U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

In cooperation with the U.S. Environmental Protection Agency

Geologic, Hydrologic, and Water-Quality Data from Selected Boreholes and Wells In and Near Belvidere, Illinois, 1989–96

By P.C. Mills (U.S. Geological Survey), D.J. Yeskis (U.S. Environmental Protection Agency), and T.D. Straub (U.S. Geological Survey)

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CONVERSION FACTORS AND VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Volume	
gallon (gal)	3.785	liter
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second
	Pressure	
pound per square inch (lb/in^2)	6.895	kilopascal
	Radioactivity	
picocurie per liter (pCi/L)	0.037	becquerel per liter
	Transmissivity*	
foot squared per day (ft^2/d)	0.09290	meter squared per day
	Hydraulic conductivity**	
foot per day (ft/d)	0.3048	meter per day

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

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 level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Altitude, as used in this report, refers to distance above or below sea level.

***Transmissivity:** The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness $[(ft^3/d)/ft^2]ft$. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.

****Hydraulic conductivity:** The standard unit for hydraulic conductivity is cubic foot per day per square foot of aquifer cross-sectional area $(ft^3/d)/ft^2$. In this report, the mathematically reduced form, foot per day (ft/d), is used for convenience.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C) or millisiemens per centimeter at 25 degrees Celsius (mS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Oxidation-reduction potential (Eh) is given in millivolts (mv).

Other abbreviations:

g/cm^3	grams per cubic centimeter

Geologic, Hydrologic, and Water-Quality Data from Selected Boreholes and Wells In and Near Belvidere, Illinois, 1989–96

By P.C. Mills, D.J. Yeskis, *and* T.D. Straub

Abstract

This report presents selected geologic, hydrologic, and water-quality data collected in and near Belvidere, Ill., during 1989–96. The data were collected primarily by the U.S. Geological Survey and U.S. Environmental Protection Agency in support of an ongoing ground-water study of the glacial drift aquifer and bedrock aquifers of Ordovician and Cambrian age underlying the area. These data were collected from 8 boreholes and 52 wells within a 4 square-mile urbanized part of the 80 square-mile study area. Data include stratigraphic, lithologic, and physical descriptions of rock cores from 5 boreholes; geophysical logs of 23 boreholes; surface-geophysical surveys at 3 sites; ground-water levels at 46 wells; horizontal hydraulic conductivity estimated from slug tests at 32 boreholes and wells; and ground-water-quality information at 26 boreholes and wells. Ground-water-quality information include field characteristics and laboratory analyses of inorganic constituents, tritium, volatile organic compounds, and semivolatile organic compounds. Also included are construction logs for 11 monitoring wells and descriptions of the methods used for data collection.

INTRODUCTION

The city of Belvidere in Boone County, Ill. (fig. 1) is a community of about 18,000 in north-central Illinois. Since the late 1800's, Belvidere has had a mixed agricultural- and industrial-based economy. In some cases, potentially hazardous wastes generated at local industrial or commercial facilities have been disposed on the grounds of the facilities or at one of three nearby solid-waste landfills (Brown and Mills, 1995). Presently, one closed industrial facility and two of the three closed landfills are listed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly known as Superfund).

Potentially hazardous industrial-use constituents (hereafter, referred to as contaminants), such as volatile and semivolatile organic compounds (VOC's and SVOC's, respectively) and metals, have been detected in the glacial drift and bedrock aquifers underlying the Belvidere area. Because contaminants have been detected in the community's 8 water-supply wells and approximately 20 domestic and industrial wells, the U.S. Environmental Protection Agency (USEPA) requested that the U.S. Geological Survey (USGS) study the hydrogeology and water quality of the aquifers in the area. The study is intended to provide the data and conceptual framework necessary to (1) determine the general distribution and migration pathways of contaminants in the aquifers, (2) evaluate ongoing and possible future ground-water contamination problems of the 80-mi^2 Belvidere study area (fig. 1) on a regional basis, and (3) develop strategies for remediation of ground-water problems and the protection of regional ground-water supplies.

Purpose and Scope

This report presents selected geologic, hydrologic, and water-quality data collected by the USGS and USEPA in support of the ongoing ground-water study in the vicinity of Belvidere, Ill. The data were collected during 1989–96 from temporary wells,

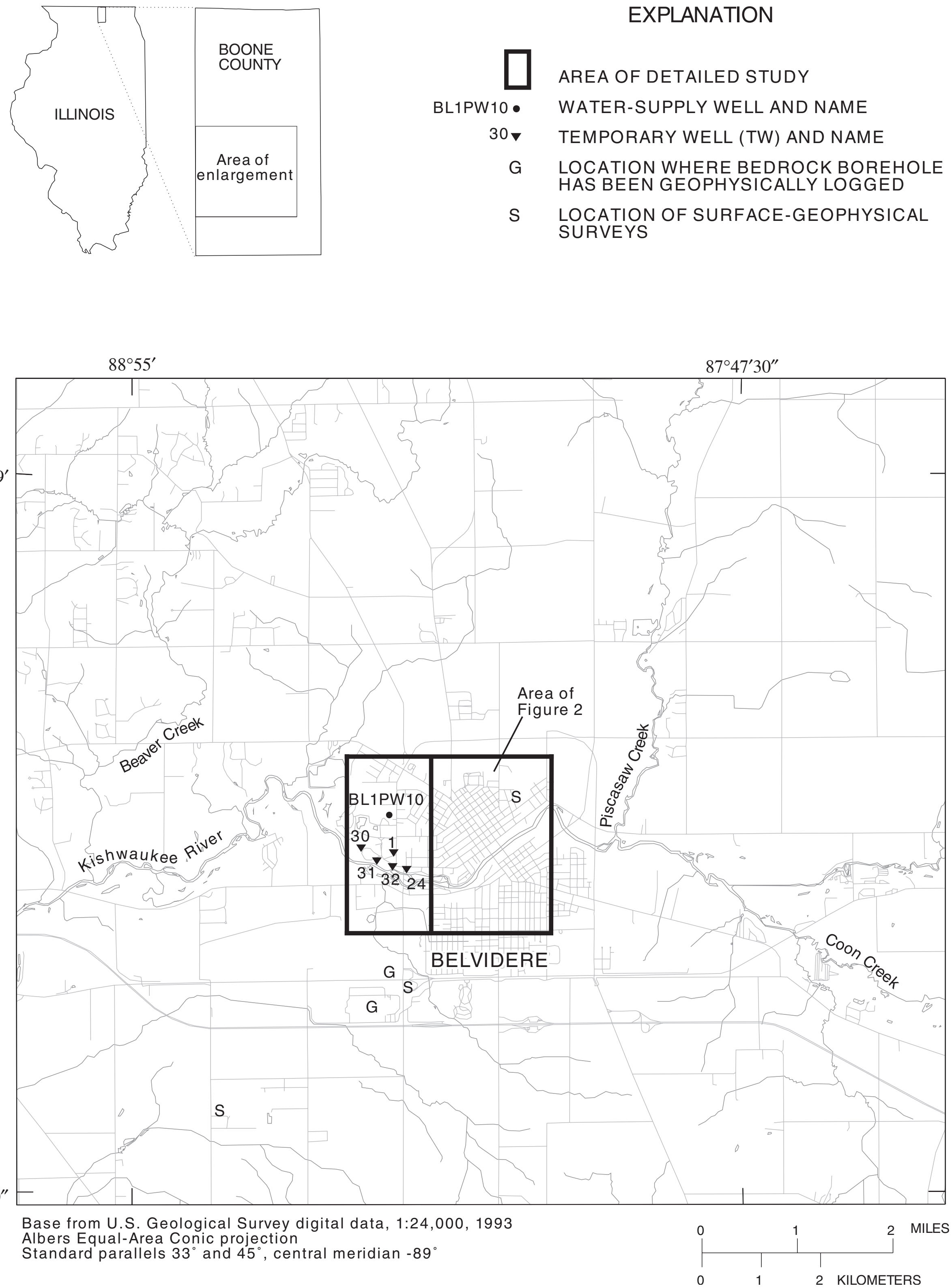


Figure 1. Regional study area, area of detailed study, and selected locations of wells and geophysical studies in and near Belvidere, Ill.

boreholes, monitoring wells, water-supply wells, and surface-geophysical surveys. Most of the data were collected within a 4-mi^2 urbanized area of detailed study (figs. 1 and 2). Also presented are selected data collected during 1985–1995 by private geotechnical firms, and municipal and State agencies. These data are included in this report to provide a more comprehensive data resource than is currently available for reviewing the areal, vertical, and time distribution of hydrogeologic and ground-water-quality data collected in the area of Belvidere. Data collected as part of synoptic water-level and water-quality studies in July 1993, May–June 1994, May–June 1995, and September–October 1996 are not included in this report. For the most part, the data collected during the synoptic studies were from a separate network of domestic water-supply wells. Data collected as part of the synoptic studies are presented in Mills and others (in press).

Data presented in this report include stratigraphic and lithologic descriptions and physical properties (porosity, bulk density, and particle density) of rock cores, borehole-geophysical logs, surface-geophysical surveys, ground-water levels, horizontal hydraulic conductivities, and ground-water-quality information. Ground-water levels include data collected during unstressed and stressed periods. Ground-water-quality information include field characteristics and laboratory analyses of inorganic constituents, tritium, VOC's, and SVOC's. Field characteristics were vertically profiled at two boreholes and determined at the well head at other sample sites. Also included in this report are (1) a description of the network of boreholes and wells where data were collected; (2) construction logs for 11 monitoring wells installed by the USGS; and (3) brief descriptions or references to the methods used to drill and construct the wells; collect geologic, geophysical, hydrologic, and water-quality data; determine the physical properties of rock cores; and analyze aquifer-test data. The methods of study are described in conjunction with the presentation of the data. All data tables are included at the end of the report.

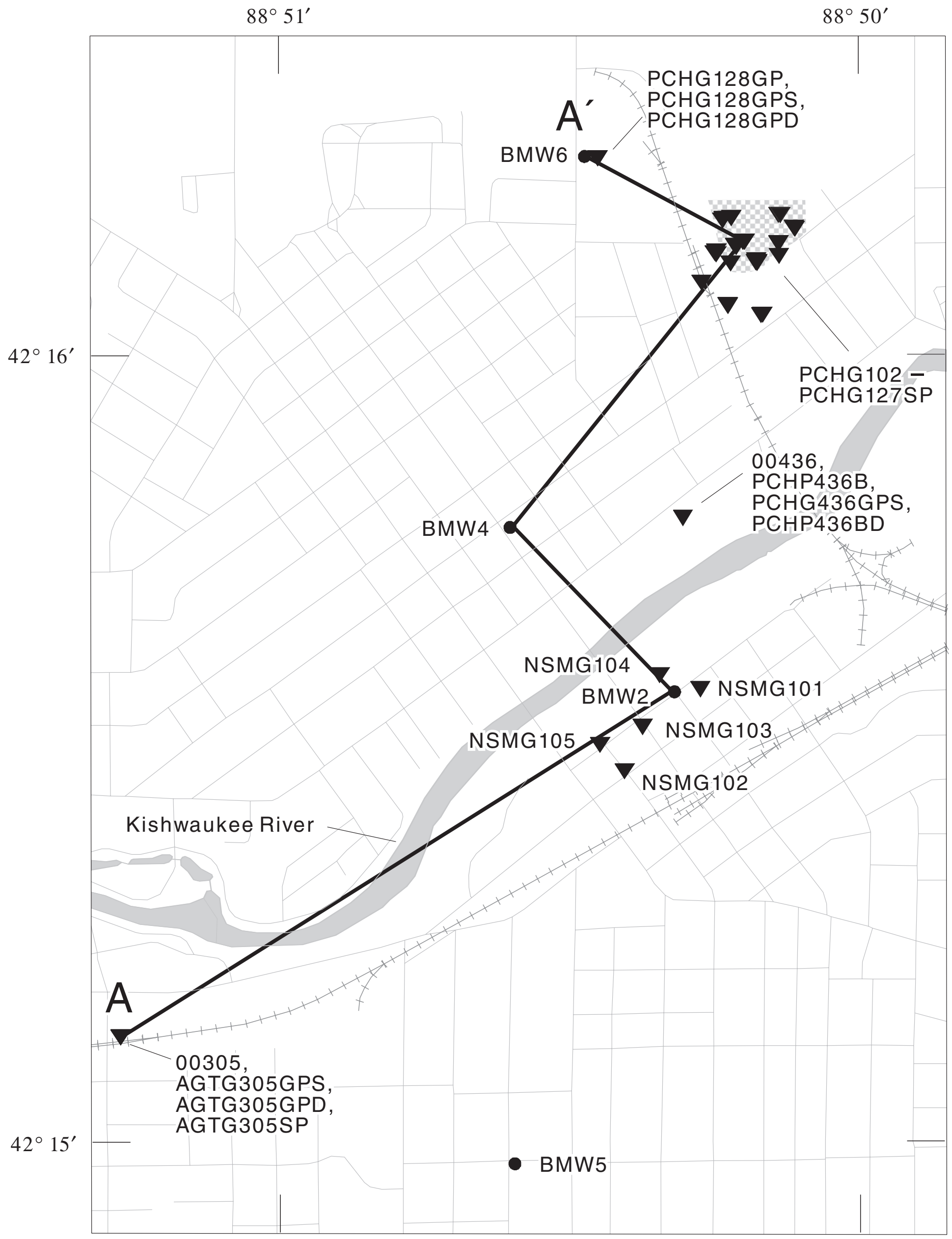
Description of the Study Area

The outer boundary shown in figure 1 represents the 80-mi^2 study area for the regional hydrogeologic and water-quality study. Most data presented in this report were collected within the 4-mi^2 urbanized area of detailed study shown in figures 1 and 2. The boundary of the detailed study area was selected because (1) several municipal water-supply wells in this area were available for extensive data collection (as described in this report), and (2) in many cases, data were collected in this area to complement ongoing site-specific ground-water investigations (Mills, 1993a,b,c; Illinois Environmental Protection Agency, 1988).

A detailed description of the physiographic setting of the regional study area is provided in Brown and Mills (1995). The setting of the detailed study area is characterized by broad lowlands drained by the westward flowing Kishwaukee River (figs. 1 and 2). Land-surface altitude at the river channel is about 750 ft. Beyond the narrow river channel, land surface is generally flat; altitude is about 780 ft.

The general geologic and hydrologic stratigraphy underlying the area of Belvidere is summarized in the following paragraphs and detailed in figures 3 and 4 (line of section A-A′ shown in figure 2). The stratigraphic nomenclature used in this report does not necessarily follow the usage of the USGS. The geologic nomenclature is that of the Illinois State Geological Survey (ISGS) (Willman and others, 1975). The hydrologic nomenclature is slightly modified from that of the Illinois State Water Survey (ISWS) (Woller and Sanderson, 1974). The modified nomenclature accounts for differences in the sizes and hydrogeologic conditions of the areas represented by the USGS/USEPA and the ISWS studies.

The principal aquifers in the study area are the glacial drift aquifer of Quaternary age, the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers of Ordovician age, and the Ironton-Galesville and Elmhurst-Mt. Simon aquifers of Cambrian age. For the purposes of this report, all wells open to sand-and-gravel and (or) silt deposits underlying the study area are considered to be completed in a single glacial drift aquifer. When considering ground-water flow in the regional 80-mi^2 study area, this assumption is reasonable. In the context of the 4-mi^2 area of detailed study, however, specific sand-and-gravel deposits may compose units that are hydraulically isolated from one another or represent alluvial deposits of Holocene age. In this report, the aquifer system composed of the Galena and Platteville Groups and the St. Peter Sandstone is referred to as the Ordovician aquifer, and the aquifer system composed of bedrock units of Ordovician and Cambrian age is referred to as the Cambrian-Ordovician aquifer. Specific aquifers within



Base from U.S. Geological Survey digital data,
1:24,000, 1993
Albers Equal-Area Conic projection
Standard parallels 33° and 45°, central meridian -89°

0 500 1,000 FEET
0 125 250 METERS

EXPLANATION

APPROXIMATE LOCATION OF THE PARSON'S CASKET HARDWARE SUPERFUND SITE

A-A′ LINE OF SECTION

▼ 00305 MONITORING WELL OR BOREHOLE AND NAME--Closely spaced wells are represented by overlapping well symbols

● BMW5 MUNICIPAL WATER-SUPPLY WELL AND NAME

Figure 2. Location of selected boreholes and wells, and line of section A-A′ in the area of detailed study in Belvidere, Ill.

SYSTEM	ROCK STRATIGRAPHY	AQUIFER OR CONFINING UNIT			LOG	THICK-NESS (FEET)	DESCRIPTION
QUATERNARY	Undesignated	Glacial drift aquifer and Confining unit				0-385	Unconsolidated glacial deposits-pebbly clay (till), silt, sand and gravel Alluvial silts and sands of Holocene age along streams
						Fissure fillings	Shale, sandy, brown to black
ORDOVICIAN	Maquoketa Shale Group	Confining unit				0-45	Shale, silty, dolomitic, greenish gray, weak (Upper unit) Dolomite and limestone, white, light gray, interbedded shale (Middle unit) Shale, dolomitic, brown, gray (Lower unit)
	Galena Group	Galena-Platteville aquifer	Ordovician aquifer	Cambrian-Ordovician aquifer		0-300	Dolomite and/or limestone, cherty (Lower unit) Dolomite, shale partings, speckled Dolomite and/or limestone, cherty, sandy at base
	Platteville Group						
	Glenwood Formation (Ancell Group)	Confining unit				0-55	Dolomite, sandstone; silty
	St. Peter Sandstone (Ancell Group)	St. Peter Sandstone aquifer				180-290	Sandstone, fine to coarse grained; locally cherty red shale at base
CAMBRIAN	Eminence Formation	Confining unit				40-120	Dolomite, light colored, sandy, thin sandstones
	Potosi Dolomite						Dolomite, fine-grained, gray to brown, drusy quartz
	Franconia Formation					60-100	Dolomite, sandstone and shale, glauconitic, green to red, micaceous
	Ironton Sandstone	Ironton-Galesville aquifer				115-160	Sandstone, fine to coarse grained, well sorted; upper part dolomitic
	Galesville Sandstone						
	Eau Claire Formation	Confining unit				200-380	Shale and siltstone, dolomitic, glauconitic; sandstone, dolomitic, glauconitic
	Elmhurst Sandstone Member	Elmhurst-Mt. Simon aquifer				about 1,600	Sandstone, coarse grained, white, red in lower half; lenses of shale and siltstone, red, micaceous in upper part
	Mt. Simon Sandstone						
PRE-CAMBRIAN							Granitic rocks

Figure 3. Geologic and hydrologic stratigraphy in and near Belvidere, Ill. (modified from Woller and Sanderson, 1974, fig. 1).

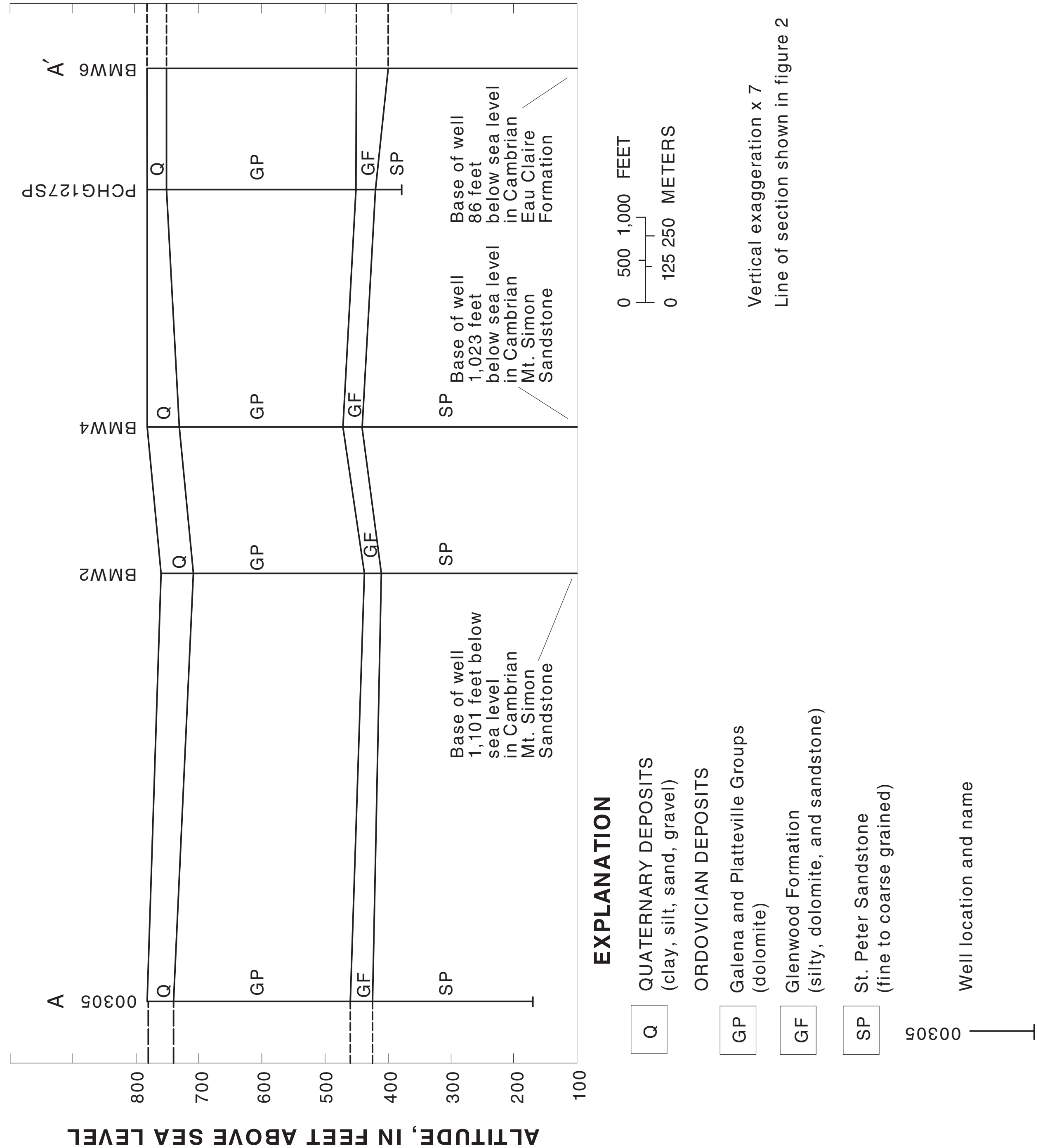


Figure 4. Geologic section A-A′ in Belvidere, Ill.

the systems generally are separated by confining units. The reader is referred to figure 3, Brown and Mills (1995), Berg and others (1984), and Willman and Kolata (1978), for general descriptions of the thickness, lithology, and hydrology of the aquifers.

Acknowledgments

The authors thank Jim Grimes, Superintendent of the Water and Sewer Department, Belvidere, Ill., and the citizens of Belvidere for generously allowing access to the municipal and private wells, respectively, in the study area. The authors also thank Dennis Kolata and Michael Sargent (ISGS) for their assistance in the lithologic and stratigraphic description of rock cores. Frederick Paillet (USGS) and James Ursic (USEPA, Superfund Division, Technical Support Section, Chicago, Ill.) are acknowledged for the collection and interpretation of borehole-geophysical data, and Peter Joesten and John Lane, Jr. (USGS) for the interpretation of the surface-geophysical data. James Rauman (USGS) is acknowledged for his assistance in borehole-packer testing and monitoring-well construction. Craig Thomas (USEPA, Superfund Division, Remedial Response Branch, Chicago, Ill.) is recognized for his assistance in data collection and for the scientific input and managerial oversight he provided in the initial phases of the study.

BOREHOLE AND WELL NETWORK

The network of 8 boreholes and 52 wells from which the data presented in this report were collected are shown in figures 1 and 2; specific locations of wells PCHG102–PCHG127SP are available from the USGS. A description of the boreholes and wells is provided in table 1. The network includes 5 temporary wells installed by the USEPA, 11 monitoring wells constructed by the USGS, 31 monitoring wells constructed by the Illinois Environmental Protection Agency (IEPA), 4 municipal water-supply wells, and 3 used and unused private water-supply wells (unused wells are referred to as boreholes in this report).

The following criteria are used for the classification and naming of temporary wells, boreholes, and wells. A temporary well is a 1-in. outside-diameter steel rod with a 2-ft long slotted screen installed in the glacial drift aquifer. Installed to a depth less than 30 ft below land surface, the well remains in place for less than 1 hour for measurement of the ground-water level and collection of a water sample. A temporary well is identified by the leading alphabetical characters TW (for example, **TW**1). A borehole, as used in this report, is an open hole in a bedrock aquifer that was present (1) before the subsequent construction of a monitoring well or use as a water-supply well, or (2) after use as a water-supply well is discontinued. A borehole name generally is the same as the subsequently constructed well name. A borehole with only numerical characters (for example, 00305) initially was constructed as a water-supply well. Leading alphabetical characters relate the boreholes and wells to site-specific studies (for example, PCH represents the Parson's Casket Hardware Superfund site and BMW represents a Belvidere municipal well). Monitoring wells are identified by the alphabetical characters **G** or **P** preceding several numerical characters (for example, PCH**G**426BD and PCH**P**436B). Monitoring wells comprise 2-in. inside-diameter (nominal) stainless-steel or polyvinylchloride (PVC) risers with stainless-steel or PVC slotted screens; screens are 5- or 10-ft (nominal) in length. As described in Brown and Mills (1995) and Science Applications International Corporation (1992), monitoring well names generally indicate the aquifer to which a well is open and the relative depth of a well in the aquifer. The well name also may indicate the specific fracture in the Galena-Platteville aquifer to which a well is open.

Temporary wells were installed using the Geoprobe system. This is a hydraulically powered system that uses the weight of the transport vehicle supplemented by a percussion hammer to advance the steel well rod. Details regarding the system are described in the sampling and analysis plan for the Belvidere ground-water study (U.S. Geological Survey and U.S. Environmental Protection Agency, 1993) and the manufacturer's operation manual (Kejr Engineering, undated). The target depth for the temporary wells was 5 ft below the water table (presumably in sand-and-gravel deposits) or the base of the glacial drift aquifer if the saturated thickness of the aquifer was less than 5 ft.

The boreholes and permanent wells were drilled and constructed by various methods, including augering, water-rotary, and air-percussion. A general description of the drilling and construction methods used for the boreholes and 11 wells installed by the USGS is in Mills (1993a,b). The reader also is referred to the completion records for the wells in appendix 2 (A list of abbreviations used in appendix 2 is given in appendix 1). Drilling and construction methods used for the wells installed by the IEPA are described in Illinois Environmental Protection Agency (1988) and Science Applications International Corporation (1992). A brief description of the construction of the municipal wells can be found in Woller and Sanderson (1974). Construction methods for the private water-supply wells are not well documented; details that are available on the well-construction permit are given in table 1.

GEOLOGIC DATA

Various types of geologic data were collected during this study in order to understand the geologic framework of the aquifers underlying the vicinity of Belvidere. Understanding this framework aids conceptualization of the movement of ground water and contaminants within the aquifers. Rock cores were collected from the bedrock units of Ordovician age to determine the stratigraphy, lithology, texture (visible porosity and grain size), and structure (presence of fractures) of the units. Selected cores were analyzed in the USGS, Illinois District laboratory in Urbana to determine the physical characteristics of matrix porosity, bulk density, and particle density. Selected boreholes were geophysically logged to provide additional information on the lithology, texture, structure, and hydraulic characteristics of the rock units. A surface-geophysical-logging procedure, the azimuthal square-array direct-current resistivity method, was used to interpret the orientation of high-angle fractures in the bedrock. Such fractures can affect hydraulic anisotropy in the bedrock aquifer. A quantified estimate of secondary porosity and information on layering of geologic units also can be obtained with this method.

Stratigraphy and Lithology of Rock Cores

Rock cores were collected from four boreholes (PCHG125B, PCHG115BD, PCHG127GP, PCHG127SP) at or near the Parson's Casket Hardware Superfund site and one borehole (PCHG128GP) located within 0.25 mi of the site (fig. 2). The 1.75–3-in. diameter cores were collected at various depth intervals in the bedrock units of Ordovician age underlying the area. Cores from all boreholes except PCHG115BD were collected by the USGS. The core from borehole PCHG115BD was collected by the IEPA.

All cores collected by the USGS were briefly described in the field (Mills, 1993b,c). The stratigraphy and lithology of the cores were described in detail in the laboratory by ISGS personnel specializing in the Ordovician-aged units of northern Illinois. Most cores were cut to slabs to reveal textural features and sedimentary structures that were not visible because of the rough surface of the cores. The cores were examined both wet and dry under fluorescent lights.

The approximately 360-ft thick sequence of the Galena and Platteville Groups, the Glenwood Formation, and the uppermost part of the St. Peter Sandstone in the vicinity of Belvidere is considered to be fully represented. The boreholes from which the cores were obtained are in close proximity and the core-sample intervals overlap. Detailed descriptions of core lithology by the ISGS are presented in appendix 3; a summarized description is presented in table 2.

Stratigraphic classification of the bedrock geologic units, based on all available rock-core data, is presented in tables 2 and 3. Stratigraphic classification of the Galena-Platteville Groups are based primarily on criteria developed from characteristics of the weathered surfaces of the carbonate units. The small-diameter, unweathered cores and the composited stratigraphic sequence represented by the cores were not ideally suited for classification with these criteria. Furthermore, stratigraphic classifications from the rock cores based on weathered-surface criteria were not necessarily equivalent to those classifications based on borehole-geophysical log characteristics, such as natural-gamma activity. Because of the difficulties in determining stratigraphic classifications in some unweathered rock cores, the classifications and related depths/thicknesses presented in tables 2 and 3 are not certain and subject to additional revision.

Physical Characteristics of Rock Cores

Fifty-seven subsections of the rock cores were selected for laboratory analysis of matrix porosity, bulk density, and particle density. The approximately 0.25-ft long subsections were selected as representative of each of the identified stratigraphic units (formations and members). For relatively thick stratigraphic units or units with variable lithology, multiple core sections were selected for analysis. The detailed lithologic descriptions of the cores by the ISGS and indications of clay content from natural-gamma logs were used to select representative subsections from stratigraphic units with variable lithologies.

The methods used for the analysis of porosity, bulk density, and particle density are detailed in appendix 4; the resulting values for these analyses are presented in tables 4–6. The analytical methods underestimate porosity and bulk density for core sections with exposed cavities (vugs or vesicles). To account for the underestimated values, a qualitative scale was used to estimate the volume of the unrepresented cavities. The scale ranges from 1 to 5, representing smooth (1) to very vuggy (5) core surfaces. The estimated values of porosity and bulk density based on this accounting are presented in the data tables as adjusted values. For quality-assurance purposes, some core sections were reanalyzed to determine the repeatability of the measurements. The reanalyzed sections are identified in the data tables as second-run measurements.

The vertical distribution of matrix porosity in the Ordovician-age bedrock units, as represented by composited data from boreholes PCHG115B, PCHG115BD, PCHG127GP, PCHG120GP, and PCHG127SP, is shown in figure 5. Also shown are the stratigraphy and selected physical and hydraulic characteristics of the units, including lithographic texture (visible porosity), clay content (indicated by natural-gamma activity), fracture presence (indicated by borehole diameter), horizontal hydraulic conductivity, and vertical ground-water flow.

Borehole and Surface Geophysics

Twenty-three boreholes or wells were geophysically logged by the USGS and USEPA. A listing of all boreholes or wells that were logged, the logging performed, and the agency that performed the logging are given in table 7. Fourteen monitoring wells open to glacial drift and shallow-bedrock deposits at the Parson's Casket Hardware Superfund site (PCH wells 102-122D in table 7 and figure 2) were logged for natural-gamma activity. All six boreholes open to deep-bedrock deposits at the Parson's Casket Hardware Superfund site (PCHG115BD, PCHG125BD, PCHG126BD, PCHG127GP, PCHG127SP, PCHG128GP), boreholes 00305 and 00436, and Belvidere municipal water-supply well BMW2 (fig. 2, table 1) were logged with multiple tools (table 7). The reader is referred to Schlumberger (1972), Paillet and Williams (1994), and Cohen (1995) for a general description of the principles, techniques, and applications of geophysical logging in hydrogeology. Niva (1991) provides an overview of ground-penetrating-radar logging. Hess (1990) describes the use of the heat-pulse flow meter to characterize vertical ground-water flow.

All geophysical logs completed by the USGS or USEPA as part of the study are shown in appendix 5 (a list of abbreviations and units used in appendix 5 is given in appendix 1). Additional logging of the bedrock deposits of Ordovician age has been done by a private geotechnical firm (GZA GeoEnvironmental, Inc., 1993, 1994) at several locations 0.5–1 mi southwest of the detailed study area (fig. 1). The northern location of borehole-geophysical logging shown in figure 1 represents a Belvidere municipal well (BMW8); the southern location represents several closely clustered boreholes at a manufacturing facility.

Logging of borehole PCHG127GP (open to the Galena-Platteville aquifer) by ground-penetrating radar was originally described in Niva (1991) and Mills (1993b). The description included a limited analysis of the full data set. An expanded analysis of the data set was later completed (John Lane, U.S. Geological Survey, written commun., 1993). The expanded analysis is summarized in table 8, which shows the interpreted reflectors (cavities, bedding-plane-solution features, and inclined fractures) in the vicinity of borehole PCHG127GP.

Vertical ground-water-flow data were collected using a heat-pulse flow meter at several locations in the study area. Data collected at borehole PCHG127GP are presented in Mills (1993b) and are shown in appendix 5. Data collected at borehole PCHG128GP (open to the Galena-Platteville aquifer) are presented in table 9 and are shown in appendix 5. Data collected at borehole 00436 (open to the Galena-Platteville aquifer) and the then unused municipal well BMW2 (open to the Cambrian-Ordovician aquifer) are shown in appendix 5.

Azimuthal square-array direct-current resistivity (SAR) surveys were done at three surface sites (fig. 1). The survey sites were selected on the basis of four criteria: (1) bedrock surface within 30 ft of land surface, (2) minimal clay or other fine-grained sediments in the unconsolidated deposits overlying bedrock, (3) surface area large enough to accommodate a 315–446-ft-diameter SAR array, and (4) widest

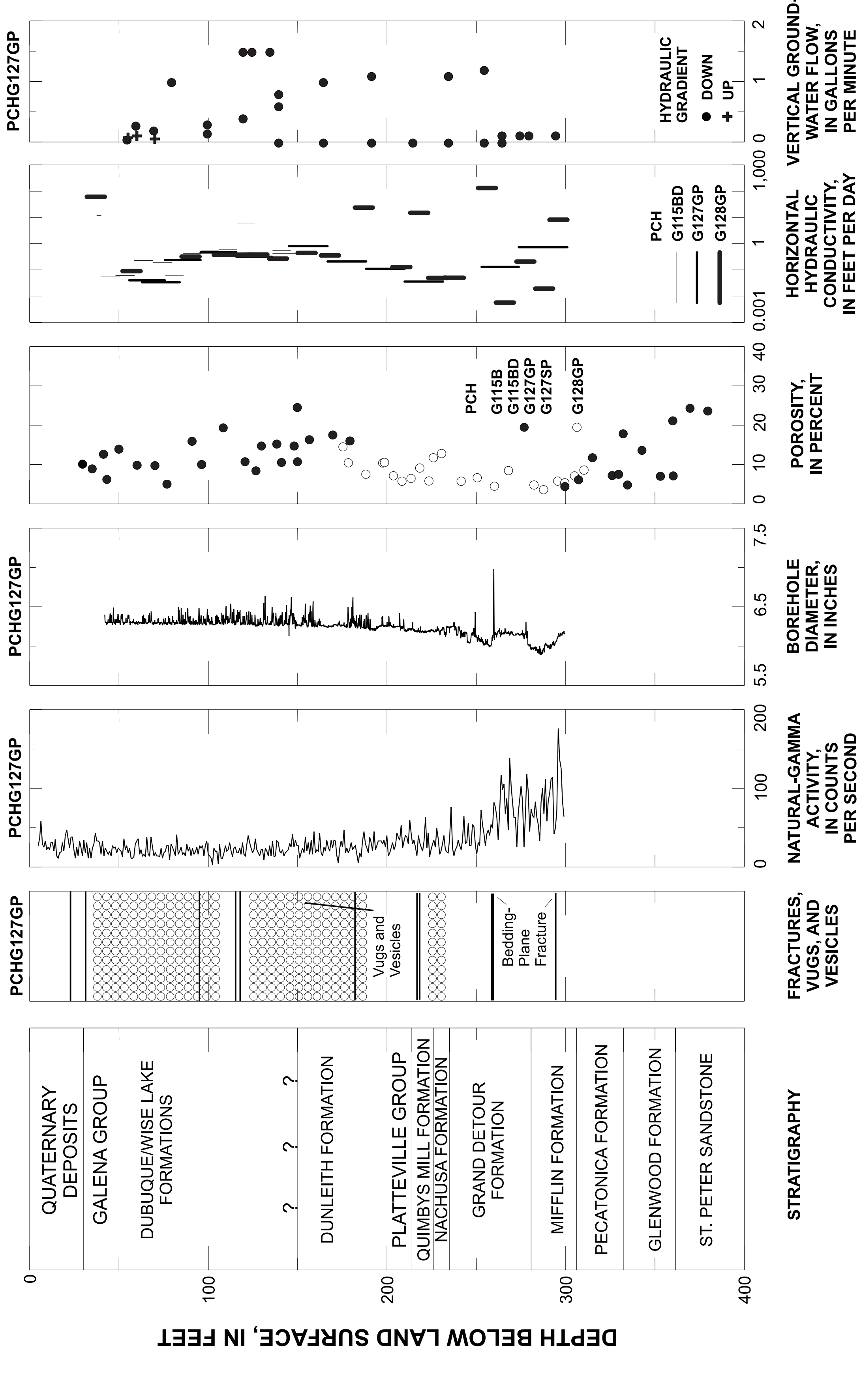


Figure 5. Stratigraphy and vertical distribution of geologic, geophysical, and hydraulic characteristics at selected boreholes in and near Belvidere, Ill. (See figure 2 for location of boreholes.)

possible distribution of sites within the 80-mi^2 regional study area. Two of the sites were southwest of the area of detailed study (about 0.5 and 3 mi, respectively). Theoretical considerations of the SAR method and the procedures of data collection and analysis are detailed in Lane and others (1995) and Habberjam (1979). The SAR data and analysis are presented in a document (Peter Joesten and John W. Lane, Jr., U.S. Geological Survey, written commun., 1996) provided, in part, in appendix 6. Graphical presentations of individual squares within the survey arrays and results of numerical geophysical modeling are available from the USGS.

