SELECTED DATA ON CHARACTERISTICS OF GLACIAL-DEPOSIT AND CARBONATE-ROCK AQUIFERS, MIDWESTERN BASINS AND ARCHES REGION

By Robert L. Joseph and Sandra M. Eberts

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	*By*	*To obtain*
foot (ft)	3.048×10^{-1}	meter
square mile (mi^2)	2.590×10^{0}	square kilometer
foot per day (ft/d)	3.048×10^{-1}	meter per day
foot squared per day (ft^2/d)	9.290×10^{-2}	meter squared per day

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first order nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

SELECTED DATA ON CHARACTERISTICS OF GLACIAL-DEPOSIT AND CARBONATE-ROCK AQUIFERS, MIDWESTERN BASINS AND ARCHES REGION

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ABSTRACT

In 1988, the U.S. Geological Survey (USGS) began a study to examine the hydrogeologic framework, ground-water-flow systems, water chemistry, and withdrawal response of aquifers in glacial deposits and carbonate rock in the Midwestern Basins and Arches Region in western Ohio and eastern Indiana. As part of this study, data from pumped-well tests and instantaneous-recharge tests (slug tests) of wells completed in the glacial-deposit and carbonate-rock aquifers were compiled from reports and information on file with State agencies, environmental consulting firms, drilling firms, municipalities, universities, and the USGS. The data, from 73 counties in Ohio and Indiana, were entered into a computerized data base in a spreadsheet format and subsequently into a geographic information system (GIS).

Aquifer-characteristics data from this compilation include the results of 105 pumped-well tests and 39 slug tests in wells completed in glacial deposits, 174 pumped-well tests in wells completed in the carbonate-rock aquifer, and 4 slug tests in wells completed in limestones and shales of Ordovician age. Transmissivities from the pumped-well tests in wells completed in glacial till and glacial-deposit aquifers (sands and gravels) range from 1.54 to 69,700 feet squared per day. Storage coefficients or specific yields range from 0.00002 to 0.38 at these wells. Horizontal-hydraulic conductivities from the slug tests in wells completed in glacial-deposit aquifers range from 0.33 to 1,000 feet per day. Transmissivities from the pumped-well tests in wells completed in the carbonate-rock aquifer range from 70 to 52,000 feet squared per day. Storage coefficients or specific yields at these wells range from 0.00001 to 0.05. Horizontal-hydraulic conductivities from the slug tests in wells completed in limestones and shales of Ordovician age range from 0.0016 to 12 feet per day. These data are summarized in tables and figures within this report.

INTRODUCTION

The collection and compilation of selected aquifer-characteristics data for the glacial-deposit and carbonate-rock aquifers within the Midwestern Basin and Arches Region of Shaver (1985) are an essential part of the Midwestern Basins and Arches Regional Aquifer-Systems Analysis (Midwestern Basins and Arches RASA) project of the U.S. Geological Survey (USGS). Specifically, the data are needed to help describe ground-water flow in the regional aquifer system, which is one of the objectives of the Midwestern Basins and Arches RASA project (Bugliosi, 1990). To meet this objective, the Midwestern Basins and Arches RASA began subprojects in the Ohio and Indiana offices of the USGS to collect and compile available aquifer-characteristics data from aquifer tests of the glacial-deposit and carbonate-rock aquifers. The data were not reanalyzed to verify accuracy because of time constraints and insufficient data in many cases.

Purpose and Scope

This report presents spatial distributions and summary tables of selected aquifer-characteristics data from numerous pumped-well tests and slug tests of the glacial-deposit and carbonate-rock aquifers within the Midwestern Basins and Arches RASA study area. Aquifer-characteristics data from 144 wells completed in glacial deposits and 174 wells completed in the carbonate-rock aquifer, as well as data from 4 wells completed in limestones and shales of Ordovician age, are summarized.

Definitions

An aquifer test, as defined in this report, is a test to determine hydrologic properties of an aquifer. An aquifer test involves the withdrawal of measured quantities of water from or the addition of water to a well and the measurement of resulting changes in hydraulic head in the

aquifer during and (or) after the period of discharge from or addition to the well. Pumped-well tests involve the withdrawal of water from the well and are typically done when the aquifer being analyzed is believed to be capable of producing large quantities of water. Slug tests involve the sudden introduction of a known volume of water to the well. The slug-test method is typically used when the aquifer is believed to produce small quantities of water (rather than the large quantities of water desired for a pumped-well test) or when other factors such as time, money, or contaminated waters are a concern. Aquifer tests are conducted to determine aquifer characteristics, such as transmissivity, hydraulic conductivity, storage coefficient, and specific yield.

Transmissivity is the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It is equal to an integration of the hydraulic conductivities across the saturated part of the aquifer perpendicular to the ground-water-flow path. Hydraulic conductivity is a measure of volume of water at the prevailing viscosity that will move through a medium in a unit of time under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow. The storage coefficient of an aquifer is the volume of water that is released from or taken into storage per unit surface area of the aquifer per unit change in hydraulic head. (Storage coefficient is virtually equal to the specific yield in an unconfined aquifer.) Specific yield is the ratio of the volume of water that the saturated porous medium will yield by gravity to the total volume of that porous medium. The terminology used within this report is consistent with the terminology presented by Ground Water Subcommittee of the Federal Interagency Advisory Committee on Water Data (1989) and Lohman (1979).

Approach

Data from aquifer-test analyses were collected from various sources, compiled and entered into a computerized data base in a spreadsheet format, and subsequently entered into a geographic information system (GIS). Well sites were located by latitude and longitude where possible, and figures were constructed by use of an Albers Equal Area Projection. Fourteen separate items were used to identify each well and summarize the associated aquifer characteristics. Data entered into the spread-sheet for each aquifer test were the following: (1) latitude; (2) longitude (or description of study area); (3) state; (4) county; (5) producing unit; (6) altitude of land-surface datum, in feet above sea level; (7) top of aquifer, in feet below land surface; (8) top of screened/open interval, in feet below land surface; (9) length of screened/open interval, in feet; (10) type of aquifer; (11) transmissivity, in feet squared per day, or horizontal-hydraulic conductivity, in feet per day; (12) storage coefficient (dimensionless) or specific yield (dimensionless); (13) other well identifier; and (14) source of data.

Acknowledgments

The authors express appreciation to the ground-water staff at the Indiana and Ohio Departments of Natural Resources, Divisions of Water; the Indiana Department of Environmental Management; and the Ohio Environmental Protection Agency for assistance in locating and gathering the data. The authors also appreciate the assistance and cooperation of numerous individuals from environmental consulting firms, drilling firms, and municipalities throughout the Midwestern Basins and Arches RASA study area.

GEOHYDROLOGIC SETTING

The study area is located along the axes of the Cincinnati, Findlay, and Kankakee Arches in Indiana, Ohio, and parts of Michigan and Illinois and encompasses approximately 44,000 mi^2 (fig. 1). Erosion has reduced these low, broad arches to a nearly flat plain (fig. 2). The oldest bedrock units are exposed along the axis of the Cincinnati Arch in the south-central part of the study area. Bedrock units within the study-area boundary include interbedded limestone and shale of Ordovician age, limestones and dolomites of Silurian and Devonian age, and shales of Devonian age (figs. 1 and 2). These bedrock units are directly overlain by Quaternary glacial deposits throughout most of the study area (fig. 3). Glacial deposits—which deeply cover numerous ancient bedrock valleys—include ground-moraine and end-

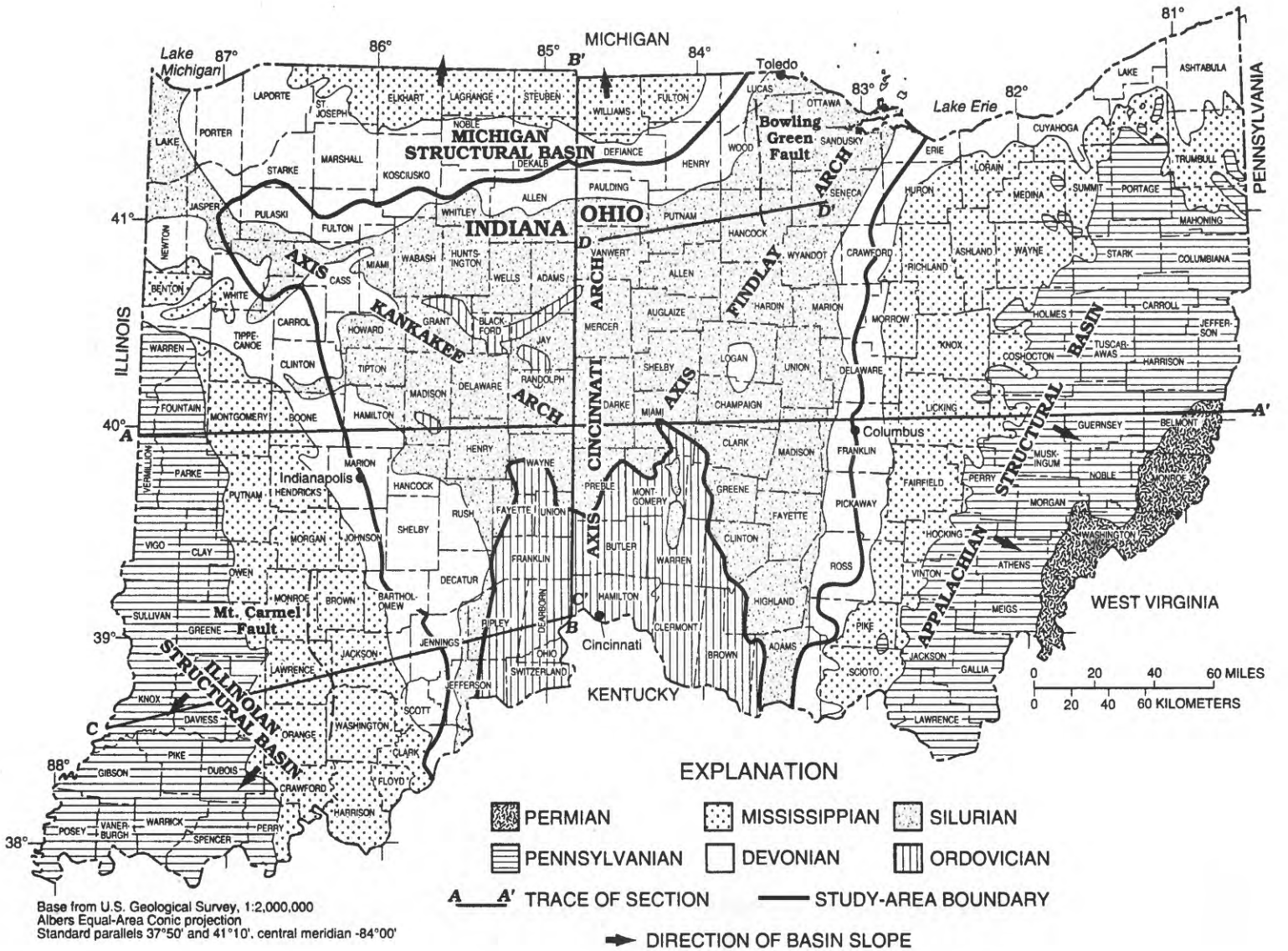


Figure 1. Bedrock geology and boundary of the Midwestern Basins and Arches Regional-Aquifer Systems Analysis study area. (From Bugliosi, 1990, fig. 2.)

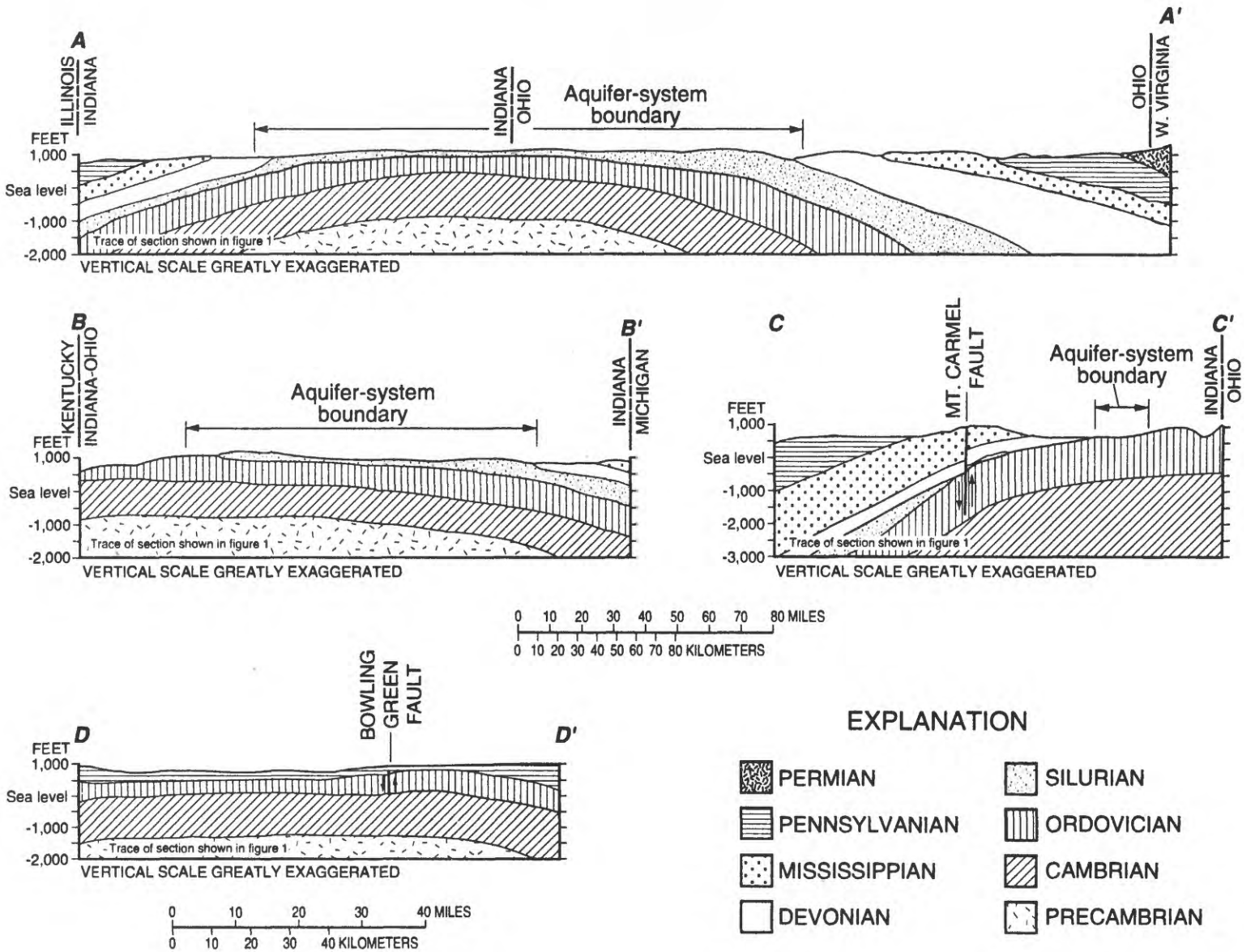


Figure 2. Generalized geologic sections through the Midwestern Basins and Arches Regional Aquifer-Systems Analysis study area. (Modified from Bugliosi, 1990, fig. 3.)

