*	*Water-level elevation 2000*	*Water-level change, ft.*
DeKalb (cont'd)							
42N05E19.4b	3	Genoa	732	830	740	685	-55
42N05E20.7a	4	Genoa	770	847	667	626	-41
DuPage							
38N10E30.4d	16	Naperville	1478	690	23	95	72
38N10E33.4h	20	Naperville	1572	748	63	46	-17
38N11E03.7e	13	Westmont	1578	740	-55	70	125
38N11E11.5c	7	Clarendon Hills	1585	722	-38	72	110
38N11E23.5e	3	Willowbrook	1620	734	13	87	74
38N11E28.1c	4	Darien	1612	767	-29	65	94
39N09E04.1b	3	West Chicago	1378	762	171	241	70
39N09E15.7h	4	West Chicago	1465	746	122	145	23
39N11E09.2h	2	Villa Park	1605	699	-171	149	320
39N11E10.1h	4	Elmhurst	1400	669	-181	136	317
39N11E20.7a	8	Lombard	1590	775	-57	92	149
39N11E24.3b	5	Oak Brook	1503	680	-110	75	185
39N11E33.6h	6	Oak Brook	1522	695	-30	101	131
40N11E16.6g	7	Wood Dale	1356	693	-97	25	122
40N11E26.2h	6	Bensenville	1900	684	148	144	144
40N11E35.5e	6	Elmhurst	1476	703	-137	90	227
Grundy							
31N08E04.1a	4	Gardner	1933	588	386	332	-54
33N07E04.2a	3	Morris	1485	523	323	327	4
33N07E04.4c	5	Morris	1462	506	344	293	-51
33N08E34.1d	5	Coal City	1785	560	312	299	-13
34N08E01.3e	4	Minooka	725	610	367	342	-25
34N08E21.3f	2	Alcoa Engineered Products	1515	525	215	164	-51
34N08E35.1e	2	Exelon - Dresden Station	1500	515	281	281	0
34N08E35.1e	2	Exelon - Dresden Station	1500	515	281	281	0
34N08E35.1g	1	Exelon - Dresden Station	1499	519	256	304	48
34N08E35.1g	1	Exelon - Dresden Station	1499	519	256	304	48
Kane							
38N07E05.2d	1	Waubonsee College	1323	703	465	438	-27
38N07E19.7e	4	Sugar Grove	1475	705	457	427	-30
38N07E25.5b	23	Aurora	1420	670	180	127	-53
38N08E01.2c	20	Aurora	1400	715	173	168	-5
38N08E03.6g	5	North Aurora	1330	700	196	148	-48
38N08E04.3g	3	North Aurora	1305	675	241	67	-174
38N08E04.8d	4	North Aurora	1325	689	225	126	-99
38N08E16.4d	17	Aurora	2152	685	210	226	16
38N08E19.5a	19	Aurora	1424	685	240	138	-102
38N08E24.7c	18	Aurora	1486	715	112	226	114
38N08E29.2h	15	Aurora	1719	665	157	108	-49
38N08E33.7c	3	Montgomery	1336	635	63	92	29
38N08E34.8g	16	Aurora	2139	660	149	280	131
39N08E02.4c	5	Geneva	2292	753	343	319	-24
39N08E09.8h	6	Geneva	1350	758	319	280	-39
39N08E11.7e	7	Geneva	2001	730	398	249	-149
39N08E22.3e	2	Batavia	2200	667	253	238	-15
39N08E22.3e	3	Batavia	2200	667	304	423	119
39N08E23.8f	4	Batavia	1357	721	243	237	-6
39N08E33.5g	3	Mooseheart Home	1386	713	231	254	23

Appendix B. (continued)