HYDROLOGIC DATA

Hydrologic data were collected from the network of monitoring wells, water-supply wells, and boreholes. The data include water levels to determine horizontal and vertical hydraulic gradients, flow directions, aquifer responses to municipal-well pumping, and horizontal hydraulic conductivities of the aquifer materials. Data from boreholes were collected from fully open boreholes and from specific depth intervals isolated by use of a straddle-packer assembly. Data-collection methods using the straddle-packer assembly are described in detail in Mills (1993a,b). A generalized view of the straddle-packer assembly is shown in figure 6.

Ground-Water Levels

Ground-water levels were measured in most of the wells included in table 1 and figure 2 during this study. Periodic measurements were made in 46 wells, and near-continuous measurements were made in one borehole (00436) and 12 wells. Periodic measurements of water level were made by a chalked-steel tape or an electric-sensor tape. The measurements were made at time intervals ranging from less-than hourly to annually, generally at selected wells during irregularly scheduled field trips. Measurements were made at all available wells in the network during several annually scheduled field trips. Near-continuous measurements of water level were obtained by the use of vented pressure transducers, generally with a pressure-sensing range of 0–10 lb/in^2. Transducers with ranges of 0–20 lb/in^2 and 0–30 lb/in^2 were used in wells with substantial fluctuations in water level in response to pumping of nearby water-supply wells. Water levels obtained by pressure transducers were recorded by a programmable data logger. The near-continuous measurements were made at time intervals ranging from 15 to 30 minutes.

Several measurements were made at each well to ensure the quality of the data. Measurements made by steel tape were repeated and accepted when the difference between measurements was less than or equal to 0.01 ft. For some wells, a larger difference was accepted because the water level fluctuated in response to pumping of nearby water-supply wells over very short intervals (minutes). Electric tapes were used to measure water levels in wells with substantial fluctuations (about 0.5 ft per minute).

The operating response of each pressure transducer was checked, after placement in a well, by raising and lowering the submerged transducer a known distance and comparing this distance with the value indicated by the data logger. Transducers that were out of tolerance were not used in the study. Water levels in the wells instrumented with transducers were periodically cross-checked with measurements made with a chalked-steel or electric-sensor tapes; data logging was reinitiated with corrected water-level inputs, as necessary.

The periodic measurements of ground-water level allowed determination of the horizontal and vertical gradients, directions of ground-water flow, and the temporal variability of the gradients and directions of flow. Periodic measurements over intervals of short-duration (less than hourly to daily) and near-continuous measurements of longer duration (days to months) also provided information about the transient effects of ground-water pumping.

Periodic measurements in the vicinity of Belvidere during 1989–96 are presented in table 10 and figure 7. Near-continuous measurements during 1992–95 are presented in figures 8–15. Locations of the boreholes and wells where ground-water levels were measured are presented in figure 2. Additional near-continuous measured water levels were collected but are not presented as part of this report. Data collected by USEPA from wells PCHG111S and PCHG111D (Douglas Yeskis, U.S. Environmental Protection Agency, written commun., 1990), as part of an initial study of the pumping effects of nearby municipal wells BMW4 and BMW6 (fig. 2) on water levels in the glacial drift and Galena-Platteville aquifers, are available from the USGS. Data collected by the USGS, as part of a multiple-well aquifer test and

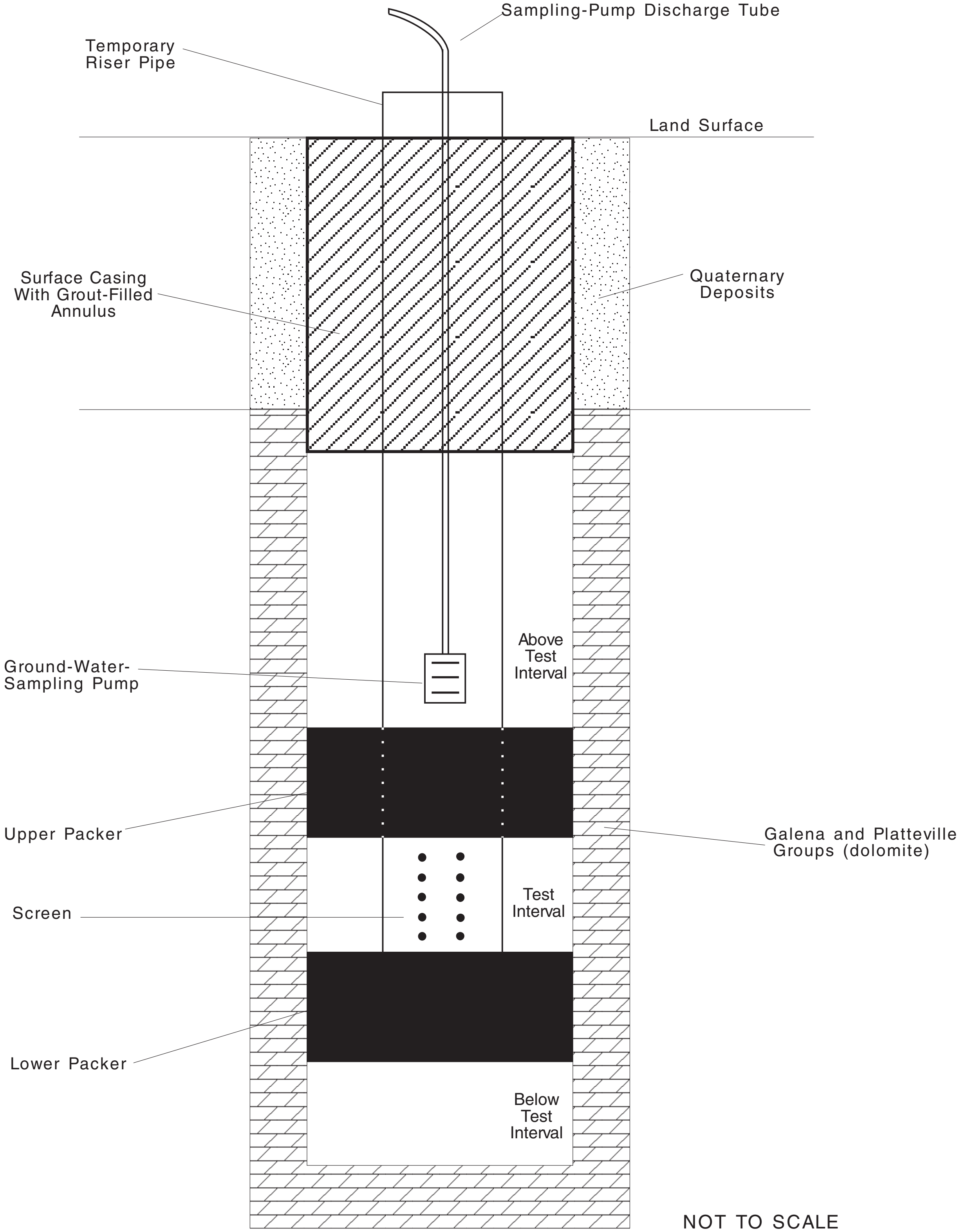


Figure 6. Generalized view of the straddle-packer assembly and ground-water-sampling pump in a borehole.

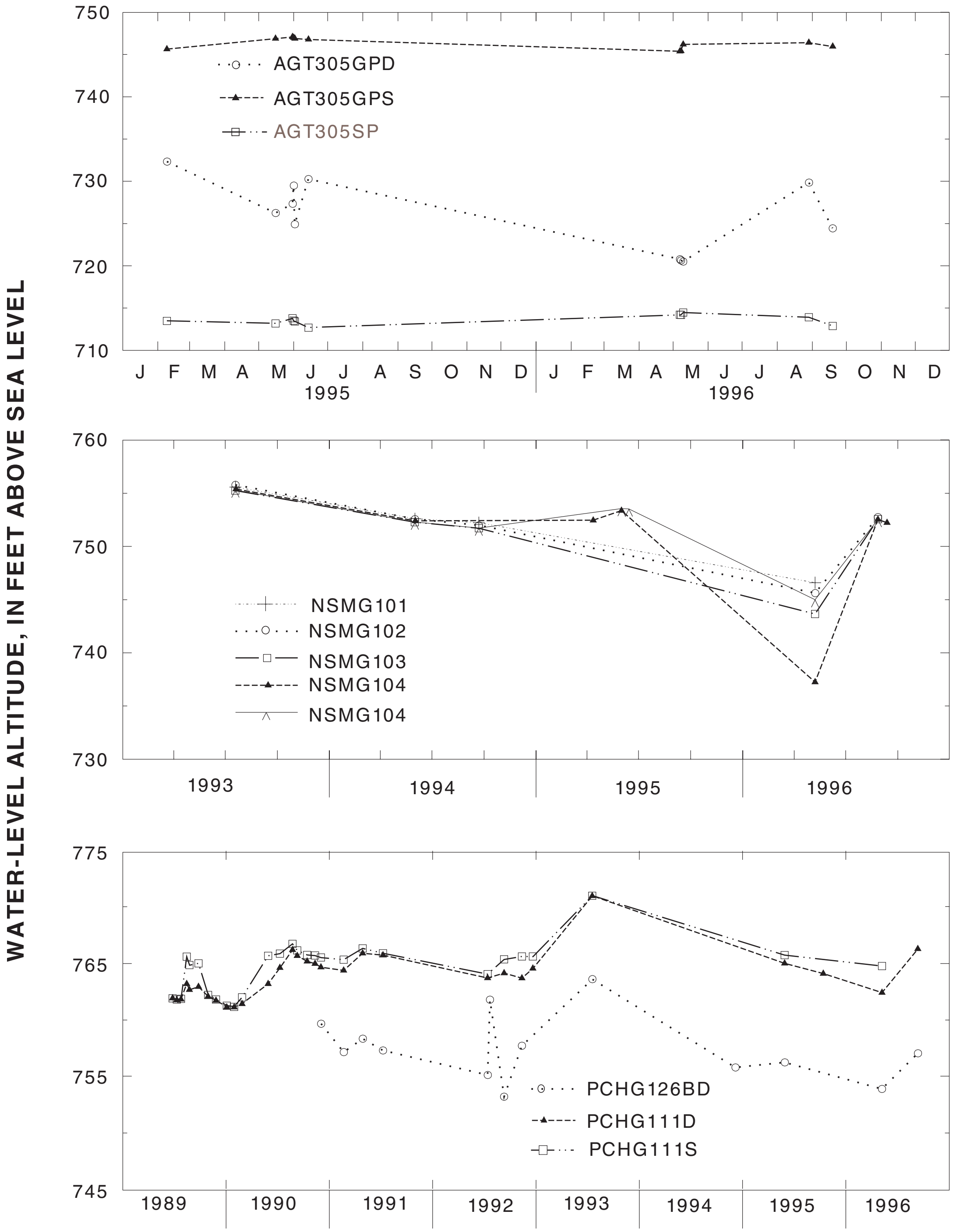


Figure 7. Periodic measured water levels in selected wells in Belvidere, Ill., 1989–96.

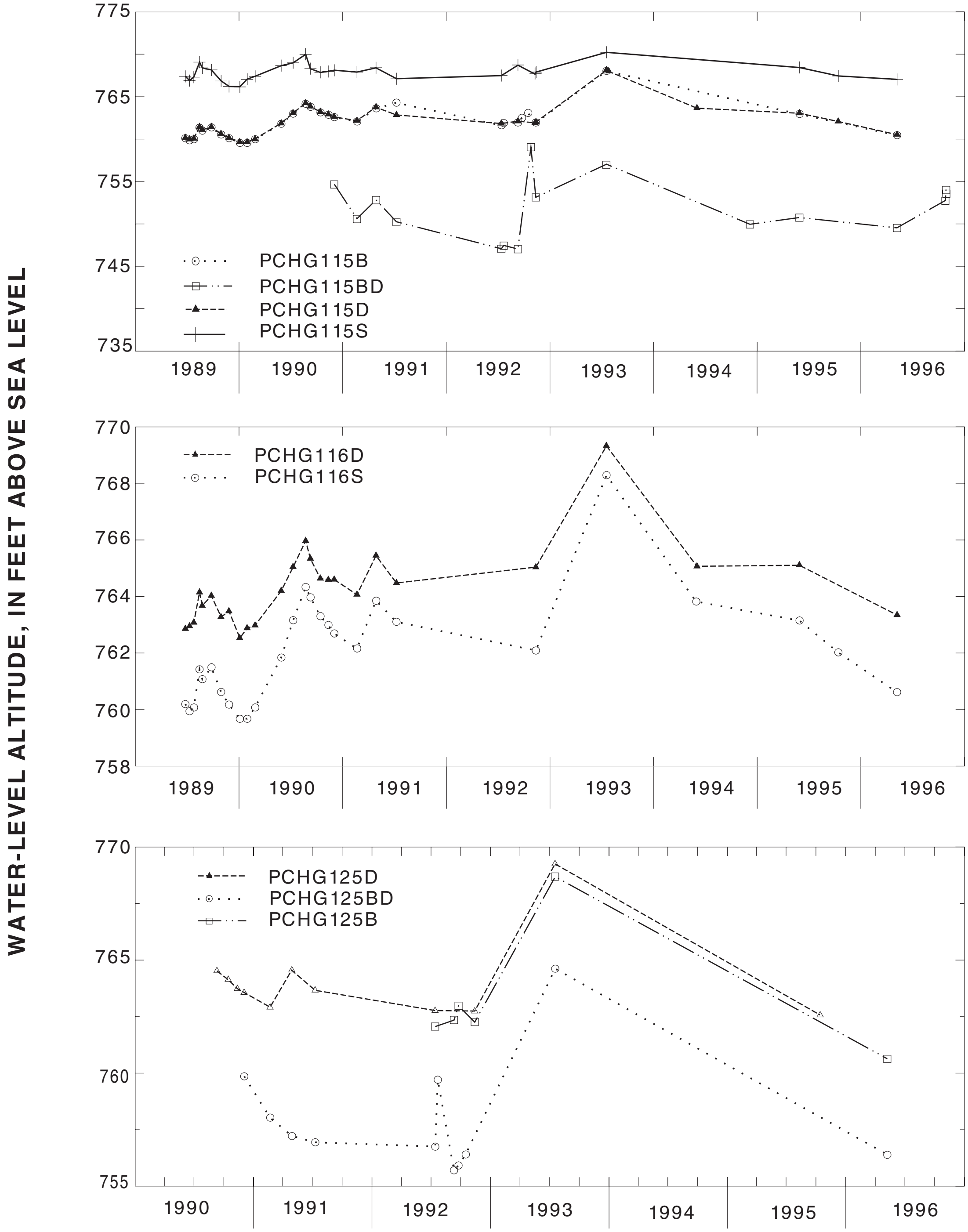


Figure 7. Continued.

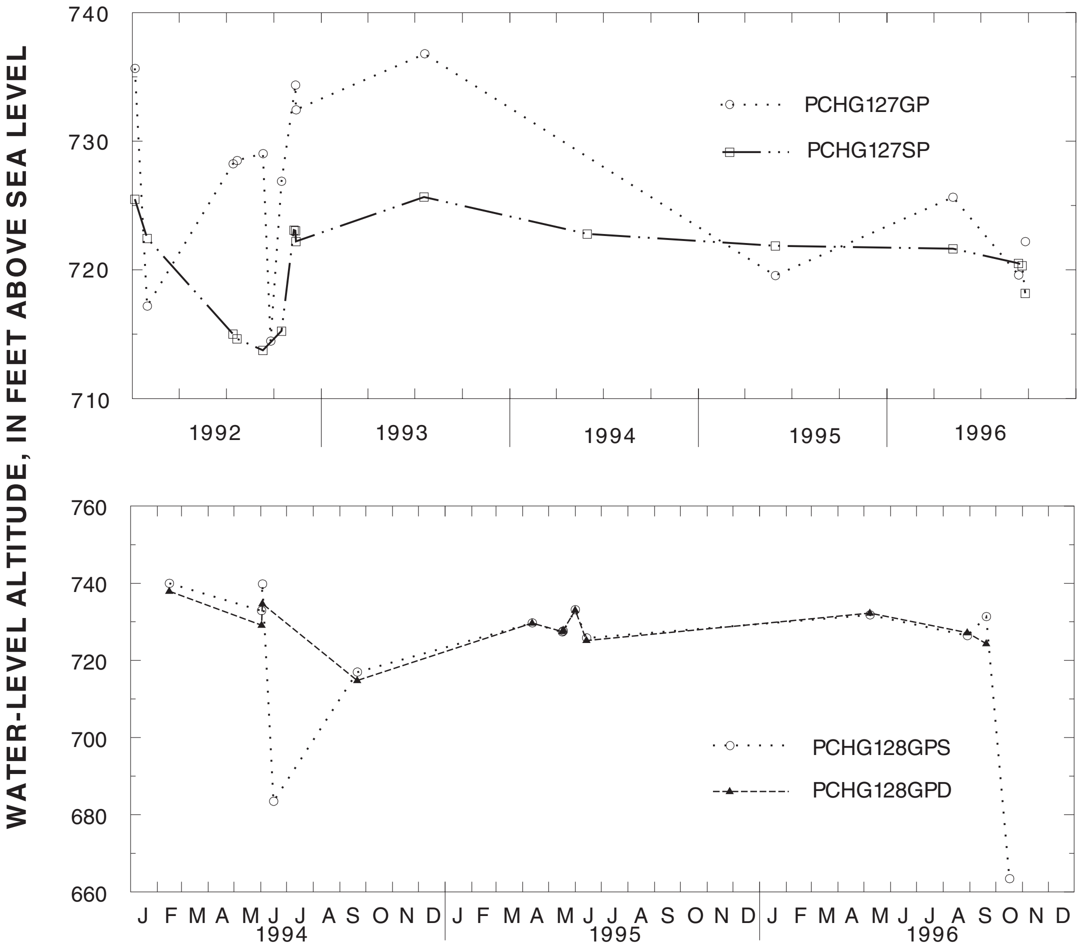


Figure 7. Continued.

as part of an expanded study of the pumping effects of wells BMW4 and BMW6, are presented in Mills (1993b). Additional information on the general techniques of water-level measurement, including the decontamination of measuring equipment, are included in the sampling and analysis plan for the Belvidere ground-water study (U.S. Geological Survey and U.S. Environmental Protection Agency, 1993).

Water-Level Response to Municipal-Well Pumping

Water-level data collected by Mills (1993b,c) and data included in this report (figs. 8–15) indicated the necessity of an expanded study of the pumping effects of the Belvidere municipal wells on water levels in the glacial drift, Galena-Platteville, and St. Peter Sandstone aquifers underlying Belvidere. During a 25-day period in November–December 1992, water levels in 10 vertically nested wells were monitored as pumping activity was recorded at the nearby (within 0.5 mi) municipal wells BMW4 and BMW6.

Water levels were monitored using vented pressure transducers with pressure-sensing ranges from 0–5 lb/in^2 and from 0–30 lb/in^2. Historical data allowed the selection of pressure ranges appropriate for expected water-level changes. The water-level data were recorded using a programmable data logger. A logarithmic monitoring schedule was used with the maximum interval of 5 minutes applied 3 hours after the start of data collection.

To help isolate the pumping effects of municipal wells BMW4, BMW6, and possibly other nearby high-capacity industrial wells, the pumping schedules for the two municipal wells were prearranged with the city of Belvidere (table 11). To ensure a very precise recording of the timing of changes in pumping status (well pump on or off), the pumping schedules were automatically

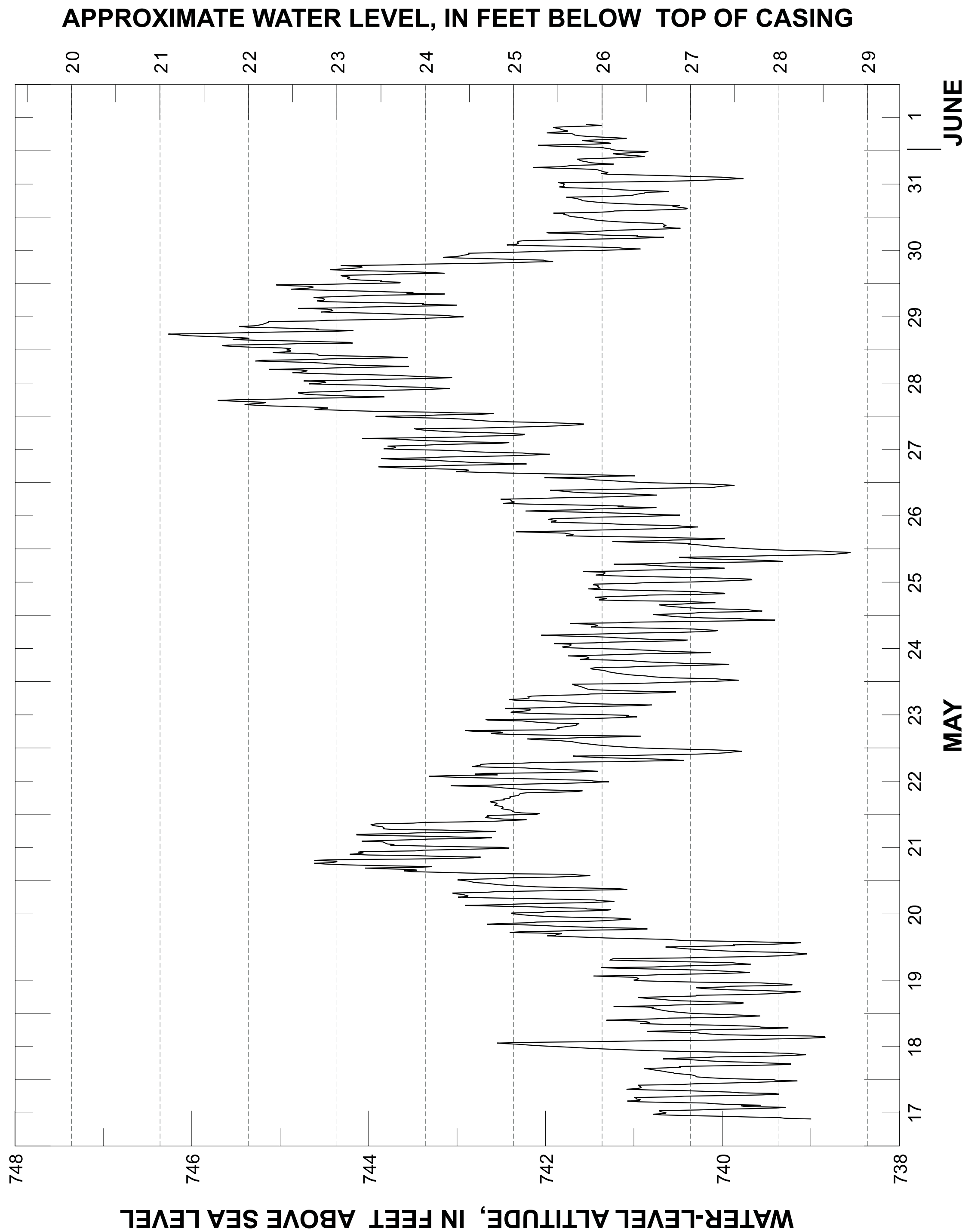


Figure 8. Near-continuous measured water levels in borehole 00436 in Belvidere, Ill., May 17–June 1, 1995.

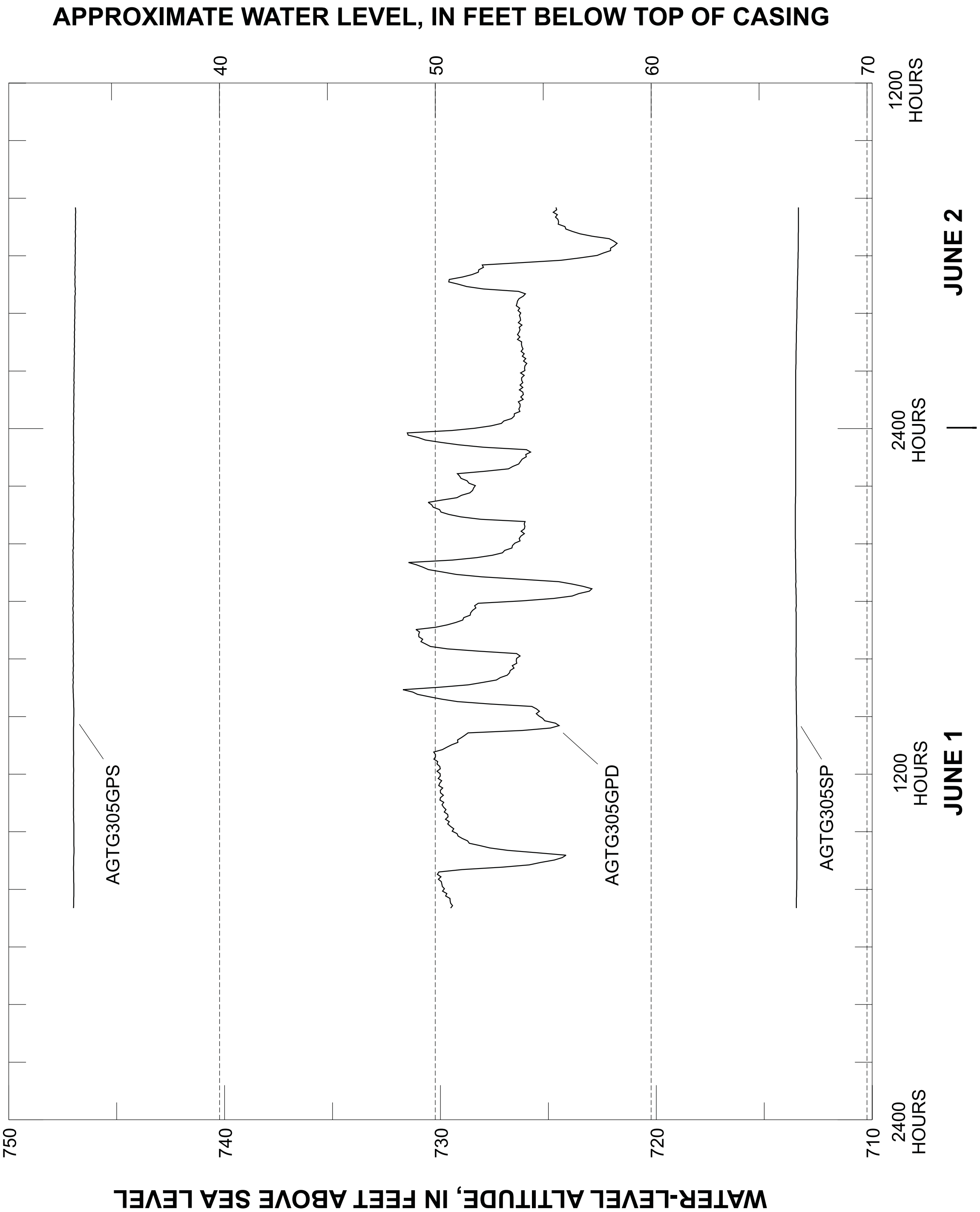


Figure 9. Near-continuous measured water levels in wells AGTG305GPS, AGTG305GPD, and AGTG305SP in Belvidere, Ill., June 1–2, 1995.

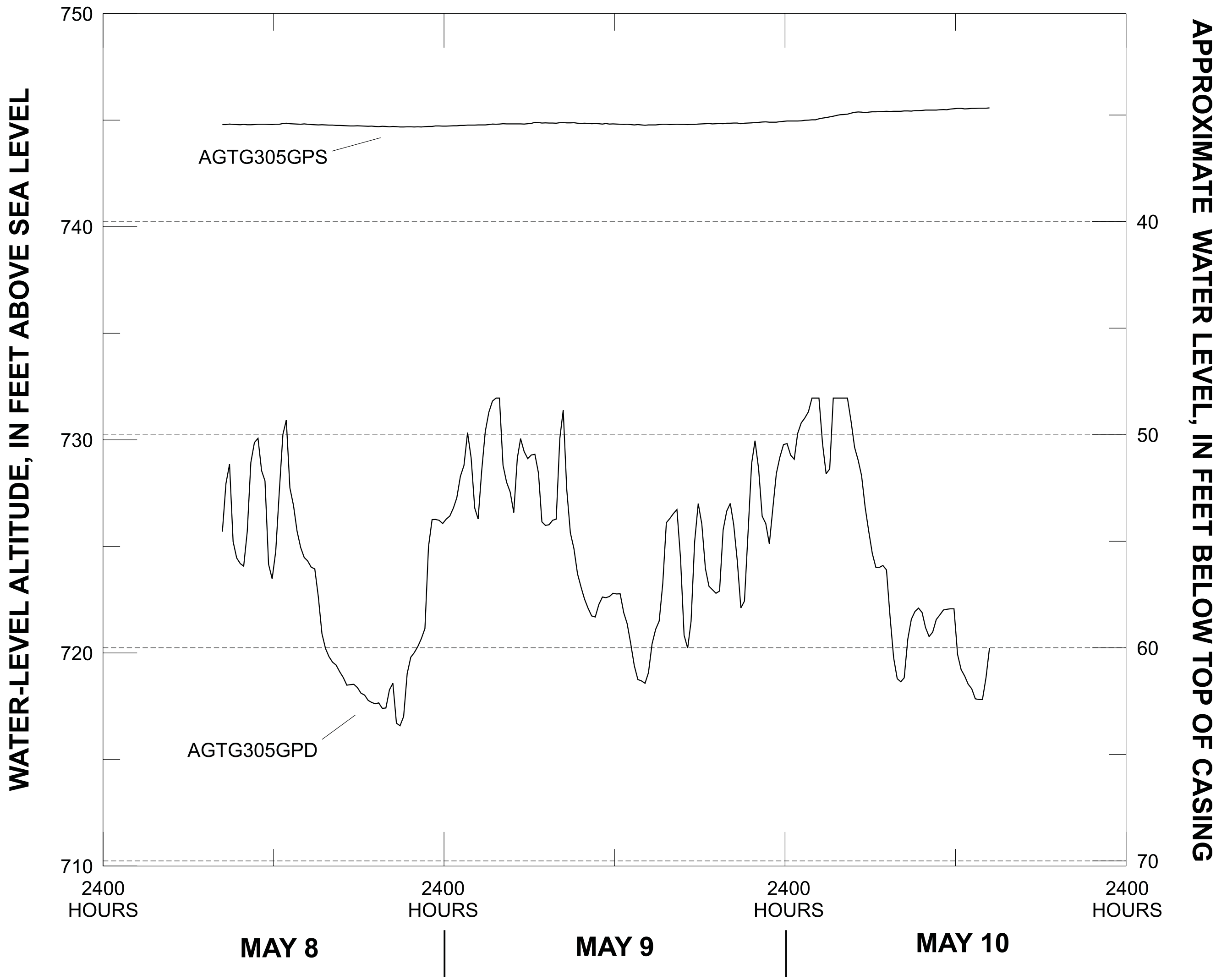


Figure 10. Near-continuous measured water levels in wells AGTG305GPS and AGTG305GPD in Belvidere, Ill., May 8–10, 1996.

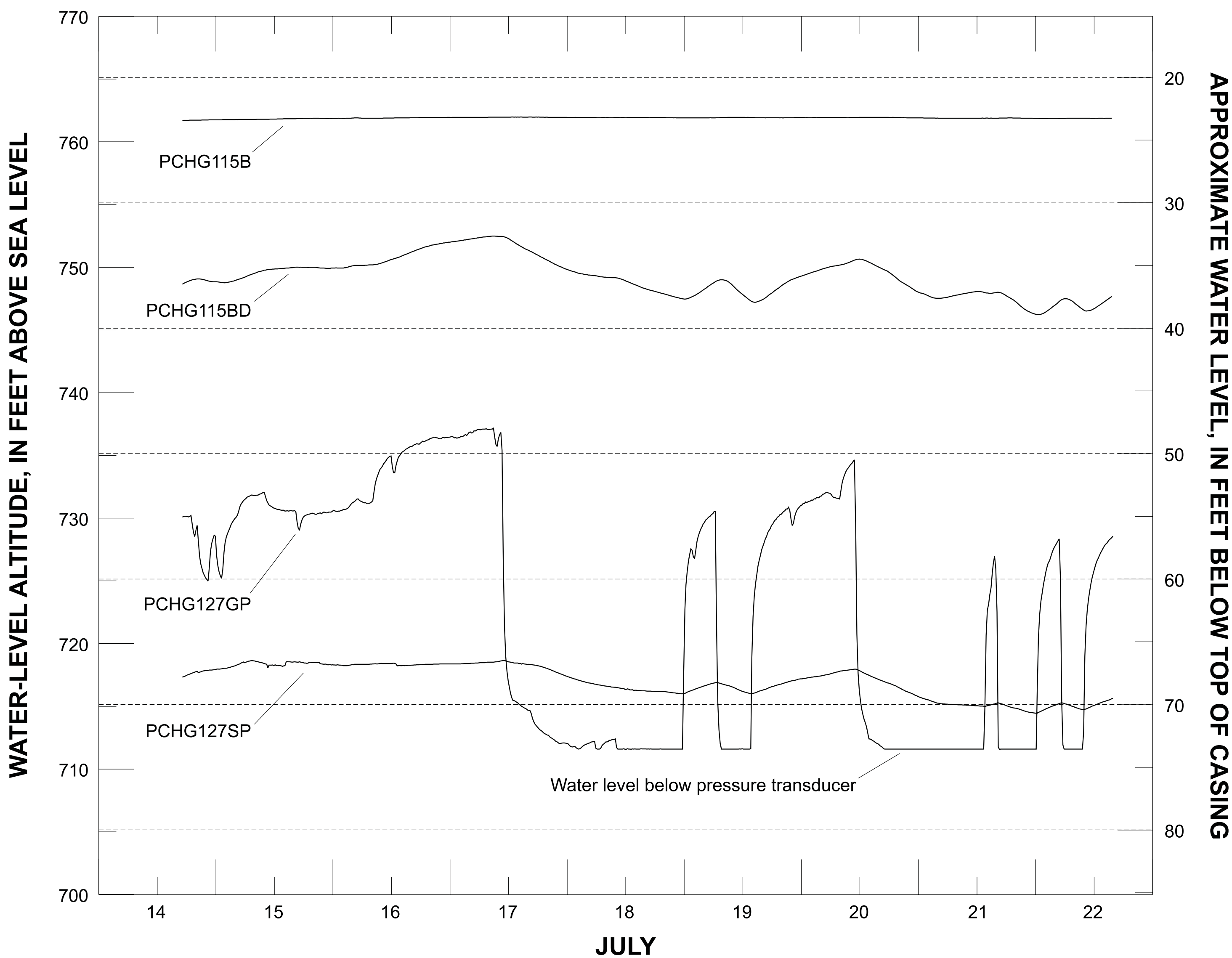


Figure 11. Near-continuous measured water levels in wells PCHG115B, PCHG115BD, PCHG127GP, and PCHG127SP in Belvidere, Ill., July 14–22, 1992.