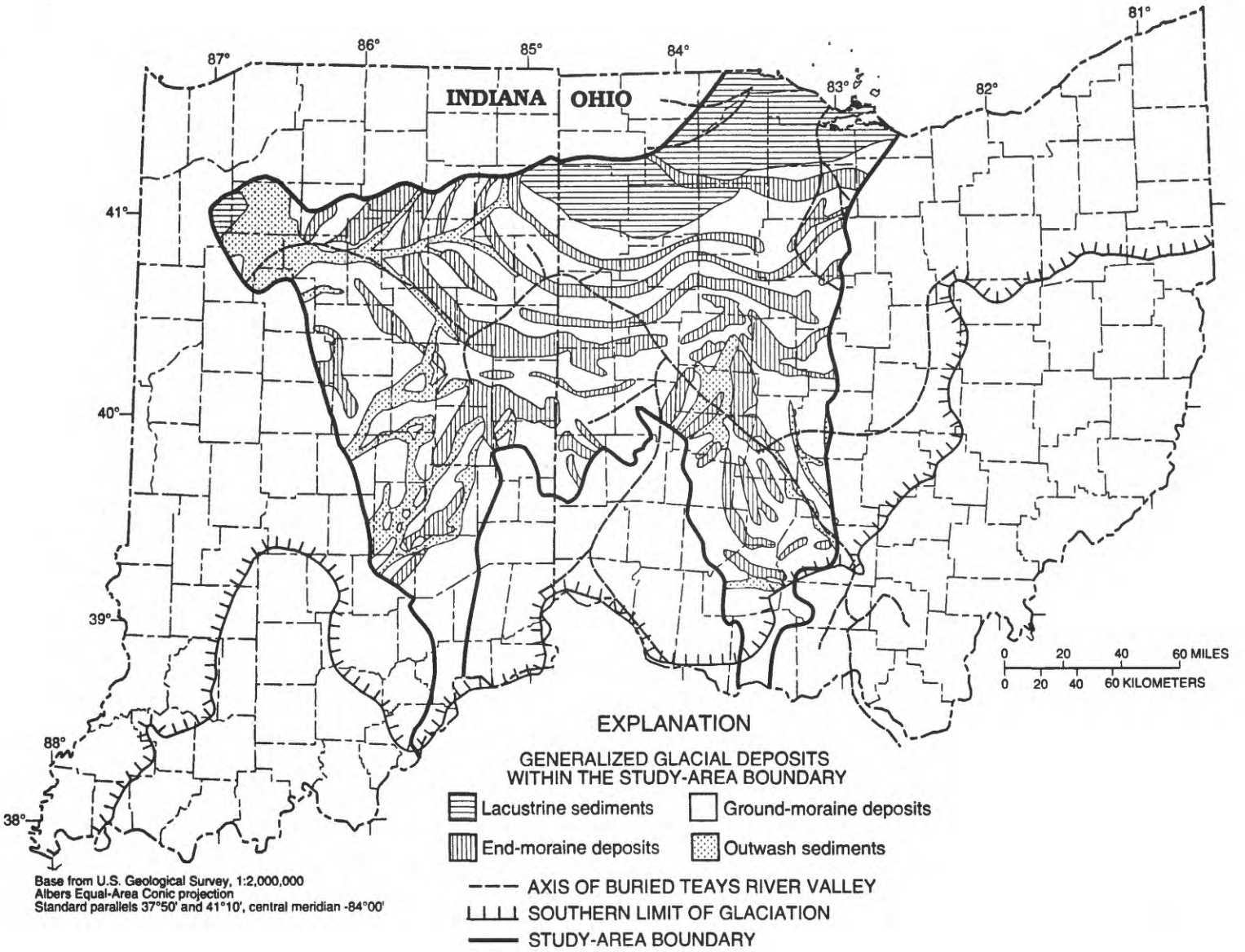


Figure 3. Generalized location of glacial deposits and limit of glaciation. (Modified from Bugliosi, 1990, fig. 5.)

moraine deposits, lacustrine sediments, outwash sediments, and small amounts of ice-contact stratified drift (Flint, 1959). Ground-moraine and end-moraine deposits constitute most of the surficial deposits within the study area.

The water table in the Midwestern Basins and Arches RASA study area generally is within the Quaternary glacial deposits (fig. 4). Glacial-deposit aquifers are composed of sands and gravels that comprise areally extensive outwash sediments or discontinuous lenses of ice-contact stratified drift within ground-moraine and end-moraine deposits. Buried ancient bedrock valleys, many of which deeply dissect the carbonate rock, serve as principal aquifers where they are filled with outwash sediments. Locally, glacial-deposit aquifers may be semiconfined or confined by glacial till. The productivity of glacial-deposit aquifers differs vertically and horizontally over small distances because of variations in the composition, continuity, and structure of the deposits (Strobel, 1990).

Water in the underlying carbonate-rock aquifer (hereafter referred to as the carbonate aquifer) is present primarily in fractures, bedding-plane partings, and other openings within the rock. The carbonate aquifer ranges in thickness from 0 to more than 1,000 ft, and it thickens away from the crest of the arches (Norris and Fidler, 1973; Rupp, 1991; G.D. Casey, U.S. Geological Survey, written commun., 1992). At the regional scale, the carbonate aquifer is semiconfined by glacial deposits where the aquifer is exposed at or near the bedrock surface and is confined by the Devonian shales elsewhere in the region (figs. 1-4). The productivity of the carbonate aquifer differs throughout the study area in relation to the concentration of openings within the rock. Some karst features are present in the Devonian limestones.

The carbonate aquifer is confined below by interbedded shales and limestones of Ordovician age (fig. 4). Although the Ordovician rocks directly underlie the carbonate aquifer throughout most of the study area, they are laterally contiguous with the carbonate aquifer along the axis of the Cincinnati Arch in the south-central part of the study area where the Ordovician rocks are exposed at the bedrock surface (fig. 1). Weathering has increased secondary porosity and has allowed for increased water circulation at shallow depths in the limestones and shales of Ordovician age in this area where they are exposed at or near the bedrock surface. Because dry holes are common and drawdowns are commonly extreme, this water-bearing unit within the upper weathered zone of the Ordovician rocks (fig. 4) is not considered to be part of the carbonate aquifer, although it may have some hydraulic connection to the aquifer.

SELECTED DATA ON AQUIFER CHARACTERISTICS

Pumped-well-test data from 279 wells and slug-test data from 43 wells were compiled and are summarized in the sections of the report that follow. Aquifer-characteristics data in this report have been subdivided into site-specific data and areal data. Site-specific data included herein represent all aquifer-characteristics data for a well site provided that the latitude and longitude of the well site could be determined from the source of data. Areal data include all data that were reported in a data source as a summary of aquifer characteristics for an area on the basis of tests at numerous wells. Descriptions of the study area were reported in the source of the areal data, and these descriptions are included in the tables at the back of this report. Transmissivities and storage coefficients for areal data are reported in the tables herein as ranges rather than as single values.

The numbers next to symbols on figures in this report are the well numbers listed in the first column of the corresponding tables at the back of the report. Wells whose transmissivities are within the same order of magnitude are signified by like symbols. The data are separated by State in the figures and tables; in addition, the data are listed by county in alphabetical order. Producing units in the tables reflect the nomenclature of the data sources and may differ between sources referenced in this report. Transmissivities and horizontal-hydraulic conductivities were reported in various units in the data sources. For consistency, all transmissivities have been converted to units of feet squared per day; and

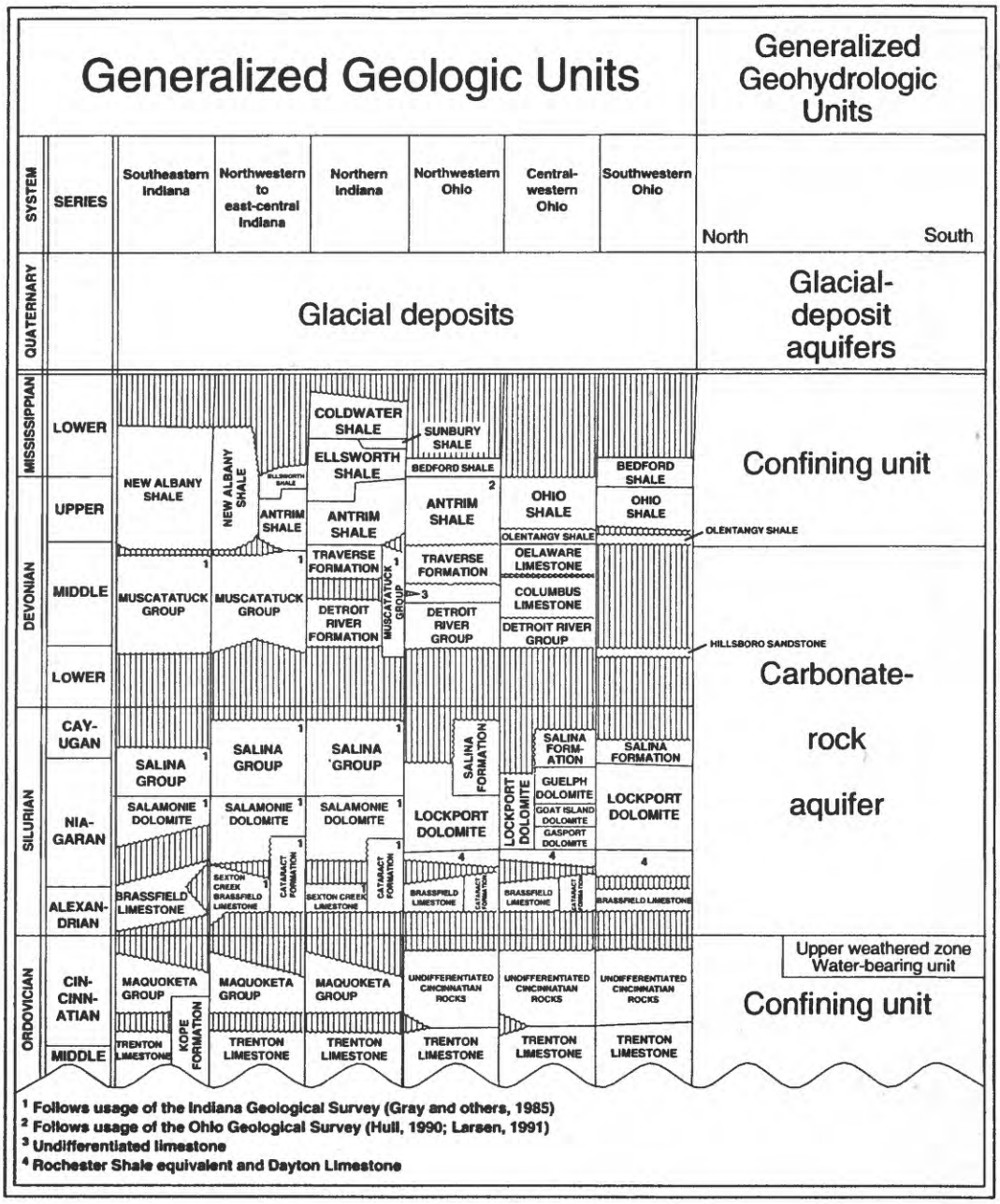


Figure 4. Relation between geologic and geohydrologic units of the Midwestern Basins and Arches glacial-deposit and carbonate-rock aquifers. (Modified from Casey, 1992, fig. 3.)

all horizontal-hydraulic conductivities have been converted to units of feet per day. Converted values have been rounded to three significant figures. Sources of data are listed in the tables and in the reference list. Previously unpublished data that are not public record are published herein with permission.

Glacial-Deposit Aquifers

Transmissivities from available aquifer tests of glacial-deposit aquifers in Indiana range from 300 to 69,700 ft^2/d; storage coefficients or specific yields range from 0.00002 to 0.38 in the same material. The locations of wells completed in glacial-deposit aquifers in Indiana for which site-specific pumped-well-test data are reported are shown in figure 5. Well and aquifer characteristics that correspond to figure 5 are presented in table 1 at the back of the report. Transmissivities from available aquifer tests of glacial-deposit aquifers in Ohio range from 1,340 to 60,300 ft^2/d, and storage coefficients or specific yields range from 0.0002 to 0.3. The locations of wells completed in glacial-deposit aquifers in Ohio for which site-specific pumped-well-test data are reported are shown in figure 6. Well and aquifer characteristics that correspond to figure 6 are listed in table 2 at the back of the report. The locations of wells completed in glacial-deposit aquifers in Ohio for which areal pumped-well-test data are reported are shown in figure 7. Well and aquifer characteristics that correspond to figure 7 are listed in table 3 at the back of the report. Transmissivities at wells completed in glacial till, which is not considered to be aquifer material, range from 1.54 to 2.07 ft^2/d; storage coefficients range from 0.015 to 0.0261. The locations of wells completed in glacial till in Ohio for which site-specific pumped-well-test data are reported are shown in figure 8. Well and aquifer characteristics that correspond to figure 8 are listed in table 4 at the back of the report.

Horizontal-hydraulic conductivities at wells completed in glacial-deposit aquifers in Ohio for which slug-test data are available range from 0.33 to 1,000 ft/d. The locations of these wells are shown in figure 9. Well and aquifer characteristics that correspond to figure 9 are listed in table 5 at the back of the report.