County location	Well no.	Owner	Depth ft.	Surface elev.	Water-level elevation 1980	Water-level elevation 2000	Water-level change, ft.
Kane (cont'd)							
39N08E33.5g	2	Mooseheart Home	1508	704	240	209	-31
40N07E32.8b	3	Elburn	1393	900	490	492	2
40N08E25.4a	8	St. Charles	1368	761	327	391	64
40N08E27.5a	3	St. Charles	1191	690	220	282	62
40N08E27.6b	4	St. Charles	1647	692	307	289	-18
40N08E31.6f	5	Illinois Youth Center	1292	763	378	420	42
40N08E31.6h	4	Illinois Youth Center	1322	790	385	384	-1
40N08E34.6e	5	St. Charles	1713	764	264	336	72
Kendall							
35N06E05.6a	3	Newark	336	690	607	601	-6
35N06E06.2e	2	Newark	287	663	583	577	-6
37N07E32.1e	3	Yorkville	1335	584	365	311	-54
37N08E05.6e	2	Fox Metro Water Reclam. Dist.	1325	628	146	129	-17
37N08E20.8h	3	Oswego	1378	640	240	200	-40
Lake							
43N09E11.2a	2	Lake Barrington Shores	1305	815	195	356	161
43N10E16.4d	8	Lake Zurich	1373	868	146	217	71
43N10E21.5e	7	Lake Zurich	1333	846	150	198	48
43N11E21.3g	1	Powernail Co.	1258	685	67	165	98
43N11E22.6d	3	Lincolnshire	1300	667	-43	217	260
43N12E31.6e	1	Baxter Corp. Headquarters	1456	685	30	156	126
44N09E24.5d	4	Wauconda	1264	792	316	322	6
44N11E21.7f	11	Libertyville	1490	703	153	288	135
45N10E15.7e	6	Round Lake Beach	1287	790	264	410	146
45N10E26.2b	4	Grayslake	1354	780	290	328	38
45N11E30.4g	4	Wildwood	1320	795	280	337	57
45N11E36.7c	3	Allegiance (formerly Baxter Healthcare)	1415	710	254	274	20
45N11E36.7d	1	Allegiance (formerly Baxter Healthcare)	1421	710	130	273	143
LaSalle							
33N01E16.8a	6	Peru	2665	540	410	348	-62
36N01E29.2d	6	Mendota	1408	771	595	546	-49
36N01E32.1a	4	Mendota	1360	740	582	597	15
McHenry							
43N08E08.2c	8	Crystal Lake	1300	900	404	406	2
43N08E14.1e	6	Cary	1300	840	329	334	5
43N08E33.4h	4	Algonquin	955	870	435	495	60
44N05E35.5h	1	Arnold Engineering Co.	846	818	688	656	656
44N08E33.5a	7	Crystal Lake	1400	930	382	341	-41
45N08E10.7c	8	Rohm & Haas	1160	835	395	283	-112
45N08E10.8d	7	Rohm & Haas	1161	850	425	390	-35
Will							
32N09E05.6d	3	Braidwood	1733	560	296	293	-3
34N09E09.4a	1	Channahon	765	570	301	255	-46
34N09E10.1h	2	BP Amoco	1405	568	-34	-86	-52
34N09E21.2d	1	BASF Corp.	1573	545	238	188	-50
34N10E07.5a	1	Peoples Gas SNG Plant	1581	609	68	52	-16
34N10E07.6b	2	Peoples Gas SNG Plant	1597	609	45	7	-38
35N09E09.3c	2	Shorewood	1499	605	25	65	40
35N09E25.1e	3	Caterpillar Tractor Co.	1556	547	-74	-88	-14

Appendix B. (concluded)

County location	*Well no.*	*Owner*	*Depth ft.*	*Surface elev.*	*Water-level elevation 1980*	*Water-level elevation 2000*	*Water-level change, ft.*
Will Co. (cont'd)							
35N10E30.6e	2	Caterpillar Tractor Co.	1543	546	-81	-104	-23
36N10E02.7f	1	Midwest Generation - Station 18	1500	587	-71	-64	7
36N10E02.7f	1	Midwest Generation - Station 18	1500	587	-71	-64	7
36N10E02.8f	3	Midwest Generation - Station 18	1507	590	-39	-86	-47
36N10E04.6g	4	Romeoville	1524	670	-38	-64	-26
Winnebago							
43N02E17.7h	36	Rockford (Unit Well 36)	1505	864	613	591	-22
44N02E35.8e	1	Cherry Valley	1201	810	666	650	-16
46N01E24.8a	6	Rockton	728	828	723	714	-9

Illinois State WATER SURVEY

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

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