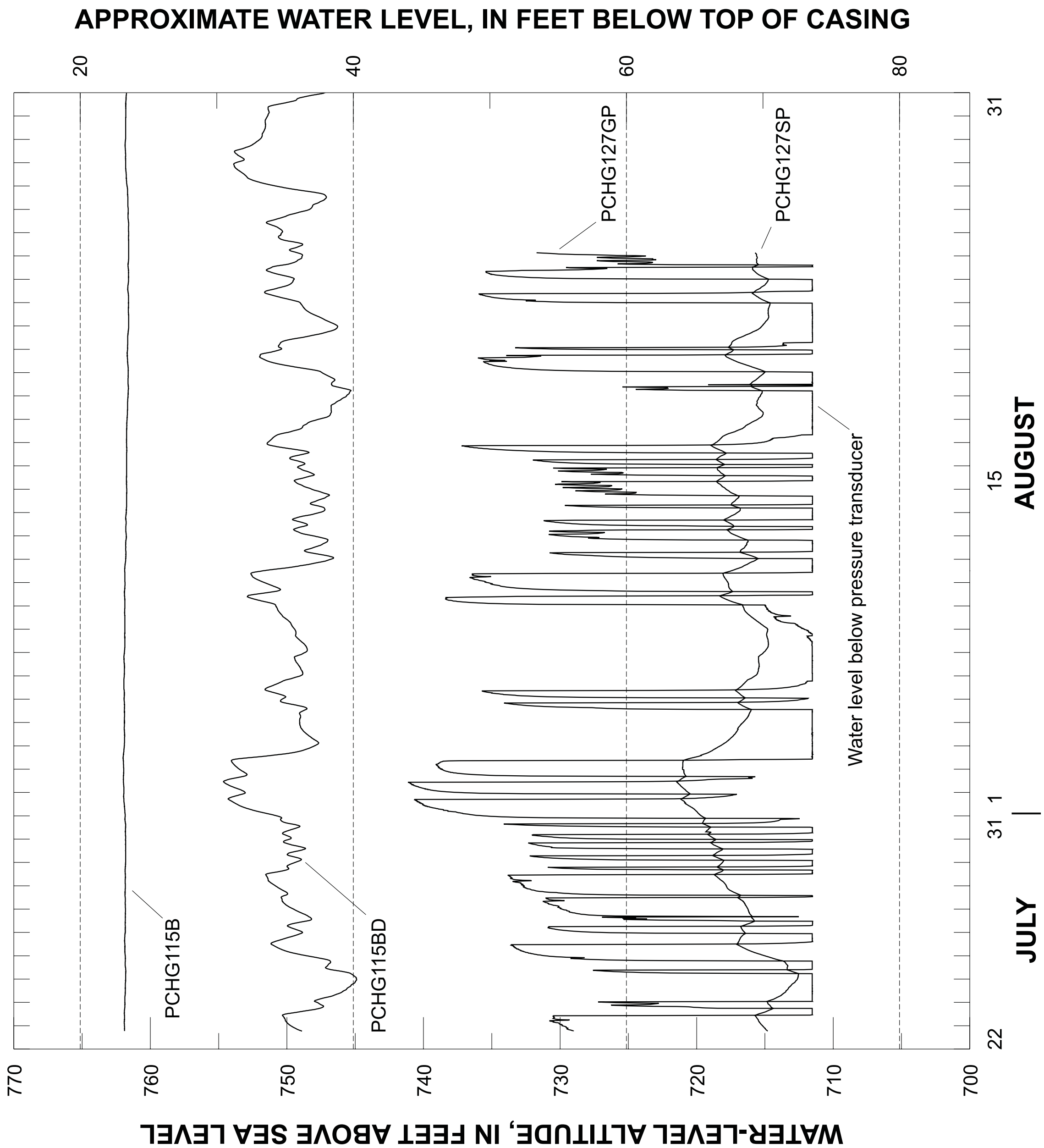


Figure 12. Near-continuous measured water levels in wells PCHG115B, PCHG115BD, PCHG127GP, and PCHG127SP in Belvidere, Ill., July 22–August 31, 1992.

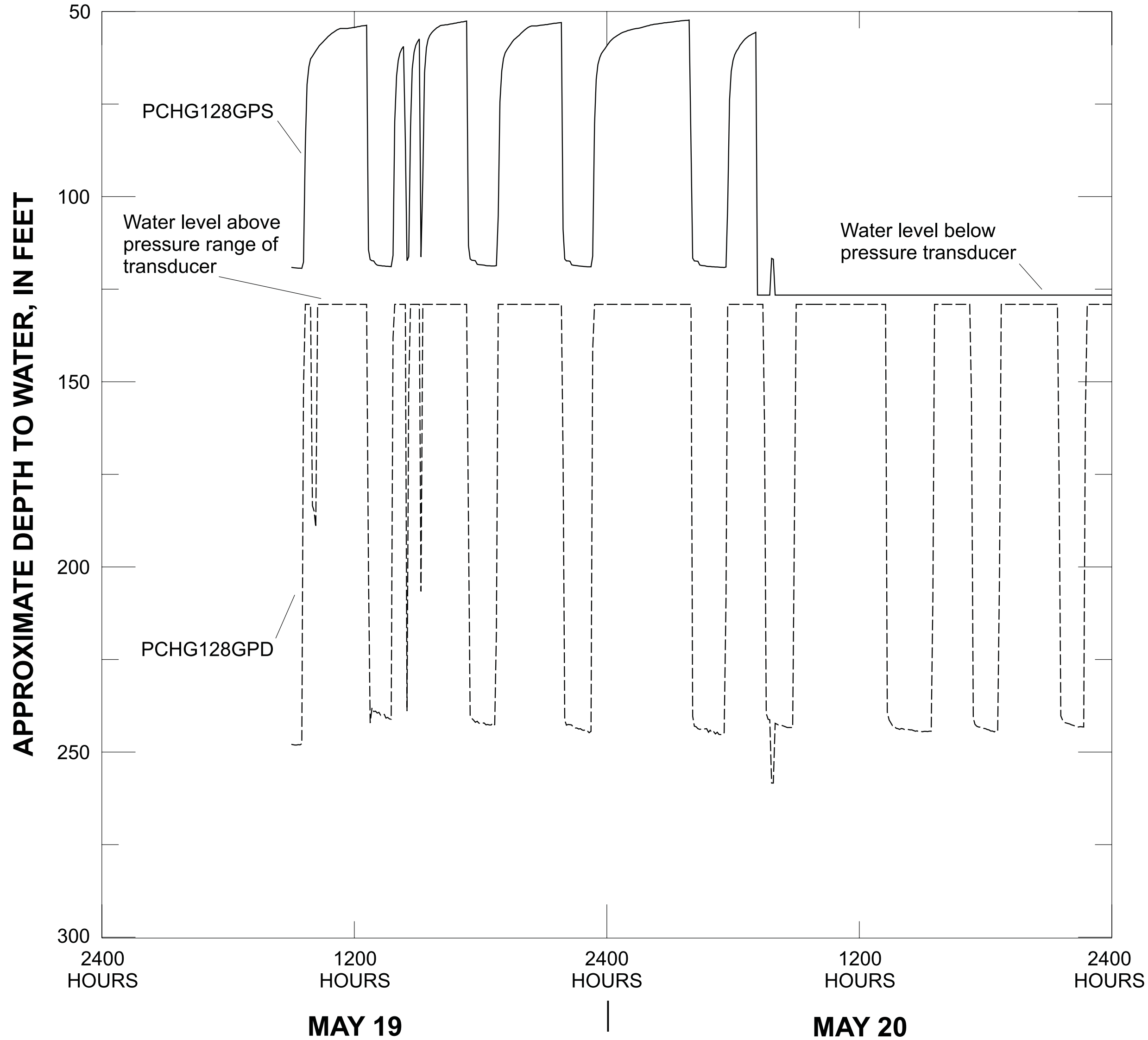


Figure 13. Near-continuous measured water levels in wells PCHG128GPS and PCHG128GPD in Belvidere, Ill., May 19–20, 1995.

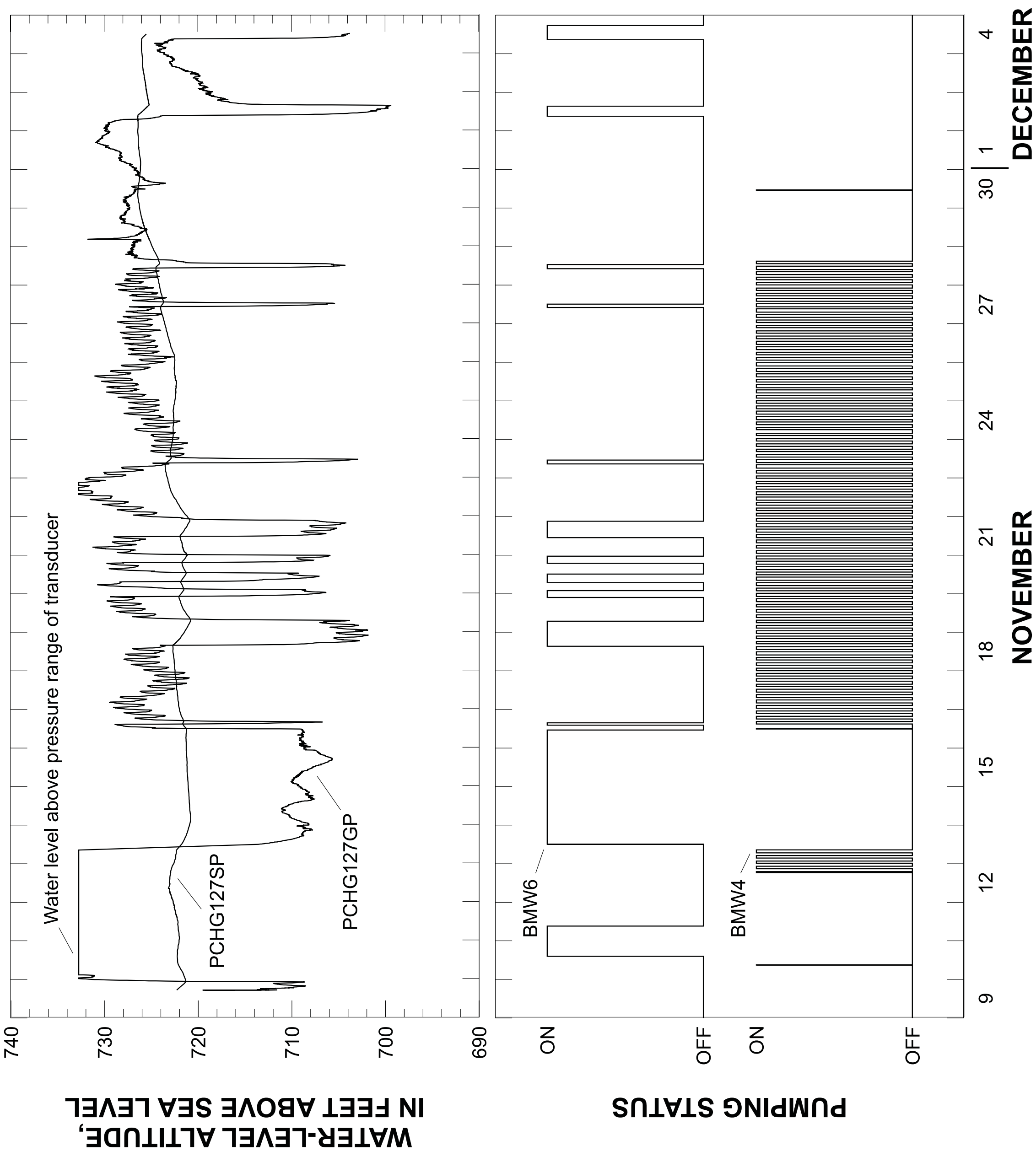


Figure 14. Near-continuous measured water levels in wells PCHG127GP and PCHG127SP, and pumping status of municipal wells BMW4 and BMW6 in Belvidere, Ill., November 9–December 4, 1992.

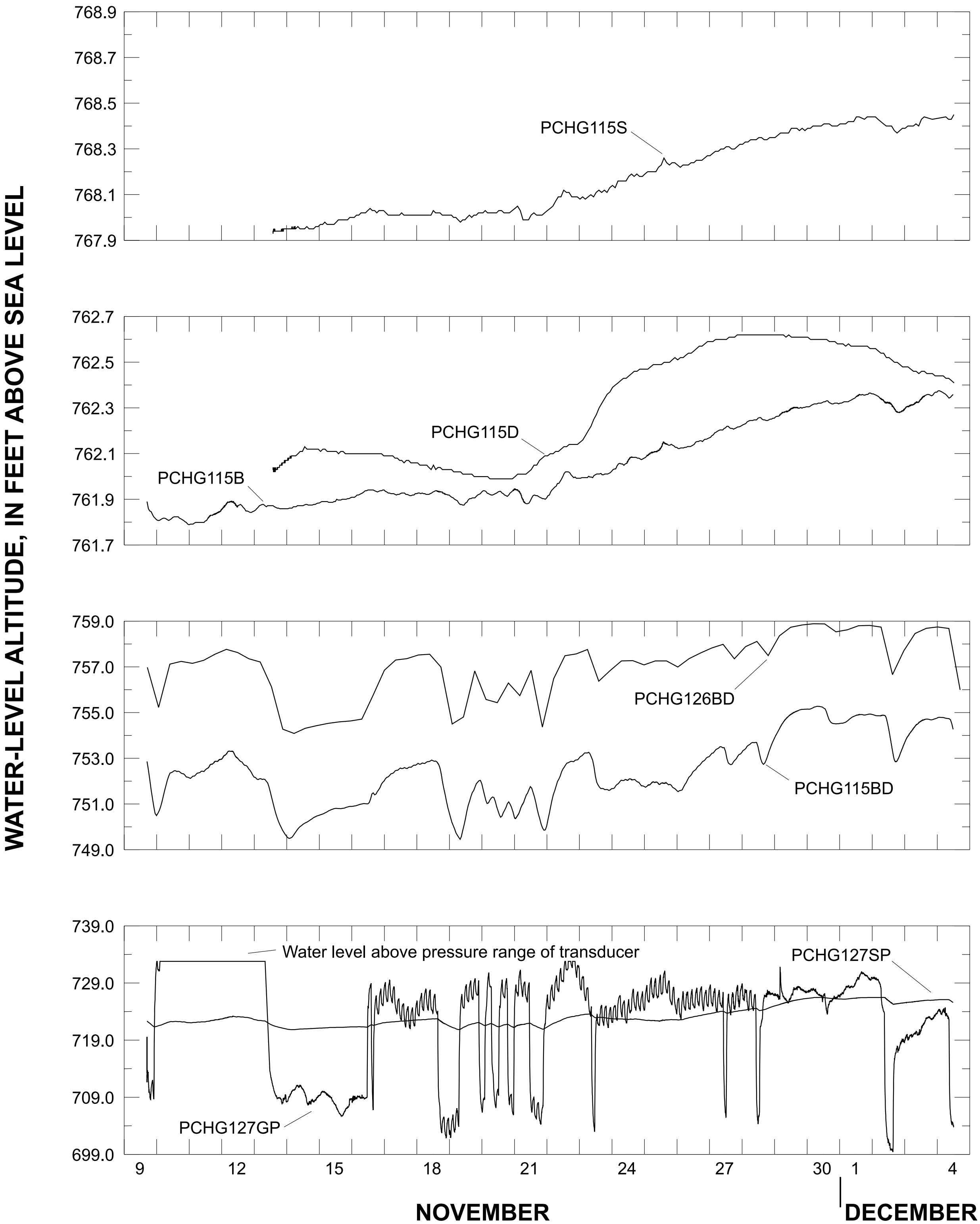


Figure 15. Near-continuous measured water levels in wells PCHG115S, PCHG115D, PCHG115B, PCHG115BD, PCHG126BD, PCHG127GP, and PCHG127SP in Belvidere, Ill., November 9–December 4, 1992.

monitored by use of an alternating current (AC) line monitor coupled with a programmable data logger. With the AC line monitor attached to an exposed current-transmitting powerline, a direct current (DC) voltage signal is output in the presence of an AC voltage in the powerline. This output was monitored by the data logger every 5 seconds; data recording was limited to the times at which the well pumps were turned on and off. The automatic monitoring also was necessary because of the possibility that the prearranged pumping schedule may not be followed to satisfy the water-supply needs of the city. As can be seen by comparing the prearranged pumping schedule in table 11 with the schedules shown in figure 14, diversion from the prearranged schedule was necessary.

Standard measures were used to assure the quality of the water-level measurements (see description in the section "Ground-Water Levels"). To ensure that the AC line-monitor/data-logger system was properly recording the pumping status of the municipal wells, several well-pumping cycles were monitored by alternative methods. One cycle was monitored by an observer. Several cycles were monitored by a tripod-mounted time-encoding video camera that visually recorded needle deflections on pump gages and audibly recorded pump-motor activity.

Water levels in wells PCHG127GP and PCHG127SP in relation to the pumping status of municipal wells BMW4 and BMW6 are shown in figure 14. The open interval of well PCHG127GP is near a hydraulically important bedding-plane fracture in the lower part of the Galena-Platteville aquifer (Mills, 1993b), and well PCHG127SP is open to the upper part of the St. Peter Sandstone aquifer. Water levels in monitoring wells open to the glacial drift, Galena-Platteville, and St. Peter Sandstone aquifers during the time period in which the pumping status of the municipal wells was monitored are shown in figure 15.

Horizontal Hydraulic Conductivity

Horizontal hydraulic conductivities (K_h) were estimated from one multiple-well aquifer test and numerous single-well aquifer (slug) tests completed in 22 monitoring wells and 5 straddle-packed boreholes. The multiple-well aquifer test was done in June 1991. Details associated with the multiple-well aquifer test, including test methods, analytical assumptions, estimates of K_h, and limitations, are provided in Mills (1993b). Slug tests were done during 1989–95. Details associated with the slug tests are provided in Vanderpool and Yeskis (1991) and Mills (1993a,b,c). Estimates of K_h from the slug tests are presented in tables 12 (glacial drift aquifer) and 13 (Galena-Platteville and St. Peter Sandstone aquifers). The distribution of K_h within the stratigraphic units that compose the glacial drift, Galena-Platteville, and St. Peter Sandstone aquifers is shown in figure 16. The vertical distribution of K_h in the Galena-Platteville aquifer, as represented by composited data from boreholes PCHG115BD, PCHG127GP, and PCHG128GP, is shown in figure 5. Also shown in figure 5 are the stratigraphy and selected physical and hydraulic characteristics of the aquifer. The vertical distribution of K_h in the Galena-Platteville aquifer in relation to concentrations of VOC's and specific conductance are shown in figures 17 (data from boreholes PCHG115BD, PCHG125BD, PCHG126BD, PCHG127GP) and 18 (data from borehole PCHG128GP).

WATER-QUALITY DATA

Ground-water-quality data were collected from all boreholes and selected wells included in table 1 and figure 2. Data include field characteristics (temperature, pH, specific conductance, redox potential (Eh) and dissolved oxygen), inorganic constituents, tritium, VOC's, and SVOC's. Specific analyses vary among sampling sites. Field-characteristic and VOC data collected from the monitoring wells and municipal water-supply wells included in table 1 and an additional network of private water-supply wells in the vicinity of Belvidere are included in Mills and others (in press).

Field characteristics of the ground water were vertically profiled at one borehole and one municipal water-supply well. All other boreholes and wells were sampled for analysis of field characteristics and (or) ground-water chemistry. Details of the vertical profiling and sampling methods are described in the following sections.

Vertical-Profile Measurements

Field characteristics of the ground water were vertically profiled at borehole PCHG127GP and municipal well BMW2 (table 1 and fig. 2). Profiling

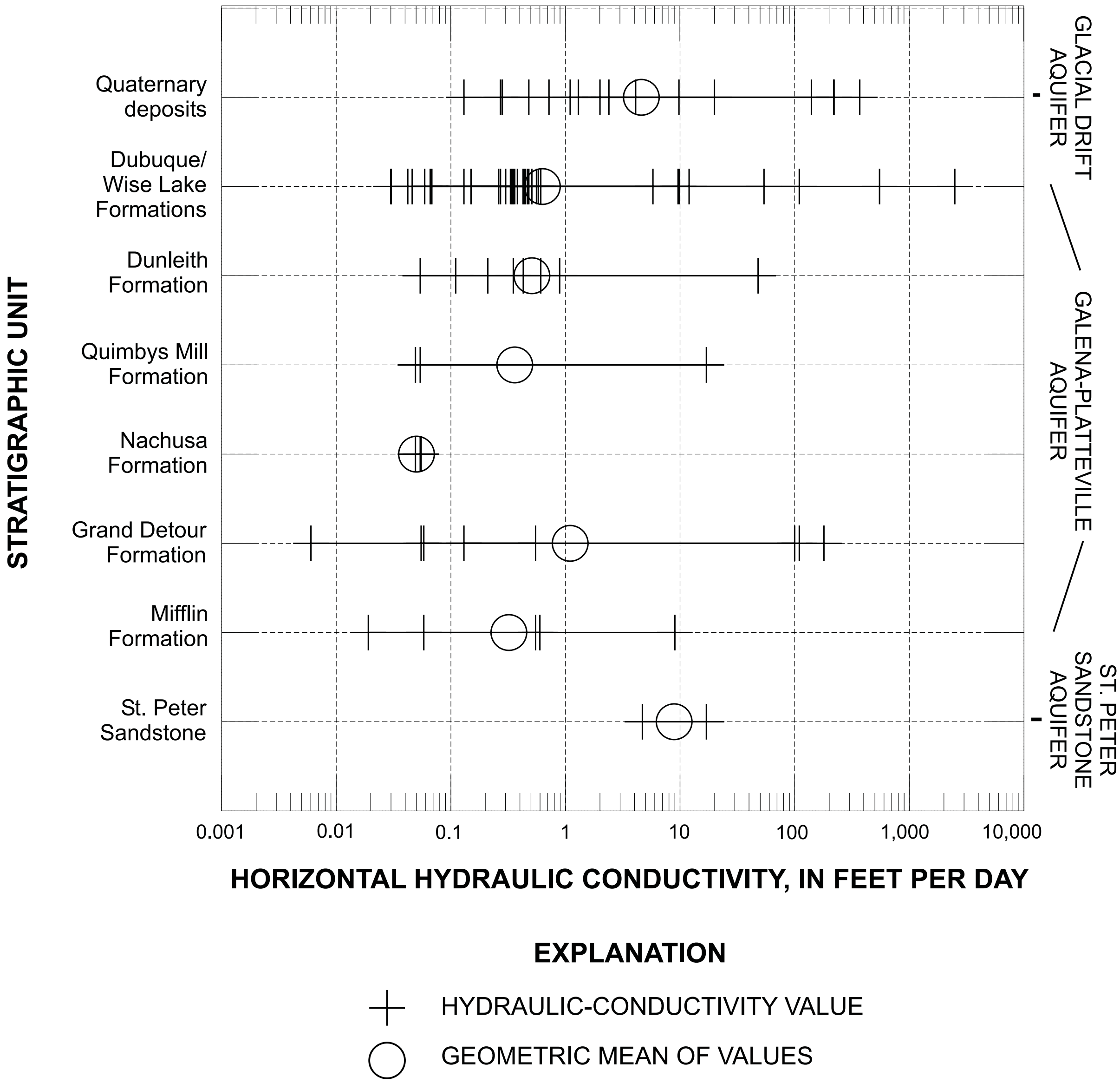


Figure 16. Distribution of horizontal hydraulic conductivity within the stratigraphic units that compose the glacial drift, Galena-Platteville, and St. Peter Sandstone aquifers underlying Belvidere, Ill.

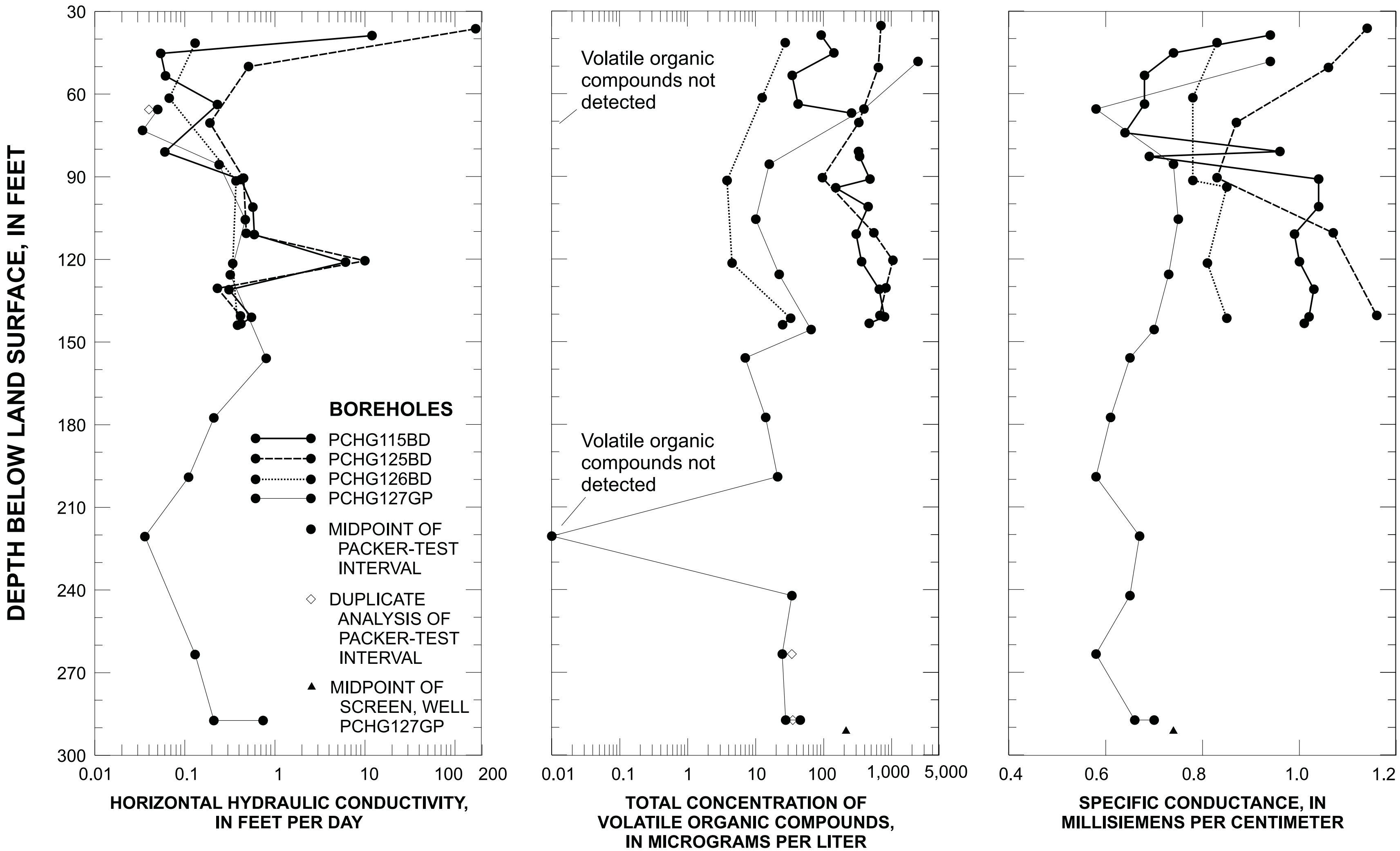


Figure 17. Vertical distribution of horizontal hydraulic conductivity, total concentration of volatile organic compounds, and specific conductance at boreholes PCHG115BD, PCHG125BD, PCHG126BD, and PCHG127GP, and monitoring well PCHG127GP in Belvidere, Ill., August 1990–November 1991.

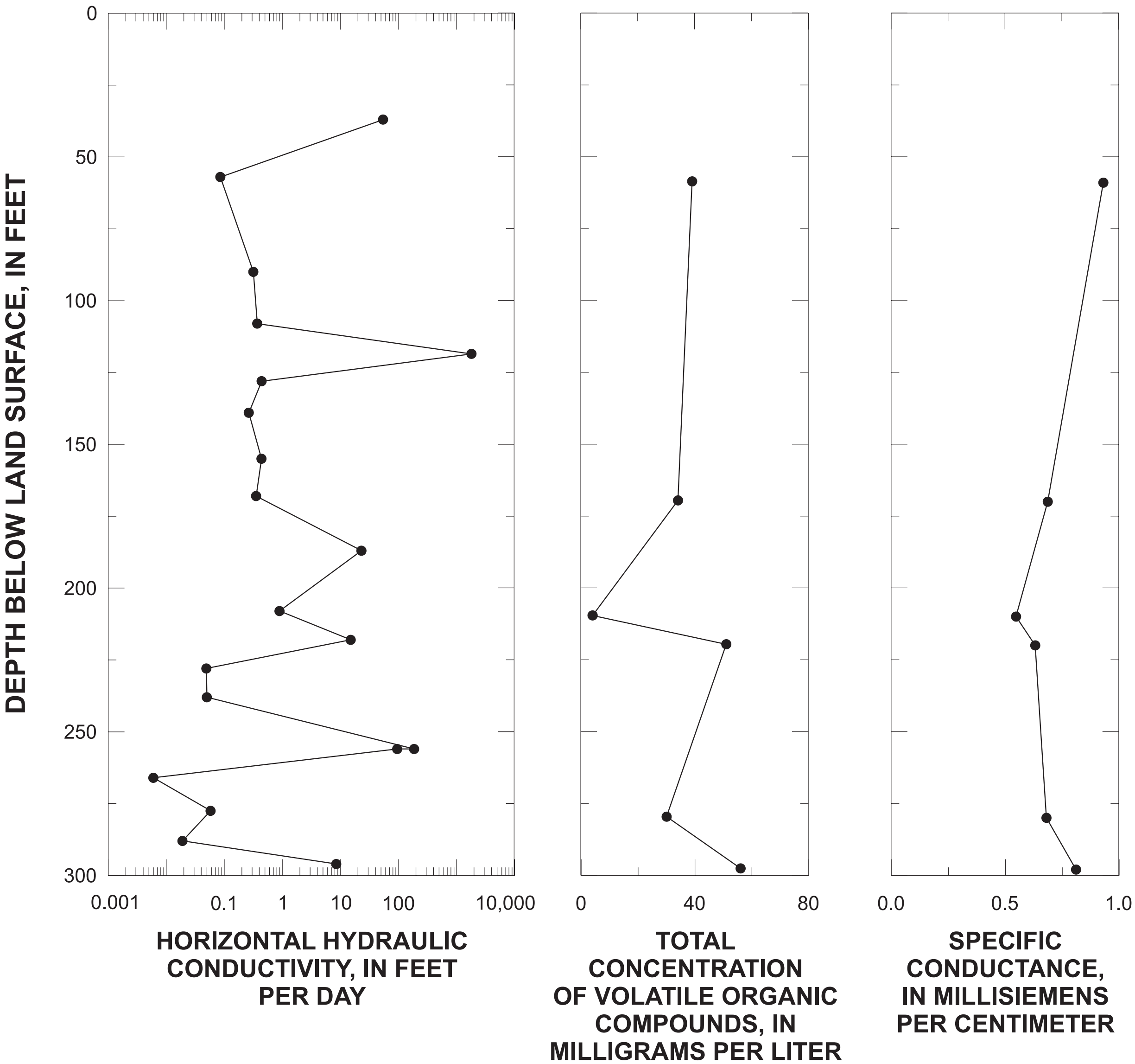


Figure 18. Vertical distribution of horizontal hydraulic conductivity, total concentration of volatile organic compounds, and specific conductance at borehole PCHG128GP in Belvidere, Ill., January 1994.

was done by use of similar submersible Hydrolab Surveyor 3 water-quality meters. Details regarding the operation and systematic calibration of the meters can be found in the manufacturer's operation manual (Hydrolab Corporation, 1991) and the unpublished sampling and analysis plan for the Belvidere ground-water study (U.S. Geological Survey and U.S. Environmental Protection Agency, 1993).

For the profiling of borehole PCHG127GP, the meter sonde was lowered by its 328-ft long cable to the base of the borehole, and field characteristics were allowed to equilibrate for about 2 hours before initial measurements were recorded. The sonde was moved up the borehole in 5- to 20-ft increments. A minimum of 5 minutes were allowed for equilibration of field characteristics at each depth increment before measurements were recorded.

For the profiling of municipal well BMW2, measurements were made as the meter sonde was lowered down the well to the 200-ft extent of its cable and repeated as the sonde was extracted from the well. Field characteristics were allowed to equilibrate for about 30 minutes before initial measurements were recorded. The sonde was moved down and up the borehole in increments no greater than about 20 ft; depth increments were varied to allow measurements to be focused on features of hydrologic interest (for example, fractures that may allow preferential movement of ground water and contaminants). A minimum of 5 minutes were allowed for equilibration of field characteristics at each depth increment before measurements were recorded. Additional measurements were recorded at selected depths after allowing as much as 20 minutes to evaluate possible temporal variability of the field characteristics.

Vertical profiling of field characteristics in borehole PCHG127GP was done in December 1991. Results of the profiling are presented in table 14 and figure 19. Vertical profiling of field characteristics in municipal well BMW2 was done in March 1993. Results of the profiling are presented in table 15 and figure 20.

Borehole and Well Samples

Water samples were collected from 7 boreholes and 19 wells for analysis of field characteristics and (or) ground-water chemistry. Samples from five boreholes were collected from specific depth intervals by use of the previously described straddle-packer assembly (refer to figure 6 and the section "Hydrologic Data"). Water samples generally were collected from the boreholes and monitoring wells with a submersible, positive-displacement sampling pump consisting of a stainless-steel pump head and polytetrafluoroethylene (PTFE) tubing. Water samples from temporary wells were collected using a peristaltic pump with a combination of PTFE and silicone tubing. Water samples from the operating water-supply wells were collected from a sampling tap located near the wells and before any in-line water treatment.

With few exceptions, measures were taken to ensure that representative samples of ground water were collected. A water-quality meter coupled with a flow-through cell was attached to the pump-discharge outlet or sampling tap to monitor the field characteristics of water purged from a borehole or well. Criteria based on stabilized field characteristics of the ground water and well volumes (generally three well volumes) were applied to ensure a sufficient volume of water had been purged from a borehole or well prior to sampling. Well-volume criteria were not applied when preparing to sample water-supply wells. Prior to sampling, recent operation of these wells was verified, and then the wells were allowed to pump and discharge through the sampling tap for about 10 minutes.

For temporary wells that were 1-in. in diameter, the PTFE tubing was lowered to the base of the well and all standing water was flushed from the pump tubing by pumping about 5-10 minutes before a water sample was collected. For boreholes that were presently unused water-supply wells (00305, 00436), water samples were not collected by use of the straddle-packer assembly. Water samples from these boreholes were collected by lowering a submersible pump to a target depth. The large volume of standing water in the boreholes precluded application of the standardized criteria for ensuring the collection of a representative ground-water sample. Alternatively, water was pumped from the boreholes for about 10 minutes to ensure that all standing water was flushed from the pump tubing before a water sample was collected. Generally, tubing volume was calculated and water temperature was monitored to determine when ground water was discharging from the pump.

The water sample from the then unused municipal well BMW2 was collected by a bottom-draining hand bailer. Because of the sampling methods used, the analytical water-quality data from all the unused water-

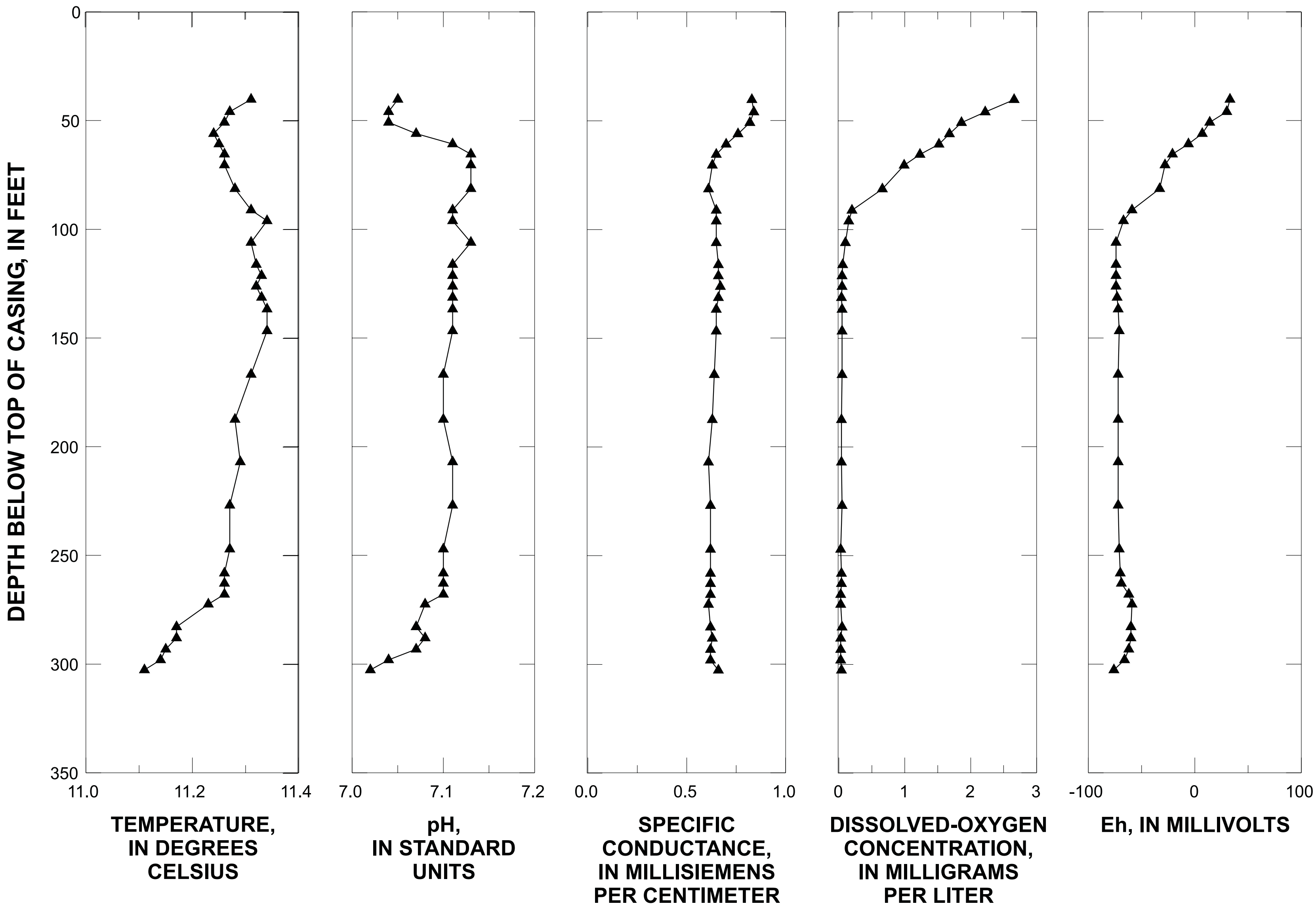


Figure 19. Vertical profile of field characteristics of ground water in borehole PCHG127GP in Belvidere, Ill., December 5, 1991.