Carbonate-Rock Aquifer

In Indiana, transmissivities from available aquifer tests of the carbonate aquifer range from 310 to 52,000 ft^2/d; storage coefficients range from 0.00001 to 0.05. The location of wells completed in the carbonate aquifer in Indiana for which site-specific pumped-well-test data are reported are shown in figure 10. Well and aquifer characteristics that correspond to figure 10 are listed in table 6 at the back of the report. Transmissivities from available aquifer tests of the carbonate aquifer in Ohio range from 70 to 28,000 ft^2/d, and storage coefficients range from 0.00003 to 0.00318. The locations of wells completed in the carbonate aquifer in Ohio for which site-specific pumped-well-test data are reported are shown in figure 11. Well and aquifer characteristics that correspond to figure 11 are listed in table 7 at the back of the report. The locations of wells completed in the carbonate aquifer in Ohio for which areal pumped-well-test data are available are shown in figure 12. Well and aquifer characteristics that correspond to figure 12 are listed in table 8 at the back of the report.

Horizontal-hydraulic conductivities calculated from slug tests of four wells completed in limestones and shales of Ordovician age range from 0.0016 to 12 ft/d. The locations of these four wells are shown in figure 13. Well and aquifer characteristics that correspond to figure 13 are listed in table 9 at the back of the report.

SUMMARY

Federal funds were appropriated in 1978 for analysis of regional aquifer systems as a result of growing concern for the availability of ground water. Twenty-eight of the Nation's most important regional aquifers were selected to be studied. The primary objective of the Regional Aquifer-Systems Analysis program was to examine the hydrogeologic framework, ground-water-flow-systems, water chemistry, and withdrawal response of aquifers within these regions. In 1988, the USGS began to study a regional aquifer system within the Midwestern Basin and Arches Region of Shaver (1985) within western Ohio and eastern Indiana.

An essential part of this Midwestern Basins and Arches RASA project was the collection and

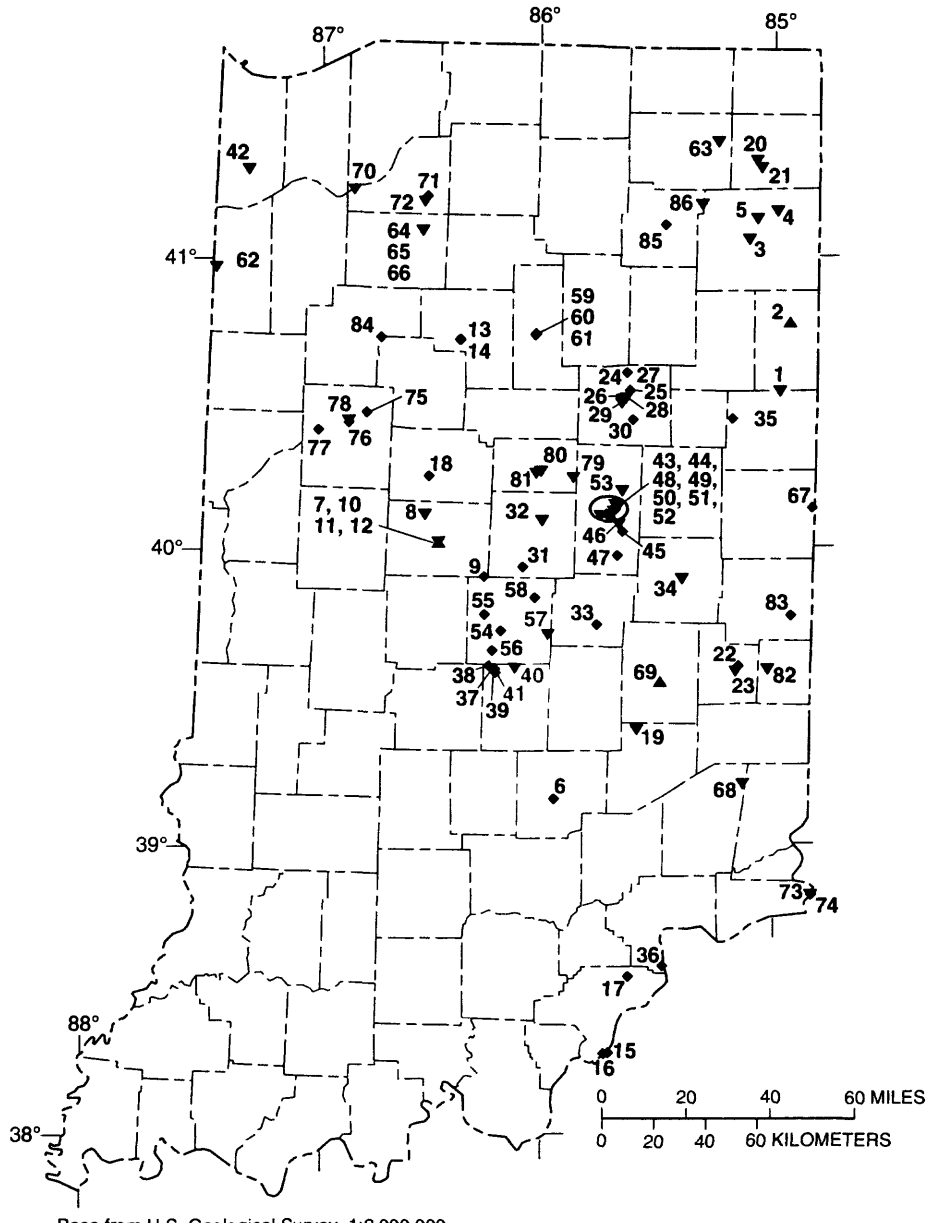
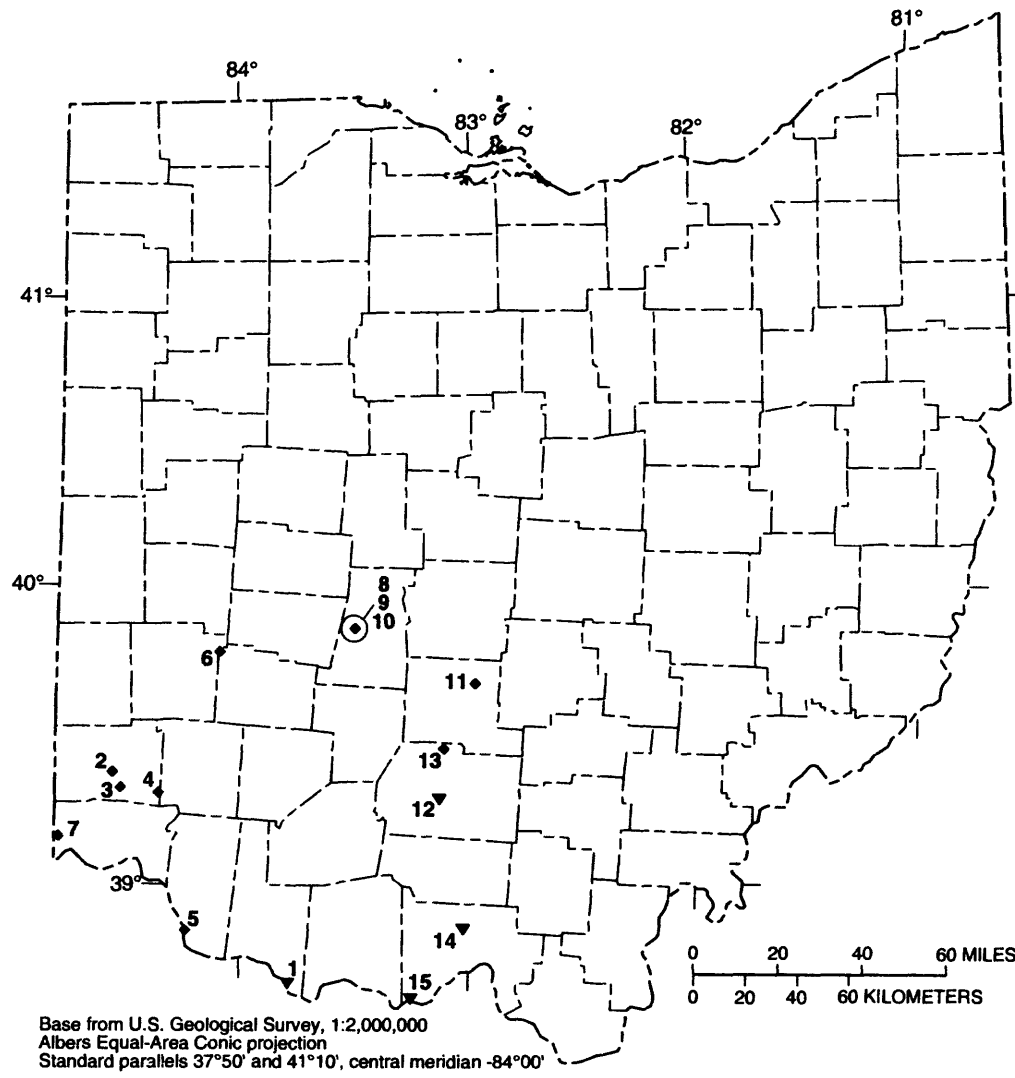


Figure 5. Wells completed in glacial-deposit aquifers in Indiana for which site-specific pumped-well-test data are reported in table 1.



EXPLANATION

WELL LOCATION, WELL NUMBER, AND TRANSMISSIVITY RANGE--
Number corresponds to number in table 2 at back of report; shape indicates transmissivity range, in feet squared per day

12▼ 1,000 to 9,999

4◆ 10,000 to 99,999

Figure 6. Wells completed in glacial-deposit aquifers in Ohio for which site-specific pumped-well-test data are reported in table 2.

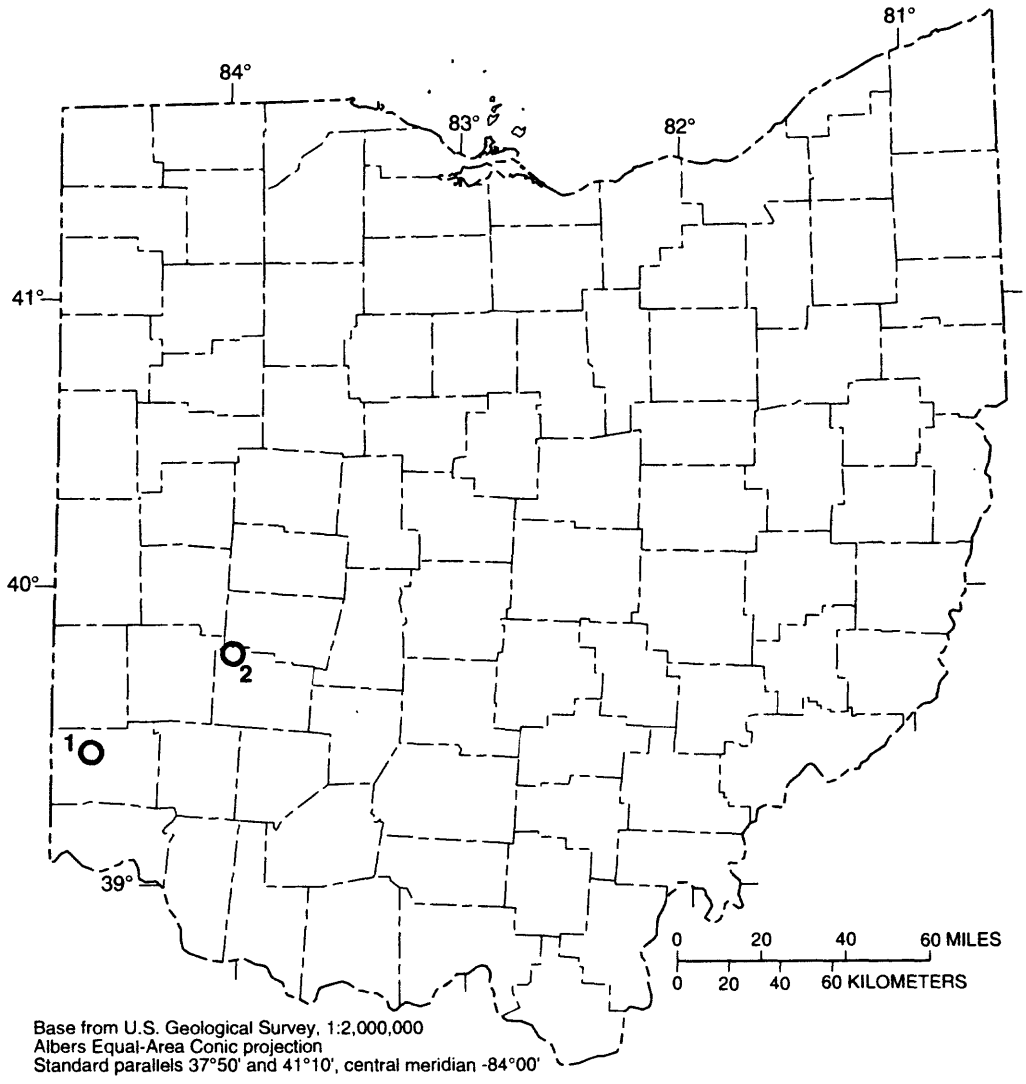


Figure 7. Areas in Ohio for which pumped-well-test data from numerous wells completed in glacial-deposit aquifers were previously summarized and are reported in table 3.