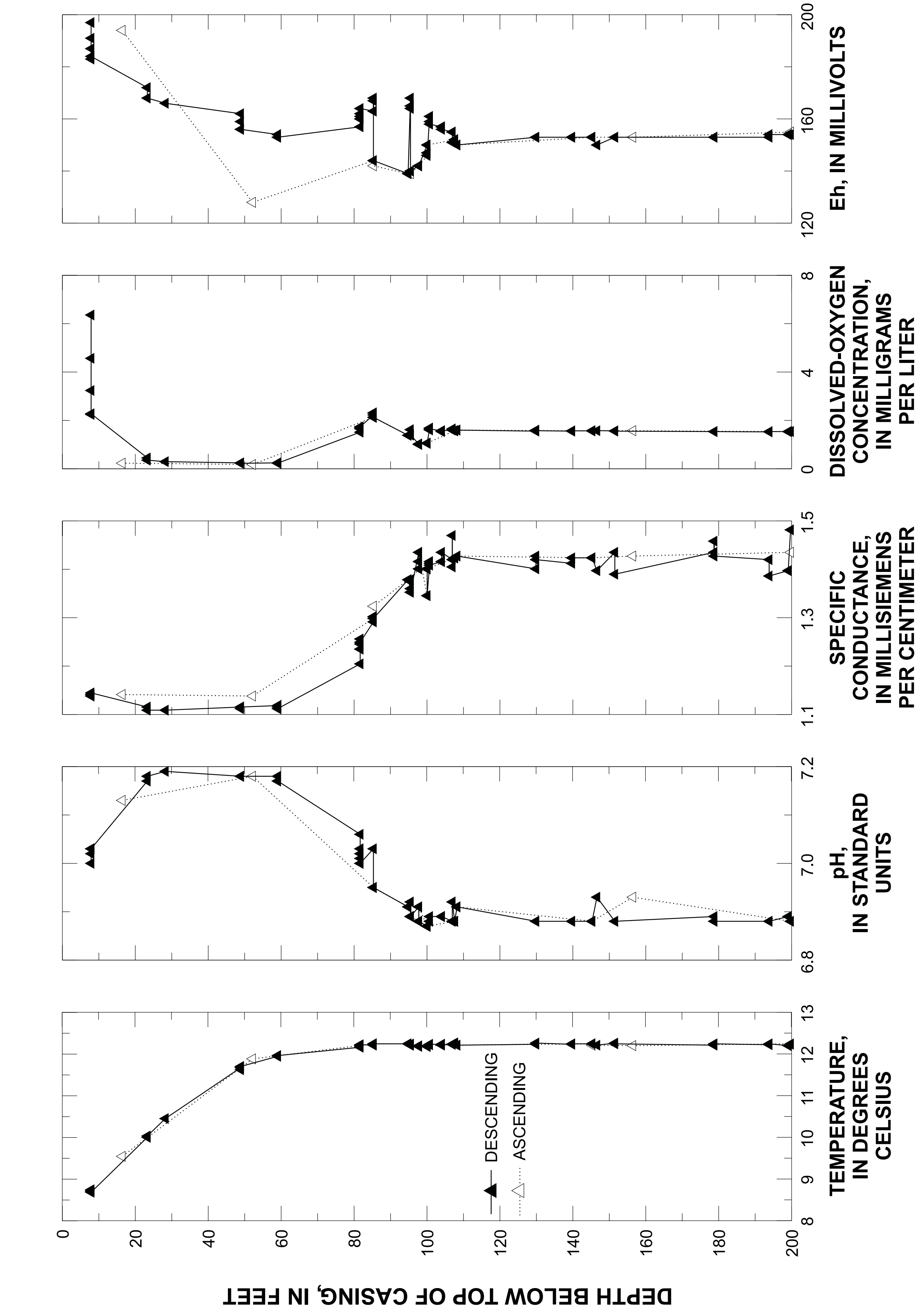


Figure 20. Vertical profile of field characteristics of ground water in municipal well BMW2 in Belvidere, Ill., March 24, 1993.

supply wells are considered screening-quality data and should be viewed with caution.

Specifics regarding the methods for collecting the water samples from the boreholes and wells are described in the sampling and analysis plan for the Belvidere ground-water study (U.S. Geological Survey and U.S. Environmental Protection Agency, 1993) and Mills (1993a,b,c). These reports document the (1) guidelines for calibrating the water-quality meters, (2) procedures for decontaminating sampling equipment, (3) methods and data for purging wells and boreholes based on field-characteristic stabilization and well-volume criteria, (4) purging and sampling pump rates, and (5) quality-assurance/quality-control (QA/QC) procedures for sample collection and handling. Also included in the reports is selected information on laboratory analytical procedures. Additional specific details and data related to the purging and sampling of specific wells and boreholes can be obtained from the USGS.

The water samples were collected from the boreholes and wells during 1985–95. Location of the boreholes and wells where water samples were collected are shown in figures 1 and 2. Analytical results of the sampling are presented in tables 16–20. The major-ion chemistry of ground water at selected boreholes and wells open to the Galena-Platteville and St. Peter Sandstone aquifers are shown in figures 21 and 22. Concentrations of VOC's and specific conductance of ground water in relation to the vertical distribution of K_h at selected boreholes (PCHG115BD, PCHG125BD, PCHG126BD, PCHG127GP, PCHG128GP) open to the Galena-Platteville aquifer are shown in figures 17 and 18.

SUMMARY

The city of Belvidere in Boone County, Ill., is a community of about 18,000 with an agricultural- and industrial-based economy. As a result of past industrial activity, potentially hazardous industrial-use constituents (contaminants) have been detected in water from the glacial drift and bedrock aquifers underlying the Belvidere area. The U.S. Geological Survey (USGS), in cooperation with the U.S. Environmental Protection Agency (USEPA), is investigating the hydrogeology and water quality of the aquifers in the area. The study is intended to provide the data and conceptual framework necessary (1) to determine the general distribution and migration pathways of contaminants in the aquifers, (2) to evaluate ongoing and possible future ground-water contamination problems in the context of the 80-mi^2 study area on a regional basis, and (3) to develop strategies for remediation of ground-water problems and the protection of regional ground-water supplies.

This report presents selected geologic, hydrologic, and water-quality data collected by the USGS and USEPA in support of the ongoing ground-water study. The data were collected during 1989–96 from temporary wells, boreholes, monitoring wells, water-supply wells, and surface-geophysical surveys primarily within a 4-mi^2 urbanized part of the study area. Data were collected from the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying the area. Also presented in this report are selected data collected by private geotechnical firms, and municipal and State agencies. These data are included in this report to provide a more comprehensive resource than is currently available for reviewing the areal, vertical, and time distribution of data collected in the vicinity of Belvidere.

Data included in the report include stratigraphic and lithologic descriptions, and physical properties of rock cores (porosity, bulk density, and particle density), borehole-geophysical logs, surface-geophysical surveys, ground-water levels, horizontal hydraulic conductivities estimated from slug tests, and ground-water-quality information. Ground-water levels include data collected during unstressed and stressed periods. Ground-water-quality information include field characteristics and laboratory analyses of inorganic constituents, tritium, volatile organic compounds and semivolatile organic compounds. Water-quality characteristics were vertically profiled at two boreholes and determined at the well head at other sampling sites.

Also included in this report are (1) a description of the network of boreholes and wells used to collect the presented data; (2) construction logs for 11 monitoring wells; and (3) descriptions or references to the methods used to construct the wells; collect geologic, geophysical, hydrologic, and water-quality data; analyze aquifer-test data; and determine the physical properties of rock cores.

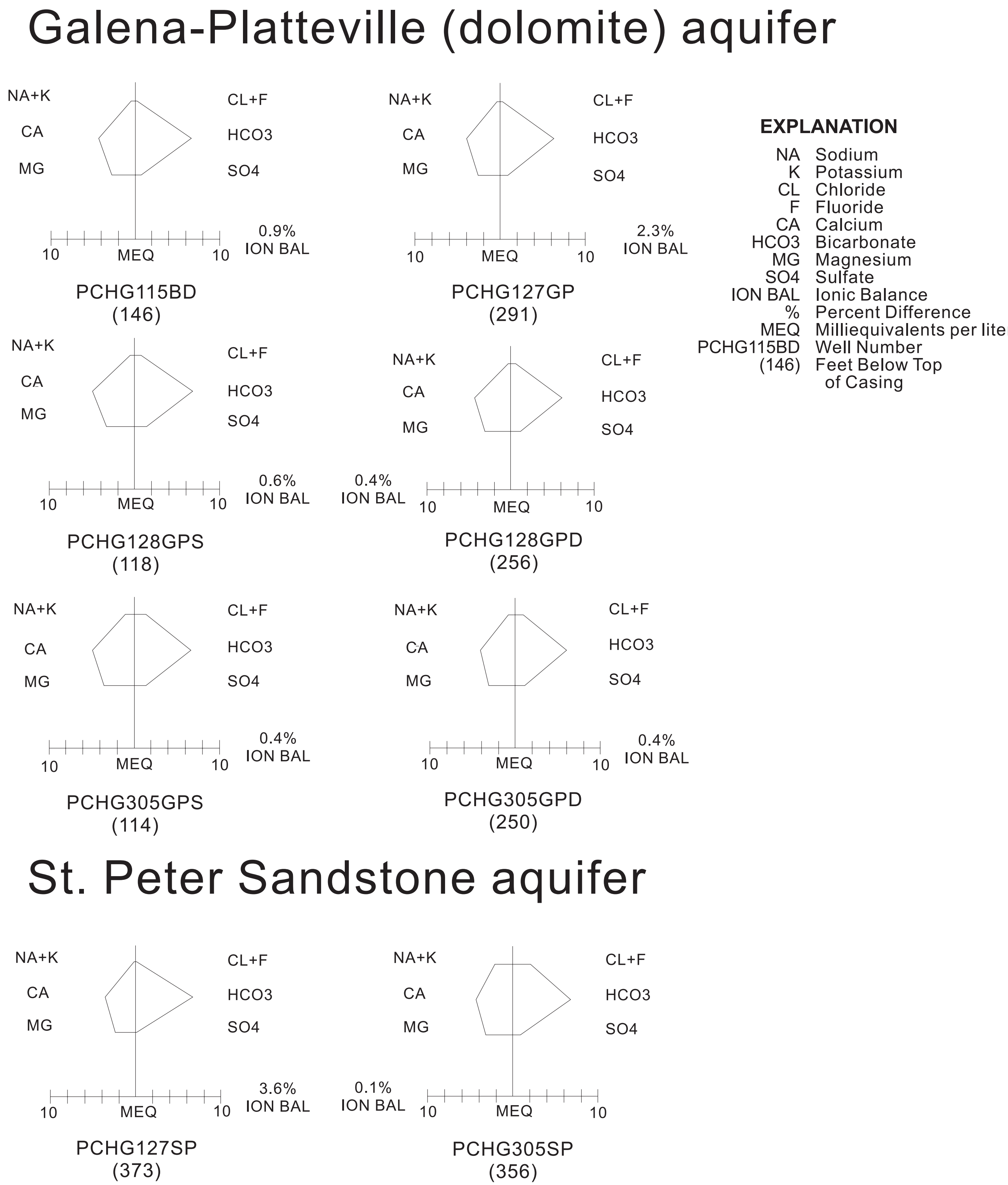


Figure 21. Concentrations of selected inorganic constituents in ground water from the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill., 1991–95.

Galena-Platteville (dolomite) aquifer:
Median Specific Conductance: 710 microsiemens/centimeter

Median pH: 7.10

St. Peter Sandstone aquifer:
Median Specific Conductance: 764 microsiemens/centimeter

Median pH: 7.15

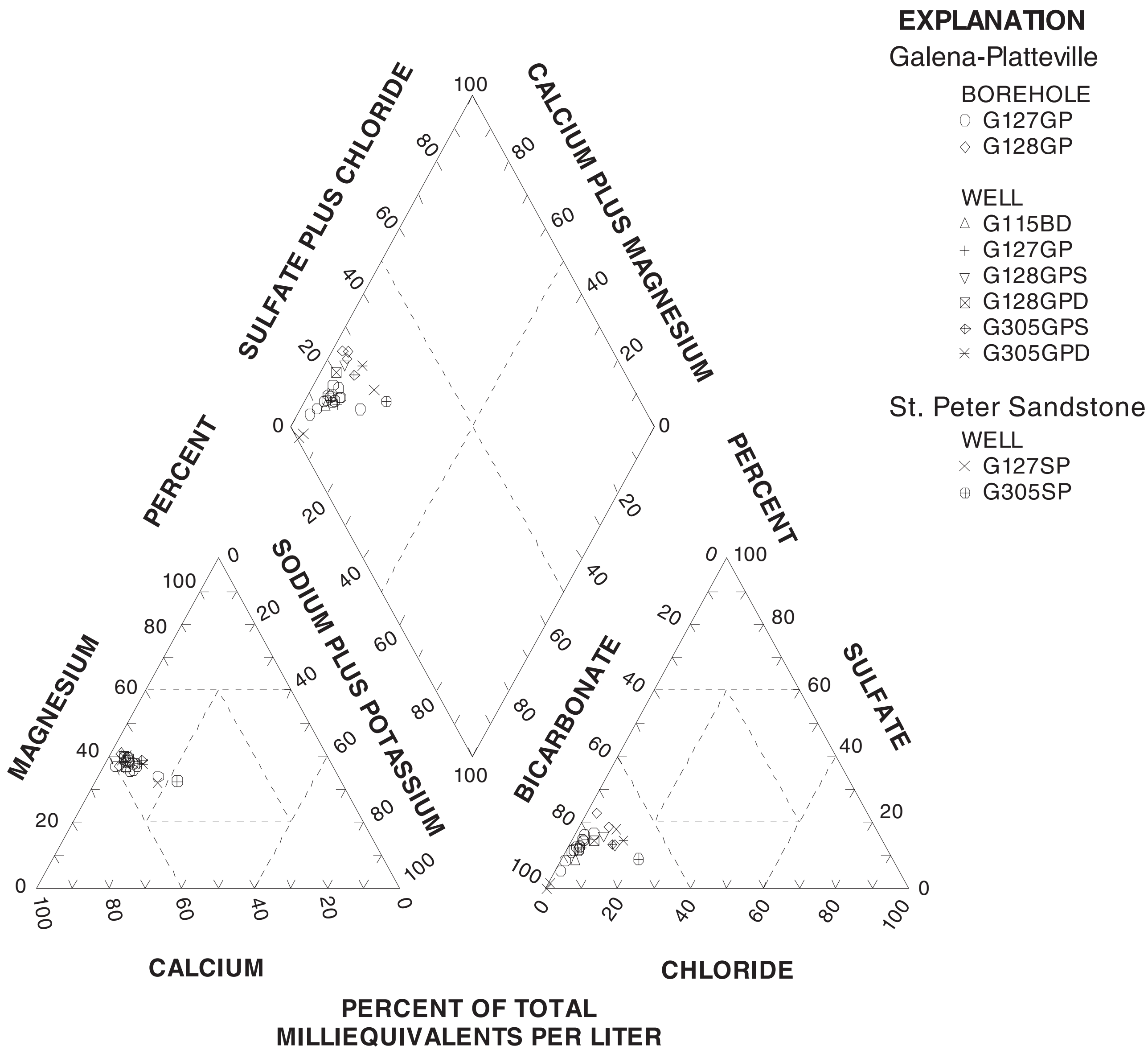


Figure 22. Characteristic inorganic water chemistry in the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill., 1991–95.

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TABLES

Table 1. Description of boreholes and wells in the ground-water-monitoring network in and near Belvidere, Ill.

[--, no data]

Type and installer: **BP, borehole, private; BIEPA, borehole, Illinois Environmental Protection Agency; BUSGS, borehole, U.S. Geological Survey; MIEPA, monitoring well, Illinois Environmental Protection Agency; MUSGS, monitoring well, U.S. Geological Survey; WSM, water-supply well, Belvidere muncipal; WSP, water-supply well, private; TUEPA, temporary well, U.S. Environmental Protection Agency.**

Borehole or well name	Type and installer	Installation date	Latitude	Longitude	Land-surface altitude, in feet above sea level	Measuring-point altitude, in feet above sea level[1]	Total depth of hole, in feet below land surface[2]	Open or screened interval, in feet below land surface	Aquifer to which well or borehole is open
[3]00305	BP	00-00-24	42°15′08″	88°51′16″	777.2	777.60	605	33.1–605	Ordovician
[3]00436	..do.....	00-00-69	42°15′48″	88°50′18″	765.8	767.36	215	27.5–215	Galena-Platteville
AGTG305GPS	MUSGS	02-09-95	42°15′08″	88°51′16″	777.2	780.24	[4]364.0	110.0–115.0	Galena-Platteville
AGTG305GPD	..do.....	02-09-95	42°15′08″	88°51′16″	777.2	779.90	[4]364.0	246.4–251.4	Galena-Platteville
AGTG305SP	..do.....	02-09-95	42°15′08″	88°51′16″	777.2	779.60	[4]364.0	352.8–357.8	St. Peter Sandstone
BL1PW10	WSP	00-00-81	42°15′49″	88°51′53″	772.7	774.52	66	56–66	Galena-Platteville
BMW2	WSM	00-00-01	42°15′34″	88°50′19″	758.6	759.58	1,860	50–1,860	Cambrian-Ordovician
BMW4	..do.....	09-00-42	42°15′47″	88°50′36″	777.1	779.50	1,800	152–1,800	Cambrian-Ordovician
BMW5	..do.....	10-00-45	42°14′58″	88°50′34″	798.6	800.94	610	152–610	Ordovician
BMW6	..do.....	08-00-55	42°16′15″	88°50′28″	781.9	783.46	868	110–868	Cambrian-Ordovician
NSMG101	MIEPA	07-21-88	42°15′34″	88°50′16″	762.0	764.30	44.6	32.9–37.9	Glacial drift
NSMG102	..do.....	07-28-88	42°15′28″	88°50′24″	771.4	773.88	50.5	44.6–49.6	Glacial drift
NSMG103	..do.....	08-11-88	42°15′32″	88°50′22″	761.6	763.65	55.0	49.9–54.9	Glacial drift
NSMG104	..do.....	07-21-88	42°15′37″	88°50′20″	759.1	759.77	70.5	54.1–59.0	Glacial drift
NSMG105	..do.....	08-19-88	42°15′30″	88°50′27″	760.8	763.18	50.5	42.8–47.8	Glacial drift
PCHG102	..do.....	05-31-84	42°16′09″	88°50′13″	783.1	786.11	29.5	23.5–28.5	Glacial drift
PCHG103	..do.....	00-00-84	42°16′08″	88°50′12″	784.1	788.13	34.5	29.5–34.5	Glacial drift
PCHG111S	..do.....	06-01-89	42°16′10″	88°50′14″	782.7	785.36	25.0	13.9–24.4	Glacial drift
PCHG111D	..do.....	05-11-89	42°16′10″	88°50′14″	782.9	784.47	35.4	30.4–35.4	Galena-Platteville
PCHG112S	..do.....	06-01-89	42°16′11″	88°50′08″	783.3	786.29	27.5	22.2–27.2	Glacial drift
PCHG112D	..do.....	05-17-89	42°16′11″	88°50′08″	783.4	785.88	38.0	31.1–36.2	Glacial drift
PCHG113S	..do.....	05-31-89	42°16′10″	88°50′07″	784.1	786.64	28.6	17.7–28.2	Glacial drift
PCHG113D	..do.....	05-16-89	42°16′10″	88°50′07″	784.1	786.02	41.1	36.1–41.1	Glacial drift
PCHG114S	..do.....	06-02-89	42°16′09″	88°50′08″	784.1	787.17	27.7	16.3–27.2	Glacial drift
PCHG114D	..do.....	05-18-89	42°16′08″	88°50′08″	784.3	786.17	35.5	30.1–35.1	Glacial drift

Table 1. Description of boreholes and wells in the ground-water-monitoring network in and near Belvidere, Ill.—Continued

Borehole or well name	Type and installer	Installation date	Latitude	Longitude	Land-surface altitude, in feet above sea level	Measuring-point altitude, in feet above sea level[1]	Total depth of hole, in feet below land surface[2]	Open or screened interval, in feet below land surface	Aquifer to which well or borehole is open
PCHG115S	..do.....	06-06-89	42°16′07″	88°50′11″	782.4	784.45	20.6	9.6–20.1	Glacial drift
PCHG115D	..do.....	05-15-89	42°16′07″	88°50′11″	782.8	785.16	37.8	32.8–37.8	Glacial drift
PCHG115B	..do.....	05-23-89	42°16′07″	88°50′11″	782.5	785.14	49.0	43.6–48.6	Galena-Platteville
PCHG115BD	BIEPA	07-16-90	42°16′07″	88°50′11″	782.5	--	151.8	37.5–151.8	Galena-Platteville
PCHG115BD	MIEPA	11-20-90	42°16′07″	88°50′11″	782.5	784.48	151.8	140.6–151.5	Galena-Platteville
PCHG116S	..do.....	06-06-89	42°16′09″	88°50′12″	784.7	787.08	25.0	19.6–24.6	Glacial drift
PCHG116D	..do.....	05-25-89	42°16′09″	88°50′12″	784.4	787.17	35.0	28.6–33.6	Glacial drift
PCHG117D	..do.....	08-16-90	42°16′07″	88°50′13″	782.3	784.49	26.5	21.0–26.0	Glacial drift
PCHG119S	..do.....	08-31-90	42°16′03″	88°50′10″	783.3	785.24	22.3	16.8–21.8	Glacial drift
PCHG119D	..do.....	08-30-90	42°16′03″	88°50′10″	783.4	785.63	37.0	31.5–36.5	Glacial drift
PCHG120D	..do.....	07-27-90	42°16′08″	88°50′08″	782.8	784.88	36.0	30.1–35.1	Glacial drift
PCHG122S	..do.....	08-30-90	42°16′04″	88°50′14″	781.9	781.71	21.9	16.4–21.4	Glacial drift
PCHG122D	..do.....	08-29-90	42°16′04″	88°50′14″	781.9	781.80	31.6	26.1–31.1	Glacial drift
PCHG123D	..do.....	08-23-90	42°16′06″	88°50′16″	782.4	782.23	22.0	16.5–21.5	Glacial drift
PCHG125D	..do.....	08-28-90	42°16′08″	88°50′15″	783.1	783.02	28.9	23.4–28.4	Glacial drift
PCHG125B	MUSGS	06-06-91	42°16′08″	88°50′15″	783.0	782.90	37.0	31.2–36.2	Galena-Platteville
PCHG125BD	BIEPA	10-16-90	42°16′08″	88°50′15″	783.0	--	150.9	31.3–150.9	Galena-Platteville
PCHG125BD	MIEPA	12-07-90	42°16′08″	88°50′15″	783.0	782.90	150.9	137.4–147.7	Galena-Platteville
PCHG126BD	BIEPA	10-11-90	42°16′10″	88°50′13″	783.7	--	152.8	29.3–152.8	Galena-Platteville
PCHG126BD	MIEPA	12-01-90	42°16′10″	88°50′13″	783.7	784.98	152.8	141.0–151.3	Galena-Platteville
PCHG127GP	BUSGS	04-27-91	42°16′08″	88°50′13″	783.8	--	301.0	41.0–301.0	Galena-Platteville
PCHG127GP	MUSGS	12-11-91	42°16′08″	88°50′13″	783.8	785.20	301.0	[5]288.9–293.9	Galena-Platteville
PCHG127SP	BUSGS	12-08-91	42°16′08″	88°50′13″	783.5	--	394.3	35.0–394.3	St. Peter Sandstone
PCHG127SP	MUSGS	12-13-91	42°16′08″	88°50′13″	783.5	785.28	394.3	[6]370.7–375.7	St. Peter Sandstone
PCHG128GP	BUSGS	10-30-93	42°16′15″	88°50′27″	782.0	784.20	310.0	30.0–310.0	Galena-Platteville

Table 1. Description of boreholes and wells in the ground-water-monitoring network in and near Belvidere, Ill.—Continued

Borehole or well name	Type and installer	Installation date	Latitude	Longitude	Land-surface altitude, in feet above sea level	Measuring-point altitude, in feet above sea level[1]	Total depth of hole, in feet below land surface[2]	Open or screened interval, in feet below land surface	Aquifer to which well or borehole is open
PCHG128GPS	MUSGS	02-01-94	42°16′15″	88°50′27″	782.0	785.05	310.0	116.0–121.0	Galena-Platteville
PCHG128GPD	..do.....	02-01-94	42°16′15″	88°50′27″	782.0	784.74	310.0	253.5–258.5	Galena-Platteville
PCHP436B	..do.....	05-10-96	42°15′48″	88°50′18″	765.8	767.36	200.1	30.0–35.0	Galena-Platteville
PCHG436GPS	..do.....	05-10-96	42°15′48″	88°50′18″	765.8	767.36	200.1	102.3–107.3	Galena-Platteville
PCHP436BD	..do.....	05-10-96	42°15′48″	88°50′18″	765.8	767.36	200.1	195.0–200.0	Galena-Platteville
TW1	TUEPA	7-22-93	42°15′33″	88°51′46″	766.58	766.58	21.0	19.0–21.0	Glacial drift
TW24	..do.....	7-20-93	42°15′26″	88°51′38″	753.33	753.33	12.0	10.0–12.0	Glacial drift
TW30	..do.....	7-26-93	42°15′38″	88°52′14″	749.28	749.28	9.0	7.0–9.0	Glacial drift
TW31	..do.....	7-19-93	42°15′29″	88°52′02″	750.51	750.51	15.0	7.0–9.0	Glacial drift
TW32	..do.....	7-20-93	42°15′28″	88°51′46″	756.06	756.06	14.0	12.0–14.0	Glacial drift

[1]Measuring point is the top of the well riser (casing).
[2]Total depth at time of sampling; depth may differ slightly from the depth at time of drilling.
[3]Unused private water-supply well (borehole).
[4]Well drilled in 1924 to a depth of 605 feet below land surface; well infilled in January 1995 with bentonite chips to 364.0 feet.
[5]Gravel-pack interval before installation of the overlying bentonite seal was 279.2–301.0 feet below land surface.
[6]Gravel-pack interval before installation of the overlying bentonite seal was 361.9–379.2 feet below land surface.

Table 2. Summarized lithologic description of rock cores from selected boreholes in Belvidere, Ill.

Depth, in feet below land surface	Borehole name	Core description
		GALENA GROUP
		Dubuque/Wise Lake Formations
30.0–150	PCHG125B PCHG115BD	**Dolomite**: light brown to light gray; locally mottled; fine to medium crystalline; slightly vessicular to vuggy; thin shaley partings; slightly fossiliferous, bioturbated
		Dunleith Formation
150–213.9	PCHG127GP PCHG128GP	**Dolomite**: locally argillaceous; light brown, orange, or gray to medium gray; locally mottled; medium to coarse crystalline; vessicular and vuggy; thin shaley partings; local chert, white to brown; slightly pyritic; very slightly to very fossiliferous, bioturbated
		PLATTEVILLE GROUP
		Quimbys Mill Formation
213.9–225.9	PCHG128GP	**Dolomite**: light brown to light gray; locally weakly mottled; very fine to fine crystalline; few vugs, thin shaley partings; few chert nodules; very slightly fossiliferous
		Nachusa Formation
225.9–235.1	PCHG128GP	**Dolomite**: grayish orange; mottled; fine to medium crystalline; large (up to 1 in.) interconnected vugs; chert, light gray; fossiliferous, bioturbated
		Grand Detour Formation
235.1–280.7	PCHG128GP	**Dolomite**: light orange to medium light gray; locally mottled; very fine to medium crystalline; locally shaley partings; very slightly fossiliferous, bioturbated
		Mifflin Formation
280.7–306	PCHG128GP PCHG127SP	**Dolomite** with interbedded shales (15 percent of section): light gray with light brown and gray interbeds; thin shales dark gray to black, red, yellowish brown; very fine to fine crystalline with interbeds of coarse crystalline calcarenite; few vugs; locally fossiliferous
		Pecatonica Formation
306–332.3	PCHG128GP PCHG127SP	**Dolomite**: gray to brown; mottled, light orange, gray; fine to medium crystalline; vessicular, vuggy; shaley partings; rare pyrite; slightly fossiliferous, bioturbated
		ANCELL GROUP
		Glenwood Formation
332.3–361.5	PCHG127SP	**Sandstone, dolomite**: argillaceous, silty; light gray to brown, locally greenish; sandstone fine to coarse, angular to rounded; dolomite fine crystalline, few vugs; locally pyritic, phosphatic; brecciated; slightly fossiliferous
		St. Peter Sandstone
361.5–394.0	PCHG127GP	**Sandstone**: light gray to white, locally greenish; fine to medium; subrounded to well rounded; quartzose, locally pyritic; friable, 25 percent intergranular porosity

Table 3. Stratigraphic classification of rock cores from selected boreholes in Belvidere, Ill.

[na, not applicable, composite of core data from multiple boreholes]

Stratigraphic unit	Depth to top of interval, in feet below land surface	Depth to bottom of interval, in feet below land surface	Borehole name
Ordovician System			
Galena Group	30.0	213.9	na
Dubuque/Wise Lake Formations	[1]30.0	[2]37.0	PCHG125B
Dubuque/Wise Lake Formations (includes Wyota and upper part of Loves Park Member of the Dunleith Formation?)	[1]41.6	[3]150.5	PCHG115BD
Dunleith Formation	150.0	213.9	na
Loves Park Member	[4]150.0	160.5	PCHG127GP
Fairplay Member	160.5	174.1	PCHG127GP
	[1]175.0	177.0	PCHG128GP
Eagle Point Member	174.1	188.4	PCHG127GP
	177.0	185.6	PCHG128GP
Beecher Member	188.4	194.4	PCHG127GP
	185.6	191.6	PCHG128GP
St. James Member	194.4	[2]199.5	PCHG127GP
	191.6	203.0	PCHG128GP
Buckhorn Member	203.0	213.9	PCHG128GP
Platteville Group	213.9	332.3	na
Quimbys Mill Formation	213.9	225.9	PCHG128GP
Strawbridge Member	213.9	214.4	PCHG128GP
Schullsburg Member	214.4	223.2	PCHG128GP
Hazel Green Member	223.2	225.9	PCHG128GP
Nachusa Formation	225.9	235.1	PCHG128GP
Grand Detour Formation	235.1	280.7	PCHG128GP
Forreston Member	235.1	256.5	PCHG128GP
Stillman Member	256.5	265.5	PCHG128GP
Cowen Member	265.5	280.7	PCHG128GP
Mifflin Formation	280.7	305.4	PCHG128GP
	[1]300.0	306.2	PCHG127SP
Pecatonica Formation	305.4	332.3	na
(undifferentiated)	305.4	[2]311.0	PCHG128GP
	306.2	329.7	PCHG127SP
Chana Member	329.7	332.3	PCHG127SP
Ancell Group	332.3	394.4	PCHG127SP
Glenwood Formation	332.3	361.5	PCHG127SP
Harmony Hill Shale Member	332.3	334.2	PCHG127SP
Daysville Dolomite Member	334.2	360.2	PCHG127SP
Kingdom Sandstone Member	360.2	361.5	PCHG127SP
St. Peter Sandstone	361.5	394.0	PCHG127SP
Starved Rock Sandstone Member	361.5	[2]394.0	PCHG127SP

[1]Topmost section of measured core sample. Represents incomplete stratigraphic interval.
[2]Bottommost section of measured core sample. Represents incomplete stratigraphic interval.
[3]Bottommost section of measured core sample.
[4]Topmost section of measured core sample.

Table 4. Porosity of rock cores from selected boreholes in Belvidere, Ill.

[--, not applicable]

Depth, in feet below land surface	Stratigraphic unit			Unadjusted porosity (percent)	Second run unadjusted porosity (percent)	Adjusted porosity[1] (percent)	Second run adjusted porosity (percent)
	Group	Formation	Member				
			Borehole PCHG125B				
30.0–30.3	Galena	Dubuque/Wise Lake	--	9.1	--	10.4	--
35.4–35.7	..do.....	..do.......	--	9.0	--	9.2	--
			Borehole PCHG115BD				
41.7–42.0	Galena	Dubuque/Wise Lake	--	12.7	--	12.9	--
[2]43.6–43.9	..do.....	..do.......	--	6.0	--	6.5	--
50.3–50.6	..do.....	..do.......	--	13.5	--	14.2	--
60.5–60.8	..do.....	..do.......	--	9.4	--	10.1	--
70.5–70.8	..do.....	..do.......	--	9.2	--	10.0	--
77.2–77.5	..do.....	..do.......	--	5.2	4.8	5.3	5.0
91.3–91.6	..do.....	..do.......	--	15.2	--	16.2	--
96.6–96.9	..do.....	..do.......	--	9.9	--	10.3	--
108.7–109.1	..do.....	..do.......	--	18.5	18.9	19.3	19.6
121.0–121.3	..do.....	..do.......	--	10.4	--	11.0	--
127.0–127.4	..do.....	..do.......	--	8.3	--	8.7	--
130.0–130.5	..do.....	..do.......	--	14.5	--	15.0	--
138.7–139.0	..do.....	..do.......	--	14.9	--	15.5	--
141.3–141.7	..do.....	..do.......	--	10.2	--	10.8	--
148.5–148.7	..do.....	..do.......	--	12.5	14.1	13.4	15.0
150.3–150.4	..do.....	..do.......	--	23.7	--	24.8	--
150.4–150.5	..do.....	..do.......	--	9.0	--	11.0	--
			Borehole PCHG127GP				
157.0–157.3	Galena	Dunleith	Loves Park	16.4	--	16.6	--
170.0–170.4	..do.....	..do.......	Fairplay	17.5	--	17.8	--
179.7–179.9	..do.....	..do.......	Eagle Point	16.0	16.0	16.4	16.3
199.0–199.3	..do.....	..do.......	St. James	10.5	--	10.8	--
			Borehole PCHG128GP				
175.8–176.0	Galena	Dunleith	Fairplay	14.8	--	14.8	--
178.8–179.0	..do.....	..do.......	Eagle Point	10.8	--	11.2	--
188.7–188.8	..do.....	..do.......	Beecher	7.8	--	8.0	--
198.0–198.3	..do.....	..do.......	St. James	10.8	--	12.1	--
204.0–204.3	..do.....	..do.......	Buckhorn	7.4	--	7.5	--
208.8–209.1	..do.....	..do.......	Buckhorn	6.0	--	6.1	--
[3]213.8–214.2	Platteville	Quimbys Mill	Strawbridge	6.8	--	6.8	--
218.8–219.0	..do.....	..do.......	Schullsburg	9.4	--	9.4	--
223.9–224.2	..do.....	..do.......	Hazel Green	6.1	--	6.1	--
226.4–226.8	..do.....	Nachusa	--	12.0	--	12.1	--
231.1–231.4	..do.....	..do.......	--	13.1	--	13.2	--
242.0–242.2	..do.....	Grand Detour	Forreston	6.0	--	6.0	--
251.0–251.3	..do.....	..do.......	..do.......	7.0	--	7.0	--
260.6–260.9	..do.....	..do.......	Stillman	4.8	--	4.8	--
268.5–268.8	..do.....	..do.......	Cowen	8.7	--	8.8	--

Table 4. Porosity of rock cores from selected boreholes in Belvidere, Ill.—Continued

Depth, in feet below land surface	Stratigraphic unit: Group	Stratigraphic unit: Formation	Stratigraphic unit: Member	Unadjusted porosity (percent)	Second run unadjusted porosity (percent)	Adjusted porosity[1] (percent)	Second run adjusted porosity (percent)
			Borehole PCHG128GP—Continued				
282.7–283.0	Platteville	Mifflin	--	5.1	--	5.1	--
288.1–288.4	..do.....	..do.......	--	3.9	--	4.0	--
296.0–296.3	..do.....	..do.......	--	6.1	--	6.1	--
299.9–300.4	..do.....	..do.......	--	5.7	--	5.7	--
305.4–305.8	..do.....	Pecatonica	--	7.4	--	7.4	--
[4]310.7–311.0	..do.....	..do.......	--	8.9	--	8.9	--
			Borehole PCHG127SP				
300.0–300.3	Platteville	Mifflin	--	4.3	4.5	4.5	4.7
307.7–308.0	..do.....	Pecatonica	--	6.4	--	6.4	--
315.5–315.8	..do.....	..do.......	--	11.7	--	12.0	--
326.6–326.8	..do.....	..do.......	--	7.5	--	7.5	--
330.0–330.4	..do.....	..do.......	Chana	7.7	--	7.8	--
332.7–333.0	Ancell	Glenwood	Harmony Hill Shale	18.0	--	18.1	--
335.0–335.4	..do.....	..do.......	Daysville Dolomite	5.0	--	5.1	--
343.2–343.5	..do.....	..do.......	..do.......	12.3	13.9	12.3	13.9
353.5–353.8	..do.....	..do.......	..do.......	7.3	--	7.3	--
360.5–360.7	..do.....	..do.......	Kingdom Sandstone	21.2	--	21.4	--
360.7–361.1	..do.....	..do.......	..do.......	7.3	--	7.4	--
370.1–370.4	..do.....	St. Peter Sandstone	Starved Rock Sandstone	24.5	--	24.6	--
380.0–380.3	..do.....	..do.......	..do.......	23.8	--	23.9	--

[1]A qualitative scale from 1 to 5, representing “smooth” (1) to “very vuggy” (5) core surfaces, was used to approximate the percentage of pores open to the surface of the cores. The standard laboratory method used to determine porosity could not account for these core volumes.

[2]Porosity values may be higher because of possible error in measurement of core volume.

[3]Depth of 213.8–213.9 feet below land surface represents Buckhorn member of the Dunleith Formation.

[4]Measured depth of core. Total depth of borehole was 310.0 feet.

Table 5. Bulk density of rock cores from selected boreholes in Belvidere, Ill.

[g/cm³, grams per cubic centimeter; --, not applicable]

Depth, in feet below land surface	Stratigraphic unit			Bulk density (g/cm³)	Second run bulk density (g/cm³)
	Group	Formation	Member		
		Borehole PCHG125B			
30.0–30.3	Galena	Dubuque/Wise Lake	--	2.5	--
35.4–35.7	..do.....	..do.....	--	2.6	--
		Borehole PCHG115BD			
41.7–42.0	Galena	Dubuque/Wise Lake	--	2.2	--
[1]43.6–43.9	..do.....	..do.....	--	1.2	--
50.3–50.6	..do.....	..do.....	--	2.5	--
60.5–60.8	..do.....	..do.....	--	2.5	--
70.5–70.8	..do.....	..do.....	--	2.6	--
77.2–77.5	..do.....	..do.....	--	2.7	2.7
91.3–91.6	..do.....	..do.....	--	2.4	--
96.6–96.9	..do.....	..do.....	--	2.5	--
108.7–109.1	..do.....	..do.....	--	2.3	2.3
121.0–121.3	..do.....	..do.....	--	2.5	--
127.0–127.4	..do.....	..do.....	--	2.6	--
130.0–130.5	..do.....	..do.....	--	2.4	--
138.7–139.0	..do.....	..do.....	--	2.4	--
141.3–141.7	..do.....	..do.....	--	2.6	--
148.5–148.7	..do.....	..do.....	--	2.4	2.6
150.3–150.4	..do.....	..do.....	--	2.0	--
150.4–150.5	..do.....	..do.....	--	2.6	--
		Borehole PCHG127GP			
157.0–157.3	Galena	Dunleith	Loves Park	2.4	--
170.0–170.4	..do.....	..do.....	Fairplay	2.4	--
179.7–179.9	..do.....	..do.....	Eagle Point	2.4	2.4
199.0–199.3	..do.....	..do.....	St. James	2.5	--
		Borehole PCHG128GP			
175.8–176.0	Galena	Dunleith	Fairplay	2.6	--
178.8–179.0	..do.....	..do.....	Eagle Point	2.5	--
188.7–188.8	..do.....	..do.....	Beecher	2.6	--
198.0–198.3	..do.....	..do.....	St. James	2.5	--
204.0–204.3	..do.....	..do.....	Buckhorn	2.6	--
208.8–209.1	..do.....	..do.....	Buckhorn	2.6	--
[2]213.8–214.2	Platteville	Quimbys Mill	Strawbridge	2.6	--
218.8–219.0	..do.....	..do.....	Schullsburg	2.5	--
223.9–224.2	..do.....	..do.....	Hazel Green	2.6	--
226.4–226.8	..do.....	Nachusa	--	2.5	--
		Borehole PCHG128GP			
231.1–231.4	Platteville	Nachusa	--	2.4	--
242.0–242.2	..do.....	Grand Detour	Forreston	2.6	--
251.0–251.3	..do.....	..do.....	..do.....	2.6	--
260.6–260.9	..do.....	..do.....	Stillman	2.7	--
268.5–268.8	..do.....	..do.....	Cowen	2.6	--

Table 5. Bulk density of rock cores from selected boreholes in Belvidere, Ill—Continued

Depth, in feet below land surface	Stratigraphic unit			Bulk density (g/cm^3)	Second run bulk density (g/cm^3)
	Group	Formation	Member		
		Borehole PCHG128GP—Continued			
282.7–283.0	Platteville	Mifflin	--	2.7	--
288.1–288.4	..do.....	..do.....	--	2.7	--
296.0–296.3	..do.....	..do.....	--	2.6	--
299.9–300.4	..do.....	..do.....	--	2.6	--
305.4–305.8	..do.....	Pecatonica	--	2.6	--
[3]310.7–311.0	..do.....	..do.....	--	2.6	--
		Borehole PCHG127SP			
300.0–300.3	Platteville	Mifflin	--	2.7	2.9
307.7–308.0	..do.....	Pecatonica	--	2.6	--
315.5–315.8	..do.....	..do.....	--	2.5	--
326.6–326.8	..do.....	..do.....	--	2.6	--
330.0–330.4	..do.....	..do.....	Chana	2.6	--
332.7–333.0	Ancell	Glenwood	Harmony Hill Shale	2.2	--
335.0–335.4	..do.....	..do.....	Daysville Dolomite	2.7	--
343.2–343.5	..do.....	..do.....	..do.....	2.4	2.4
353.5–353.8	..do.....	..do.....	..do.....	2.6	--
360.5–360.7	..do.....	..do.....	Kingdom Sandstone	2.2	--
360.7–361.1	..do.....	..do.....	..do.....	2.6	--
370.1–370.4	..do.....	St. Peter Sandstone	Starved Rock Sandstone	2.1	--
380.0–380.3	..do.....	..do.....	..do.....	2.0	--

[1]Bulk density may be higher because of possible error in the measurement of the core volume.
[2]Depth of 213.8–213.9 feet below land surface represents the Buckhorn Member of the Dunleith Formation.
[3]Measured depth of core. Total depth of borehole was 310.0 feet.

Table 6. Particle density of rock cores from selected boreholes in Belvidere, Ill.

[g/cm^3, grams per cubic centimeter; --, not applicable]

Depth, in feet below land surface	Stratigraphic unit			Particle density (g/cm^3)	Second run particle density (g/cm^3)
	Group	Formation	Member		
		Borehole PCHG125B			
30.0–30.3	Galena	Dubuque/Wise Lake	--	2.8	--
35.4–35.7	..do.....	..do.....	--	2.8	--
		Borehole PCHG115BD			
41.7–42.0	Galena	Dubuque/Wise Lake	--	2.8	--
43.6–43.9	..do.....	..do.....	--	2.8	--
50.3–50.6	..do.....	..do.....	--	2.8	--
60.5–60.8	..do.....	..do.....	--	2.8	--
70.5–70.8	..do.....	..do.....	--	2.8	--
77.2–77.5	..do.....	..do.....	--	2.8	2.8
91.3–91.6	..do.....	..do.....	--	2.8	--
96.6–96.9	..do.....	..do.....	--	2.8	--
108.7–109.1	..do.....	..do.....	--	2.8	2.8
121.0–121.3	..do.....	..do.....	--	2.8	--
127.0–127.4	..do.....	..do.....	--	2.8	--
130.0–130.5	..do.....	..do.....	--	2.8	--
138.7–139.0	..do.....	..do.....	--	2.8	--
[1]141.3–141.7	..do.....	..do.....	--	1.8	--
148.5–148.7	..do.....	..do.....	--	2.8	2.8
150.3–150.4	..do.....	..do.....	--	2.6	--
150.4–150.5	..do.....	..do.....	--	2.8	--
		Borehole PCHG127GP			
157.0–157.3	Galena	Dunleith	Loves Park	2.8	--
170.0–170.4	..do.....	..do.....	Fairplay	2.5	--
179.7–179.9	..do.....	..do.....	Eagle Point	2.8	2.8
199.0–199.3	..do.....	..do.....	St. James	2.8	--
		Borehole PCHG128GP			
175.8–176.0	Galena	Dunleith	Fairplay	2.8	--
178.8–179.0	..do.....	..do.....	Eagle Point	2.8	--
188.7–188.8	..do.....	..do.....	Beecher	2.8	--
198.0–198.3	..do.....	..do.....	St. James	2.8	--
204.0–204.3	..do.....	..do.....	Buckhorn	2.8	--
208.8–209.1	..do.....	..do.....	..do.....	2.8	--
[2]213.8–214.2	Platteville	Quimbys Mill	Strawbridge	[3]--	--
218.8–219.0	..do.....	..do.....	Schullsburg	2.8	--
223.9–224.2	..do.....	..do.....	Hazel Green	2.8	--
226.4–226.8	..do.....	Nachusa	--	2.8	--
231.1–231.4	..do.....	..do.....	--	2.7	--
242.0–242.2	..do.....	Grand Detour	Forreston	2.8	--
251.0–251.3	..do.....	..do.....	..do.....	2.8	--
260.6–260.9	..do.....	..do.....	Stillman	2.8	--
268.5–268.8	..do.....	..do.....	Cowen	2.8	--
282.7–283.0	..do.....	Mifflin	--	2.8	--
288.1–288.4	..do.....	..do.....	--	2.8	--
296.0–296.3	..do.....	..do.....	--	2.8	--
299.9–300.4	..do.....	..do.....	--	[3]--	--
305.4–305.8	..do.....	Pecatonica	--	[3]--	--
[4]310.7–311.0	..do.....	..do.....	--	2.8	--

Table 6. Particle density of rock cores from selected boreholes in Belvidere, Ill.—Continued

Depth, in feet below land surface	Stratigraphic unit			Particle density (g/cm^3)	Second run particle density (g/cm^3)
	Group	Formation	Member		
			Borehole PCHG127SP		
300.0–300.3	Platteville	Mifflin	--	2.8	2.8
307.7–308.0	..do.....	Pecatonica	--	2.8	--
315.5–315.8	..do.....	..do.....	--	2.8	--
326.6–326.8	..do.....	..do.....	--	2.8	--
330.0–330.4	..do.....	..do.....	Chana	2.7	--
332.7–333.0	Ancell	Glenwood	Harmony Hill Shale	2.7	--
[1]335.0–335.4	..do.....	..do.....	Daysville Dolomite	2.0	--
343.2–343.5	..do.....	..do.....	..do.....	2.7	2.7
353.5–353.8	..do.....	..do.....	..do.....	2.7	--
360.5–360.7	..do.....	..do.....	Kingdom Sandstone	2.6	--
360.7–361.1	..do.....	..do.....	..do.....	2.8	--
370.1–370.4	..do.....	St. Peter Sandstone	Starved Rock Sandstone	2.6	--
380.0–380.3	..do.....	..do.....	..do.....	2.6	--

[1]Particle density may be higher because of a possible error in the measurement of the saturated core suspended in water.
[2]Depth of 213.8–213.9 feet below land surface represents the Buckhorn Member of the Dunleith Formation.
[3]Value could not be determined. Core sample weight exceeded limits of the laboratory scale.
[4]Measured depth of core. Total depth of borehole was 310.0 feet.

Table 7. Borehole geophysical logs and source of logs collected in Belvidere, Ill.

[GAM, natural gamma; CAL, three-arm caliper; SP, spontaneous potential; SPR, single-point resistance; RES(16N), resistivity 16-inch normal; RES(64N), resistivity 64-inch normal; RES(L), lateral resistivity; RES(FL), fluid resistivity; TEMP, temperature; NEUT(N), neutron, near; NEUT(F), neutron, far; AT, acoustic televiewer; BHF, heat-pulse borehole flowmeter; BVC, borehole video camera; USEPA, U.S. Environmental Protection Agency; X, log completed; --, no log completed; USGS, U.S. Geological Survey; Y, log completed by second listed agency under "Source of geophysical logs"]

Borehole or well name	Source of geophysical logs	GAM	CAL	SP	SPR	RES(16N)	RES(64N)	RES(L)	RES(FL)	TEMP	NEUT(N)	NEUT(F)	AT	BHF	BVC
00305	USEPA	X	X	X	X	X	X	--	--	X	--	--	--	--	X
00436	USEPA	X	X	X	X	X	X	X	X	X	--	--	X	X	X
BMW2	USGS/USEPA	X	X	X	X	X	X	--	Y	X/Y	--	--	X	X	X
PCHG102	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG111S	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG111D	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG112S	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG112D	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG113S	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG113D	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG114S	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG114D	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG115S	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG115D	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG115BD	USEPA	X	X	X	X	--	--	--	X	X	--	--	--	--	X
PCHG116S	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG116D	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG122D	USEPA	X	--	--	--	--	--	--	--	--	--	--	--	--	--
PCHG125BD	USEPA	X	X	X	X	--	--	--	--	--	--	--	--	--	X
PCHG126BD	USEPA	X	X	X	X	--	--	--	--	--	--	--	--	--	X
PCHG127GP	USGS/USEPA	X/Y	X	X	X	--	--	--	Y	X/Y	--	--	X	X	X
PCHG127SP	USEPA	X	X	X	X	--	--	--	X	X	--	--	--	--	--
PCHG128GP	USGS	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 8. Ground-penetrating radar interpreted reflectors from borehole PCHG127GP in Belvidere, Ill.

[Data collected and interpreted by Niva (1991), reinterpreted by John Lane, U.S. Geological Survey, written commun., 1993; F, fracture; na, not applicable; --, no data; BPF, bedding-plane fracture; P, point—cavity or other undetermined feature]

Depth, in feet below land surface	Type of reflector	Distance from borehole, in feet	Dip angle (degrees)	Dip orientation (degrees)	Strike orientation (degrees)
[1]–598.3	F	na	85.6	--	--
–245.3	F	na	83.7	N. 50 W.	N. 140 W.
–150.9	F	na	78.4	N. 160 W.	N. 70 W.
–127.3	F	na	76.0	--	--
–52.2	F	na	66.5	N. 0 W.	N. 90 W.
11.2	F	na	51.3	--	--
49.9	F	na	52.8	--	--
50.2	BPF	na	.0	na	na
77.4	BPF	na	.0	na	na
96.4	BPF	na	.0	na	na
101.7	BPF	na	.0	na	na
108.2	BPF	na	.0	na	na
123.7	P	9.8	na	na	na
124.6	BPF	na	.0	na	na
141.7	P	12.8	na	na	na
143.0	F	na	48.9	--	--
144.6	BPF	na	.0	na	na
145.0	P	37.1	na	na	na
159.7	P	20.3	na	na	na
175.8	F	na	69.8	N. 90 E.	N. 0 E.
187.0	BPF	na	.0	na	na
193.2	P	20.0	na	na	na
209.6	BPF	na	.0	na	na
244.0	P	32.1	na	na	na
256.5	F	na	10.2	na	na
274.2	BPF	na	.0	na	na
279.5	P	37.4	na	na	na
282.4	F	na	46.3	--	--
283.4	P	43.0	na	na	na
284.4	P	52.8	na	na	na
286.3	F	na	63.2	--	--
302.1	F	na	71.0	N. 40 E.	N. 50 W.
307.0	F	na	32.8	N. 160 W.	N. 70 W.
312.9	F	na	61.7	N. 0 W.	N. 90 W.
670.1	F	na	84.2	N. 170 W.	N. 80 W.

[1] Values represent projection of the fracture intercept with the borehole trace and fractures may not physically intercept the borehole.

Table 9. Ground-water-flow data from borehole PCHG128GP in Belvidere, Ill., November 11, 1993

[Table summarizes data from F.L. Paillet, U.S. Geological Survey, written commun., 1994; gal/min, gallons per minute; < , less than]

Depth, in feet below land surface	Flow direction	Estimated ground-water-flow rate[1] (gal/min)
50	Down	15.9
80	Down	14.9
110	Down	14.9
125	Down	13.2
130	Down	13.5
140	Down	13.2
180	Down	12.8
200	Down	12.5
210	Down	11.9
225	Down	12.1
240	Down	13.5
255	Down	12.8
265	Down	3.1
265	Down	3.0
280	Down	2.9
292	Down	3.0
301	No flow	<.2
250	Down	13.2
150	Down	9.9
100	Down	14.9
60	Down	15.5
40	Down	14.3

[1]Data collected from a borehole-heat-pulse flowmeter. Flow represents ambient vertical flow in the borehole open to the Galena-Platteville aquifer. Flow in the borehole was supplemented by flow from the overlying glacial drift aquifer. Supplemental flow was through one to four approximately 1-inch-diameter holes in the lower 5 feet of the 32-feet long steel surface casing. Outflow from the borehole was primarily through bedding-plane fractures at depths of about 121 feet (15 percent of outflow), 259 feet (65 percent of outflow), and 300 feet (20 percent of outflow) below land surface.

Table 10. Depth to water and water-level altitude in selected wells in Belvidere, Ill., 1989–96

[Depth to water in feet below top of well riser; water-level altitudes in feet above sea level; --, no data; >, greater than; <, less than. Unless specified, water levels were measured by the U.S. Geological Survey. Water levels in PCH wells on June 26, 1990 through February 27, 1990, July 11, 1990, and October 14, 1995 were measured by Science Applications International Corporation (1992; 1996). Water levels in PCH wells on May 30, 1990 and February 21, 1991 were measured by the U.S. Environmental Protection Agency, Region 5, Chicago, Ill. (Douglas Yeskis, U.S. Environmental Protection Agency, written commun., 1991)]

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
	Well AGTG305GPS			**Well AGTG305GPD**			**Well AGTG305SP**	
[1]02-09-95	34.59	745.65	[1]02-09-95	47.57	732.33	[1]02-09-95	66.11	713.49
05-16-95	33.35	746.89	05-16-95	53.66	726.24	05-16-95	66.42	713.18
05-31-95	33.14	747.10	05-31-95	52.56	727.34	05-31-95	65.81	713.79
06-01-95	33.24	747.00	06-01-95	50.40	729.50	06-01-95	66.09	713.51
06-02-95	33.33	746.91	06-02-95	54.99	724.91	06-02-95	66.18	713.42
06-14-95	33.44	746.80	06-14-95	49.64	730.26	06-14-95	66.91	712.69
05-07-96	34.86	745.38	05-07-96	59.12	720.78	05-07-96	65.39	714.21
05-08-96	34.81	745.43	05-08-96	59.26	720.64	05-08-96	65.41	714.19
05-10-96	34.03	746.21	05-10-96	59.40	720.50	05-10-96	65.13	714.47
08-29-96	33.82	746.42	08-29-96	50.05	729.85	08-29-96	65.68	713.92
09-19-96	34.28	745.96	09-19-96	55.46	724.44	09-19-96	66.71	712.89
	Well BMW2			**Well BMW4**			**Well BMW5**	
03-24-93	5.75	753.83	07-23-93	>200	<579.5	06-14-95	76.51	724.43
07-20-93	4.62	754.96	11-13-93	55.80	723.70	08-29-96	74.20	726.74
	Well BMW6			**Well NSMG101**			**Well NSMG102**	
01-12-93	43.38	740.08	07-19-93	8.71	755.59	07-19-93	18.09	755.79
07-21-93	44.69	738.77	06-01-94	11.69	752.61	06-01-94	21.31	752.57
07-22-93	45.26	738.20	09-22-94	12.06	752.24	09-22-94	21.89	751.99
05-30-94	49.98	733.48	05-08-96	17.70	746.60	05-08-96	28.26	745.62
09-23-94	55.45	728.01	08-26-96	11.48	752.82	08-27-96	21.13	752.75
06-14-95	57.10	726.36	--	--	--	--	--	--
09-20-96	52.57	730.89	--	--	--	--	--	--
	Well NSMG103			**Well NSMG104**			**Well NSMG105**	
07-19-93	8.39	755.26	[2]07-20-93	3.7	755.4	07-19-93	7.89	755.29
06-01-94	11.37	752.28	[2]06-02-94	6.7	752.4	06-01-94	10.90	752.28
09-22-94	11.94	751.71	04-12-95	7.31	752.46	09-22-94	11.46	751.72
05-08-96	19.99	743.66	06-01-95	6.40	753.37	06-01-95	9.63	753.55
08-27-96	11.08	752.57	05-08-96	22.51	737.26	06-14-95	9.67	753.51
09-12-96	11.35	752.30	08-27-96	7.24	752.53	05-08-96	18.19	744.99
--	--	--	09-12-96	7.53	752.24	08-27-96	10.66	752.52
--	--	--	--	--	--	09-12-96	10.91	752.27

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
	Well PCHG102			**Well PCHG103**			**Well PCHG111S**	
06-26-89	25.80	760.31	06-26-89	27.93	760.20	06-26-89	23.44	761.92
07-26-89	26.00	760.11	07-26-89	28.00	760.13	07-11-89	23.55	761.81
08-25-89	24.90	761.21	08-25-89	27.30	760.83	07-26-89	23.50	761.86
09-26-89	24.40	761.71	09-26-89	26.65	761.48	08-15-89	19.75	765.61
10-30-89	27.60	758.51	10-30-89	25.45	762.68	08-25-89	20.50	764.86
11-27-89	25.80	760.31	11-27-89	27.95	760.18	09-26-89	20.34	765.02
01-04-90	26.40	759.71	01-04-90	28.45	759.68	10-30-89	23.15	762.21
01-30-90	26.45	759.66	01-30-90	28.45	759.68	11-27-89	23.55	761.81
02-27-90	26.00	760.11	02-27-90	28.10	760.03	01-04-90	24.10	761.26
05-30-90	23.91	762.20	05-30-90	26.29	761.84	01-30-90	24.20	761.16
07-11-90	22.69	763.42	07-11-90	25.01	763.12	02-27-90	23.35	762.01
08-24-90	21.50	764.61	08-24-90	23.81	764.32	05-30-90	19.67	765.69
09-10-90	21.82	764.29	09-10-90	24.19	763.94	07-11-90	19.48	765.88
10-15-90	22.54	763.57	10-15-90	24.85	763.28	08-24-90	18.61	766.75
11-12-90	22.80	763.31	11-12-90	25.14	762.99	09-10-90	19.20	766.16
12-03-90	23.17	762.94	12-03-90	25.45	762.68	10-15-90	19.60	765.76
--	--	--	--	--	--	11-12-90	19.65	765.71
--	--	--	--	--	--	12-03-90	19.83	765.53
--	--	--	--	--	--	02-21-91	20.01	765.35
--	--	--	--	--	--	04-29-91	19.01	766.35
--	--	--	--	--	--	..do.....	19.04	766.32
--	--	--	--	--	--	07-10-91	19.45	765.91
--	--	--	--	--	--	07-14-92	21.30	764.06
--	--	--	--	--	--	09-10-92	19.99	765.37
--	--	--	--	--	--	11-12-92	19.73	765.63
--	--	--	--	--	--	12-21-92	19.74	765.62
--	--	--	--	--	--	07-19-93	14.33	771.03
--	--	--	--	--	--	05-30-95	19.61	765.75
--	--	--	--	--	--	05-08-96	20.58	764.78

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
Well PCHG111D			**Well PCHG112S**			**Well PCHG112D**		
06-26-89	22.54	761.93	06-26-89	24.58	761.71	06-26-89	25.10	760.78
07-11-89	22.71	761.76	07-11-89	25.08	761.21	07-11-89	25.30	760.58
07-26-89	22.65	761.82	07-26-89	24.30	761.99	07-26-89	25.20	760.68
08-15-89	21.27	763.20	08-15-89	23.06	763.23	08-15-89	23.80	762.08
08-25-89	21.80	762.67	08-25-89	23.25	763.04	08-25-89	24.15	761.73
09-26-89	21.53	762.94	09-26-89	23.44	762.85	09-26-89	23.89	761.99
10-30-89	22.40	762.07	10-30-89	24.60	761.69	10-30-89	24.75	761.13
11-27-89	22.75	761.72	11-27-89	25.00	761.29	11-27-89	25.20	760.68
01-04-90	23.35	761.12	01-04-90	25.70	760.59	01-04-90	25.75	760.13
01-30-90	23.35	761.12	01-30-90	25.30	760.99	01-30-90	25.70	760.18
02-27-90	23.05	761.42	02-27-90	24.75	761.54	02-27-90	25.35	760.53
05-30-90	21.28	763.19	05-30-90	22.89	763.40	05-30-90	23.52	762.36
07-11-90	19.84	764.63	07-11-90	21.76	764.53	07-11-90	22.16	763.72
08-24-90	18.26	766.21	08-24-90	20.26	766.03	08-24-90	20.60	765.28
09-10-90	18.78	765.69	09-10-90	21.27	765.02	09-10-90	21.22	764.66
10-15-90	19.28	765.19	10-15-90	20.88	765.41	10-15-90	21.68	764.20
11-12-90	19.48	764.99	11-12-90	21.64	764.65	11-12-90	22.01	763.87
12-03-90	19.80	764.67	12-03-90	21.90	764.39	12-03-90	22.26	763.62
02-21-91	20.08	764.39	02-21-91	22.60	763.69	02-21-91	22.76	763.12
04-29-91	18.56	765.91	07-10-91	21.70	764.59	07-10-91	21.77	764.11
..do.....	18.56	765.91	--	--	--	10-14-95	22.97	762.91
07-10-91	18.73	765.74	--	--	--	--	--	--
07-14-92	20.76	763.71	--	--	--	--	--	--
09-10-92	20.32	764.15	--	--	--	--	--	--
11-12-92	20.77	763.70	--	--	--	--	--	--
12-21-92	19.91	764.56	--	--	--	--	--	--
07-19-93	13.46	771.01	--	--	--	--	--	--
05-30-95	19.46	765.01	--	--	--	--	--	--
10-14-95	20.37	764.10	--	--	--	--	--	--
05-08-96	22.06	762.41	--	--	--	--	--	--
09-12-96	18.18	766.29	--	--	--	--	--	--

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
	Well PCHG113S			**Well PCHG113D**			**Well PCHG114S**	
06-26-89	26.25	760.39	06-26-89	25.62	760.40	06-26-89	21.46	765.71
07-11-89	26.48	760.16	07-11-89	25.83	760.19	07-11-89	22.00	765.17
07-26-89	26.50	760.14	07-26-89	25.65	760.37	07-26-89	21.20	765.97
08-15-89	25.01	761.63	08-15-89	24.35	761.67	08-15-89	19.96	767.21
08-25-89	25.25	761.39	08-25-89	24.60	761.42	08-25-89	20.25	766.92
09-26-89	24.98	761.66	09-26-89	24.36	761.66	09-26-89	20.45	766.72
10-30-89	25.85	760.79	10-30-89	25.25	760.77	10-30-89	21.40	765.77
11-27-89	26.25	760.39	11-27-89	25.65	760.37	11-27-89	21.70	765.47
01-04-90	26.80	759.84	01-04-90	26.30	759.72	01-04-90	22.00	765.17
01-30-90	26.85	759.79	01-30-90	26.20	759.82	01-30-90	21.65	765.52
02-27-90	26.45	760.19	02-27-90	25.95	760.07	02-27-90	21.30	765.87
05-30-90	24.72	761.92	05-30-90	24.72	761.30	05-30-90	19.89	767.28
07-11-90	23.18	763.46	07-11-90	22.55	763.47	07-11-90	19.60	767.57
08-24-90	21.60	765.04	08-24-90	21.01	765.01	08-24-90	19.20	767.97
09-10-90	22.29	764.35	09-10-90	21.68	764.34	09-10-90	19.87	767.30
10-15-90	22.81	763.83	10-15-90	22.18	763.84	10-15-90	20.16	767.01
11-12-90	23.18	763.46	11-12-90	22.55	763.47	11-12-90	24.43	762.74
12-03-90	23.38	763.26	12-03-90	22.77	763.25	12-03-90	20.60	766.57
02-21-91	23.99	762.65	02-21-91	23.35	762.67	02-21-91	20.68	766.49
07-10-91	22.90	763.74	07-10-91	22.36	763.66	07-10-91	20.77	766.40
10-14-95	24.12	762.52	10-14-95	23.50	762.52	10-14-95	21.73	765.44
05-08-96	25.86	760.78	05-08-96	25.25	760.77	--	--	--
	Well PCHG114D			**Well PCHG115S**			**Well PCHG115D**	
06-26-89	25.66	760.51	06-26-89	17.05	767.40	06-26-89	25.00	760.16
07-11-89	25.84	760.33	07-11-89	17.55	766.90	07-11-89	25.17	759.99
07-26-89	25.80	760.37	07-26-89	17.15	767.30	07-26-89	25.10	760.06
08-15-89	24.36	761.81	08-15-89	15.38	769.07	08-15-89	23.70	761.46
08-25-89	24.65	761.52	08-25-89	16.05	768.40	08-25-89	24.05	761.11
09-26-89	24.36	761.81	09-26-89	16.29	768.16	09-26-89	23.70	761.46
10-30-89	25.35	760.82	10-30-89	17.60	766.85	10-30-89	24.55	760.61
11-27-89	25.75	760.42	11-27-89	18.25	766.20	11-27-89	25.00	760.16
01-04-90	26.20	759.97	01-04-90	18.30	766.15	01-04-90	25.50	759.66
01-30-90	26.25	759.92	01-30-90	17.40	767.05	01-30-90	25.50	759.66

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
Well PCHG114D—Continued			**Well PCHG115S—Continued**			**Well PCHG115D—Continued**		
02-27-90	25.80	760.37	02-27-90	17.05	767.40	02-27-90	25.15	760.01
05-30-90	23.97	762.20	05-30-90	15.79	768.66	05-30-90	23.28	761.88
07-11-90	22.78	763.39	07-11-90	15.45	769.00	07-11-90	22.07	763.09
08-24-90	21.61	764.56	08-24-90	14.46	769.99	08-24-90	20.91	764.25
09-10-90	22.02	764.15	09-10-90	16.15	768.30	09-10-90	21.30	763.86
10-15-90	22.65	763.52	10-15-90	16.58	767.87	10-15-90	21.94	763.22
11-12-90	22.95	763.22	11-12-90	16.47	767.98	11-12-90	22.24	762.92
12-03-90	23.22	762.95	12-03-90	16.33	768.12	12-03-90	22.54	762.62
02-21-91	23.72	762.45	02-21-91	16.55	767.90	02-21-91	22.98	762.18
07-10-91	22.70	763.47	04-29-91	16.04	768.41	04-29-91	21.37	763.79
10-14-95	23.95	762.22	..do.....	16.06	768.39	..do.....	21.40	763.76
--	--	--	07-10-91	17.34	767.11	07-10-91	22.30	762.86
--	--	--	07-14-92	16.96	767.49	07-14-92	23.31	761.85
--	--	--	09-10-92	15.72	768.73	09-10-92	23.04	762.12
--	--	--	11-09-92	16.78	767.67	11-09-92	23.24	761.92
--	--	--	11-12-92	16.69	767.76	11-12-92	23.15	762.01
--	--	--	11-13-92	16.55	767.90	11-13-92	23.14	762.02
--	--	--	..do.....	16.51	767.94	..do.....	23.13	762.03
--	--	--	07-19-93	14.22	770.23	07-19-93	17.03	768.13
--	--	--	05-30-95	16.01	768.44	..do.....	17.02	768.14
--	--	--	10-14-95	17.01	767.44	07-27-93	17.16	768.00
--	--	--	05-08-96	17.42	767.03	06-03-94	21.50	763.66
--	--	--	--	--	--	05-30-95	22.10	763.06
--	--	--	--	--	--	10-14-95	23.07	762.09
--	--	--	--	--	--	05-08-96	24.63	760.53

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
Well PCHG115B			**Well PCHG115BD**			**Well PCHG116S**		
06-26-89	25.03	760.11	12-03-90	29.82	754.66	06-26-89	24.22	762.86
07-11-89	25.29	759.85	02-21-91	33.90	750.58	07-11-89	24.13	762.95
07-26-89	25.15	759.99	07-10-91	34.25	750.23	07-26-89	24.00	763.08
08-15-89	23.79	761.35	04-29-91	31.68	752.80	08-15-89	22.93	764.15
08-25-89	24.15	760.99	..do.....	32.70	751.78	08-25-89	23.40	763.68
09-26-89	23.76	761.38	07-14-92	37.43	747.05	09-26-89	23.05	764.03
10-30-89	24.60	760.54	..do.....	35.82	748.66	10-30-89	23.80	763.28
11-27-89	25.05	760.09	07-22-92	37.04	747.44	11-27-89	23.60	763.48
01-04-90	25.60	759.54	..do.....	36.25	748.23	01-04-90	24.55	762.53
01-30-90	25.60	759.54	09-10-92	37.47	747.01	01-30-90	24.20	762.88
02-27-90	25.15	759.99	10-26-92	25.43	759.05	02-27-90	24.10	762.98
05-30-90	23.34	761.80	11-12-92	31.36	753.12	05-30-90	22.88	764.20
07-11-90	22.14	763.00	07-19-93	27.44	757.04	07-11-90	22.03	765.05
08-24-90	20.99	764.15	12-07-94	34.54	749.94	08-24-90	21.11	765.97
09-10-90	21.34	763.80	05-30-95	33.74	750.74	09-10-90	21.74	765.34
10-15-90	22.00	763.14	05-08-96	34.96	749.52	10-15-90	22.44	764.64
11-12-90	22.28	762.86	09-23-96	31.06	753.42	11-12-90	22.49	764.59
12-03-90	22.56	762.58	10-25-96	31.75	752.73	12-03-90	22.48	764.60
02-21-91	23.06	762.08	10-28-96	30.48	754.00	02-21-91	23.01	764.07
04-29-91	21.51	763.63	10-29-96	30.91	753.57	04-29-91	21.63	765.45
..do.....	21.52	763.62	--	--	--	..do.....	21.66	765.42
07-10-91	20.85	764.29	--	--	--	07-10-91	22.60	764.48
07-14-92	23.51	761.63	--	--	--	11-12-92	22.04	765.04
..do.....	23.43	761.71	--	--	--	07-19-93	17.75	769.33
07-22-92	23.25	761.89	--	--	--	..do.....	17.75	769.33
09-10-92	23.18	761.96	--	--	--	07-27-93	17.89	769.19
09-24-92	22.64	762.50	--	--	--	06-03-94	22.01	765.07
..do.....	22.64	762.50	--	--	--	05-30-95	21.97	765.11
10-16-92	22.05	763.09	--	--	--	05-08-96	23.73	763.35
11-12-92	23.20	761.94	--	--	--	--	--	--
07-19-93	17.11	768.03	--	--	--	--	--	--
05-30-95	22.17	762.97	--	--	--	--	--	--
05-08-96	24.68	760.46	--	--	--	--	--	--

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
Well PCHG116D			**Well PCHG117D**			**Well PCHG119S**		
06-26-89	26.98	760.19	08-24-90	19.88	764.61	09-10-90	22.37	762.87
07-11-89	27.23	759.94	09-10-90	20.20	764.29	10-15-90	23.11	762.13
07-26-89	27.10	760.07	10-15-90	20.88	763.61	11-12-90	23.43	761.81
08-15-89	25.75	761.42	11-12-90	21.19	763.30	12-03-90	Dry	<761.5
08-25-89	26.10	761.07	12-03-90	21.53	762.96	02-21-91	Dry	..do.....
09-26-89	25.68	761.49	02-21-91	22.15	762.34	07-10-91	Dry	..do.....
10-30-89	26.55	760.62	04-29-91	20.40	764.09	07-19-93	19.25	765.99
11-27-89	27.00	760.17	..do.....	20.46	764.03	05-30-95	Dry	<761.5
01-04-90	27.50	759.67	07-10-91	21.32	763.17	10-14-95	Dry	..do.....
01-30-90	27.50	759.67	07-19-93	15.99	768.50	05-08-96	Dry	..do.....
02-27-90	27.10	760.07	05-30-95	21.18	763.31	--	--	--
05-30-90	25.33	761.84	10-14-95	22.37	762.12	--	--	--
07-11-90	24.01	763.16	05-08-96	23.86	760.63	--	--	--
08-24-90	22.84	764.33	--	--	--	--	--	--
09-10-90	23.20	763.97	--	--	--	--	--	--
10-15-90	23.87	763.30	--	--	--	--	--	--
11-12-90	24.18	762.99	--	--	--	--	--	--
12-03-90	24.48	762.69	--	--	--	--	--	--
02-21-91	25.01	762.16	--	--	--	--	--	--
04-29-91	23.32	763.85	--	--	--	--	--	--
..do.....	23.34	763.83	--	--	--	--	--	--
07-10-91	24.07	763.10	--	--	--	--	--	--
11-12-92	25.08	762.09	--	--	--	--	--	--
07-19-93	18.88	768.29	--	--	--	--	--	--
05-31-94	23.35	763.82	--	--	--	--	--	--
05-30-95	24.02	763.15	--	--	--	--	--	--
10-14-95	25.15	762.02	--	--	--	--	--	--
05-08-96	26.56	760.61	--	--	--	--	--	--