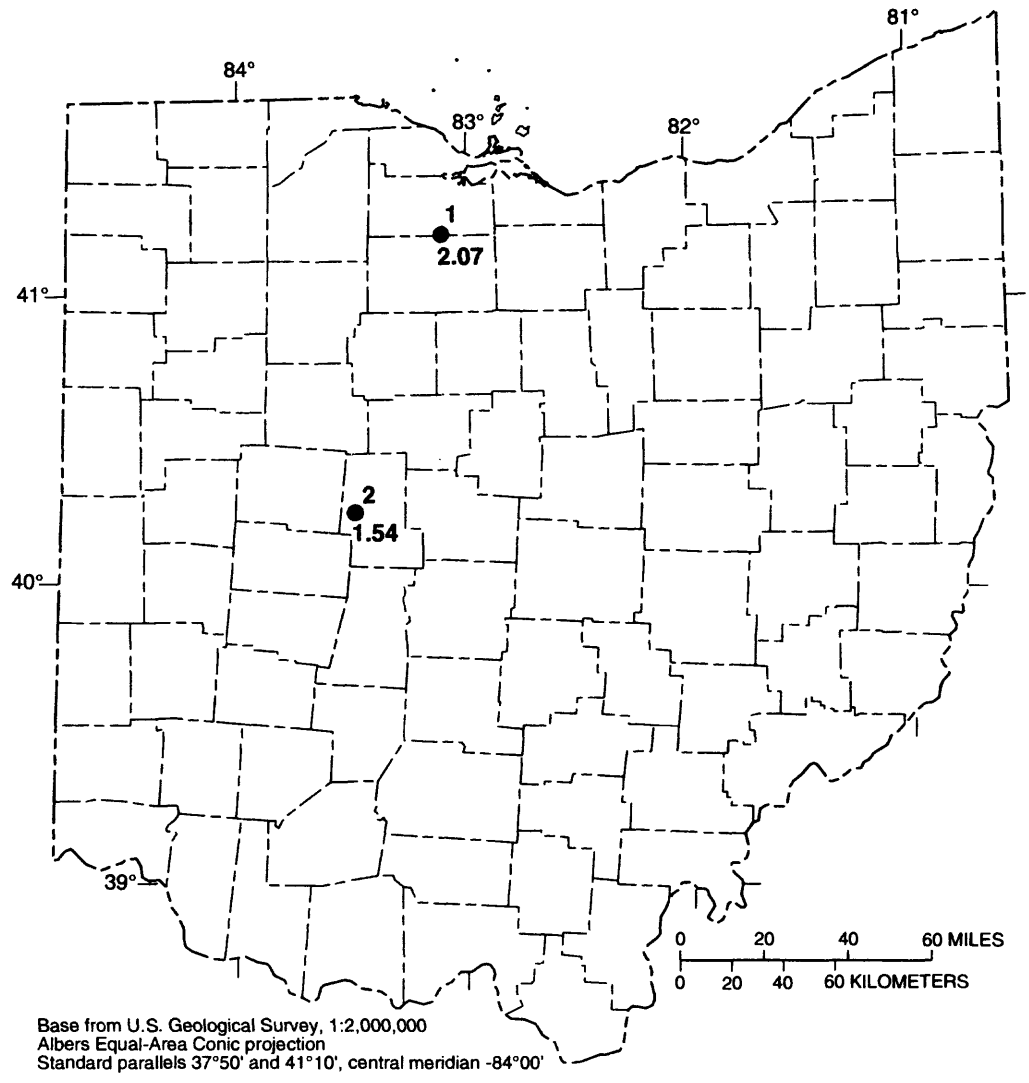


Figure 8. Wells completed in glacial till in Ohio for which site-specific pumped-well-test data are reported in table 4.

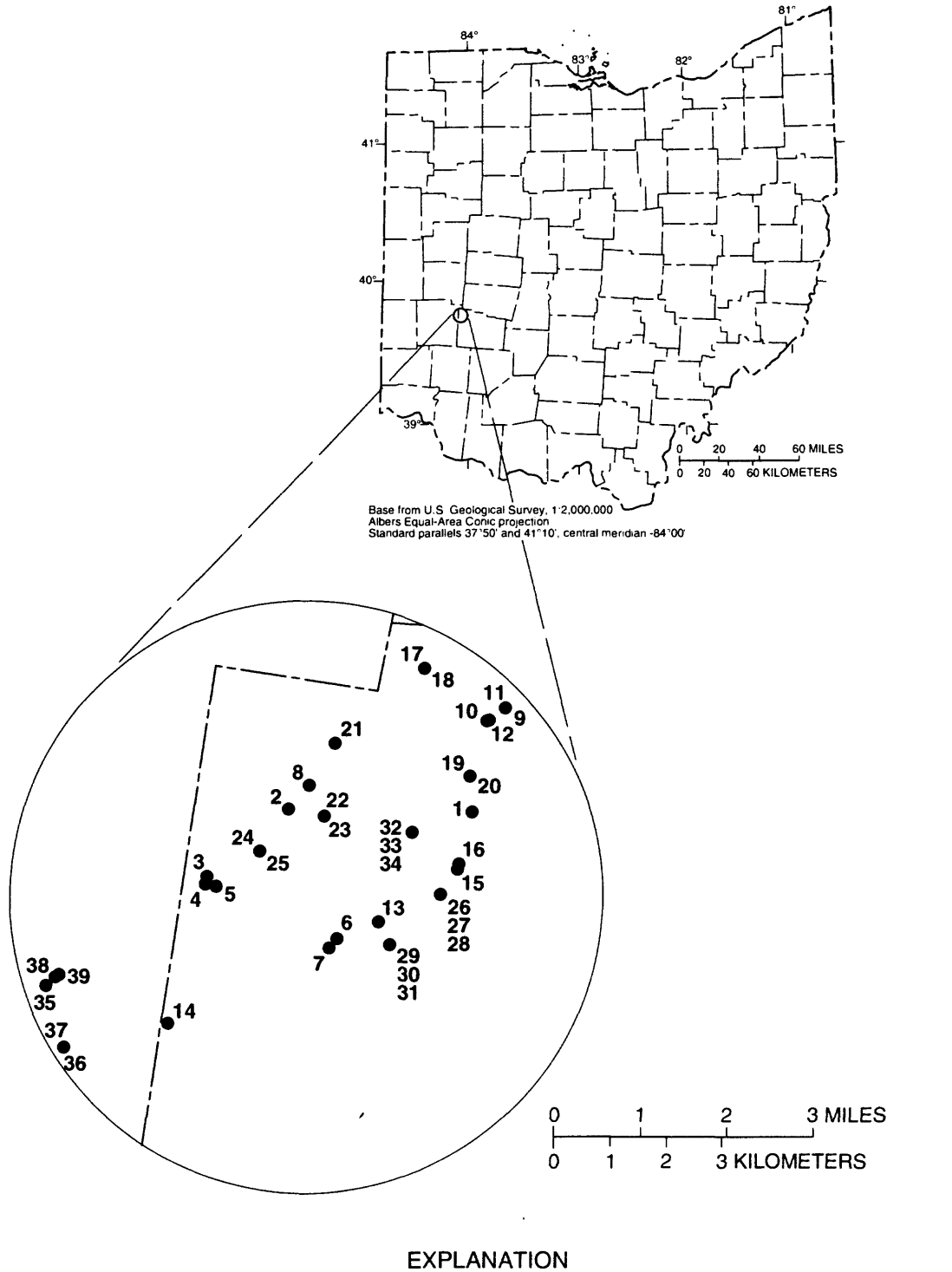


Figure 9. Wells completed in glacial-deposit aquifers in Ohio for which slug-test data are reported in table 5.

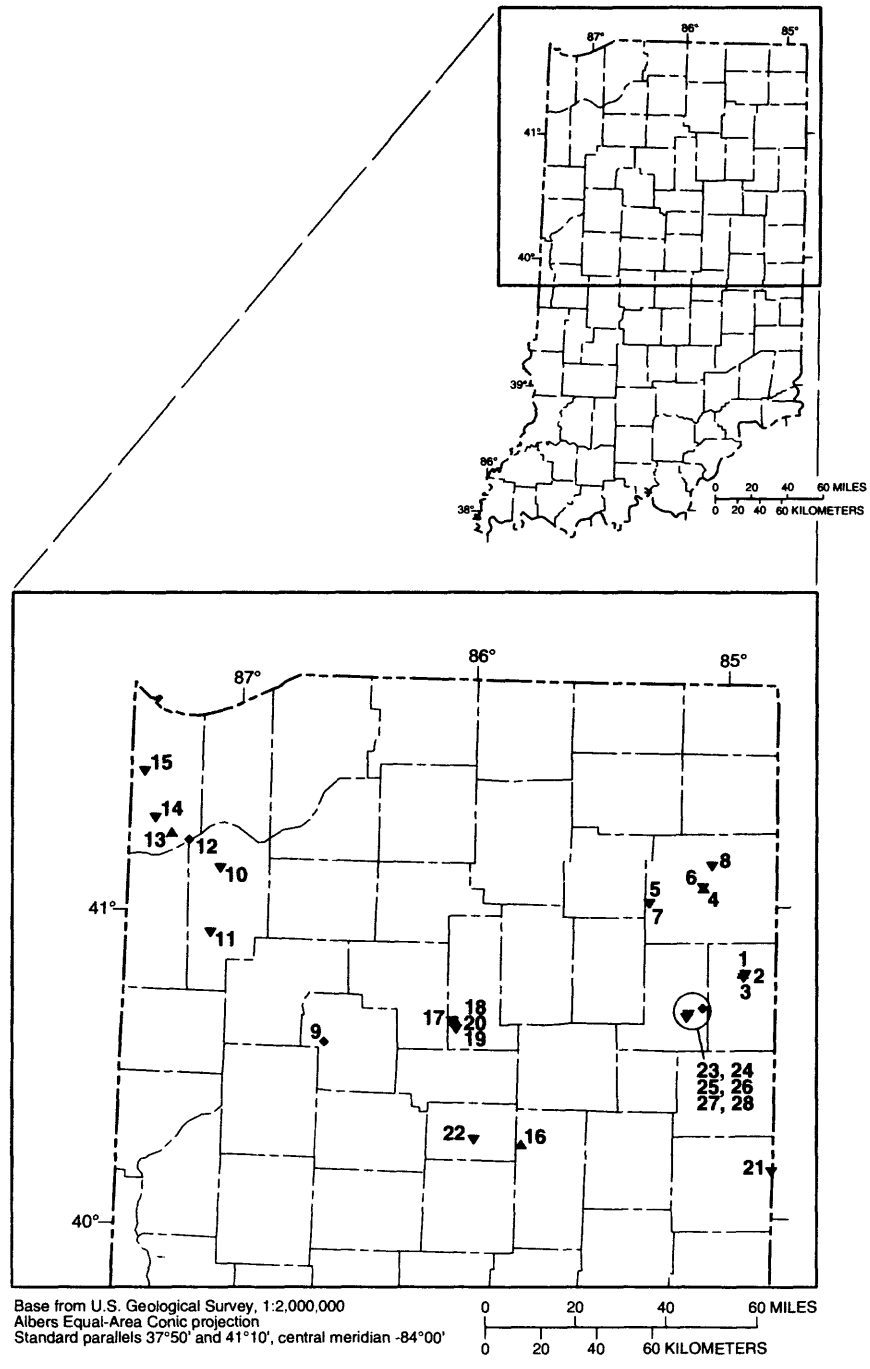


Figure 10. Wells completed in the carbonate-rock aquifer in Indiana for which site-specific pumped-well-test data are reported in table 6.

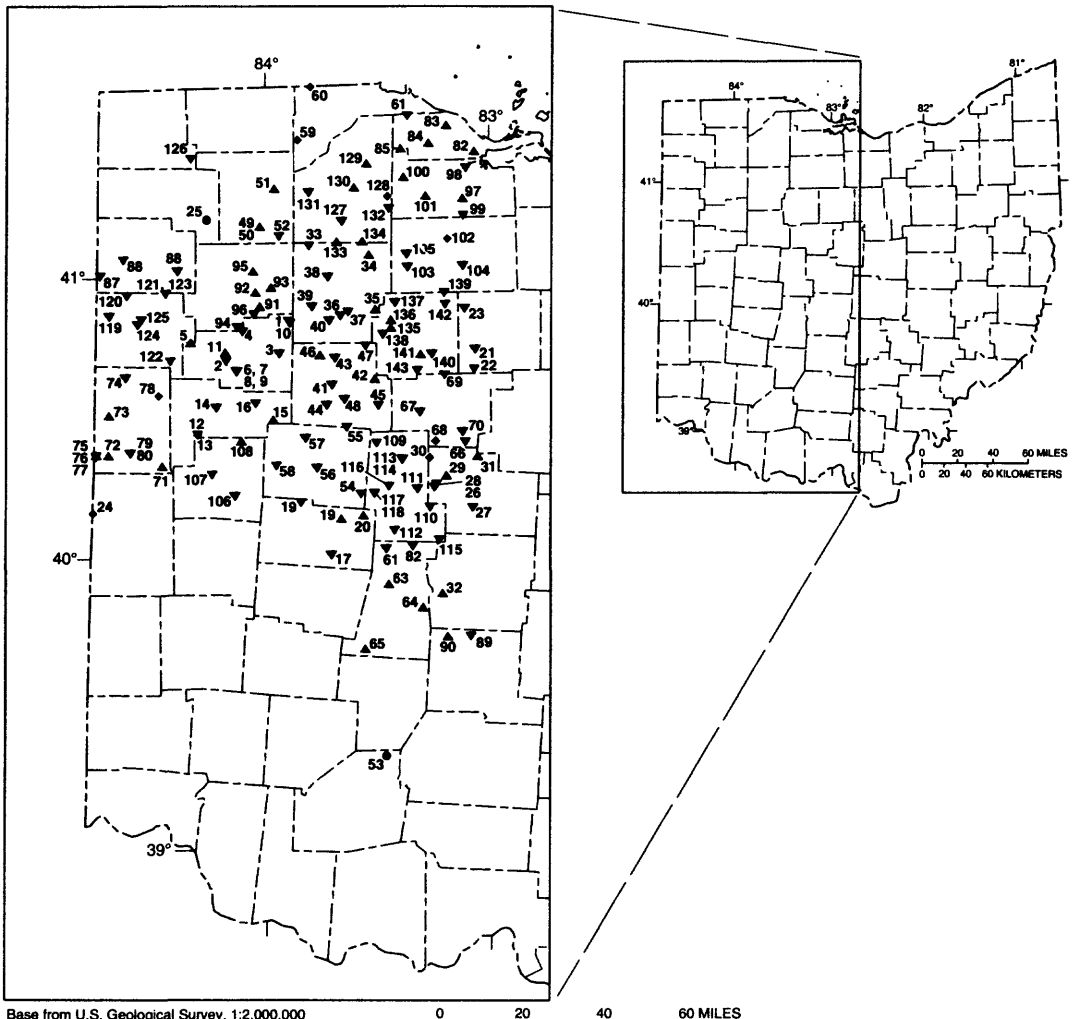


Figure 11. Wells completed in the carbonate-rock aquifer in Ohio for which site-specific pumped-well-test data are reported in table 7.