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
	Well PCHG119D			**Well PCHG120D**			**Well PCHG122S**	
09-10-90	21.95	763.68	08-24-90	20.60	764.28	09-10-90	18.64	763.07
10-15-90	22.61	763.02	09-10-90	20.99	763.89	10-15-90	19.27	762.44
11-12-90	22.95	762.68	10-15-90	21.61	763.27	11-12-90	19.78	761.93
12-03-90	23.24	762.39	11-12-90	22.92	761.96	12-03-90	20.11	761.60
02-21-91	23.86	761.77	12-03-90	22.34	762.54	02-21-91	20.70	761.01
07-10-91	23.05	762.58	02-21-91	22.68	762.20	07-10-91	19.85	761.86
07-19-93	18.10	767.53	07-10-91	21.85	763.03	10-14-95	20.81	760.90
05-30-95	22.98	762.65	07-19-93	16.63	768.25	--	--	--
10-14-95	24.14	761.49	05-30-95	21.78	763.10	--	--	--
05-08-96	25.33	760.30	10-14-95	22.91	761.97	--	--	--
--	--	--	05-08-96	24.26	760.62	--	--	--
	Well PCHG122D			**Well PCHG123D**			**Well PCHG125D**	
09-10-90	17.88	763.92	08-24-90	17.34	764.89	09-10-90	18.50	764.52
10-15-90	18.57	763.23	09-10-90	17.59	764.64	10-15-90	18.89	764.13
11-12-90	18.87	762.93	10-15-90	17.71	764.52	11-12-90	19.29	763.73
12-03-90	19.16	762.64	11-12-90	17.90	764.33	12-03-90	19.46	763.56
02-21-91	19.76	762.04	12-03-90	18.04	764.19	02-21-91	20.11	762.91
07-10-91	18.80	763.00	02-21-91	18.31	763.92	04-29-91	18.47	764.55
10-14-95	19.87	761.93	07-10-91	16.75	765.48	..do.....	18.52	764.50
--	--	--	--	--	--	07-10-91	19.36	763.66
--	--	--	--	--	--	07-14-92	20.26	762.76
--	--	--	--	--	--	11-13-92	20.28	762.74
--	--	--	--	--	--	07-19-93	13.77	769.25
--	--	--	--	--	--	10-14-95	20.45	762.57
	Well PCHG125B			**Well PCHG125BD**			**Well PCHG126BD**	
07-14-92	20.84	762.06	12-03-90	23.04	759.86	12-03-90	25.32	759.66
09-10-92	20.55	762.35	02-21-91	24.87	758.03	02-21-91	27.85	757.13
09-24-92	19.92	762.98	04-29-91	25.68	757.22	04-29-91	26.65	758.33
11-13-92	20.64	762.26	..do.....	30.86	752.04	07-10-91	27.70	757.28
07-19-93	14.21	768.69	07-10-91	25.96	756.94	07-14-92	29.88	755.10

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
Well PCHG125B—Continued			**Well PCHG125BD—Continued**			**Well PCHG126BD—Continued**		
05-08-96	22.27	760.63	07-14-92	26.15	756.75	07-22-92	23.19	761.79
--	--	--	07-22-92	23.19	759.71	09-10-92	31.81	753.17
--	--	--	09-10-92	27.20	755.70	11-12-92	27.28	757.70
--	--	--	09-24-92	26.98	755.92	07-19-93	21.37	763.61
--	--	--	..do.....	27.22	755.68	12-07-94	29.21	755.77
--	--	--	10-16-92	26.50	756.40	05-30-95	28.76	756.22
--	--	--	07-19-93	18.28	764.62	05-08-96	31.12	753.86
--	--	--	05-08-96	26.51	756.39	09-12-96	27.95	757.03
Well PCHG127GP			**Well PCHG127SP**			**Well PCHG128GPS**		
01-06-92	49.54	735.66	01-06-92	59.79	725.49	[1]02-15-94	45.02	740.03
01-30-92	68.02	717.18	01-30-92	62.83	722.45	[1]06-02-94	52.13	732.92
07-14-92	56.96	728.24	07-14-92	70.27	715.01	06-03-94	45.17	739.88
..do.....	55.12	730.08	..do.....	69.25	716.03	..do.....	46.34	738.71
07-22-92	56.7	728.5	07-22-92	70.64	714.64	06-16-94	101.57	683.48
..do.....	56.12	729.08	..do.....	70.35	714.93	09-21-94	68	717
09-10-92	56.17	729.03	09-10-92	71.54	713.74	..do.....	54.40	730.65
09-25-92	70.73	714.47	10-16-92	70.04	715.24	04-12-95	55.35	729.70
..do.....	82.22	702.98	11-09-92	62.20	723.08	05-17-95	57.67	727.38
10-16-92	58.32	726.88	11-12-92	62.24	723.04	..do.....	119.4	665.6
11-12-92	50.84	734.36	11-13-92	63.08	722.20	05-18-95	57.42	727.63
11-13-92	52.76	732.44	..do.....	63.59	721.69	06-01-95	51.93	733.12
..do.....	71.69	713.51	07-19-93	59.62	725.66	06-14-95	59.23	725.82
07-20-93	48.41	736.79	05-31-94	62.49	722.79	05-08-96	53.27	731.78
05-30-95	65.65	719.55	05-30-95	63.42	721.86	08-29-96	58.60	726.45
..do.....	66.35	718.85	05-08-96	63.65	721.63	09-20-96	53.70	731.35
05-08-96	59.56	725.64	09-12-96	64.78	720.50	10-17-96	121.60	663.45
09-12-96	65.60	719.60	09-19-96	64.94	720.34	--	--	--
09-19-96	63.49	721.71	..do.....	64.95	720.33	--	--	--
..do....	70.41	714.79	09-25-96	67.10	718.18	--	--	--
09-25-96	63.0	722.2	--	--	--	--	--	--

Table 10. Depth to water and water-level altitude in seleted wells in Belvidere, Ill., 1989–96—Continued

Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude	Date measured	Depth to water	Water-level altitude
Well PCHG128GPD			**Well PCHP436B**			**Well PCHG436GPS**		
[1]02-15-94	46.83	737.91	[1]05-10-96	15.46	752.40	[1]05-10-96	17.50	750.40
06-02-94	55.67	729.07	[1]05-16-96	15.19	752.67	[1]05-16-96	16.77	751.13
06-03-94	50.07	734.67	08-27-96	12.68	754.68	08-27-96	13.65	753.71
..do.....	51.76	732.98	08-29-96	12.80	754.56	08-29-96	13.80	753.56
09-21-94	70.00	714.74	--	--	--	--	--	--
..do.....	59.54	725.20	--	--	--	--	--	--
04-12-95	55.11	729.63	--	--	--	--	--	--
05-17-95	57.31	727.43	--	--	--	--	--	--
..do.....	>200	<584.74	--	--	--	--	--	--
05-18-95	56.94	727.80	--	--	--	--	--	--
06-01-95	51.80	732.94	--	--	--	--	--	--
06-14-95	59.61	725.13	--	--	--	--	--	--
05-08-96	52.53	732.21	--	--	--	--	--	--
08-29-96	57.60	727.14	--	--	--	--	--	--
09-20-96	60.45	724.29	--	--	--	--	--	--
Well PCHP436BD								
[2]05-10-96	32.50	735.14	--	--	--	--	--	--
[2]05-16-96	30.85	736.79	--	--	--	--	--	--
08-27-96	24.13	743.23	--	--	--	--	--	--

[1]Predevelopment water level.
[2]Water levels are estimated. Measurements were referenced to land-surface altitude because of damage to the well riser pipe.

Table 11. Prearranged pumping schedule for municipal wells BMW4 and BMW6 in Belvidere, Ill., November–December 1992

Pumping period (days)	Pumping activity	
	Well BMW4	Well BMW6
1–3	Pump off	Pump intermittently
3–6	Pump off	Pump continuously
6–9	Pump continuously[1]	Pump continuously
10–18	Pump uncontrolled[2]	Pump uncontrolled
18–25	Pump off	Pump off

[1]Ground water is pumped from well BMW4 to a 75,000 gallon underground reservoir adjacent to the well. After the reservoir is filled, the well pump automatically turns off, and water is pumped from the reservoir to the distribution system by a second pump, as needed. For this study, continuous pumping of well BMW4 consisted of having the reservoir pumped continuously and the well pump automatically turning on and off as the reservoir filled and drained to preset levels.

[2]Usage of pumps was not prearranged. The municipal-well operator was allowed to pump wells BMW4 and BMW6 according to normal usage patterns.

Table 12. Estimated horizontal hydraulic conductivities at selected wells open to the glacial drift aquifer underlying Belvidere, Ill

[All slug-test data are hydraulic conductivities in feet per day; --, test not done; Data from all PCH (Parson's Casket Hardware Superfund site) wells except PCHG125D collected and analyzed by the U.S. Environmental Protection Agency (Vanderpool and Yeskis, 1991).]

Borehole or well name	Slug test (Bower and Rice, 1976)	
	Falling head	Rising head
NSMG101	0.52	0.39
[1]NSMG102	190	260
[2]NSMG104	1.8, .95	1.0, .53
NSMG103	11	8.7
NSMG105	1.4	1.1
..do.....	1.5	1.2
PCHG111S	--	2.0
PCHG112S	2.2	2.5
PCHG112D	4.9	3.3
PCHG113S	--	220
PCHG113D	20	19
PCHG114S	--	.13
PCHG114D	.60	.35
PCHG115D	.33	.22
PCHG116S	--	370
PCHG116D	130	150
PCHG125D	.45	.092

[1]Transmissivities (950 and 1,300 square feet per day for falling- and rising-head tests, respectively) were estimated by the method of van der Kamp (1976). Horizontal hydraulic conductivity was estimated by dividing transmissivity by the length of the test interval.

[2]First and second values represent early-time and late-time estimates of horizontal hydraulic conductivity from falling- and rising-head tests, respectively. Tests affected by pumping of nearby wells, hydraulic boundaries, and (or) other undetermined effects (Mills, 1993a,b,c).

Table 13. Estimated horizontal hydraulic conductivities at selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill.

[All slug-test and constant-discharge aquifer-test data are hydraulic conductivities in feet per day; --, test not done; NI, test data were not interpretable because of violations of operating assumptions of the analytical-test method]

Test interval, in feet below land surface	Slug test (Bouwer and Rice, 1976)		Constant–discharge aquifer test (Cooper and Jacob, 1946)	
	Falling head	Rising head	Pumping	Recovery
	GALENA-PLATTEVILLE AQUIFER			
	Well AGTG305GPS			
[1]110.0–115.0	640	520	--	--
..do.....	440	600		
	Well AGTG305GPD			
[2]246.4–251.4	98	130	--	--
	Well PCHG111D[3]			
30.4–35.4	9.6	9.7	--	--
	Well PCHG115B[3]			
43.6–48.6	.032	.027	--	--
	Borehole PCHG115BD			
37.5–40.0	12	11	99	--
37.5–96.6	--	--	.14	0.12
40.0–50.4	.054	.078	--	.38
..do.....	--	--	--	.38
..do.....	--	--	--	.48
48.1–58.6	.061	.047	--	.25
..do.....	--	.070	--	--
58.6–69.0	[4].23–.75	.17	.071	.37
..do.....	.19	.29–.76	.19	.13
69.0–79.4	--	--	.11	.13
..do.....	--	--	--	.10
..do.....	--	--	--	.12
69.0–96.6	.060	.024–.040	--	--
86.0–96.0	.23–.42	.39	1.9	--
96.0–106.0	.57	.55	2.5	2.6
106.0–116.0	.59	.56	2.8	2.6
116.0–126.0	.34–6.1	.65–16.0	26	37
126.0–136.0	.31	.18–.26	--	3.6
136.0–146.0	.55	.47	3.6	3.5
136.0–151.8	.42	.32–.55	4.0	11
	Well PCHG115BD			
140.6–151.5	.42–.47	.43–.57	--	--

Table 13. Estimated horizontal hydraulic conductivities at selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill.—Continued

Test interval, in feet below land surface	Slug test (Bouwer and Rice, 1976)		Constant–discharge aquifer test (Cooper and Jacob, 1946)	
	Falling head	Rising head	Pumping	Recovery
	GALENA-PLATTEVILLE AQUIFER—Continued			
	Borehole PCHG125BD			
31.3–41.3	170	180	--	--
..do.....	--	170	--	--
44.5–55.5	.51	.43	--	--
65.5–75.5	.19	.11	--	--
85.5–95.5	.45	.43	1.2	1.2
105.5–115.5	.48	.48	1.7	--
115.5–125.5	10	9.8	37	--
125.5–135.5	.23	.28	--	--
135.5–145.5	.39–.44	.49–.56	2.0	2.5
	Borehole PCHG126BD			
29.3–152.8	--	--	19	--
36.5–46.5	.13	.13	2.3	--
56.5–66.5	.067	--	.94	--
86.5–96.5	.37	.32	.97	1.1
116.5–126.5	.34	.35	1.6	--
136.5–152.8	.20–.57	.34–.67	3.8	--
	Well PCHG126BD			
141.0–152.8	.37	.39	--	--
	Borehole PCHG127GP			
41.0–301.0	--	--	.32–.88	.14–3.5
55.6–75.6	.050	.035	--	--
..do.....	--	.040	--	--
62.4–84.0	.034	.025	--	--
75.6–95.6	.24	.27	--	--
95.6–115.6	.47	.42	--	--
115.6–135.6	.32	.34	.14	.11
135.6–155.6	NI	NI	NI	NI
145.1–166.7	.80	.42	.18	.39
166.7–188.3	.21	.21	.088	.18
188.3–209.8	.11	.11	.035	.074
209.8–231.4	.036	.073	.038	NI
231.4–253.0	NI	NI	NI	.086
253.0–273.8	.13	NI	5.8	NI
273.8–301.0	.21	.69	.15	.17
..do.....	.74	NI	NI	NI
	Well PCHG127GP			
288.9–293.9	.73	.48	--	--

Table 13. Estimated horizontal hydraulic conductivities at selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill.—Continued

Test interval, in feet below land surface	Slug test (Bouwer and Rice, 1976)		Constant–discharge aquifer test (Cooper and Jacob, 1946)	
	Falling head	Rising head	Pumping	Recovery
	GALENA-PLATTEVILLE AQUIFER—Continued			
	Borehole PCHG128GP			
32.0–42.0	54	--	--	--
52.0–62.0	.075–.096	.041–.058	--	--
85.0–95.0	.29–.34	.21–.34	--	--
103.0–113.0	.37	.33	--	--
123.0–133.0	.44	.38–.51	--	--
134.0–144.0	.26	.28	--	--
150.0–160.0	.44	.42	--	--
163.0–173.0	.30–.40	--	--	--
[5]182.0–192.0	23	74	--	--
203.0–213.0	.085–1.7	--	--	--
213.0–223.0	15	19	--	--
223.0–233.0	.049	.049	--	--
233.0–243.0	.050	.060	--	--
[6]251.0–261.0	95	110	--	--
261.0–271.0	.006	.005	--	--
273.0–283.0	.058	--	--	--
283.0–293.0	.019	--	--	--
291.0–301.0	5.9–11	8.2–11	--	--
	Well PCHG128GPS			
[7]116.0–121.0	1,900	--	--	--
..do.....	1,700	3,800	--	--
	Well PCHG128GPD			
[8]253.5–258.5	220	160	--	--
..do.....	150	170	--	--

Table 13. Estimated horizontal hydraulic conductivities at selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill.—Continued

Test interval, in feet below land surface	Slug test (Bouwer and Rice, 1976)		Constant–discharge aquifer test (Cooper and Jacob, 1946)	
	Falling head	Rising head	Pumping	Recovery
	ST. PETER SANDSTONE AQUIFER			
	Well AGTG305SP			
[9]352.8–357.8	5.2	4.8	--	--
..do.....	4.4	4.7	--	--
..do.....	4.4	--	--	--
	Well PCHG127SP			
370.7–375.7	17.53	--	--	--

[1]Transmissivities (3,200 and 2,600 feet squared per day (ft^2/d) for first falling- and rising-head tests, respectively, and 2,200 and 3,300 ft^2/d for second falling- and rising-head tests, respectively) were estimated by the method of van der Kamp (1976). Hydraulic conductivity estimated by dividing transmissivity by length of test interval.

[2]Transmissivities (490 and 630 ft^2/d for falling- and rising-head tests, respectively) were estimated by the method of van der Kamp (1976). Hydraulic conductivity estimated by dividing transmissivity by length of test interval.

[3]Data collected and analyzed by the U.S. Environmental Protection Agency (Vanderpool and Yeskis, 1991).

[4]All data presented as ranges represent early and late-time hydraulic conductivities, respectively. Tests affected by nearby pumping wells, hydraulic boundaries, and (or) other undetermined effects (Mills, 1993a,b,c).

[5]Tests affected by nearby pumping wells, hydraulic boundaries, and (or) other undetermined effects (Mills, 1993a,b,c).

[6]Transmissivities (950 and 1,100 ft^2/d for falling- and rising-head tests, respectively) were estimated by the method of van der Kamp (1976). Hydraulic conductivity estimated by dividing transmissivity by length of test interval.

[7]Transmissivities (9,300 ft^2/d for first falling-head test, and 8,500 and 18,900 ft^2/d for second falling- and rising-head tests, respectively) were estimated by the method of van der Kamp (1976). Hydraulic conductivity estimated by dividing transmissivity by length of test interval.

[8]Transmissivities (1,100 and 800 ft^2/d for first falling- and rising-head tests, respectively, and 750 and 860 ft^2/d for second falling- and rising-head tests, respectively) were estimated by the method of van der Kamp (1976). Hydraulic conductivity estimated by dividing transmissivity by length of test interval.

[9]First pair of falling- and rising-head test done after initial well development (480 gallons of water removed). Second and third pair of tests were done after additional well development (130 gallons of water removed).

Table 14. Vertical profile of field characteristics of ground water in borehole PCHG127GP[1] in Belvidere, Ill., December 5, 1991

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter]

Approximate depth, in feet below top of casing	Approximate altitude, in feet above sea level	Depth, in feet below water surface	Time	Temperature (°C)	pH (standard units)	Specific conductance[2] (µS/cm)	Dissolved oxygen (mg/L)	Eh (millivolts)
40.2	744.6	[3]1.6	1842	11.31	7.05	830	2.66	33
45.9	738.9	4.7	1834	11.27	7.04	840	2.22	30
50.8	734.0	9.4	1827	11.26	7.04	820	1.86	14
56.0	728.8	14.5	1820	11.24	7.07	760	1.68	7
60.7	724.1	19.4	1812	11.25	7.11	700	1.52	–6
65.4	719.4	23.9	1805	11.26	7.13	650	1.23	–21
70.4	714.4	28.9	1759	11.26	7.13	630	.99	–28
81.3	703.5	39.6	1750	11.28	7.13	610	.66	–33
91.1	693.7	[4]49.6	1739	11.31	7.11	650	.20	–59
96.1	688.7	54.3	1733	11.34	7.11	650	.15	–67
106.0	678.8	64.1	1726	11.31	7.13	650	.10	–74
116.2	668.6	74.0	1717	11.32	7.11	660	.06	–74
121.3	663.5	79.1	1712	11.33	7.11	660	.05	–74
126.2	658.6	84.0	1659	11.32	7.11	670	[5].05	–74
131.3	653.5	88.8	1652	11.33	7.11	660	.04	–73
136.7	648.1	93.7	1645	11.34	7.11	650	.05	–72
146.7	638.1	103.5	1638	11.34	7.11	650	.05	–71
166.7	618.1	123.4	1629	11.31	7.10	640	.05	–72
187.4	597.4	143.5	1621	11.28	7.10	630	.04	–72
207.0	577.8	162.8	1612	11.29	7.11	610	.04	–72
227.0	557.8	182.7	1607	11.27	7.11	620	.05	–72
247.1	537.7	201.5	1559	11.27	7.10	620	.03	–71
258.2	526.6	210.5	1550	11.26	7.10	620	.04	–70
262.9	521.9	214.2	1544	11.26	7.10	620	.04	–69
267.9	516.9	219.4	1537	11.26	7.10	620	.03	–62
272.5	512.3	223.9	1530	11.23	7.08	610	.03	–59
282.9	501.9	234.5	1521	11.17	7.07	620	.05	–60
288.0	496.8	239.5	1514	11.17	7.08	630	.03	–60
293.2	491.6	244.7	1507	11.15	7.07	620	.03	–62
298.1	486.7	249.3	1501	11.14	7.04	620	.03	–66
302.7	482.1	254.1	1453	11.11	7.02	660	.04	–76

[1]Data collected with a Hydrolab Surveyor 3 water-quality meter.
[2]Values tended to fluctuate by about +/– 15 units around approximate mean presented in the table.
[3]Meter sonde was out of the water when reading 1.6 feet.
[4]Approximate depth.
[5]Initial concentration was 0.11 milligram per liter; after about 1 minute, the concentration decreased to 0.5 milligram per liter.

Table 15. Vertical profile of field characteristics of ground water in municipal well BMW2[1] in Belvidere, Ill., March 24, 1993

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter]

Approximate depth, in feet below top of casing	Approximate altitude, in feet above sea level	Depth, in feet below water surface	Time	Temperature (°C)	pH (standard units)	Specific conductance (µS/cm)	Dissolved oxygen (mg/L)	Eh (millivolts)
7.9	756.1	2.1	1300	8.74	7.00	1,045	6.36	197
..do.....	..do.....	..do.....	1305	8.73	7.02	1,044	4.57	191
..do.....	..do.....	..do.....	1310	8.70	7.03	1,044	3.24	187
..do.....	..do.....	..do.....	1312	8.71	7.03	1,045	2.25	183
..do.....	..do.....	..do.....	1315	8.68	7.03	1,046	2.28	184
23.3	740.7	17.5	1320	10.00	7.17	1,037	.45	172
..do.....	..do.....	..do.....	..do.....	10.03	7.18	1,035	.36	168
28.2	735.8	22.5	1325	10.45	7.19	1,035	.30	166
48.9	715.1	..do.....	1330	11.67	7.18	1,037	.25	162
..do.....	..do.....	..do.....	1335	11.62	7.18	1,036	.24	159
48.9	..do.....	..do.....	1338	11.67	7.18	1,037	.23	156
..do.....	..do.....	..do.....	1340	11.70	7.18	1,037	.23	156
59.0	705.0	53.3	1345	11.94	7.18	1,038	.25	154
..do.....	..do.....	..do.....	1346	11.96	7.17	1,037	.24	153
..do.....	..do.....	..do.....	1350	11.96	7.17	1,036	.24	153
81.7	682.3	75.9	1355	12.16	7.06	1,064	1.52	157
..do.....	..do.....	..do.....	1357	12.19	7.02	1,076	1.66	160
..do.....	..do.....	..do.....	1400	12.19	7.03	1,073	1.67	160
..do.....	..do.....	..do.....	1405	12.21	7.01	1,073	1.72	161
..do.....	..do.....	..do.....	1410	12.21	7.00	1,079	1.73	162
81.7	..do.....	..do.....	1415	12.22	7.00	1,077	1.74	164
85.3	678.7	79.5	1420	12.21	7.03	1,089	2.23	163
..do.....	..do.....	..do.....	1423	12.23	6.95	1,092	2.32	168
..do.....	..do.....	..do.....	1425	12.23	6.95	1,092	2.31	167
95.4	668.6	89.7	1430	12.21	6.92	1,108	1.62	168
95.4	..do.....	..do.....	1432	12.21	6.89	1,113	1.41	164
..do.....	..do.....	..do.....	1435	12.21	6.89	1,112	1.42	165
100.7	663.3	95.0	1440	12.22	6.88	1,122	1.69	161
..do.....	..do.....	..do.....	..do.....	12.22	6.88	1,123	1.61	159
..do.....	..do.....	..do.....	1445	12.23	6.89	1,121	1.65	158
104.	660.0	98.2	1449	12.23	6.89	1,123	1.57	157
..do.....	..do.....	..do.....	1450	12.23	6.89	1,123	1.54	157
..do.....	..do.....	..do.....	1455	12.21	6.89	1,128	1.58	156
106.9	657.1	101.2	1459	12.23	6.88	1,124	1.60	155
..do.....	..do.....	..do.....	1500	12.23	6.88	1,137	1.65	155

Table 15. Vertical profile of field characteristics of ground water in municipal well BMW2[1] in Belvidere, Ill., March 24, 1993—Continued

Approximate depth, in feet below top of casing	Approximate altitude, in feet above sea level	Depth, in feet below water surface	Time	Temperature (°C)	pH (standard units)	Specific conductance (μS/cm)	Dissolved oxygen (mg/L)	Eh (millivolts)
106.9	657.1	101.2	1505	12.23	6.92	1,120	1.61	151
129.9	634.1	124.1	1510	12.23	6.88	1,119	1.56	153
..do.....	..do.....	..do.....	..do.....	12.26	6.88	1,126	1.60	153
..do.....	..do.....	..do.....	1515	12.26	6.88	1,124	1.58	153
139.7	624.3	134.0	1520	12.23	6.88	1,122	1.56	153
139.7	..do.....	..do.....	..do.....	12.24	6.88	1,125	1.57	153
146.6	617.4	140.9	1525	12.21	6.93	1,118	1.58	150
151.5	612.5	145.8	1528	12.26	6.88	1,128	1.57	153
..do.....	..do.....	..do.....	1530	12.24	6.88	1,116	1.56	153
178.8	585.2	173.0	1535	12.21	6.89	1,128	1.54	153
178.8	..do.....	..do.....	1536	12.23	6.88	1,134	1.54	153
..do.....	..do.....	..do.....	1540	12.24	6.88	1,126	1.54	153
193.9	570.2	188.1	1545	12.22	6.88	1,124	1.53	153
..do.....	..do.....	..do.....	..do.....	12.24	6.88	1,115	1.54	154
199.1	564.9	193.4	1550	12.20	6.89	1,118	1.54	154
199.8	564.2	194.0	1552	12.23	6.88	1,140	1.55	154
..do.....	..do.....	..do.....	1555	12.24	6.88	1,128	1.54	155
156.5	607.5	150.7	1600	12.20	6.93	1,126	1.58	151
145.3	618.7	139.6	1605	12.21	6.88	1,125	1.58	153
..do.....	..do.....	..do.....	1607	12.24	6.88	1,125	1.57	153
145.3	..do.....	..do.....	1610	12.24	6.88	1,125	1.57	153
108.2	655.8	102.5	1615	12.21	6.91	1,126	1.60	150
107.6	656.4	101.8	1620	12.24	6.88	1,125	1.58	152
..do.....	..do.....	..do.....	1621	12.26	6.88	1,125	1.58	152
..do.....	..do.....	..do.....	1625	12.26	6.88	1,125	1.58	152
100.0	664.0	94.3	1630	12.18	6.87	1,119	1.06	150
..do.....	..do.....	..do.....	1635	12.18	6.87	1,119	1.06	147
..do.....	..do.....	..do.....	..do.....	12.19	6.87	1,104	1.06	146
97.7	666.3	92.0	1640	12.18	6.91	1,128	1.03	142
..do.....	..do.....	..do.....	1643	12.19	6.88	1,123	1.01	142
97.7	..do.....	..do.....	1645	12.19	6.88	1,119	1.01	142
95.4	668.6	89.7	1650	12.23	6.89	1,113	1.42	139
..do.....	..do.....	..do.....	..do.....	12.23	6.89	1,106	1.40	140
94.8	669.2	89.0	1655	12.24	6.91	1,113	1.39	139
85.3	678.7	79.5	1700	12.24	6.95	1,098	2.13	142
..do.....	..do.....	..do.....	..do.....	12.24	6.95	1,091	2.13	144
52.2	711.8	46.4	1711	11.88	7.18	1,044	.18	128
16.4	747.6	10.6	1722	9.54	7.13	1,045	.24	194

[1]Data collected with a Hydrolab Surveyor 3 water-quality meter.

Table 16. Field characteristics of ground water in selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill., 1990–94

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; -- no data or remarks]

Test interval, in feet below land surface	Date of sample	Field characteristics					Remarks
		pH (standard units)	Temperature (°C)	Specific conductance (µS/cm)	Eh (millivolts)	Dissolved oxygen (mg/L)	
				GALENA-PLATTEVILLE AQUIFER			
				Borehole PCHG115BD			
37.5–40.0	08-15-90	8.4	[1]15.0	940	--	--	Suspected hole in casing installed in overlying drift; water-quality data may represent mixed water from drift and stated depth interval in bedrock.
40.0–50.4	08-17-90	7.8	[1]16.3	740	--	--	--
48.1–58.6	08-14-90	7.6	[1]17.0	680	--	--	Droplets of floating substance; water seems to sting on contact with skin.
58.6–69.0	08-10-90	7.5	[1]15.9	680	--	--	Water cloudy, reddish; contains fine grains of pyrite; small air bubbles.
69.0–79.4	08-08-90	7.9	[1]13.3	640	--	--	Small air bubbles in water.
69.0–96.6	..do.....	7.6	[1]12.2	690	--	--	--
76.0–86.0	11-15-90	7.2	[2]13.7	960	−100	--	--
86.0–96.0	11-14-90	7.0	11.8	1,040	−69	--	--
96.0–106.0	..do.....	7.0	11.5	1,040	−130	--	--
106.0–116.0	11-13-90	7.1	11.5	990	−77	--	--
116.0–126.0	..do.....	7.0	11.3	1,000	−100	--	--
126.0–136.0	11-12-90	6.9	11.1	1,030	−97	--	--
136.0–146.0	11-08-90	7.0	11.2	1,020	−130	--	--
136.0–151.8	11-09-90	7.0	11.2	1,010	−150	--	--
				Borehole PCHG125BD			
31.3–41.3	11-30-90	6.8	12.1	1,140	180	--	--
45.5–55.5	..do.....	7.0	11.7	1,060	140	--	Water slightly cloudy.
65.5–75.5	11-29-90	7.2	9.2	870	69	--	--
85.5–95.5	..do.....	7.1	10.7	830	28	--	--
105.5–115.5	11-28-90	7.1	10.9	1,070	65	--	--
115.0–125.5	12-04-90	--	--	--	--	--	--
125.0–135.5	12-03-90	--	--	--	--	--	--
135.5–145.5	11-28-90	7.0	11.2	1,160	100	--	--

Table 16. Field characteristics of ground water in selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill., 1990–94—Continued

Test interval, in feet below land surface	Date of sample	Field characteristics: pH (standard units)	Temperature (°C)	Specific conductance (μS/cm)	Eh (millivolts)	Dissolved oxygen (mg/L)	Remarks
		GALENA-PLATTEVILLE AQUIFER—Continued					
		Borehole PCHG126BD					
36.5–46.5	11-21-90	7.2	12.5	830	140	--	--
56.5–66.5	11-20-90	7.4	11.0	780	100	--	--
86.5–96.5	..do.....	7.5	10.8	780	100	--	--
116.5–126.5	11-19-90	7.2	10.9	810	29	--	--
136.5–146.5	11-26-90	7.1	11.3	850	–168	--	--
36.5–152.8	11-18-90	7.1	11.2	850	–90	--	--
		Borehole PCHG127GP					
41.0–55.6	06-18-91	7.0	12.3	940	–52	--	Discharge water cloudy at one borehole volume, clear at one and one-half borehole volumes.
55.6–75.6	11-26-91	7.2	10.9	580	–26	--	--
75.6–95.6	11-25-91	7.2	10.6	740	–54	--	--
95.6–115.6	11-22-91	7.0	11.7	750	–59	--	--
115.6–135.6	11-21-91	7.2	11.0	730	–32	--	--
135.6–155.6	..do.....	7.3	11.3	700	–30	--	--
145.1–166.7	06-19-91	7.1	11.9	650	–2	--	--
166.7–188.3	06-21-91	7.2	11.6	610	–56	--	--
188.3–209.8	06-20-91	7.1	11.7	580	19	--	Small air bubbles in discharge water.
209.8–231.4	..do.....	7.1	11.8	670	74	--	Air bubbles in discharge water; fine grains of pyrite in water
231.4–253.0	..do.....[3]	7.3	11.9	650	–32	--	--
253.0–273.8	06-08-91	7.1	11.9	580	–34	--	Air bubbles in discharge water; fine grains of pyrite in water.
273.8–301.0	06-06-91	7.2	11.6	660	–52	--	Air bubbles in discharge water.
..do.....	11-20-91	7.1	11.0	700	–29	--	--
		Well PCHG127GP					
288.9–293.9	01-30-92	6.8	11.3	740	73	0.45	--
..do.....	11-12-92	7.1	10.9	630	--	.13	--

Table 16. Field characteristics of ground water in selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill., 1990–94—Continued

Test interval, in feet below land surface	Date of sample	Field characteristics					
		pH (standard units)	Temperature (°C)	Specific conductance (μS/cm)	Eh (millivolts)	Dissolved oxygen (mg/L)	Remarks
		GALENA-PLATTEVILLE AQUIFER—Continued					
		Borehole PCHG128GP					
52.0–62.0	01-17-94	7.0	4.8	930	--	0.24	--
163.0–173.0	01-13-94	7.0	10.7	690	–59	.15	--
203.0–213.0	..do.....	7.0	10.2	550	–23	1.13	--
213.0–223.0	01-12-94	7.1	10.8	630	93	.92	--
273.0–283.0	01-11-94	7.1	10.6	680	--	1.99	--
291.0–301.0	01-12-94	6.9	11.1	810	95	2.42	--
		ST. PETER SANDSTONE AQUIFER					
		Well PCHG127SP					
370.7–375.7	01-06-92	7.1	10.8	1,030	150	--	--
..do.....	01-30-92	7.0	10.7	1,040	190	.40	--
..do.....	11-12-92	7.2	11.1	540	--	.03	--

[1]Flow-through cell not used. Water temperature reflects response to ambient air temperature during sampling.
[2]Flow-through cell used. Water temperature probably reflects response to ambient air temperature during sampling.
[3]Purged 0.9 borehole volume.

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95

[All inoganic-constituent concentrations are in milligrams per liter; tritium concentrations are in picocuries per liter; --, concentration below instrument reporting limits; na, not analyzed]

Analytical laboratory: O, other laboratory, sample collected by State or city agency or private firm; USEPA1, U.S. Environmental Protection Agency (USEPA) contract laboratory; USEPA2, USEPA regional laboratory, Chicago, Ill.; USGS, U.S. Geological Survey, National Water-Quality Laboratory, Arvada, Colo.