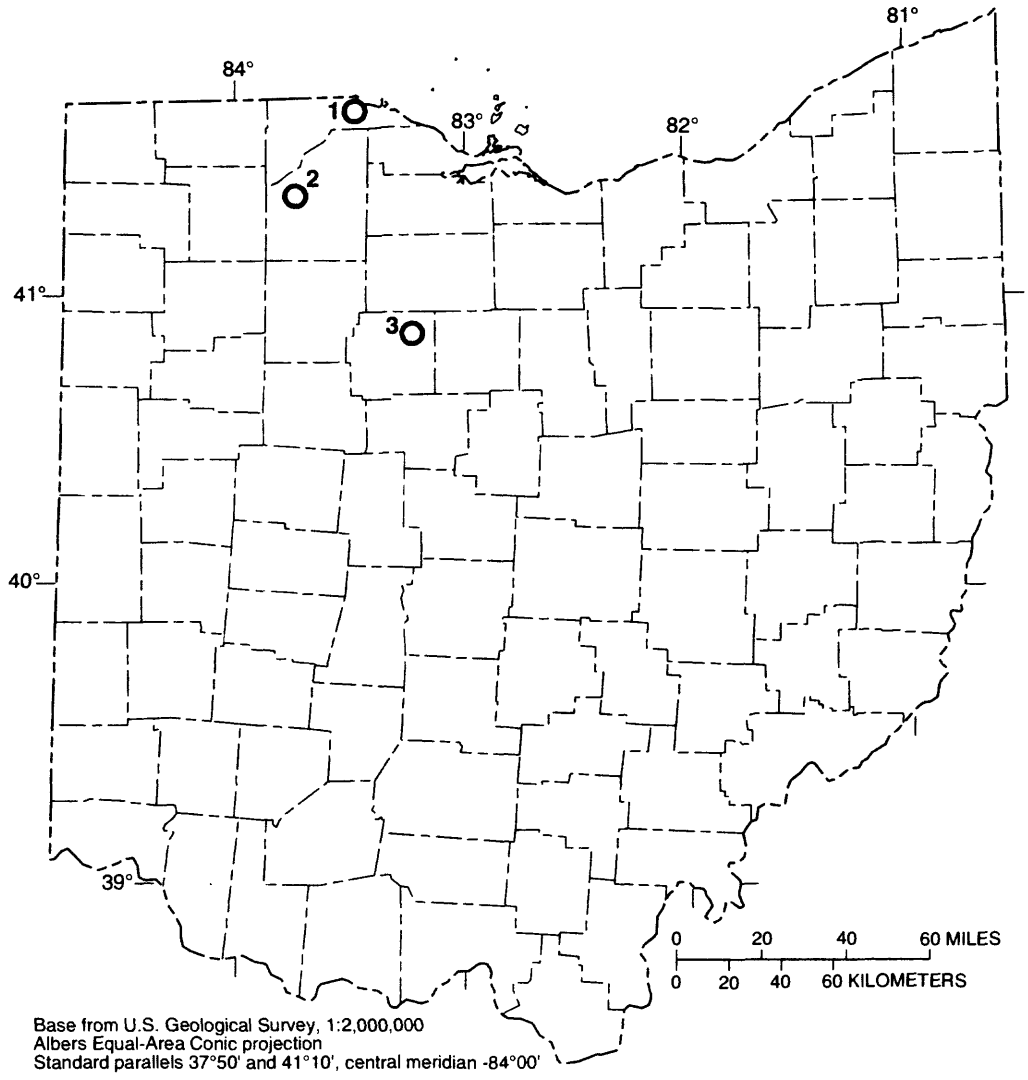


Figure 12. Areas in Ohio for which pumped-well-test data from numerous wells completed in the carbonate-rock aquifer were previously summarized and are reported in table 8.

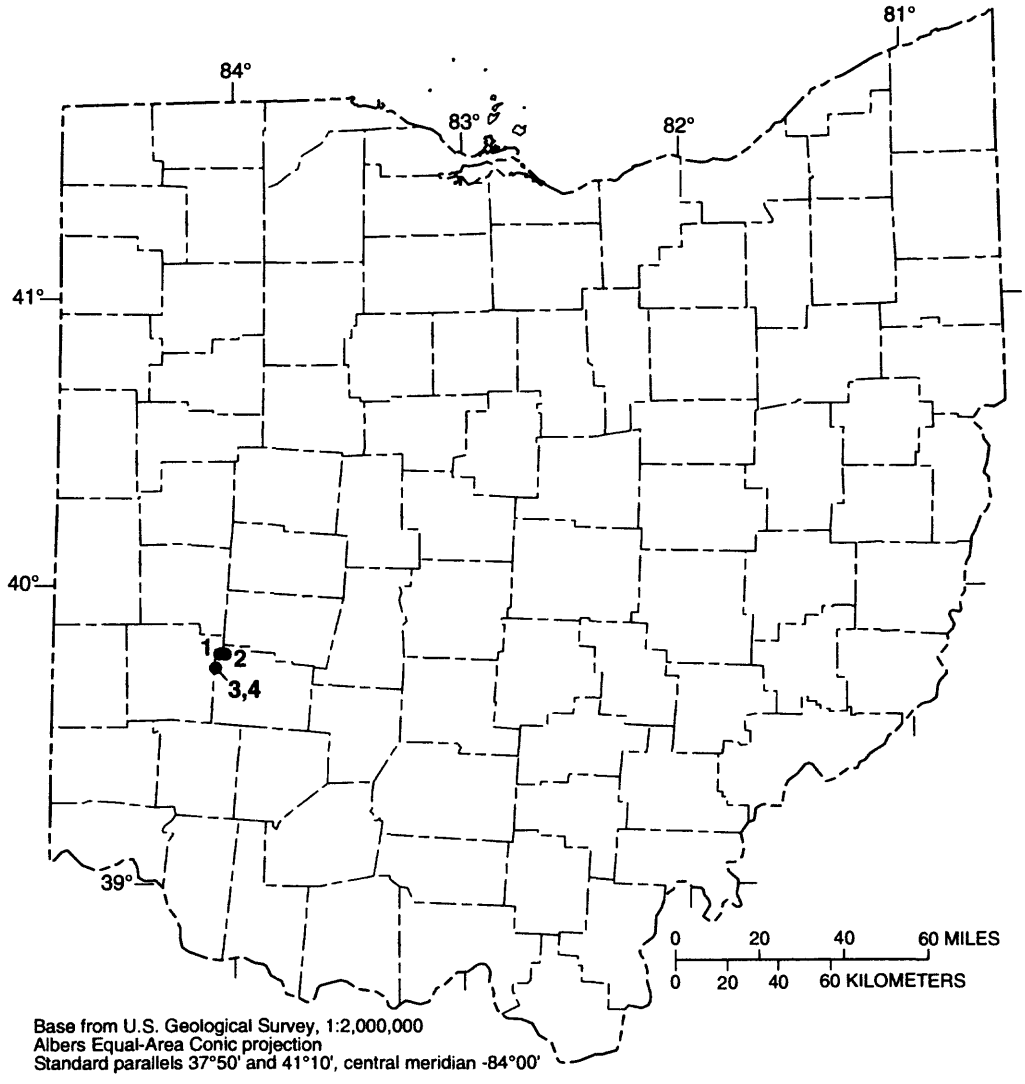


Figure 13. Wells completed in limestones and shales of Ordovician age for which slug-test data are reported in table 9.

compilation of aquifer-characteristics data for wells completed in the glacial-deposit and carbonate-rock aquifers within the Midwestern Basins and Arches Region for which pumped-well-test or slug-test data were available. Such data were compiled from reports and information on file with State agencies, environmental consulting firms, drilling firms, municipalities, universities, and the USGS. Data for wells from 73 counties in Ohio and Indiana were entered into a computerized data base in a spreadsheet format and subsequently entered into a GIS. Aquifer-characteristics data for 323 wells are summarized in tables and figures in this report.

On the basis of and including data from 105 wells completed in glacial till and glacial-deposit aquifers (sands and gravels), transmissivities range from 1.54 to 69,700 ft^2/d. Storage coefficients or specific yields range from 0.00002 to 0.38 within glacial deposits across the study area. Slug-test data for 39 wells completed in glacial-deposit aquifers include horizontal-hydraulic conductivities that range from 0.33 to 1,000 ft/d. On the basis of data from 174 wells completed in the carbonate aquifer, transmissivities range from 70 to 52,000 ft^2/d. Storage coefficients or specific yields for the carbonate aquifer within the study area range from 0.00001 to 0.05. Horizontal-hydraulic conductivities from slug tests of four wells completed in limestones and shales of Ordovician age range from 0.0016 to 12 ft/d.

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Table 1. *Aquifer characteristics from site-specific pumped-well tests of Indiana wells completed in glacial-deposit aquifers*

[fasl, feet above sea level; fbsl, feet below land surface; ft^2/d, feet squared per day; --, data not available; C, confined; U, unconfined; SC, semiconfined; ″, inch; degree, minute, and second symbols are omitted from the latitude and longitude coordinates]

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of screened interval (fbls)	Length of screened interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
1	403521	0845723	Adams	Sand & gravel	--	--	171	10	--	3,830	0.003	6″ well	Ortman (1987)[1]
2	404931	0845455	Adams	Sand & gravel	--	--	54	10	C	985	.000077	TW 57 A	Keck (1957a)
3	410634	0850603	Allen	Sand & gravel	--	--	94	30	--	1,240	--	TW-4A	Stremmel (1983a)[2]
4	411230	0845830	Allen	Sand & gravel	--	--	130	--	C	5,310	.0004	8″ well	Howard (1977a)
5	411045	0850400	Allen	Sand & gravel	--	--	147	5	C	3,760	.00028	TW2	Stremmel (1979)[2]
6	391035	0855604	Bartholomew	Sand & gravel	--	--	54	36	U	36,900	.2	4-h	Sieco (1969a)[3]
7	400305	0862829	Boone	Sand & gravel	927	212	--	--	C	938	.0002	BoF36-1-10	Brown (1949)
8	400843	0863221	Boone	Sand & gravel	--	25	112	30	U	4,000	.15	--	Nuzman (1977a)
9	395527	0861538	Boone	Gravel	--	--	72	20	--	11,400	--	57D	Keck (1957b)
10	400305	0862831	Boone	Sand & gravel	926	--	--	--	C	1,340	.0006	BoF36-1-1	Brown (1949)
11	400306	0862829	Boone	Sand & gravel	928	86	--	--	C	1,340	.0006	BoF36-1-7	Brown (1949)
12	400306	0862831	Boone	Sand & gravel	927	94	--	--	C	1,340	.0006	BoF36-1-3	Brown (1949)
13	404442	0862412	Cass	Sand & gravel	--	--	68	20	C	15,500	.0006	4A	Annable (1986a)
14	404445	0862355	Cass	Sand & gravel	--	--	49	20	--	16,400	.002	2	Annable and Barnhart (1991)
15	381814	0853916	Clark	Sand & gravel	--	--	43	--	--	19,700	.047	3	Keck (1951)
16	381739	0854114	Clark	Sand & gravel	--	30	--	--	--	10,900	--	TW 60A	Linck (1960a)
17	383409	0853527	Clark	Sand	693	32	--	--	C	16,100	.0071	C	Sieco (1964)[3]
18	401641	0863133	Clinton	Sand & gravel	--	--	70	20	C	19,300	.0057	16	Keck Assoc. (1960)[4]
19	392510	0853425	Decatur	Sand & gravel	800	1	27	10	U	5,930	.22	PW-1	Reynolds (1980)[5]
20	412246	0850426	De Kalb	Sand & gravel	--	--	163	25	--	9,380	.001	15	Annable (1987)

Table 1. *Aquifer characteristics from site-specific pumped-well tests of Indiana wells completed in glacial-deposit aquifers*--Continued

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of screened interval (fbls)	Length of screened interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
21	412117	0850311	De Kalb	Sand & gravel	--	--	223	20	C	6,030	0.0003	2A	Annable (1989a)
22	393836	0850738	Fayette	Sand & gravel	--	63	63	24	U	22,400	.028	P-1	Watkins (1964)
23	393739	0850823	Fayette	Sand & gravel	785	--	--	--	--	9,300	--	--	Klaer Assoc. (1963)[6]
24	403844	0853848	Grant	Sand & gravel	--	110	160	20	C	10,800	.0031	MPW 1	Stremmel (1984)[2]
25	403226	0854013	Grant	Sand & gravel	--	35	67	20	C	9,380	.0015	17	Stremmel (1985)[2]
26	403329	0853902	Grant	Sand & gravel	--	88	106	30	C	9,380	.0015	11	Stremmel (1985)[2]
27	403836	0853807	Grant	Sand & gravel	--	179	222	20	--	10,800	.00015	MPW 2	Stremmel (1984)[2]
28	403506	0853800	Grant	Gravel	--	--	--	--	--	18,600	.0018	TW 65-F	Keck Assoc. (1965a)[4]
29	403314	0853955	Grant	Sand & gravel	--	80	106	30	C	7,370	.00023	6A	Stremmel (1985)[2]
30	402907	0853706	Grant	Sand & gravel	--	108	--	--	C	11,200	.00082	3	Ferris (1945)
31	395814	0860547	Hamilton	Sand & gravel	--	30	--	--	U	10,700	.003	5	Nuzman (1973)
32	400754	0860051	Hamilton	Sand & gravel	--	30	100	--	C	6,500	.0051	1	Howard (1977b)
33	394635	0854541	Hancock	Sand & gravel	--	--	--	--	--	14,200	.015	East well	Keck Assoc. (1968)[4]
34	395632	0852306	Henry	Sand & gravel	--	--	108	14	C	7,370	.00025	T-5	IDC (1951)[7]
35	402939	0851013	Jay	Gravel	--	12	49	10	C	14,200	.03	1	Stremmel (1981)[2]
36	383631	0852627	Jefferson	Sand & gravel	459	37	63	12	C	60,300	.004	WW-1	Torp-Smith (1978)
37	393706	0861229	Johnson	Sand & gravel	--	--	88	25	C	10,900	.00036	TW 59D	Keck (1959)
38	393742	0861404	Johnson	Gravel	--	12	25	30	U	11,000	.2	1	Groundwater (1988)[8]
39	393622	0861216	Johnson	Sand & gravel	665	9	--	--	C	11,800	.00075	--	Herring (1970)
40	393717	0860704	Johnson	Sand & gravel	--	--	--	--	--	5,360	.07	--	Ferris and Klaer (1944)
41	393712	0861251	Johnson	Sand & gravel	661	--	--	--	--	11,400	--	TW 67D	Keck Assoc. (1967a)[4]
42	411841	0872317	Lake	Sand	--	--	64	25	C	1,800	.001	5	Annable (1989b)
43	400910	0854513	Madison	Sand & gravel	--	--	--	--	C	8,800	.0016	67-12Z	Keck Assoc. (1967b)[4]
44	401112	0854033	Madison	Sand & gravel	--	85	--	--	--	3,350	.01	--	Keck Assoc. (1967c)[4]
45	400605	0853919	Madison	Sand & gravel	--	25	--	--	C	14,500	.00052	55L	Keck (1955)

Table 1. *Aquifer characteristics from site-specific pumped-well tests of Indiana wells completed in glacial-deposit aquifers*--Continued

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of screened interval (fbls)	Length of screened interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
46	400737	0854020	Madison	Sand & gravel	--	--	--	--	C	8,160	0.00053	11T-7	Stallman and Klaer (1946)
47	400107	0854026	Madison	Sand & gravel	--	--	125	31	U	10,300	.02	11	Keck Assoc. (1972)[4]
48	400857	0854239	Madison	Sand & gravel	--	--	--	--	C	43,300	.02	TW 65-E	Keck Assoc. (1965b)[4]
49	401135	0854122	Madison	Sand & gravel	--	125	--	--	C	6,660	.0007	PW 3	Keck Assoc. (1967d)[4]
50	401038	0854114	Madison	Sand & gravel	--	45	95	30	C	35,500	.000022	--	Keck Assoc. (1967e)[4]
51	401015	0854146	Madison	Sand & gravel	--	--	--	--	SC	9,550	.0068	67-12C	Keck Assoc. (1967f)[4]
52	400942	0854339	Madison	Sand & gravel	--	--	145	30	U	13,400	.0016	67-12CC	Keck Assoc. (1967g)[4]
53	401427	0853932	Madison	Sand & gravel	--	--	92	30	C	5,900	.0103	57B	Keck (1957c)
54	394453	0861107	Marion	Sand & gravel	--	--	--	--	U	21,600	--	77-10-C	Nuzman (1977b)
55	394816	0861540	Marion	Sand & gravel	--	60	--	--	C	15,000	.00019	TW 60 H	Linck (1960b)
56	394055	0861318	Marion	Sand & gravel	--	--	29	20	--	17,200	--	--	Meyer (1978)
57	394417	0855836	Marion	Outwash	--	--	--	--	C	1,300	.00002	--	Flemming (1989)
58	395156	0860230	Marion	Sand & gravel	--	14	30	10	--	26,800	--	1-82	Stremmel (1982a)[2]
59	404557	0860349	Miami	Sand & gravel	--	--	75	60	--	40,200	--	5	Stremmel (1980)[2]
60	404614	0860332	Miami	Sand & gravel	--	--	99	36	U	36,700	.052	2	Stremmel (1983b)[2]
61	404613	0860338	Miami	Sand & gravel	--	--	116	42	U	24,700	.13	1	Stremmel (1983b)[2]
62	405817	0873104	Newton	Sand	665	--	17	10	--	1,610	--	--	Steen (1978)
63	412629	0851507	Noble	Sand & gravel	991	72	71	42	U	1,250	.06	27	Stallman and Klaer (1950)
64	410711	0863456	Pulaski	Sand & gravel	704	25	30	8	--	8,220	--	D	Bruns (1979)
65	410711	0863501	Pulaski	Sand & gravel	710	20	29	7	--	3,690	--	B	Bruns (1979)
66	410711	0863507	Pulaski	Sand & gravel	711	11	30	5	C	2,220	.00012	A	Bruns (1979)
67	401137	0844830	Randolph	Sand & gravel	--	--	98	20	C	10,100	--	78-F	Nuzman (1978)
68	391407	0850451	Ripley	Sand & gravel	--	--	--	--	--	8,630	.0047	5	George (1979)
69	393514	0852820	Rush	Sand & gravel	--	--	74	10	C	300	.00048	TW 56B	Keck (1957d)
70	411509	0865401	Starke	Sand & gravel	--	--	15	10	U	6,970	.38	72C	D'Appolonia (1972)[9]

Table 1. *Aquifer characteristics from site-specific pumped-well tests of Indiana wells completed in glacial-deposit aquifers*--Continued

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of screened interval (fbls)	Length of screened interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
71	411420	0863400	Starke	Sand & gravel	--	--	--	--	C	11,100	0.000029	--	Jordan (1956)
72	411312	0863443	Starke	Sand & gravel	--	--	--	--	C	8,800	--	--	Jordan (1956)
73	385140	0844745	Switzerland	Sand & gravel	--	--	48	50	--	31,600	.0013	PW-1	Smith and Picking (1977)
74	385132	0844752	Switzerland	Sand & gravel	--	--	--	--	--	6,740	.003	8″ well	Smith (1984)
75	402926	0864852	Tippecanoe	Gravel	--	127	168	20	C	63,700	.0003	TW 57F	Keck (1957e)
76	402732	0865335	Tippecanoe	Sand & gravel	--	103	--	--	C	6,140	.0017	70C	Minning (1970)
77	402529	0870136	Tippecanoe	Sand & gravel	--	--	--	--	U	26,800	--	13	Henry (1973)
78	402713	0865330	Tippecanoe	Sand & gravel	--	--	63	25	--	69,700	--	1	Keck (1957f)
79	401654	0855033	Tipton	Sand & gravel	--	--	--	--	C	5,360	.0001	9	Keck (1952)
80	401804	0860122	Tipton	Sand & gravel	--	--	--	--	C	8,710	.00013	--	Herring (1973)
81	401740	0860239	Tipton	Sand & gravel	--	--	--	--	C	5,150	.0000283	3	Heckard and Steen (1952)
82	393804	0845951	Union	Sand & gravel	--	--	--	--	U	4,170	--	TW 58C	Keck (1958)
83	394911	0845354	Wayne	Sand & gravel	--	--	--	--	C	16,100	.00005	8″ well	Keck (1953)
84	404452	0864532	White	Gravel	--	--	67	30	--	43,300	.00066	3	Barnhart and Annable (1991)
85	410924	0852904	Whitley	Sand & gravel	845	186	186	30	--	26,100	.12	7	Herring (1972)
86	411339	0851912	Whitley	Sand & gravel	--	--	--	--	U	9,380	.15	1-74	Walker (1974)

[1]Ortman; Ortman Drilling, Inc.
[2]Stremmel; Stremmel and Hill, Inc.
[3]Sieco; Sieco, Inc.
[4]Keck Assoc.; Keck, W.G., and Associates, Inc.
[5]Reynolds; Reynolds National Corporation.
[6]Klaer Assoc.; Klaer, F.H., Jr. and Associates, Inc.
[7]IDC; Indiana Department of Conservation.
[8]Groundwater; Groundwater Management and Layne-Northern Company, Inc.
[9]D'Appolonia; D'Appolonia, E., Consulting Engineers, Inc.

Table 2. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in glacial-deposit aquifers*

[fasl, feet above sea level; fbsl, feet below land surface; ft^2/d, feet squared per day; --, data not available; C, confined; U, unconfined; SC, semiconfined; degree, minute, and second symbols are omitted from the latitude and longitude coordinates]

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of screened interval (fbls)	Length of screened interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
1	384101	0834641	Brown	--	500	--	71	15	C	7,430	0.05	S&G 5	ODNR (1971)[1]
2	392430	0843328	Butler	Buried valley	--	--	131	25	C	22,800	.001	North Well	Smith Assoc. (1960)[2]
3	392116	0843111	Butler	Buried valley	613	--	156	80	U	60,300	--	F-15	Klaer and Kasmann (1943)
4	392019	0843617	Butler	Buried valley	557	--	118	32	U	46,900	--	F-1	Klaer and Kasmann (1943)
5	385156	0841353	Clermont	Outwash	495	56	56	30	C	13,400	.3	S&G 1	ODNR (1971)[1]
6	394923	0840456	Greene	Sand & gravel	795	--	--	--	--	37,500	.067	140	Walton and Scudder (1960)
7	391113	0844734	Hamilton	Buried valley	490	79	79	25	C	47,100	.21	S&G 2	ODNR (1971)[1]
8	395409	0832839	Madison	Sand & gravel	1,070	--	--	--	C	36,400	.0002	8	Norris (1987)
9	395407	0832842	Madison	Sand & gravel	1,065	--	--	--	C	38,900	.00035	9	Norris (1987)
10	395406	0832845	Madison	Sand & gravel	1,065	--	--	--	C	37,400	.0003	10	Norris (1987)
11	394235	0825636	Pickaway	--	690	--	81	10	C	14,700	.02	S&G 4	ODNR (1971)[1]
12	391837	0830617	Ross	--	667	--	40	10	C	1,340	.25	S&G 2	ODNR (1971)[1]
13	392908	0830502	Ross	--	670	--	66	25	C	17,100	.0004	S&G 1-A	ODNR (1971)[1]
14	385152	0830023	Scioto	--	523	--	50	10	C	1,340	.3	S&G 3	ODNR (1971)[1]
15	383742	0831402	Scioto	--	490	--	61	20	C	6,000	.2	S&G 6	ODNR (1971)[1]

[1]ODNR; Ohio Department of Natural Resources, Division of Water.
[2]Smith Assoc.; Smith, Robert C., and Associates, Inc.

Table 3. *Aquifer characteristics for areas in Ohio for which pumped-well-test data have been previously summarized for wells completed in glacial-deposit aquifers*

[ft^2/d; feet squared per day; --, data not available; WPAB, Wright Patterson Air Force Base]

Area number	Description of study area	Producing unit	Number of tests	Range of transmissivities (ft^2/d)	Range of storage coefficients	Source
1	Robert Morris Property near Ross, Ohio	Buried valley	4	25,400 - 53,100	--	Sieco, Inc., (1969b)
2	Well field near Huffman Dam at WPAB	Outwash	6	34,800 - 41,500	0.020 - 0.100	Walton and Scudder (1960)

Table 4. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in glacial till*

[fasl, feet above sea level; fbls, feet below land surface; --, data not available; U, unconfined; ft^2/d, feet squared per day; degree, minute, and second symbols are omitted from the latitude and longitude coordinates]

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of screened interval (fbls)	Length of screened interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
1	411550	0830443	Sandusy	Till	676	45	--	--	--	2.07	0.015	Site 3	Strobel (1990)
2	401753	0832825	Union	Till	1,000	--	--	--	U	1.54	.0261	Site 2	Strobel (1990)

Table 5. *Aquifer characteristics from slug tests of Ohio wells completed in glacial-deposit aquifers*

[fasl, feet above sea level; fbls, feet below land surface; ft/d, feet per day; degree, minute, and second symbols are omitted from the latitude and longitude coordinates]

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Number of tests	Top of screened interval (fbls)	Length of screened interval (feet)	Range of horizontal-hydraulic conductivities (ft/d)	Other well identifier	Source
1	394907	0840146	Greene	Outwash	834	4	80.4	10	11 - 20	00-600	Dumouchelle (1992)
2	394859	0840406	Greene	Outwash	798	6	50.5	10	147 - 622	07-608	Dumouchelle (1992)
3	394811	0840505	Greene	Outwash	789	6	11.0	10	35 - 55	08-020	Dumouchelle (1992)
4	394808	0840505	Greene	Outwash	789	6	13.0	10	35 - 48	08-021	Dumouchelle (1992)
5	394807	0840457	Greene	Outwash	794	4	26.0	10	338 - 393	08-022	Dumouchelle (1992)
6	394743	0840323	Greene	Outwash	817	4	9.8	10	8 - 18	11-540	Dumouchelle (1992)
7	394737	0840328	Greene	Outwash	816	4	55.1	10	86 - 105	11-618	Dumouchelle (1992)
8	394915	0840352	Greene	Outwash	806	4	39.7	10	207 - 322	12-621	Dumouchelle (1992)
9	395011	0840126	Greene	Outwash	820	4	6.0	10	135 - 161	14-017	Dumouchelle (1992)
10	395004	0840139	Greene	Outwash	822	6	8.3	10	106 - 177	14-553	Dumouchelle (1992)
11	395012	0840126	Greene	Outwash	820	4	50.3	10	9 - 11	14-625	Dumouchelle (1992)
12	395004	0840137	Greene	Outwash	822	4	65.2	10	25 - 27	14-626	Dumouchelle (1992)
13	394755	0840252	Greene	Outwash	830	2	29.7	10	.33 - .80	15-555	Dumouchelle (1992)
14	394645	0840552	Greene	Outwash	807	3	45.0	10	210 - 771	GR-329	Dumouchelle (1992)
15	394831	0840155	Greene	Outwash	836	6	30.2	10	132 - 280	23-577	Dumouchelle (1992)
16	394834	0840154	Greene	Outwash	838	4	31.5	10	11 - 15	23-578	Dumouchelle (1992)
17	395032	0840231	Greene	Outwash	812	4	47.8	5	422 - 1,000	GR-316	Dumouchelle (1992)
18	395032	0840231	Greene	Outwash	812	4	126.0	5	2 - 36	GR-317	Dumouchelle (1992)
19	394929	0840150	Greene	Outwash	822	3	43.4	5	79 - 901	GR-318	Dumouchelle (1992)
20	394929	0840150	Greene	Outwash	822	4	150.5	10	87 - 202	GR-319	Dumouchelle (1992)

Table 5. *Aquifer characteristics from slug tests of Ohio wells completed in glacial-deposit aquifers*--Continued