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Aluminum	Antimony	Arsenic	Barium	Cadmium	Calcium	Chromium
				GLACIAL DRIFT AQUIFER					
				Well NSMG103					
49.9–54.9	08-25-88	O	0.260	0.12	--	[1]0.056	0.007	125	--
..do.....	[2]07-19-93	USEPA1	[1].0873	--	--	[1].106	--	119	--
..do.....	..do.....	..do.....	[1].0684	--	--	[1].0635	--	122	--
				Well NSMG104					
54.1–59.0	08-25-88	O	[1].160	.100	--	[1].063	.011	106	0.010
..do.....	06-01-95	USEPA2	--	--	0.0002	.053	--	111	--
				Well NSMG105					
42.8–47.8	08-25-88	O	[1].150	.160	--	[1].075	.006	100	--
..do.....	06-01-95	USEPA2	.807	--	.0016	.081	--	126	.098
				Temporary well TW1					
19.0–21.0	07-22-93	USEPA1	--	--	--	[1].0136	--	67.6	--
				Temporary well TW24					
10.0–12.0	07-20-93	USEPA1	[1].0594	--	--	[1].0359	--	81.3	--
				Temporary well TW30					
7.0–9.0	07-26-93	USEPA1	[1].0152	--	--	[1].0341	--	55.4	--
				Temporary well TW31					
7.0–9.0	07-19-93	USEPA1	[1].339	--	.0011	[1].0573	--	119	--
				Temporary well TW32					
12.0–14.0	07-20-93	USEPA1	--	--	--	[1].0239	--	72.3	--

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Aluminum	Antimony	Arsenic	Barium	Cadmium	Calcium	Chromium
GALENA-PLATTEVILLE AQUIFER									
Well AGTG305GPS									
110.0–115.0	05-31-95	USGS	na	na	na	na	na	98	na
..do.....	..do.....	USEPA2	--	--	0.0002	0.062	--	96	0.009
..do.....	..do.....	..do.....	--	--	.0003	.062	--	95	--
Well AGTG305GPD									
246.4–251.4	05-31-95	USGS	na	na	na	na	na	83	na
..do.....	..do.....	USEPA2	--	--	.0002	.088	--	81	--
Well BL1PW10									
56.0–66.0	01-15-86	O	--	--	--	--	--	81	.013
..do.....	07-20-93	USEPA1	[1]0.0472	--	--	[1].0468	--	87.3	--
..do.....	..do.....	..do.....	--	--	--	[1].0484	--	84.3	--
Well PCHG115BD									
140.6–151.5	[3]01-14-91	USEPA1	--	--	--	.104	--	135	--
..do.....	05-31-95	USGS	na	na	na	na	na	86	na
Borehole PCHG127GP									
41.0–55.6	06-18-91	USEPA1	.101	--	--	.153	--	103	--
55.6–75.6	11-26-91	USGS	na	na	na	na	na	77	na
75.6–95.6	11-25-91	..do.....	na	na	na	na	na	92	na
95.6–115.6	11-22-91	..do.....	na	na	na	na	na	92	na
115.6–135.6	11-21-91	..do.....	na	na	na	na	na	87	na
135.6–155.6	11-21-91	..do.....	na	na	na	na	na	86	na
145.1–166.7	06-19-91	USEPA1	.111	--	--	.0957	--	83.2	--
166.7–188.3	06-21-91	..do.....	.0851	--	--	.0963	--	77.7	--
188.3–209.8	06-20-91	..do.....	.0808	--	--	.0787	--	72.2	--
209.8–231.4	..do.....	..do.....	.0841	--	--	.126	--	85.2	--
[4]231.4–253.0	06-20-91	..do.....	.0799	--	--	.108	--	73.9	--
253.0–273.8	06-08-91	..do.....	.0614	[1]0.0645	.0022	.0999	--	86.6	.0024
273.8–301.0	06-06-91	..do.....	.0453	[1].052	[1].0066	.178	--	86.8	.008
..do.....	11-20-91	USGS	na	na	na	na	na	87	na

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Aluminum	Antimony	Arsenic	Barium	Cadmium	Calcium	Chromium
GALENA-PLATTEVILLE AQUIFER—Continued									
Well PCHG127GP									
288.9–293.9	01-30-92	USEPA1	--	--	0.0097	0.144	--	77.4	0.0038
..do.....	11-12-92	USGS	na	na	na	na	na	81	na
..do.....	07-22-93	..do.....	na	na	na	na	na	na	na
..do.....	05-31-95	..do.....	na	na	na	na	na	86	na
Borehole PCHG128GP									
52.0–62.0	01-17-94	USGS	na	na	na	na	na	120	na
..do.....	..do.....	USEPA1	1.05	--	--	.121	--	122	.0065
163.0–173.0	01-13-94	USGS	na	na	na	na	na	84	na
..do....	..do.....	USEPA1	.0279	--	--	.117	--	79.5	--
291.0–301.0	01-12-94	USGS	na	na	na	na	na	94	na
..do.....	01-12-94	USEPA1	.0318	--	--	.137	--	95.7	--
..do.....	..do.....	..do.....	.0318	--	--	.140	--	94.9	--
Well PCHG128GPS									
116.0–121.0	06-01-95	USGS	na	na	na	na	na	100	na
Well PCHG128GPD									
253.5–258.5	06-01-95	USGS	na	na	na	na	na	88	na
ST. PETER SANDSTONE AQUIFER									
Well AGTG305SP									
352.8–357.8	05-31-95	USGS	na	na	na	na	na	89	na
..do.....	..do.....	USEPA2	--	--	.0003	.059	--	86	--
Well PCHG127SP									
370.7–375.7	01-06-92	USGS	na	na	na	na	na	110	na
..do.....	..do.....	..do.....	na	na	na	na	na	110	na
..do.....	01-30-92	USEPA1	.0213	--	.0052	.110	--	105	--
..do.....	11-12-92	USGS	na	na	na	na	na	73	na
..do.....	07-20-93	..do.....	na	na	na	na	na	na	na
..do.....	05-31-95	..do.....	na	na	na	na	na	72	na

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Aluminum	Antimony	Arsenic	Barium	Cadmium	Calcium	Chromium
				ORDOVICIAN AQUIFER					
				Borehole 00305					
[5]33.1–605.0	01-10-95	USGS	0.006	--	--	0.074	--	na	0.002
				CAMBRIAN-ORDOVICIAN AQUIFER					
				Well BMW4					
152–1,800	11-19-85	USGS	--	na	--	.297	--	79	--
..do.....	08-29-89	O	.0431	--	--	.256	--	84.7	--
..do.....	07-23-93	USEPA1	.0632	--	--	.197	--	84.8	--
..do.....	..do.....	..do.....	--	--	--	.202	--	86.2	--

Test interval, in feet below land surface	Date of sample	Cobalt	Copper	Cyanide	Iron	Lead	Magnesium	Manganese	Mercury	Nickel
					GLACIAL DRIFT AQUIFER					
					Well NSMG103					
49.9–54.9	08-25-88	--	0.169	0.007	--	[1]0.005	57.1	0.037	--	--
..do.....	07-19-93	--	--	--	[1]0.0295	[1]--	54.7	.0158	[1]--	--
..do.....	..do.....	--	[1].006	--	[1].0278	[1]--	53.4	.0163	[1]--	0.017
					Well NSMG104					
54.1–59.0	08-25-88	--	.055	.005	[1].061	.008	58	.11	--	--
..do.....	06-01-95	--	--	--	[1].780	--	48	.037	--	--
					Well NSMG105					
42.8–47.8	08-25-88	--	.215	--	[1].061	.037	71.7	.23	--	--
..do.....	06-01-95	--	.008	--	5.68	.003	68	.336	--	.267
					Temporary well TW1					
19.0–21.0	07-22-93	--	[1].0057	--	.192	[1]--	36.2	.0409	[1]--	--
					Temporary well TW24					
10.0–12.0	07-20-93	--	--	--	[1].0936	[1].0014	40.3	.0116	[1]--	--
					Temporary well TW30					
7.0–9.0	07-26-93	--	[1].0056	--	[1]1.60	[1]--	29.6	.103	--	--

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Cobalt	Copper	Cyanide	Iron	Lead	Magnesium	Manganese	Mercury	Nickel
					GLACIAL DRIFT AQUIFER—Continued					
					Temporary well TW31					
7.0–9.0	07-19-93	--	[1]0.0089	--	1.07	[1]0.0019	39.5	0.0729	[1]--	--
					Temporary well TW32					
12.0–14.0	07-20-93	--	[1].0052	--	.284	[1]--	31	.116	[1]--	--
					GALENA-PLATTEVILLE AQUIFER					
					Well AGTG305GPS					
110.0–115.0	05-31-95	na	na	na	--	na	43	.028	na	na
..do.....	..do.....	--	--	--	--	.003	41	.03	--	--
..do.....	..do.....	--	--	--	--	--	40	.028	--	--
					Well AGTG305GPD					
246.4–251.4	05-31-95	na	na	na	.017	na	38	.019	na	na
..do.....	..do.....	--	--	--	--	.003	36	.02	--	--
					Well BL1PW10					
56.0–66.0	01-15-86	--	.067	--	--	--	34	--	--	--
..do.....	07-20-93	--	[1].0128	--	[1].0138	[1].0036	36.6	--	[1]--	--
..do.....	..do.....	--	[1].0101	--	[1].0159	[1].003	35.4	--	[1]--	--
					Well PCHG115BD					
140.6–151.5	01-14-91	--	--	--	.0181	--	51.4	.0199	--	0.0237
..do.....	05-31-95	na	na	na	.21	na	34	.008	--	na
					Borehole PCHG127GP					
41.0–55.6	06-18-91	--	--	na	.258	--	42.7	.0838	--	.0168
55.6–75.6	11-26-91	na	na	na	na	na	29	na	na	na
75.6–95.6	11-25-91	na	na	na	na	na	35	na	na	na
95.6–115.6	11-22-91	na	na	na	na	na	36	na	na	na
115.6–135.6	11-21-91	na	na	na	na	na	36	na	na	na
135.6–155.6	11-21-91	na	na	na	na	na	36	na	na	na
145.1–166.7	06-19-91	--	--	na	1.02	--	36.3	.0136	--	--
166.7–188.3	06-21-91	--	--	na	.527	--	32.9	.0147	--	--

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Cobalt	Copper	Cyanide	Iron	Lead	Magnesium	Manganese	Mercury	Nickel
GLACIAL DRIFT AQUIFER—Continued										
Borehole PCHG127GP—Continued										
188.3–209.8	06-20-91	--	--	na	0.261	--	31.1	0.0154	--	--
209.8–231.4	..do.....	--	--	na	.334	--	35.7	.0175	--	--
231.4–253.0	..do.....	--	--	na	.325	--	31.5	.0262	--	--
253.0–273.8	06-08-91	0.0037	--	na	.283	--	36.4	.0355	--	[1]0.0126
273.8–301.0	06-06-91	--	--	na	.647	--	37.9	.0237	--	--
..do.....	11-20-91	na	na	na	na	na	34	na	na	na
Well PCHG127GP										
288.9–293.9	01-30-92	--	0.0051	na	.0424	0.003	32.9	.0483	--	.0177
..do.....	11-12-92	na	na	na	.004	na	33	.018	na	na
..do.....	07-22-93	na	na	na	na	na	na	na	na	na
..do.....	05-31-95	na	na	na	.019	na	37	.011	na	na
Borehole PCHG128GP										
52.0–62.0	01-17-94	na	na	na	.460	na	46	.022	na	na
..do.....	..do.....	.002	--	--	.560	.0002	48.9	.0565	--	--
163.0–173.0	01-13-94	na	na	na	.290	na	37	.004	na	na
..do.....	..do.....	--	--	--	.296	.0037	35.6	.0039	--	--
291.0–301.0	01-12-94	na	na	na	.037	na	38	.004	na	na
..do.....	..do.....	--	--	--	.0773	.0034	39.5	.0049	--	.005
..do.....	..do.....	.002	--	--	.0904	--	39.2	.0046	--	.005
Well PCHG128GPS										
116.1–121.1	06-01-95	na	na	na	.420	na	41	.012	na	na
Well PCHG128GPD										
253.5–258.5	06-01-95	na	na	na	.080	na	38	.021	na	na

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Cobalt	Copper	Cyanide	Iron	Lead	Magnesium	Manganese	Mercury	Nickel
					ST. PETER SANDSTONE AQUIFER					
					Well AGTG305SP					
352.8–357.8	05-31-95	na	na	na	--	na	39	0.016	na	na
..do.....	..do.....	--	--	--	--	--	37	.016	--	--
					Well PCHG127SP					
370.7–375.7	01-06-92	na	na	na	na	na	42	na	na	na
..do.....	..do.....	na	na	na	na	na	42	na	na	na
..do.....	01-30-92	0.0106	0.0212	--	0.0675	0.0023	40.7	.216	--	0.148
..do.....	11-12-92	na	na	na	.007	na	30	.09	na	na
..do.....	07-20-93	na	na	na	na	na	na	na	na	na
..do.....	05-31-95	na	na	na	.007	na	32	.016	na	na
					ORDOVICIAN AQUIFER					
					Borehole 00305					
33.1–605.0	01-10-95	--	.002	--	na	.002	na	.006	--	.010
					CAMBRIAN-ORDOVICIAN AQUIFER					
					Well BMW4					
152–1,800	11-19-85	--	.012	--	.180	--	40	.007	0.00012	--
..do.....	08-29-89	--	--	--	[1].0557	--	36.3	.0108	--	--
..do.....	07-23-93	--	--	--	[1].0275	[1].0014	36.6	.004	[1]--	--
..do.....	..do.....	--	--	--	[1].0422	[1].0017	37.5	.0042	[1]--	--

Test interval, in feet below land surface	Date of sample	Potassium	Selenium	Sodium	Vanadium	Zinc	Tritium
				GLACIAL DRIFT AQUIFER			
				Well NSMG103			
49.9–54.9	08-25-88	5.8	[1]0.003	63	--	0.052	na
..do.....	07-19-93	8.7	[1].0052	54.3	--	[1].0106	na
..do.....	..do.....	6.92	[1]--	54.3	--	[1].0235	na
				Well NSMG104			
54.1–59.0	08-25-88	[1]4.6	--	77	--	--	na
..do.....	06-01-95	7.0	--	102	--	--	na

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Potassium	Selenium	Sodium	Vanadium	Zinc	Tritium
			GLACIAL DRIFT AQUIFER—Continued				
			Well NSMG105				
42.8–47.8	08-25-88	7.3	--	62	--	--	na
..do.....	06-01-95	7.0	--	88	0.006	--	na
			Temporary well TW1				
19.0–21.0	07-22-93	1.25	[1]--	17	--	--	na
			Temporary well TW24				
10.0–12.0	07-20-93	.829	[1]0.0032	[1]9.87	--	--	na
			Temporary well TW30				
7.0–9.0	07-26-93	.702	[1]--	[1]3.21	--	[1]0.0147	na
			Temporary well TW31				
7.0–9.0	07-19-93	1.22	[1]--	[1]8.31	--	[1].0226	na
			Temporary well TW32				
12.0–14.0	07-20-93	--	[1]--	[1]13.0	--	[1].031	na
			GALENA-PLATTEVILLE AQUIFER				
			Well AGTG305GPS				
110.0–115.0	05-31-95	1.3	na	22	na	na	na
..do.....	..do.....	--	--	22	--	--	na
..do.....	..do.....	--	--	22	--	--	na
			Well AGTG305GPD				
246.4–251.4	05-31-95	1.6	na	17	na	na	na
..do.....	..do.....	--	--	17	--	--	na
			Well BL1PW10				
56.0–66.0	01-15-86	--	--	10	--	.42	na
..do.....	07-20-93	2.24	[1]--	23.2	--	[1].126	na
..do.....	..do.....	2.08	[1]--	22.3	--	[1].131	na
			Well PCHG115BD				
140.6–151.5	01-14-91	3.24	--	29	--	[1].0219	na
..do.....	05-31-95	1.8	na	9.6	na	na	na

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Potassium	Selenium	Sodium	Vanadium	Zinc	Tritium
			GALENA-PLATTEVILLE AQUIFER—Continued				
			Borehole PCHG127GP				
41.0–55.6	06-18-91	4.16	[1]0.0036	36.7	--	0.219	na
55.6–75.6	11-26-91	na	na	5	na	na	na
75.6–95.6	11-25-91	na	na	15	na	na	na
95.6–115.6	11-22-91	na	na	17	na	na	na
115.6–135.6	11-21-91	na	na	17	na	na	na
135.6–155.6	..do.....	na	na	12	na	na	na
145.1–166.7	06-19-91	1.56	--	8.23	--	.132	na
166.7–188.3	06-21-91	2.05	--	7.23	--	.0974	na
188.3–209.8	06-20-91	1.46	--	5.63	--	.134	na
209.8–231.4	..do.....	1.80	--	12	--	.340	na
231.4–253.0	..do.....	1.61	--	8.01	--	.272	na
253.0–273.8	06-08-91	2.20	--	13	--	.0597	na
273.8–301.0	06-06-91	1.78	--	8.99	--	.0387	na
..do.....	11-20-91	na	na	11	na	na	20
			Well PCHG127GP				
288.9–293.9	01-30-92	2.19	.0147	15.7	--	--	na
..do.....	11-12-92	na	na	9.6	na	na	na
..do.....	07-22-93	na	na	na	na	na	32
..do.....	05-31-95	1.9	na	13	na	na	na
			Borehole PCHG128GP				
52.0–62.0	01-17-94	na	na	9.9	na	na	na
..do.....	..do.....	2.53	--	10.2	0.0043	.0255	na
163.0–173.0	01-13-94	na	na	4.8	na	na	na
..do.....	..do.....	1.24	--	4.55	.0038	.0097	na
291.0–301.0	01-12-94	na	na	9.6	na	na	na
..do.....	..do.....	5.75	--	9.54	--	.0069	na
..do.....	..do.....	5.53	--	9.41	--	.0094	na
			Well PCHG128GPS				
116.1–121.1	06-01-95	4.10	na	8.7	na	na	na

Table 17. Concentrations of detected inorganic constituents (cations) and tritium in ground water in selected boreholes and wells open to the glacial drift, Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1985–95—Continued

Test interval, in feet below land surface	Date of sample	Potassium	Selenium	Sodium	Vanadium	Zinc	Tritium
			GALENA-PLATTEVILLE AQUIFER—Continued				
			Well PCHG128GPD				
253.5–258.5	06-01-95	2.6	na	6.1	na	na	na
			ST. PETER SANDSTONE AQUIFER				
			Well AGTG305SP				
352.8–357.8	05-31-95	1.5	na	50	na	na	na
..do.....	..do.....	--	--	50	--	--	na
			Well PCHG127SP				
370.7–375.7	01-06-92	4.7	na	40	na	na	na
..do.....	..do.....	4.8	na	40	na	na	na
..do.....	01-30-92	4.49	--	37.8	--	--	41
..do.....	11-12-92	na	na	5.7	na	na	na
..do.....	07-20-93	na	na	na	na	na	1.2
..do.....	05-31-95	1.5	na	5.9	na	na	na
			ORDOVICIAN AQUIFER				
			Borehole 00305				
33.1–605.0	01-10-95	na	--	na	na	0.005	na
			CAMBRIAN-ORDOVICIAN AQUIFER				
			Well BMW4				
152–1,800	11-19-85	3.6	--	10	--	--	na
..do.....	08-29-89	.515	--	13.6	--	--	na
..do.....	07-23-93	4.68	[1]--	[1]16.1	--	[1].0134	na
..do.....	..do.....	5	[1]--	[1]16.4	--	[1].0222	na

[1]Concentration is estimated. Specific reasons why the concentration was estimated can be obtained from the U.S. Geological Survey (USGS).
[2]Metal concentrations of all samples collected in July 1993 or analyzed at the USGS laboratory represent dissolved fraction.
[3]Data collected January 14–16, 1991 (Science Application International Corporation, 1992).
[4]Purged 0.9 borehole volume.
[5]Sample collected at a depth of about 2 feet below the water surface (about 30 feet below land surface).

Table 18. Concentrations of selected inorganic constituents (anions) in ground water in selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill., 1991–95

[All concentrations are in milligrams per liter; na, not analyzed; --, concentration below instrument reporting limits]

Analytical laboratory: USGS, U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo.; USEPA1, U.S. Environmental Protection Agency contract laboratory.

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Bromide	Chloride	Fluoride	Nitrite-Nitrate	Silica, as silica dioxide	Sulfate	Alkalinity, as calcium carbonate[1]
GALENA-PLATTEVILLE AQUIFER									
Well AGTG305GPS									
110.0–115.0	05-31-95	USGS	0.11	48	0.20	na	14	66	340
Well AGTG305GPD									
246.4–251.4	05-31-95	USGS	.08	34	.2	na	11	52	300
Well PCHG115BD									
140.6–151.5	05-31-95	USGS	.05	9.7	.3	na	12	33	340
Borehole PCHG127GP									
41.0–55.6	[2]06-18-91	USEPA1	na	18.6	.19	0.69	na	83.4	410
55.6–75.6	11-26-91	USGS	na	4.2	.2	na	na	18	330
75.6–95.6	11-25-91	..do.....	na	9.4	.2	na	na	52	360
95.6–115.6	11-22-91	..do.....	na	9.8	.2	na	na	59	350
115.6–135.6	11-21-91	..do.....	na	9.7	.2	na	na	58	340
135.6–155.6	11-21-91	USGS	na	9.0	.2	na	na	48	330
145.1–166.7	[2]06-19-91	USEPA1	na	7.09	.35	--	na	54.1	310
166.7–188.3	[2]06-21-91	..do.....	na	3.76	.23	--	na	38.1	310
188.3–209.8	[2]06-20-91	..do.....	na	2.62	.29	--	na	26.5	300
209.8–231.4	..do.....	..do.....	na	7.20	.21	--	na	61.8	320
231.4–253.0	[2]06-20-91	USEPA1	na	4.87	.25	--	na	38.8	300
253.0–273.8	[2]06-08-91	..do.....	na	5.81	1.8	--	na	41.7	320
273.8–301.0	[2]06-06-91	..do.....	na	6.31	.19	--	na	48.7	340
..do.....	11-20-91	USGS	na	9.0	.2	na	na	46	340
Well PCHG127GP									
288.9–293.9	01-30-92	USEPA1	na	13.2	na	--	14	[3]46	350
..do.....	11-12-92	USGS	.03	9.2	.2	na	11	[4]41	320
..do.....	05-31-95	..do.....	.1	11	.2	na	13	41	340
Borehole PCHG128GP									
52.0–62.0	01-17-94	USGS	na	31	.1	na	13	96	390
163.0–173.0	01-13-94	..do.....	na	7.8	.1	na	13	85	290
291.0–301.0	01-12-94	..do.....	na	36	.1	na	13	51	300

Table 18. Concentrations of selected inorganic constituents (anions) in ground water in selected boreholes and wells open to the Galena-Platteville (dolomite) and St. Peter Sandstone aquifers underlying Belvidere, Ill., 1991–95—Continued

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Bromide	Chloride	Fluoride	Nitrite-Nitrate	Silica, as silica dioxide	Sulfate	Alkalinity, as calcium carbonate[1]
GALENA-PLATTEVILLE AQUIFER—Continued									
Well PCHG128GPS									
116.0–121.0	06-01-95	USGS	0.11	26	0.2	na	14	67	340
Well PCHG128GPD									
253.5–258.5	06-01-95	USGS	.14	17	.2	na	13	54	310
ST. PETER SANDSTONE AQUIFER									
Well AGTG305SP									
352.8–357.8	05-31-95	USGS	.09	74	.2	na	14	42	340
Well PCHG127SP									
370.7–375.7	01-06-92	USGS	na	42	.40	na	na	98	410
..do.....	..do.....	..do.....	na	42	.50	na	na	100	410
..do.....	01-30-92	USEPA1	na	37	na	4.4	15	[3]84	400
..do.....	11-12-92	USGS	.01	.7	.20	na	11	[4].4	340
..do.....	05-31-95	..do.....	.03	.8	.3	na	11	5.2	330

[1]Alkalinity determined by laboratory analysis.
[2]Sulfate and fluoride concentrations are estimated. Alkalinity determined by field analysis.
[3]Concentration is estimated. Specific reasons why the concentration was estimated can be obtained from the U.S. Geological Survey.
[4]Sulfide also analyzed for, but not detected.

Table 19. Concentrations of detected volatile organic compounds in ground water in selected boreholes and wells open to the Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1990–95

[All concentrations are in micrograms per liter (µg/L); --, concentration below instrument reporting limits (reporting limits vary among analyses but generally are less than 10 µg/L); na, not analyzed; nn, not analyzed or not detected; nd, not detected]

Analytical Laboratory: USEPA1, U.S. Environmental Protection Agency (USEPA) contract laboratory; USGS, U.S. Geological Survey, National Water Quality Laboratory, Arvada, Colo.; USEPA2, USEPA regional laboratory, Chicago, Ill.

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Trichloroethene	Tetrachloroethene	1,1,1-Trichloroethane	Total 1,2-dichloroethene	*trans*-1,2-Dichloroethene	*cis*-1,2-Dichloroethene	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	1,1,2-Trichloroethane	Trichlorofluoromethane	Benzene	Chlorobenzene	Ethylbenzene	*m*-Xylene, *p*-Xylene	*o*-Xylene	Methylene chloride	Toluene	Chloromethane	Chloroform	Acetone	Carbon disulfide	4-Methyl-2-pentanone	2-Hexanone	Dichlorodifluoromethane	Methyltertbutylether	Unknown1	Unknown2
GALENA-PLATTEVILLE AQUIFER																														
Borehole 00436																														
[1]30.0–32.0	06-01-95	USEPA2	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.11	--	--
..do.....	..do.....	..do.....	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Borehole PCHG115BD																														
37.5–40.0	08-15-90	USEPA2	--	--	--	na	--	na	92	--	--	--	na	--	0.5	--	10.0	1.7	nn	119	--	--	--	nn	--	--	--	na	--	--
37.5–96.6	..do.....	..do.....	257	35	--	na	--	na	--	--	--	--	na	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
37.5–151.8	..do.....	..do.....	--	--	132	na	--	11.3	2.5	4.9	--	--	na	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
40.0–50.4	08-17-90	..do.....	--	--	133	na	--	na	8.5	--	--	25.5	na	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
48.1–58.6	08-14-90	..do.....	--	--	--	na	--	na	34.5	--	--	--	na	2.7	1.1	4.1	9.6	5	nn	--	--	--	--	nn	--	--	--	na	--	--
58.6–69.0	08-10-90	USEPA2	--	--	--	na	--	na	42	--	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
69.0–79.4	08-08-90	..do.....	--	--	--	na	--	na	--	--	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
69.0–96.6	..do.....	..do.....	227	85	103	na	8	na	--	--	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
76.0–86.0	11-15-90	..do.....	[2]236	40.4	[2]72.5	na	--	4.4	--	11.9	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
86.0–96.0	11-14-90	..do.....	[2]324	64.3	[2]147	na	--	8.9	--	--	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
96.0–106.0	11-14-90	USEPA2	[2]304	58.1	[2]133	na	--	8.1	--	6.0	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
106.0–116.0	11-13-90	..do.....	[2]211	34.7	89.3	na	--	--	--	--	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
116.0–126.0	..do.....	..do.....	[2]245	33.7	112	na	--	4.4	--	--	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
126.0–136.0	11-12-90	..do.....	[2]440	75.4	[2]206	na	--	11.0	--	--	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
136.0–146.0	11-08-90	..do.....	[2]376	[2]132	[2]260	na	--	[2]23.2	--	127	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
136.0–151.8	11-09-90	USEPA2	306	[2]77	137	na	--	12.3	1.7	10.1	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
Borehole PCHG125BD																														
31.3–41.3	11-30-90	USEPA2	[2]302	[2]48.7	[2]361	na	--	26.2	2.8	4.4	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
45.5–55.5	..do.....	..do.....	[2]285	[2]27.8	[2]331	na	--	14.8	2.1	3.8	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
65.5–75.5	11-29-90	..do.....	[2]168	[2]21.2	[2]145	na	--	11.9	1.2	2.9	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
85.5–95.5	..do.....	..do.....	352	4.9	[2]40.1	na	--	2.1	--	1.4	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
105.5–115.5	11-28-90	..do.....	[2]266	[2]34.7	[2]262	na	--	15.0	1.4	3.3	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--

Table 19. Concentrations of detected volatile organic compounds in ground water in selected boreholes and wells open to the Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1990–95—Continued

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Trichloroethene	Tetrachloroethene	1,1,1-Trichloroethane	Total 1,2-dichloroethene	*trans*-1,2-Dichloroethene	*cis*-1,2-Dichloroethene	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	1,1,2-Trichloroethane	Trichlorofluoromethane	Benzene	Chlorobenzene	Ethylbenzene	*m*-Xylene, *p*-Xylene	*o*-Xylene	Methylene chloride	Toluene	Chloromethane	Chloroform	Acetone	Carbon disulfide	4-Methyl-2-pentanone	2-Hexanone	Dichlorodifluoromethane	Methyltertbutylether	Unknown1	Unknown2
GALENA-PLATTEVILLE AQUIFER—Continued																														
Borehole PCHG125BD—Continued																														
115.5–125.5	12-04-90	USEPA2	[2]570	[2]220	[2]410	na	0.4	49.0	7.1	8.2	--	0.6	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
125.5–135.5	12-03-90	..do.....	[2]338	[2]72.7	[2]442	na	--	36.2	4.4	4	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
135.5–145.5	11-28-90	..do.....	[2]303	[2]48.8	[2]354	na	--	10.0	2.4	3.0	--	--	nd	na	na	na	na	na	nn	na	--	--	--	nn	--	--	--	na	--	--
Borehole PCHG126BD																														
36.5–46.5	11-21-90	USEPA2	14	1.1	13.2	na	--	--	--	--	--	--	--	na	nd	nd	nd	nd	nn	nd	--	--	--	nn	--	--	--	na	--	--
56.5–66.5	11-20-90	..do.....	7.6	--	4.8	na	--	--	--	--	--	--	--	nd	nd	nd	nd	nd	nn	nd	--	--	--	nn	--	--	--	na	--	--
86.5–96.5	..do.....	..do.....	1.8	--	2.0	na	--	--	--	--	--	--	--	nd	nd	nd	nd	nd	nn	nd	--	--	--	nn	--	--	--	na	--	--
116.5–126.5	11-19-90	..do.....	2.3	--	2.2	na	--	--	--	--	--	--	--	nd	nd	nd	nd	nd	nn	nd	--	--	--	nn	--	--	--	na	--	--
136.5–146.5	11-26-90	..do.....	17.8	--	14.9	na	--	--	--	--	--	--	--	nd	nd	nd	nd	nd	nn	nd	--	--	--	nn	--	--	--	na	--	--
136.5–152.8	11-19-90	USEPA2	13.1	--	11.7	na	--	--	--	--	--	--	--	nd	nd	nd	nd	nd	nn	nd	--	--	--	nn	--	--	--	na	--	--
Borehole PCHG127GP																														
41.0–55.6	06-18-91	USEPA1	1,300	--	900	[2]33	na	na	[2]42	[2]39	--	na	--	--	--	--	nd	nd	130	--	--	--	--	--	--	--	--	na	--	--
55.6–75.6	11-26-91	USGS	220	--	160	na	na	3	4.5	3	0.2	.5	--	--	--	--	nd	nd	--	19	--	--	--	nd	--	--	--	na	--	--
75.6–95.6	11-25-91	..do.....	9.7	--	5.7	na	na	.2	.2	--	--	na	--	--	--	--	nd	nd	--	4.2	--	--	--	nd	--	--	--	na	--	--
95.6–115.6	11-22-91	..do.....	6	--	3.8	--	na	na	.2	--	--	na	--	--	--	--	nd	nd	--	1.9	--	--	--	nd	--	--	--	na	--	--
115.6–135.6	11-21-91	..do.....	14	--	6.7	na	na	.2	1.1	.2	--	na	--	--	--	--	nd	nd	--	1.9	--	--	--	nd	--	--	--	na	--	--
135.6–155.6	11-21-91	USGS	40	.2	19	na	na	.6	4.6	.8	--	na	--	--	--	--	nd	nd	--	6.9	--	--	--	nd	--	--	--	na	--	--
145.1–166.7	06-19-91	..do.....	5	--	[2]2	--	na	na	--	--	--	na	--	--	--	--	nd	nd	--	--	[2]2	--	--	--	--	--	--	na	--	--
166.7–188.3	06-21-91	..do.....	9	--	5	--	na	na	--	--	--	na	--	--	--	--	nd	nd	--	--	--	--	--	--	--	--	--	na	--	--
188.3–209.8	06-20-91	..do.....	14	--	5	--	na	na	[2]2	--	--	na	--	--	--	--	nd	nd	--	--	--	--	--	--	--	--	--	na	--	--
209.8–231.4	..do.....	..do.....	--	--	--	--	na	na	--	--	--	na	--	--	--	--	nd	nd	--	--	--	--	--	--	--	--	--	na	--	--
[3]231.4–253.0	06-20-91	USGS	20	--	14	--	na	na	--	--	--	na	--	--	--	--	nd	nd	--	--	--	--	--	--	--	--	--	na	--	--
253.0–273.8	06-08-91	..do.....	14	--	9	[2].8	na	na	[2].8	--	--	na	--	--	--	--	nd	nd	--	--	--	--	[2]6	--	--	--	--	na	--	--
..do.....	..do.....	..do.....	20	--	14	--	na	na	--	--	--	na	--	--	--	--	nd	nd	--	7.4	--	--	--	nd	--	--	--	na	--	--
273.8–301.0	06-06-91	USEPA1	21	--	[2]4	[2]2	na	na	--	--	--	na	--	--	--	--	nd	nd	--	--	--	--	--	[2]0.6	--	--	--	na	--	--
..do.....	..do.....	USGS	26	--	9.1	--	na	na	--	--	--	na	--	--	--	--	nd	nd	--	6.3	--	--	--	nd	--	--	--	na	--	--
273.8–301.0	11-20-91	USGS	31	[2].2	11	na	na	1.4	1.3	.4	--	na	--	--	--	--	nd	nd	--	3.5	--	--	--	nd	--	--	--	na	--	--
[4]41.0–301.0	06-11-91	USEPA1	21	--	15	[2].8	na	na	[2]1	[2].7	--	na	--	--	--	--	nd	nd	--	[2].5	--	--	--	--	--	--	--	na	--	--
..do.....	06-12-91	..do.....	6	--	[2]3	[2].6	na	na	--	--	--	na	--	--	--	--	nd	nd	--	--	--	--	--	--	--	--	--	na	--	--

Table 19. Concentrations of detected volatile organic compounds in ground water in selected boreholes and wells open to the Galena-Platteville (dolomite), St. Peter Sandstone, Ordovician, and Cambrian-Ordovician aquifers underlying Belvidere, Ill., 1990–95—Continued

Test interval, in feet below land surface	Date of sample	Analytical laboratory	Trichloroethene	Tetrachloroethene	1,1,1-Trichloroethane	Total 1,2-dichloroethene	*trans*-1,2-Dichloroethene	*cis*-1,2-Dichloroethene	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	1,1,2-Trichloroethane	Trichlorofluoromethane	Benzene	Chlorobenzene	Ethylbenzene	*m*-Xylene, *p*-Xylene	*o*-Xylene	Methylene chloride	Toluene	Chloromethane	Chloroform	Acetone	Carbon disulfide	4-Methyl-2-pentanone	2-Hexanone	Dichlorodifluoromethane	Methyltertbutylether	Unknown1	Unknown2
GALENA-PLATTEVILLE AQUIFER—Continued																														
Borehole PCHG128GP																														
[5]30.0–32.0	11-01-93	USGS	0.4	0.5	0.9	na	--	--	--	--	--	--	8.2	--	--	--	na	na	--	--	na	--	na	--	na	na	0.2	--	--	--
..do.....	12-13-93	..do.....	[2].5	[2].6	[2]1.51	na	--	--	--	--	--	--	11	--	--	--	na	na	--	--	na	--	na	--	na	na	--	--	--	--
52.0–62.0	01-17-94	USEPA1	[2]2	--	--	--	na	na	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	[2]3	[2]8	--	na	[2]9	[2]17
[5]145.0–150.0	11-01-93	USGS	.4	.4	1.1	na	--	--	--	--	--	--	8.6	--	--	--	na	na	--	--	na	--	na	--	na	na	--	--	na	--
163.0–173.0	01-13-94	USEPA1	--	--	--	--	na	na	--	--	--	--	--	--	--	--	--	--	--	[2]2	--	--	--	--	--	--	--	na	[2]12	[2]20
203.0–213.0	01-13-94	USEPA1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	[2]4	--	--	--	--	--	--	--	na	--	--
213.0–223.0	01-12-94	..do.....	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	na	[2]18	[2]33
..do.....	..do.....	..do.....	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	na	[2]32	[2]22
[5]225.0–230.0	11-01-93	USGS	.4	.4	.8	--	--	--	--	--	--	--	6.4	--	--	--	na	na	--	--	na	--	na	--	na	na	--	--	na	--
273.0–283.0	01-11-94	USEPA1	--	--	[2]1	--	--	--	--	--	--	--	[2]14	--	--	--	--	--	--	[2]3	--	--	--	--	--	--	--	na	[2]6	[2]6
291.0–301.0	01-12-94	USEPA1	--	--	[2]1	--	--	--	--	--	--	--	[2]15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	na	[2]25	[2]15
ORDOVICIAN AQUIFER																														
Borehole 00305																														
[6]30.0–32.0	01-10-95	USGS	1.1	--	--	--	na	na	--	--	--	--	--	0.3	--	[2]0.19	na	na	--	--	na	--	na	--	na	na	--	[2]0.11	--	--
[6]113.0–115.0	..do.....	..do.....	1.2	--	--	--	na	na	--	--	--	--	--	[2].19	--	--	na	na	--	--	na	--	na	--	na	na	--	--	--	--
CAMBRIAN-ORDOVICIAN AQUIFER																														
Well BMW2																														
[7]6.0–8.0	07-20-93	USEPA1	4	--	--	--	na	na	--	--	--	--	--	--	--	--	na	na	--	--	--	4	--	--	--	--	--	na	--	--

[1]Grab sample pumped from unpurged borehole open from 27.5–215 feet below land surface.

[2]Concentration is estimated. Specific reasons why the concentration was estimated can be obtained from the U.S. Geological Survey.

[3]Purged 0.9 borehole volume.

[4]First concentration represents sample collected at the start of an aquifer test (about 450 gallons pumped); second concentration represents sample collected at the end of an aquifer test (about 30,000 gallons pumped).

[5]Grab sample pumped from unpurged borehole open from 30 to 310 feet.

[6]Grab sample pumped from unpurged borehole open from 33 to 605 feet.

[7]Grab sample bailed from unpurged borehole open from 50 to 1,860 feet.