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Number of tests	Top of screened interval (fbls)	Length of screened interval (feet)	Range of horizontal-hydraulic conductivities (ft/d)	Other well identifier	Source
21	394942	0840335	Greene	Outwash	801	5	16.8	5	330 - 888	GR-320	Dumouchelle (1992)
22	394855	0840339	Greene	Outwash	798	4	37.6	5	375 - 564	GR-321	Dumouchelle (1992)
23	394855	0840339	Greene	Outwash	798	4	137.2	10	155 - 232	GR-322	Dumouchelle (1992)
24	394831	0840427	Greene	Outwash	796	4	45.6	5	61 - 100	GR-323	Dumouchelle (1992)
25	394831	0840427	Greene	Outwash	796	6	117.6	10	113 - 536	GR-324	Dumouchelle (1992)
26	394815	0840207	Greene	Outwash	839	4	39.5	10	212 - 469	GR-330	Dumouchelle (1992)
27	394815	0840207	Greene	Outwash	839	4	105.0	10	112 - 184	GR-331	Dumouchelle (1992)
28	394815	0840207	Greene	Outwash	839	3	185.5	10	26 - 31	GR-332	Dumouchelle (1992)
29	394743	0840243	Greene	Outwash	838	4	33.6	5	107 - 131	GR-326	Dumouchelle (1992)
30	394743	0840243	Greene	Outwash	838	6	143.7	10	142 - 301	GR-327	Dumouchelle (1992)
31	394743	0840243	Greene	Outwash	838	3	239.5	5	116 - 125	GR-328	Dumouchelle (1992)
32	394852	0840231	Greene	Outwash	812	4	25.1	10	27 - 35	GR-333	Dumouchelle (1992)
33	394852	0840231	Greene	Outwash	812	4	145.0	10	67 - 99	GR-334	Dumouchelle (1992)
34	394852	0840231	Greene	Outwash	812	10	234.5	10	30 - 85	GR-335	Dumouchelle (1992)
35	394659	0840701	Montgomery	Outwash	782	6	23.1	10	156 - 306	18-559	Dumouchelle (1992)
36	394623	0840644	Montgomery	Outwash	791	6	26.0	10	72 - 130	MT-152	Dumouchelle (1992)
37	394623	0840644	Montgomery	Outwash	791	4	80.2	10	17 - 34	MT-153	Dumouchelle (1992)
38	394704	0840655	Montgomery	Outwash	783	6	24.8	10	230 - 582	18-560	Dumouchelle (1992)
39	394706	0840651	Montgomery	Outwash	784	4	25.6	10	89 - 584	18-561	Dumouchelle (1992)

Table 6. *Aquifer characteristics from site-specific pumped-well tests of Indiana wells completed in the carbonate-rock aquifer*

[Sil., Silurian; Dev., Devonian; dol., dolomite; Fm., formation; fasl, feet above sea level; fbls, feet below land surface; ft^2/d, feet squared per day; -- data not available; degree, minute, and second symbols are omitted from the latitude and longitude coordinates; names in the "Producing unit" column are those used by authors listed in the "Source" column]

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
1	405008	0845553	Adams	Sil., dolomite	798	36	--	--	C	320	0.0002	1	Klaer (1946)
2	404956	0845516	Adams	Limestone	790	32	--	--	C	3,080	.0004	7	Klaer (1946)
3	404920	0845540	Adams	Sil., dolomite	805	45	--	--	C	3,620	.005	4	Klaer (1946)
4	410632	0850612	Allen	Dev., limestone	--	--	129	215	C	1,490	.0001	TW-3	Stremmel (1983a)[1]
5	410327	0851938	Allen	Limestone	943	154	154	146	C	5,430	.00028	TW 86B	Annable (1986b)
6	410629	0850604	Allen	Dev., limestone	--	--	125	179	--	310	--	TW-1	Stremmel (1983a)[1]
7	410325	0851934	Allen	Limestone	--	150	--	--	--	1,890	--	7	Annable (1988)
8	411045	0850356	Allen	Limestone	--	--	--	--	C	3,750	.00001	1	Stremmel (1979)
9	403538	0864039	Carroll	Silurian	--	43	--	--	--	11,100	.01	90A	Annable (1990a)
10	410813	0870832	Jasper	Dev., Sil.	684	58	58	595	C	7,500	--	RASA 3	Arihood (1992)
11	405552	0871036	Jasper	Salamonie Dolomite	--	23	24	331	C	2,460	.0025	3	Yarling (1990)
12	411312	0871635	Lake	Dev., Sil.	639	54	54	545	C	52,000	--	RASA 2	Arihood (1992)
13	411450	0872114	Lake	Dev., Sil.	709	163	163	470	C	500	--	RASA 1	Arihood (1992)
14	411735	0872533	Lake	Middle Sil., dol.	--	119	119	161	C	1,080	.00013	3	Annable (1990b)
15	412621	0872840	Lake	Sil., Niagaran	--	125	--	--	C	6,700	.001	4	Annable (1984)
16	401657	0855042	Madison	Silurian	--	--	--	--	--	940	--	2	Heckard and Steen (1952)
17	403958	0860834	Miami	Liston Creek Fm.	--	65	--	--	C	2,280	.00001	26/3-25N1	Watkins and Rosenshein (1963)
18	404014	0860802	Miami	Liston Creek Fm.	788	--	--	--	C	540	--	26/3-25K1	Watkins and Rosenshein (1963)
19	403835	0860746	Miami	Liston Creek Fm.	812	70	--	--	C	5,580	.0007	25/3-1H3	Watkins and Rosenshein (1963)
20	404008	0860851	Miami	Liston Creek Fm.	790	65	--	--	C	1,740	--	26/3-26J1	Watkins and Rosenshein (1963)
21	401223	0844810	Randolph	--	1,090	--	95	103	--	3,440	.0001	3	Klaer Assoc. (1969)[2]
22	401738	0860238	Tipton	Limestone	--	--	--	--	C	1,400	.00081	4	Heckard and Steen (1952)
23	404208	0850925	Wells	Limestone	--	38	--	--	C	5,630	.00025	BTW-3	Stremmel (1982b)[1]
24	404127	0850955	Wells	Limestone	--	--	61	203	C	8,700	.00025	BTW-1	Stremmel (1982b)[1]
25	404136	0850942	Wells	Limestone	--	45	--	--	C	2,950	.00025	BTW-2	Stremmel (1982b)[1]

Table 6. *Aquifer characteristics from site-specific pumped-well tests of Indiana wells completed in the carbonate-rock aquifer*--Continued

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
26	404323	0850552	Wells	Limestone	--	--	70	--	--	10,700	--	--	Steen (1973)
27	404212	0850922	Wells	Limestone	--	38	65	--	C	10,200	0.05	8	Stremmel (1983c)[1]
28	404135	0850942	Wells	Limestone	--	--	48	--	C	1,260	.000033	2	Stremmel (1982b)[1]

[1]Stremmel; Stremmel and Hill, Inc.

[2]Klaer Assoc.; Klaer, F.H., Jr. and Associates, Inc.

Table 7. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in the carbonate-rock aquifer*

[Sil., Silurian; Lo., Lower; Dev., Devonian; Is., Islands; Up., Upper; fasl, feet above sea level; fbls, feet below land surface; ft^2/d, feet squared per day; --, data not available; degree, minute, and second symbols are omitted from the latitude and longitude coordinates; names in the "Producing unit" column are those used by authors in the "Source" column]

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
1	405256	0835312	Allen	Tymochtee, Sil.	825	10	32	228	C	1,100	0.0001	M-9	ODNR (1969)[1]
2	404454	0841107	Allen	Tymochtee, Sil.	825	15	21	349	C	1,160	.0001	M-15	ODNR (1969)[1]
3	404633	0835610	Allen	Tymochtee, Sil.	910	5	11	349	C	2,800	.0018	M-14	ODNR (1968)[1]
4	405112	0840633	Allen	Tymochtee, Sil.	785	15	18	282	C	3,500	.0007	M-16	ODNR (1968)[1]
5	404857	0842102	Allen	Greenfield, Sil.	775	10	12	348	C	880	.0001	M-23	ODNR (1968)[1]
6	404247	0840809	Allen	Greenfield, Sil.	861	130	130	270	C	8,800	.00004	P-1	Leggette (1970)[2]
7	404236	0840810	Allen	Greenfield, Sil.	861	82	82	320	C	6,800	.00004	P-2	Leggette (1970)[2]
8	404255	0840808	Allen	Greenfield, Sil.	845	51	52	448	C	8,100	.00003	P-3	Leggette (1970)[2]
9	404255	0840806	Allen	Greenfield, Sil.	853	38	39	361	C	8,800	.00007	P-6	Leggette (1970)[2]
10	405320	0835337	Allen	Silurian	825	--	--	--	--	6,700	.0011	2	Klaer Assoc. (1968)[3]
11	404647	0841121	Allen	Tymochtee	815	--	--	--	--	450	--	4	Eagon (1975)[4]
12	402916	0841856	Auglaize	--	912	--	--	--	C	20,200	.00012	Well 2	Eagon (1990a)[4]
13	402916	0841855	Auglaize	--	912	--	--	--	C	4,420	--	Well 1	Eagon (1990b)[4]
14	403505	0841347	Auglaize	Greenfield, Sil.	870	55	57	223	C	2,400	.0001	M-21	ODNR (1969)[1]
15	403233	0835745	Auglaize	Lo. Sil., Gasport	1,015	52	52	328	C	850	--	SW-5	ODNR (1971)[1]
16	403559	0840243	Auglaize	Tymochtee, Sil.	985	45	52	298	C	3,700	.0001	M-20	ODNR (1969)[1]
17	400350	0834138	Champaign	Goats Island	1,100	118	118	192	C	5,560	--	SW-21	ODNR (1971)[1]
18	401132	0833902	Champaign	Lockport	1,275	90	90	330	C	830	--	SW-20	ODNR (1971)[1]
19	401458	0834958	Champaign	Brassfield	1,075	235	235	125	C	1,390	--	SW-18	ODNR (1971)[1]
20	401218	0833254	Champaign	Brassfield	1,072	25	25	325	C	420	--	CPBR-19	ODNR (1971)[1]
21	404719	0830138	Crawford	Devonian	950	24	26	259	C	6,700	.0001	S-1	ODNR (1970)[1]
22	404304	0830156	Crawford	Upper Silurian	972	55	62	251	C	5,030	.0001	CPBR-6	ODNR (1971)[1]
23	405550	0830429	Crawford	Columbus, Dev.	922	18	19	311	C	7,800	.0001	S-12	ODNR (1970)[1]
24	401231	0844745	Darke	--	1,082	75	77	188	--	22,100	.0001	5	Eagon (1983b)[4]
25	411444	0841654	Defiance	Tymochtee, Sil.	743	78	80	500	C	70	.0001	M-32	ODNR (1968)[1]

Table 7. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in the carbonate-rock aquifer--Continued*

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
26	401807	0831311	Delaware	Goat Island	940	30	30	370	C	2,490	--	CPBR-17	ODNR (1971)[1]
27	401348	0830242	Delaware	Silurian dolomite	940	12	340	545	C	1,000	--	CPBR-18	ODNR (1971)[1]
28	401844	0831237	Delaware	Salina	--	--	--	--	C	2,850	0.00033	OM-2	SSC for Ohio (1987)
29	402039	0830948	Delaware	Greenfield	900	10	10	340	C	510	--	CPBR-9	ODNR (1971)[1]
30	402426	0831426	Delaware	Dayton	920	12	12	338	C	28,000	--	CPBR-13	ODNR (1971)[1]
31	402445	0830106	Delaware	Bass Islands	370	26	67	303	C	620	.0001	CPBR-14	ODNR (1971)[1]
32	395537	0831112	Franklin	--	905	133	234	106	C	390	--	CPBR-26	ODNR (1971)[1]
33	410912	0834758	Hancock	Bass Islands, Sil.	722	78	109	311	C	2,200	.0001	P-6	ODNR (1969)[1]
34	410721	0833121	Hancock	Lockport, Sil.	784	41	42	178	C	370	.0001	P-2	ODNR (1970)[1]
35	405554	0832931	Hancock	Greenfield, Sil.	840	13	16	204	C	960	.0001	M-2	ODNR (1969)[1]
36	405427	0833914	Hancock	Limestone	860	--	--	--	--	2,880	--	4	Eagon (1989a)[4]
37	405517	0833706	Hancock	Tymochtee, Sil.	830	13	16	304	C	2,500	.0001	M-4	ODNR (1969)[1]
38	410239	0834248	Hancock	Tymochtee, Sil.	770	17	22	308	C	1,870	.0001	M-7	ODNR (1968)[1]
39	405619	0834703	Hancock	Tymochtee, Sil.	810	6	10	310	C	7,730	.0001	M-6	ODNR (1968)[1]
40	405332	0834217	Hancock	Tymochtee, Sil.	850	4	7	273	C	5,030	.0001	M-5	ODNR (1969)[1]
41	404000	0834128	Hardin	Lockport	985	37	37	288	C	1,440	--	CPBR-1	ODNR (1970)[1]
42	404115	0832943	Hardin	Greenfield, Sil.	920	41	43	287	C	410	.0001	S-8	ODNR (1970)[1]
43	404542	0834040	Hardin	Raisin River, Sil.	965	18	21	229	C	3,800	.0001	S-15	ODNR (1970)[1]
44	403543	0834258	Hardin	Lo. Sil., Gasport	1,095	93	93	317	C	1,950	--	SW-6	ODNR (1971)[1]
45	403531	0832841	Hardin	Lockport	945	27	27	173	C	6,350	--	CPBR-3	ODNR (1971)[1]
46	404619	0834451	Hardin	Tymochtee, Sil.	939	28	31	189	C	170	.0001	M-13	ODNR (1968)[1]
47	404809	0833217	Hardin	Tymochtee, Sil.	900	63	65	145	C	4,500	.0001	M-3	ODNR (1969)[1]
48	403649	0833807	Hardin	Lockport	990	35	--	--	--	2,140	.0001	5	Eagon (1977)[4]
49	411324	0840149	Henry	Detroit River	712	48	49	34	--	380	--	3	Eagon (1987)[4]
50	411325	0840144	Henry	Detroit River	712	--	126	424	C	190	--	7	Eagon (1989b)[4]

Table 7. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in the carbonate-rock aquifer--Continued*

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
51	412123	0835740	Henry	Lo. Dev., Up. Sil.	680	42	43	257	C	350	0.0001	M-37	ODNR (1969)[1]
52	411114	0835622	Henry	Tymochtee, Sil.	712	74	75	190	C	3,700	.0001	M-36	ODNR (1969)[1]
53	392113	0832648	Highland	Lilley	1,000	74	74	176	C	70	--	CPBR-8	ODNR (1971)[1]
54	401644	0833334	Logan	Gasport	1,070	28	60	240	C	1,800	--	CPBR-15	ODNR (1971)[1]
55	403054	0833727	Logan	Gasport	1,090	35	135	215	C	1,340	--	CPBR-2	ODNR (1971)[1]
56	402219	0834536	Logan	Bass Is.	1,265	--	--	--	--	2,140	.0005	13	Klaer Assoc. (1964)[3]
57	402843	0834841	Logan	Brassfield	1,030	16	16	344	C	1,240	--	SW-16	ODNR (1971)[1]
58	402248	0835648	Logan	Brassfield	990	156	156	154	C	1,260	--	SW-15	ODNR (1971)[1]
59	413143	0835116	Lucas	Tymochtee, Sil.	665	66	68	182	C	14,300	.0001	M-39	ODNR (1969)[1]
60	414257	0834742	Lucas	Tymochtee, Sil.	680	47	51	284	C	25,000	.0001	M-40	ODNR (1969)[1]
61	400510	0832639	Madison	Lockport	993	23	23	147	C	6,630	--	CPBR-24	ODNR (1971)[1]
62	400535	0831911	Madison	Greenfield	965	23	23	287	C	4,160	--	CPBR-25	ODNR (1971)[1]
63	395740	0832557	Madison	Lockport	1,020	140	145	145	C	840	--	CPBR-29	ODNR (1971)[1]
64	395240	0831634	Madison	Tymochtee	968	238	239	111	C	910	--	CPBR-27	ODNR (1971)[1]
65	394358	0833234	Madison	--	1,055	36	42	183	C	130	--	CPBR-28	ODNR (1971)[1]
66	402742	0830432	Marion	Up. Greenfield	--	--	--	--	C	3,550	.00028	WP-2	SSC for Ohio (1987)
67	403412	0831704	Marion	Lockport	910	22	32	258	C	3,290	--	CPBR-4	ODNR (1971)[1]
68	402758	0831247	Marion	Lockport	915	36	39	261	C	11,200	--	CPBR-5	ODNR (1971)[1]
69	404155	0831009	Marion	Raisin River, Sil.	920	77	78	232	C	6,700	.0001	S-4	ODNR (1971)[1]
70	402953	0830513	Marion	Upper Silurian	950	10	10	200	C	4,910	--	CPBR-7	ODNR (1971)[1]
71	402242	0842839	Mercer	Lo. Sil., Gasport	955	69	69	231	C	740	--	SW-3	ODNR (1971)[1]
72	402454	0844338	Mercer	Lo. Sil., Gasport	945	49	49	231	C	720	--	SW-2	ODNR (1971)[1]
73	403318	0844336	Mercer	Lo. Sil., Gasport	850	28	28	212	C	840	--	SW-1	ODNR (1971)[1]
74	404117	0843903	Mercer	--	815	97	97	--	C	1,110	.00044	Well 3	Eagon (1990c)[4]
75	402451	0844702	Mercer	Limestone	922	--	--	--	C	820	--	4	Eagon (1981)[4]

Table 7. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in the carbonate-rock aquifer--Continued*

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
76	402426	0844707	Mercer	Green shale	945	--	--	--	C	1,500	--	5	Eagon (1981)[4]
77	402440	0844656	Mercer	Limestone	940	--	--	--	--	1,340	--	1	Eagon (1980)[4]
78	403740	0842943	Mercer	Greenfield, Sil.	830	30	36	244	C	12,500	0.0001	M-42	ODNR (1969)[1]
79	402519	0843732	Mercer	--	954	125	134	159	C	1,280	.00056	1	Eagon (1988a)[4]
80	402518	0843732	Mercer	--	956	143	151	142	C	1,510	.00045	2	Eagon (1988a)[4]
81	413644	0832019	Ottawa	Greenfield, Sil.	580	24	29	331	C	3,200	.0031	P-16	ODNR (1969)[1]
82	412911	0830131	Ottawa	Tymochtee, Sil.	578	68	70	280	C	720	.0001	P-5	ODNR (1969)[1]
83	413438	0830928	Ottawa	Tymochtee, Sil.	575	50	120	180	C	960	.0001	P-10	ODNR (1969)[1]
84	413100	0831429	Ottawa	Bass Islands, Sil.	500	38	41	319	C	480	.0001	P-12	ODNR (1969)[1]
85	412724	0832218	Ottawa	--	640	--	--	--	--	200	.0001	1	Eagon (1979)[4]
86	410342	0842457	Paulding	Tymochtee, Sil.	720	34	38	332	C	1,700	.0001	M-29	ODNR (1968)[1]
87	410234	0844632	Paulding	Tymochtee, Sil.	755	37	37	293	C	3,400	.0001	M-30	ODNR (1969)[1]
88	410557	0844004	Paulding	Tymochtee, Sil.	730	18	20	340	C	1,100	.0001	M-31	ODNR (1969)[1]
89	394630	0830329	Pickaway	Sil., dolomite	775	118	118	122	C	1,420	--	CPBR-31	ODNR (1971)[1]
90	394637	0830949	Pickaway	--	835	65	65	257	C	550	--	CPBR-34	ODNR (1971)[1]
91	405630	0840139	Putnam	Tymochtee, Sil.	760	8	14	306	C	710	.0001	M-10	ODNR (1968)[1]
92	405926	0840250	Putnam	Bass Islands, Sil.	720	27	31	339	C	750	.0001	M-28	ODNR (1968)[1]
93	410028	0835831	Putnam	Tymochtee, Sil.	725	12	13	437	C	880	.0001	M-8	ODNR (1968)[1]
94	405203	0840803	Putnam	Tymochtee, Sil.	780	9	14	286	C	3,500	.0001	M-17	ODNR (1970)[1]
95	410354	0840341	Putnam	Tymochtee, Sil.	735	46	50	370	C	430	.0001	M-11	ODNR (1968)[1]
96	405445	0840318	Putnam	--	777	29	33	267	C	5,760	.0011	Well 4	Eagon (1990d)[4]
97	411914	0830453	Sandusky	Tymochtee, Sil.	627	92	93	70	C	230	.0001	S-3	ODNR (1970)[1]
98	412537	0830401	Sandusky	Greenfield, Sil.	575	70	72	108	C	3,000	.0001	S-18	ODNR (1970)[1]
99	411531	0830446	Sandusky	Silurian	675	95	95	13	C	8,700	.0001	S-23	ODNR (1970)[1]
100	412356	0832126	Sandusky	Greenfield, Sil.	645	19	22	228	C	390	.0001	P-11	ODNR (1969)[1]

Table 7. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in the carbonate-rock aquifer--Continued*

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
101	411948	0831515	Sandusky	Greenfield, Sil.	670	19	19	261	C	530	0.00014	P-13	ODNR (1970)[1]
102	411038	0830911	Seneca	Greenfield, Sil.	705	54	54	301	C	13,700	.0001	S-24	ODNR (1970)[1]
103	410438	0832020	Seneca	Greenfield, Sil.	800	45	55	255	C	1,200	.0001	S-16	ODNR (1970)[1]
104	410448	0830459	Seneca	Tymochtee, Sil.	835	115	115	280	C	5,700	--	S-17	ODNR (1970)[1]
105	410725	0832036	Seneca	Lockport, Sil.	775	32	32	343	C	1,300	.0001	S-19	ODNR (1970)[1]
106	401619	0840528	Shelby	Brassfield	1,015	103	103	177	C	1,770	--	SW-14	ODNR (1971)[1]
107	402056	0841449	Shelby	Lo. Sil., Gasport	985	74	74	206	C	3,720	--	SW-12	ODNR (1971)[1]
108	402806	0840646	Shelby	Lo. Sil., Gasport	1,020	184	184	231	C	650	--	SW-11	ODNR (1971)[1]
109	402736	0832913	Union	Dayton	1,040	28	28	292	C	1,580	.0001	CPBR-11	ODNR (1971)[1]
110	401355	0831424	Union	Greenfield	942	28	28	322	C	4,080	--	CPBR-20	ODNR (1971)[1]
111	401752	0831753	Union	Lockport	960	83	83	210	C	5,440	--	CPBR-21	ODNR (1971)[1]
112	400858	0832414	Union	Greenfield	980	78	78	157	C	5,400	--	CPBR-22	ODNR (1971)[1]
113	402411	0832149	Union	Dayton Limestone	975	35	35	280	C	7,490	--	CPBR-12	ODNR (1971)[1]
114	402400	0832206	Union	Columbus Limestone	--	--	--	--	C	2,370	.00037	RP-4	SSC for Ohio (1987)
115	400655	0831153	Union	Devonian	940	59	155	200	C	1,180	--	CPBR-23	ODNR (1971)[1]
116	401825	0832549	Union	Rochester	1,040	35	36	314	C	4,280	--	CPBR-16	ODNR (1971)[1]
117	401652	0832951	Union	--	1,094	75	103	177	C	6,140	.00011	1	Burgess and Niple (1978)[5]
118	401655	0832952	Union	--	1,092	73	94	186	C	3,140	.00081	2	Burgess and Niple (1978)[5]
119	405418	0844347	Van Wert	Greenfield, Sil.	790	37	38	242	C	1,600	.0001	M-25	ODNR (1969)[1]
120	405827	0843858	Van Wert	Greenfield, Sil.	750	7	12	246	C	2,700	.0001	M-26	ODNR (1969)[1]
121	405900	0842809	Van Wert	Tymochtee, Sil.	724	18	20	240	C	1,300	.0001	M-27	ODNR (1969)[1]
122	404456	0842644	Van Wert	Tymochtee, Sil.	815	50	53	307	C	2,200	.0001	M-19	ODNR (1970)[1]
123	410016	0842711	Van Wert	Greenfield, Sil.	795	147	148	192	C	1,600	.0001	M-24	ODNR (1969)[1]
124	405227	0843554	Van Wert	--	780	1	60	290	C	3,300	--	1	Phoenix (1989)[6]
125	405326	0843453	Van Wert	--	780	1	43	221	C	2,270	--	1	Phoenix (1989)[6]

Table 7. *Aquifer characteristics from site-specific pumped-well tests of Ohio wells completed in the carbonate-rock aquifer--Continued*

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Top of aquifer (fbls)	Top of open interval (fbls)	Length of open interval (feet)	Type of aquifer	Transmissivity (ft^2/d)	Storage coefficient	Other well identifier	Source
126	412736	0842128	Williams	--	712	--	--	--	C	1,470	0.000069	5	Toledo Testing (1988)[7]
127	411431	0833851	Wood	Lockport	698	2	25	75	--	1,340	.0001	9	Eagon (1983a)[4]
128	411943	0832603	Wood	--	688	6	43	254	C	16,800	--	Well 6	Eagon (1990e)[4]
129	412645	0833158	Wood	Bass Islands, Sil.	650	48	51	199	C	240	.0001	P-14	ODNR (1969)[1]
130	412140	0833527	Wood	Greenfield, Sil.	670	22	22	213	C	200	.0001	P-9	ODNR (1970)[1]
131	412031	0834802	Wood	Raisin River, Sil.	678	65	66	444	C	1,300	.00015	M-38	ODNR (1968)[1]
132	411705	0832541	Wood	Lockport, Sil.	705	28	32	228	C	1,280	--	P-8	ODNR (1970)[1]
133	411007	0834015	Wood	Greenfield, Sil.	735	25	26	274	C	210	--	P-18	ODNR (1969)[1]
134	411011	0833308	Wood	Lockport	745	--	--	--	--	200	.0004	4	Eagon (1988b)[4]
135	405203	0832510	Wyandot	Greenfield, Sil.	850	47	48	172	C	500	.0001	S-9	ODNR (1970)[1]
136	405339	0832509	Wyandot	Greenfield, Sil.	840	32	39	161	C	850	.0001	S-10	ODNR (1970)[1]
137	405716	0832356	Wyandot	Silurian	840	22	50	150	--	3,530	.00318	1	Eagon (1989c)[4]
138	405035	0832728	Wyandot	Greenfield, Sil.	865	33	35	205	C	4,280	.0001	M-1	ODNR (1970)[1]
139	405929	0831012	Wyandot	Upper Silurian	790	64	64	136	C	9,300	.0001	S-14	ODNR (1970)[1]
140	404630	0831338	Wyandot	Tymochtee, Sil.	842	10	14	306	C	2,700	.0001	S-5	ODNR (1970)[1]
141	404628	0831646	Wyandot	Tymochtee, Sil.	870	72	76	224	C	920	.0001	S-6	ODNR (1970)[1]
142	405650	0830952	Wyandot	Silurian	855	85	95	255	C	2,130	.00086	Well 9	Eagon (1990f)[4]
143	404252	0831745	Wyandot	Bass Islands Dol., Sil.	890	81	82	208	C	5,300	.0001	S-7	ODNR (1970)[1]

[1]ODNR; Ohio Department of Natural Resources, Division of Water.
[2]Leggette; Leggette, Brashears & Graham, Inc.
[3]Klaer Assoc.; Klaer, F.H., Jr. and Associates, Inc.
[4]Eagon; Eagon & Associates, Inc.
[5]Burgess and Niple; Burgess & Niple Limited.
[6]Phoenix; Phoenix Consulting of Kentucky.
[7]Toledo Testing; Toledo Testing Laboratories.

Table 8. *Aquifer characteristics for areas in Ohio for which pumped-well-test data have been previously summarized for wells completed in the carbonate-rock aquifer*

[ft^2/d, feet squared per day; --, data not available]

Area number	Description of study area	Producing unit	Number of tests	Range of transmissivity values (ft^2/d)	Range of storage coefficients	Source
1	Envirosafe Landfill, Lucas County	--	2	700 - 3,700	--	Weston, Roy F., Inc. (1987)
2	Wood County Landfill	Lockport	4	263 - 390	--	Ohio Ground Water Consultants, Inc. (1989)
3	Wyandot County Landfill	Tymochtee	2	305 - 490	--	Ohio Ground Water Consultants, Inc. (1988)

Table 9. *Aquifer characteristics from slug tests of Ohio wells completed in limestones and shales of Ordovician age*

[fasl, feet above sea level; fbls, feet below land surface; ft/d, feet per day; degree, minute, and second symbols are omitted from the latitude and longitude coordinates]

Well number	Latitude	Longitude	County	Producing unit	Altitude of land surface datum (fasl)	Number of tests	Top of screened/ open interval (fbls)	Length of screened/ open interval (feet)	Range of horizontal-hydraulic conductivities (ft/d)	Other well identifier	Source
1	394929	0840150	Greene	Ordovician	822	2	232	10	0.282 - 0.329	GR-314	Dumouchelle (1992)
2	394942	0840335	Greene	Ordovician	801	2	51	10	0.386 -0 .393	GR-303	Dumouchelle (1992)
3	394706	0840458	Greene	Ordovician	977	4	44	60	9 - 12	GR-309	Dumouchelle (1992)
4	394706	0840458	Greene	Ordovician	977	1	116	20	0.0016	GR-312	Dumouchelle (1992)

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