Table 20. Estimated concentrations of detected semivolatile organic compounds in ground water in municipal well BMW2 in Belvidere, Ill., July 20, 1993

[Sample collected about 2 feet below the water surface and about 8 feet below land surface. Concentrations are in micrograms per liter]

Semivolatile organic compound	Concentration
Di-*n*-butylphthalate	1
Unknown hydrocarbon	3
Unknown1	8
Unknown2	6
Unknown3	2

APPENDIXES

APPENDIX 1. LIST OF ABBREVIATIONS AND UNITS USED IN APPENDIXES

Well-completion Records

USGS	U.S. Geological Survey
No.	number
ft	feet
#	number
lbs.	pounds
mm	millimeters
pvc	polyvinylchloride
W.T.	water table
sch.	schedule
in.	inches
I.D.	inside diameter
WRD	Water Resources Division
BM	benchmark
GPS	Global Positioning System

Geophysical Logs

AT	acoustic televiewer
BHF	borehole flow
CAL	three-arm caliper, in inches
GAM	natural-gamma activity, in counts per second
gpm	gallons per minute
NEUT(F)	neutron (far), in counts per second
NEUT(N)	neutron (near), in counts per second
RES(FL)	resistivity (fluid), in ohm-meters
RES (L)	lateral resistivity
RES(16N)	resistance (16-inch normal), in ohm-meters
RES(64N)	resistance (64-inch normal), in ohm-meters
SP	spontaneous potential, in millivolts
SPR	single-point resistance, in ohms
TEMP-C	temperature, in degrees Celsius
TEMP-F	temperature, in degrees Fahrenheit

APPENDIX 2. COMPLETION RECORDS FOR SELECTED WELLS IN BELVIDERE, ILL.

[See appendix 1 for list of abbreviations and units used in appendix 2.]

WELL-COMPLETION RECORD

PCHS

Site: 4215480885018 County: Boone Well No.: P436B, G436GPS, P436BD

Site Name: 615 Lincoln Ave. Belvidere, Ill. Grid Coordinates:Latitude 421548 Longitude 0885018

Drilling Contractor: Darr Silvius Date Drilling Started: 1969

Driller: Unknown Geologist: Unknown Date Drilling Ended: 1969

Drilling Method: Cable tool? Drilling Fluid (type): Unknown

ANNULAR SPACE DETAILS:

Type of Surface Seal: Unknown

Type of Annular Sealant: Portland cement Type I
Granular Bentonite

Amount of cement: # of bags 0.25 lbs. per bag 94

Amount of bentonite: # of bags 25.5 lbs. per bag 50

Type of bentonite seal (granular, pellets): granular, 3-6mm

Type of Sand Pack: 0.35 - 0.45, 0.45 - 1 mm, Silica Sand

Amount of Sand: # of bags 6.1 lbs. per bag 50

Type of Gravel Pack: 3-6 mm Pea Gravel

Amount of Gravel: # of bags 6 lbs. per bag 50

Source of Sand/Gravel:

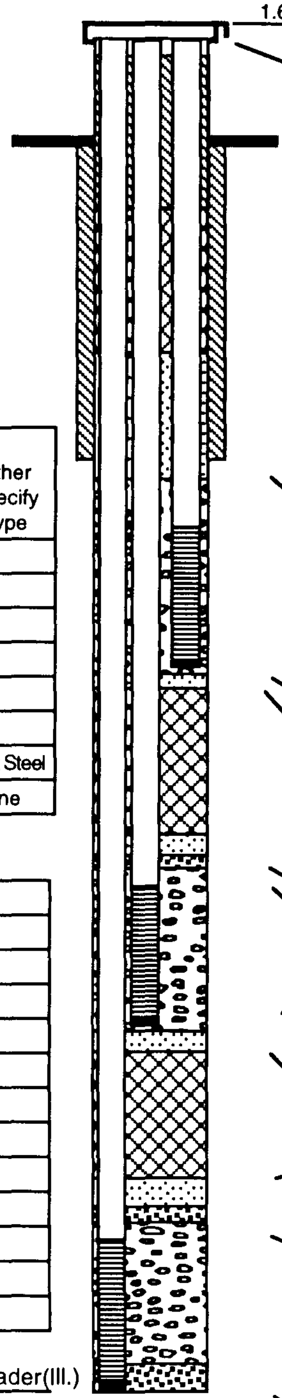
WELL CONSTRUCTION MATERIALS:

Date of Construction: 05-08-96 05-10-96	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser Coupling Joint				
Riser pipe above W.T.			sch. 80	
Riser pipe below W.T.			sch. 80	
Screen			sch. 80	
Coupling joint screen to riser				
End cap			sch. 80	
Surface Casing				Black Steel
Protective Casing				None

MEASUREMENTS:

	P436BD	G436GPS	P436B
Riser pipe length	196.6 ft	103.9 ft	31.6 ft
Protective casing length			
Screen length	5.0 ft	5.0 ft	5.0 ft
Top of open screen to first joint			
Bottom of open screen to end cap			
End cap	0.01ft	0.19 ft	0.01ft
Dimensions of surface casing		5 in x 29.1 ft	
Screen slot size	10 slot		10 slot
No. of openings in screen			
I.D. of riser pipe	0.75 in	2.0 in	0.75 in
Diameter of bore hole		5 in	

ALTITUDE ABOVE MEAN SEA LEVEL, IN FEET
DISTANCE FROM LAND SURFACE IN FEET



Well Constructed By: USGS - WRD, Pat Mills (Ill.), Dave Schrader(Ill.)

Surveyed By: USGS-Mills BM PCHG127GP - GPS

Form Completed By: USGS - Mills

WELL-COMPLETION RECORD

Site: 4215080885116 County: Boone Well No.: AGT G305GPS, G305GPD, G305SP

Site Name: 726 Columbia Ave. Belvidere, Ill. Grid Coordinates:Latitude 421508 Longitude 0885116

Drilling Contractor: P.E. Millis Date Drilling Started: 1924

Driller: Unknown Geologist: Unknown Date Drilling Ended: 1924

Drilling Method: Cable tool? Drilling Fluid (type): Unknown

ANNULAR SPACE DETAILS:

Type of Surface Seal: Unknown

Type of Annular Sealant: Portland cement Type I; Aquaguard Bentonite Grout

Amount of cement: # of bags 1.5 lbs. per bag 94

Amount of bentonite: # of bags 117 lbs. per bag 50

Type of bentonite seal (granular, pellets): granular 54 50 lb. bags

Type of Sand Pack: 0.35 - 1 mm Silica Sand

Amount of Sand: # of bags 32 lbs. per bag 50

Type of Gravel Pack: 3-6 mm Pea Gravel

Amount of Gravel: # of bags 20 lbs. per bag 50

Source of Sand/Gravel:

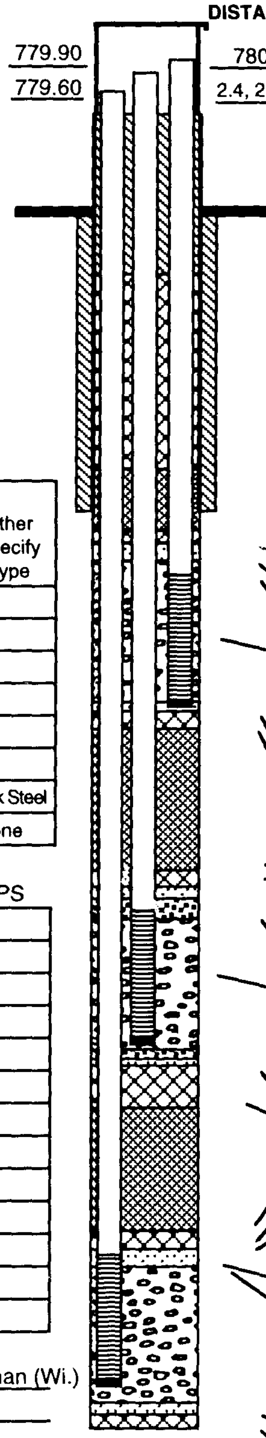
WELL CONSTRUCTION MATERIALS:

Date of Construction: 1-30-95 -- 2-09-95	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser Coupling Joint				
Riser pipe above W.T.			sch. 80	
Riser pipe below W.T.			sch. 80	
Screen			sch. 80	
Coupling joint screen to riser			sch. 80	
End cap			sch. 80	
Surface Casing				Black Steel
Protective Casing				None

MEASUREMENTS:

	G305SP	G305GPD	G305GPS
Riser pipe length	355.2 ft	249.1 ft	113.0 ft
Protective casing length			
Screen length	5.0 ft	5.0 ft	5.0 ft
Top of open screen to first joint			
Bottom of open screen to end cap			
End cap	0.35 ft	0.35 ft	0.35 ft
Dimensions of surface casing	12 in x 33.5 ft		
Screen slot size	10 slot	10 slot	10 slot
No. of openings in screen			
I.D. of riser pipe	2.0 in	2.0 in	2.0 in
Diameter of bore hole	12 in		

ALTITUDE ABOVE MEAN SEA LEVEL, IN FEET
DISTANCE FROM LAND SURFACE IN FEET



Well Constructed By: USGS - WRD, Pat Mills (Ill.), Jim Rauman (Wi.)

Surveyed By: USGS-Mills BM MW-1

Form Completed By: USGS - Mills

WELL-COMPLETION RECORD

Site: 4216070885015 County: Boone Well No.: PCHG125B

Site Name: Parson's Casket Hardware Grid Coordinates:Latitude 0421608 Longitude 00885015

Drilling Contractor: USGS Wisconsin Date Drilling Started: 6-4-91

Driller: Bart Manion Geologist: Pat Mills Date Drilling Ended: 6-5-91

Drilling Method: Hollow Stem Auger (6.25 in) 0-31 ft Water Rotary 31-37 ft Drilling Fluid (type): Water 31-37 ft

ANNULAR SPACE DETAILS:

Type of Surface Seal: Quick Crete

Type of Annular Sealant: Portland Cement Type I

Amount of cement: # of bags 4.5 lbs. per bag 94

Amount of bentonite: # of bags ____ lbs. per bag ____

Type of bentonite seal (granular, pellets): Pellets

1 Bucket = 50 lbs.

Type of Sand Pack: 0.35 - 0.45 mm Silica Sand

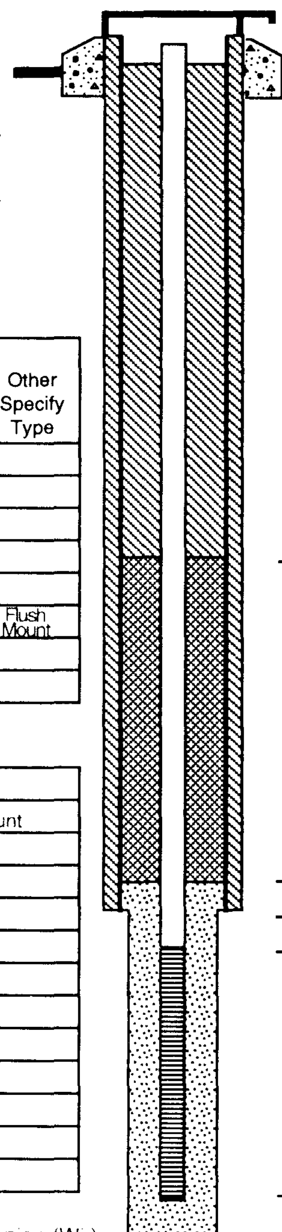
Amount of Sand: # of bags 2.75 lbs. per bag 100

Type of Gravel Pack: ____

Amount of Gravel: # of bags ____ lbs. per bag ____

Source of Sand/Gravel: ____

ALTITUDE ABOVE MEAN SEA LEVEL, IN FEET
DISTANCE FROM LAND SURFACE, IN FEET



WELL CONSTRUCTION MATERIALS:

Date of Construction: 06-06-91	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser Coupling Joint	T304			
Riser pipe above W.T.	T304			
Riser pipe below W.T.	T304			
Screen	T304			
Coupling joint screen to riser	T304			
Protective Casing				Flush Mount
Surface Casing			sch. 40	

MEASUREMENTS

Riser pipe length	31.0 ft
Protective casing length	10.25 in x 1.25 ft flush mount
Screen length	5.00 ft
Top of open screen to first joint	0.167 ft
Bottom of open screen to end cap	0.167 ft
End cap	0.25 ft
Dimensions of surface casing	5 in x 31 ft
Screen slot size	0.01 in
No. of openings in screen	857
I.D. of riser pipe	2.067 in
Diameter of bore hole	9.625 in } 0-31 ft
	4.875 in } 31-37 ft

Well Constructed By: USGS - WRD Pat Mills (Ill.), Bart Manion (Wi.)

Surveyed By: USGS - Illinois BM PCHG125D

Form Completed By: USGS - Mills

WELL-COMPLETION RECORD

Site: 04216080885013 County: Boone Well No.: PCHG127GP

Site Name: Parson's Casket Hardware Grid Coordinates: Latitude 0421608 Longitude 00885013

Drilling Contractor: USGS Coal Branch Date Drilling Started: 4-27-91

Driller: Dan Cheevy Geologist: Pat Mills Date Drilling Ended: 4-27-91

Drilling Method: Mud Rotary 0-41 ft, Air Hammer 41-301 ft Drilling Fluid (type): Benseal/Water

ANNULAR SPACE DETAILS:

Type of Surface Seal: Quick Crete

Type of Annular Sealant: Portland Cement Type 1

Amount of cement: # of bags 7 lbs. per bag 94

Amount of bentonite: # of bags 11 lbs. per bag 50

Type of bentonite seal (granular, pellets): Volclay

Type of Sand Pack: 0.35 - 0.45 mm Silica Sand

Amount of Sand: # of bags 1.1 lbs. per bag 100

Type of Gravel Pack: 3-6 mm Pea Gravel

Amount of Gravel: # of bags 2 lbs. per bag 100

Source of Sand/Gravel:

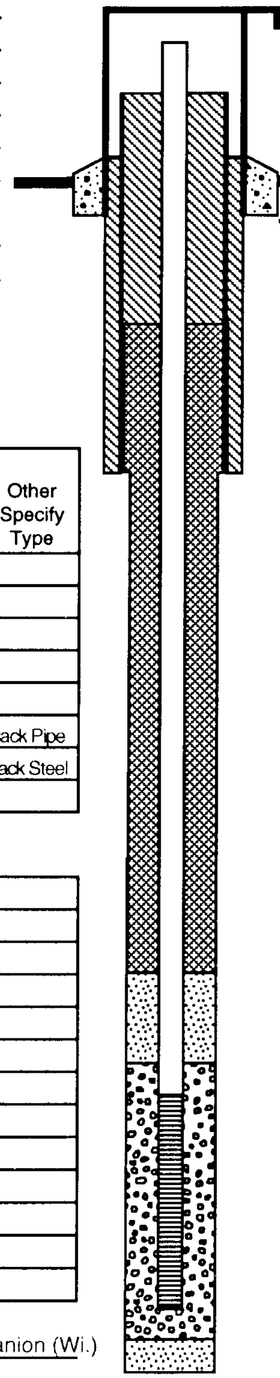
WELL CONSTRUCTION MATERIALS:

Date of Construction: 12-10-91- 12-11-91	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser Coupling Joint	T304			
Riser pipe above W.T.	T304			
Riser pipe below W.T.	T304			
Screen	T304			
Coupling joint screen to riser	T304			
Protective Casing				Black Pipe
Surface Casing				Black Steel

MEASUREMENTS

Riser pipe length	290.3 ft
Protective casing length	10 in x 5 ft
Screen length	5.01 ft
Top of open screen to first joint	0.167 ft
Bottom of open screen to end cap	0.167 ft
End cap	0.25 ft
Dimensions of surface casing	8 in x 41 ft
Screen slot size	0.01 in
No. of openings in screen	857
I.D. of riser pipe	2.067 in
Diameter of bore hole	12 in } 0-41 ft
	6 in } 41-301 ft

ALTITUDE ABOVE MEAN SEA LEVEL, IN FEET
DISTANCE FROM LAND SURFACE, IN FEET



Well Constructed By: USGS - WRD, Pat Mills (Ill.), Bart Manion (Wi.)

Surveyed By: USGS - Illinois BM PCHG116D

Form Completed By: USGS - Mills

WELL-COMPLETION RECORD

Site: 4216080885013 County: Boone Well No.: PCHG127SP

Site Name: Parson's Casket Hardware Grid Coordinates:Latitude 0421608 Longitude 00885013

Drilling Contractor: USGS Coal Branch Date Drilling Started: 12-6-91

Driller: Todd Hunter Geologist: Pat Mills Date Drilling Ended: 12-8-91

Drilling Method: Mud Rotary 0-35 ft, Air Hammer 35- 300 ft Coring 300-394 ft Drilling Fluid (type): Benseal/Water

ANNULAR SPACE DETAILS:

Type of Surface Seal: Quick Crete

Type of Annular Sealant: Portland Cement Type 1; Volclay Bentonite Grout

Amount of cement: # of bags 5.5 lbs. per bag 94

Amount of bentonite: # of bags 15.25 lbs. per bag 50

Type of bentonite seal (granular, pellets): Volclay

Type of Sand Pack: 0.35 - 0.45 mm Silica Sand

Amount of Sand: # of bags 0.6 lbs. per bag 100

Type of Gravel Pack: 3-6 mm Pea Gravel

Amount of Gravel: # of bags 1.2 lbs. per bag 100

Source of Sand/Gravel:

WELL CONSTRUCTION MATERIALS:

Date of Construction: 12-10-91- 12-13-91	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser Coupling Joint	T304			
Riser pipe above W.T.	T304			
Riser pipe below W.T.	T304			
Screen	T304			
Coupling joint screen to riser	T304			
Protective Casing				Black Pipe
Surface Casing				Black Steel

MEASUREMENTS

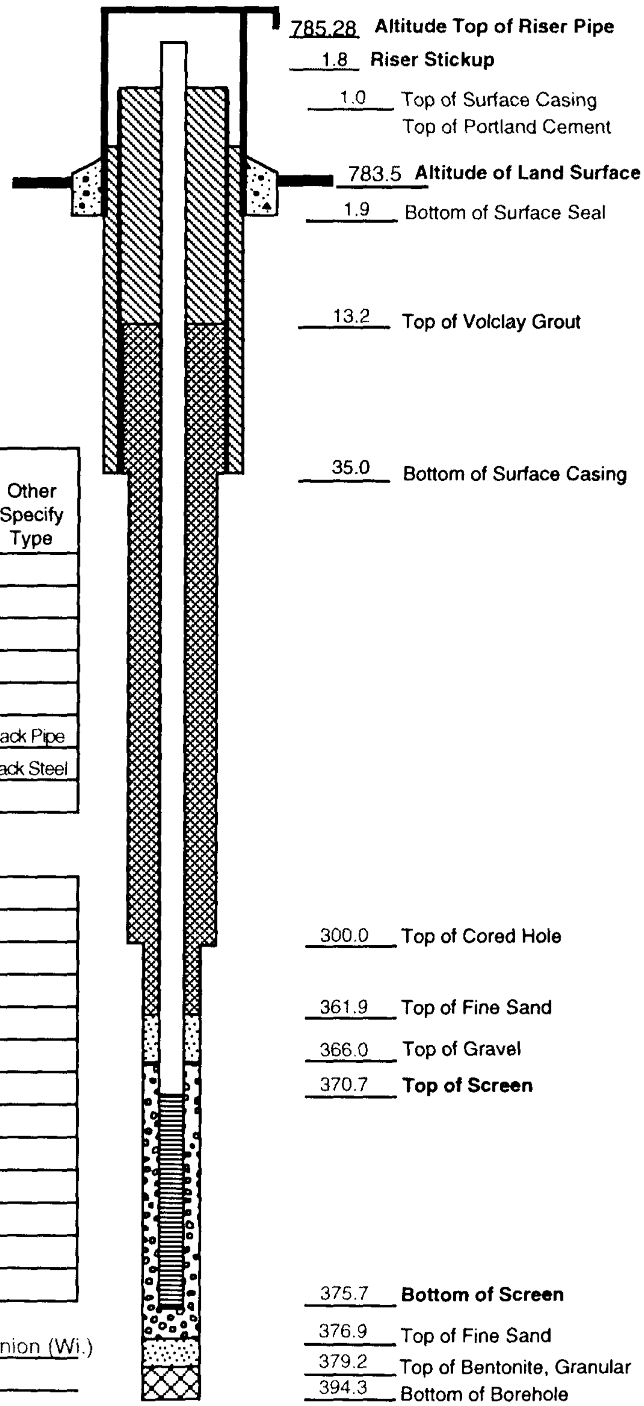
Riser pipe length	371.5 ft
Protective casing length	10 in x 5 ft
Screen length	5.01 ft
Top of open screen to first joint	0.167 ft
Bottom of open screen to end cap	0.167 ft
End cap	0.25 ft
Dimensions of surface casing	8 in x 35 ft
Screen slot size	0.01 in
No. of openings in screen	857
I.D. of riser pipe	2.067 in
Diameter of bore hole	12 in } 0-35 ft
	6 in } 35-300 ft
	4.875 in } 300-394 ft

Well Constructed By: USGS - WRD Pat Mills (Ill.), Bart Manion (Wi.)

Surveyed By: USGS - Illinois BM PCHG116D

Form Completed By: USGS - Mills

ALTITUDE ABOVE MEAN SEA LEVEL, IN FEET
DISTANCE FROM LAND SURFACE, IN FEET



WELL-COMPLETION RECORD

Site: 421615088502702 County: Boone Well No.: PCH G128GPS, G128GPD

Site Name: Municipal Well No. 6 Grid Coordinates:Latitude 0421615 Longitude 0885027

Drilling Contractor: USGS Coal Branch Date Drilling Started: 10-26-93

Driller: Todd Hunter Geologist: Pat Mills Date Drilling Ended: 10-30-93

Drilling Method: Mud Rotary 0-30 ft Air Hammer 30-310 ft Drilling Fluid (type): Quick Gel/Water

ANNULAR SPACE DETAILS:

Type of Surface Seal: None

Type of Annular Sealant: Portland Cement Type 1; Super Gel-X Bentonite Grout

Amount of cement: # of bags 3 lbs. per bag 94

Amount of bentonite: # of bags 8 lbs. per bag 50

Type of bentonite seal (granular, pellets): Super Gel-X

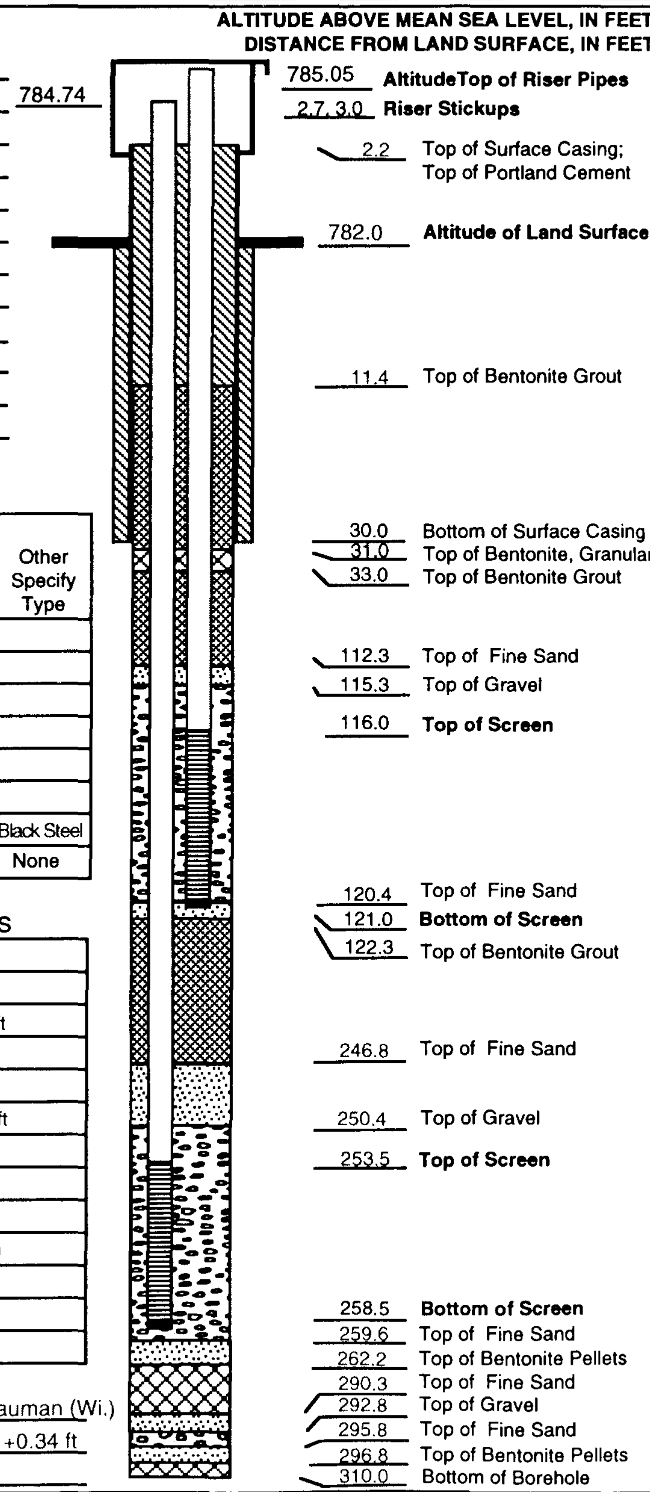
Type of Sand Pack: 0.35 - 0.45 mm Silica Sand

Amount of Sand: # of bags 4.0 lbs. per bag 50

Type of Gravel Pack: 3-6 mm Pea Gravel

Amount of Gravel: # of bags 6.5 lbs. per bag 50

Source of Sand/Gravel:



WELL CONSTRUCTION MATERIALS:

Date of Construction: 01-25-94 02-01-94

	Stainless Steel Specify Type	Teflon Specify Type	PVC Specify Type	Other Specify Type
Riser Coupling Joint				
Riser pipe above W.T.			sch. 80	
Riser pipe below W.T.			sch. 80	
Screen	T304			
Coupling joint screen to riser	T304			
End cap			sch. 80	
Surface Casing				Black Steel
Protective Casing				None

MEASUREMENTS:

	G128GPD	G128GPS
Riser pipe length	256.2 ft	119.1 ft
Protective casing length		
Screen length	5.00 ft	5.00 ft
Top of open screen to first joint	0.5 ft	0.5 ft
Bottom of open screen to end cap	0.4 ft	0.4 ft
End cap	0.35 ft	0.35 ft
Dimensions of surface casing	6 in x 32 ft	
Screen slot size	20 slot	10 slot
No. of openings in screen		
I.D. of riser pipe	2.0 in	2.0 in
Diameter of bore hole	10 in } 0-30 ft	
	6 in } 30-310 ft	

Well Constructed By: USGS - WRD, Pat Mills (Ill.), Jim Rauman (Wi.)

Surveyed By: USGS - Mills BM PCHG125B; BM GPS = +0.34 ft

Form Completed By: USGS - Mills

APPENDIX 3. DETAILED LITHOLOGIC DESCRIPTIONS OF ROCK CORES FROM SELECTED BOREHOLES IN BELVIDERE, ILL., AS PROVIDED BY THE ILLINOIS STATE GEOLOGICAL SURVEY

[See table 3 for stratigraphic classification of rock cores.]

COMPANY:	USGS-WRD-Urbana (USEPA)
FARM:	Parson's Casket-Hardware Co. #G125B
CORE NO:	C-13645
DATE DRILLED:	April 9, 1991
ELEVATION:	+783.0 feet MSL (USGS)
LOCATION:	~250' NL, ~1120' WL, NE NW NW
COUNTY:	BOONE

Study by Zakaria Lasemi and Michael Sargent
August 1992

30.0 to 37.0 feet (5.5 feet recovered) Dolomite, pale yellowish brown to grayish orange and moderate yellowish brown (10YR 6/2 to 10YR 7/4 and 10YR 5/4) mottled very pale orange (10YR 8/2) with a few mottlings of dark yellowish orange (10YR 6/6) and a few with iron-oxide staining of very dark red to moderate reddish brown (5R 2/6 to 10R 4/6); dolomite is mostly fine, becomes medium in slightly leached mottled area; it is slightly argillaceous and contains frequent paper-thin shale partings and/or stylolites usually spaced 3-4 inches apart; rock is, in part, slightly fossiliferous including molds and vugs of gastropods and pelecypods; it is burrowed and bioturbated throughout; it is, in part, slightly vuggy, vugs range from pin-head to match-head up to ¼ inch across, some vugs are fossil-moldic, but a few larger ones appear to be due to leaching of dolomite; dolomite is also slightly leached

and vesicular, especially in mottled area, strongly leached at 2 inches below the top and 6 inches above the base; overall visible porosity averages to about 5%±; iron-stains in some intervals, especially at 31.4-31.6 feet; it is banded in some zones with alternating oxidized (red) and reduced bands. Rock is broken into 1-4 inch pieces, in part, along shaly partings/stylolites; most of the breakage, however, appears to be mechanical; vertical fractures at 33.1-33.2, 34.4-34.8, 34.9-35.0 feet; vertical and a few horizontal hairline fractures throughout. There is about 1.5 feet of core loss in the unit.

PAM:BCAS\ZAK\G-125-B.PCH

COMPANY: USGS-WRD-Urbana (USEPA)
FARM: Parson's Casket-Hardware Co. #G115BD
CORE No.: C-13646
DATE DRILLED: July 16, 1990
ELEVATION: +782.5' MSL (USGS)
LOCATION: ~330' NL, ~1390' WL, 25-44N-3E
COUNTY No.: 22587

Sample study by Michael Sargent and Zakaria Lasemi
August 1992; revised Dec. 1994

Dolomite, very pale yellow to pinkish gray (10YR 8/2 to 5YR 8/1); mottled pale yellowish orange to grayish orange (10YR 8/6 to 10YR 7/4) throughout; grayish red to dusky red iron-oxide stain at 44.8 & 45.0 feet; dolomite is mostly medium crystalline, but becomes coarser in the leached beds and mottlings, in part slightly calcareous and slightly pyritic, slightly argillaceous to argillaceous throughout; slightly fossiliferous throughout, more fossiliferous in a few 1/2- to 1-inch-thick fossil-moldic beds, identifiable fossils include gastropod molds and casts and pelecypod vugs throughout, and rare poorly preserved receptaculites near the base; in addition, there are traces of identifiable carbonaceous fragments; a large gastropod ~1.5 inches long at 44.4 feet; the rock is porous throughout, pore types include: 1) fossil moldic porosity throughout the unit ranging from pin-head to match-head up to 1-inch across; 2) vesicular porosity is common in the upper 25 feet in leached beds and blotches (mottlings); 3) vugs or solution cavities resulting from dissolution of dolomite; these vugs are probably the more advanced stage of dissolution started in slightly leached, vesicular zones; these solution cavities are variable in size, but can reach 1-2 inches across and are present throughout; paper-thin wavy shale partings (mostly stylolites) spaced 1-8 inches apart occur frequently throughout; in addition to the shaly partings/stylolites there are a few very argillaceous dolomite beds 1/2-4 inches thick throughout; some of the more prominent argillaceous zones occur at 43.9-44.1, 44.7-45.0, and 47.5-48.7 feet. Rock is mostly broken into 1-10-inch pieces along stylolites and/or shaly partings; interval from 42.0-43.6 feet is thin bedded (1-2 inches) with paper-thin shaly partings and/or argillaceous dolomite interlaminations; in part banded with oxidized (iron-oxide stained) and reduced bands. It is broken mechanically into small pieces along weak planes or fractures in leached zones at 42.2-42.3, 45.9-46.0, 47.7-47.8,50.0-50.3, 50.6-51.0, and 54.4-54.6 feet; a few vertical and horizontal healed/partially healed fractures and stylolites throughout.

41.6 to 55.7'

Dolomite, very pale orange to pinkish gray (10YR 8/2 to 5YR 8/1); interbedded with moderate yellowish brown (10YR 5/4) and mottled with pale yellowish orange to grayish orange(10YR 8/6 to 10YR 7/4) from 55.7 to ~67 feet; basal part of the unit from 66.6 to 80.2 feet is mostly light brownish gray to pale yellowish brown(5YR 6/1 to 10YR 6/2), in part, slightly spotted and specked dark gray (N3), slightly mottled yellowish brown (10YR 3/4); grayish red to dusky red iron-oxide stain at 61.8 feet; paper-thin wavy shaly partings and/or stylolites, olive black to brownish black (5Y 2/1 to 5YR 2/1) in lower 14 feet, but becomes indistinguishable from the dolomite color in the more oxidized part above 66.6 feet; dolomite is mostly medium crystalline but becomes coarser in the leached beds and areas of mottling; slightly pyritic with pyrite lined vug at 80.0 feet; several receptaculites lumps on the bedding surface at 77.5 feet; waxy clay on break at 68.7 feet (possibly Dygerts K-bentonite that has mostly washed out). Some burrow or ghost burrow mottlings in some intervals; rock is more porous (~15%) above 66.6 feet, is less porous (5-10%) in the lower part of the unit; pore types include: 1) fossil-moldic porosity throughout generally ranging from pin-head to match-head with some up to 1/4-inch across; 2) vesicular porosity is very common 55.7-66.6 feet and occurs in leached beds and blotches (mottlings), vesicular porosity in the lower 14 feet is mainly limited to some leached areas, mostly 1/4-1 inch across; 3) vugs and solution cavities resulting from dissolution of dolomite, these vugs are probably the more advanced stage of dissolution started in slightly leached, vesicular zones; these solution cavities are variable in size, but can reach 1-2 inches across and are present throughout though most common in the zone from 55.7-66.6; prominent dissolution zones with large solution cavities at 58.1, 52.5, 59.7, 63.0-63.6 feet. Core is broken mechanically into small pieces along weak planes or fractures in leached zones at 76.9-77.0 feet and about 2 inches at the base; vertical fractures at 57.0-57.2 feet; a few vertical and horizontal healed/ partially healed fractures and stylolites throughout; the transition to the underlying unit is gradational. It is placed at 80.2 feet below which the dolomite becomes pure with very few paper-thin shaly partings.

55.7 to 80.2'

Dolomite, very light brownish gray to light brownish gray (5YR 7/1 to 5YR 6/1) with beds and blotches of grayish orange (10YR 7/4 to 10YR 6/4); some pale brown (5YR 5/2) and medium gray (N5) mottlings; shaly partings and/or stylolitic contacts of brownish black to olive black (5YR 2/1 to 5Y 2/1);

dolomite is mostly medium crystalline but coarser in leached areas, coarse secondary dolomite in some vugs, e.g. at 89.3 and 90.1 feet, rock is fossiliferous to slightly fossiliferous throughout, fossils are mostly molds or vugs and include gastropods and some pelecypods; traces of brachiopods and common small unidentified siliceous fragments throughout; a silicified rugose coral at 102.8 feet; Receptaculites at 108.6 feet; burrow mottling ghosts and bioturbation throughout; more prominent burrows at 91.6-95.0 feet; some white, chalky chert 105.0-105.6 feet. Rock is porous throughout with 15-20% porosity; pore types include: 1) vuggy porosity (some fossil-moldic) ranging from pin-head to match-head up to ¼ inch across; 2) vesicular porosity in leached and partially leached areas; 3) larger solution vugs ½-2 inches across, resulting from dissolution of dolomite; 4) cylindrical vugs, possibly borings or selectively leached burrows; this type of porosity is especially common at 91.6-95.0 feet and somewhat common in upper part of the unit, 80.2-91.6 feet; it is rare elsewhere. Vesicular porosity in partially leached zones and solution vugs are the most common pore types and occur frequently throughout. Paper-thin shaly partings (stylolitic contacts) spaced 4-10 inches apart in upper 16.0 feet, becoming, in part, more closely spaced at 1-5 inches elsewhere; prominent shaly and/or stylolitic zones at 95.2-96.1, 99.3-99.4, 101.3-101.6, 102.0-102.1, 108.0-108.5 feet; possible hardgrounds at 2 inches below the top and at 97.0, 99.3, 108.6 feet; contact with overlying unit is gradation; rock is broken into 1-10-inch pieces mostly along stylolites and shaly partings; it is broken into small pieces at 84.0-84.3, 104.8-105.6 feet due to fracturing and/or intense leaching; major vertical fractures are absent but there are some small (1-2-inch) single broken pieces in leached zones.

80.2 to 110.6'

No core (missing?) 110.6 to 120.5'

Dolomite as above but less porous; it is, in part, vesicular and slightly vuggy; larger solution vugs, similar to those described above, are essentially absent; overall visible porosity averages between 5-10%; stylolitic contacts 1-5 inches apart are frequent throughout; top 2 inches is very stylolitic with numerous stylolites; hardgrounds at 122.0, 123.6, 124.0, 124.5 (?), 126.3, and base at 127.0 feet; two well-preserved receptaculites at 125.0 and 125.7 feet; several silicified brachiopods at 126.75 feet (4 inches above the base).

120.5 to 127.0'

Dolomite, light brownish gray to very light brownish gray (5YR 6/1 to 5YR 7/1) in upper 13.5 feet, becoming mostly very light brownish gray in lower 8.0 feet; it is mostly light gray (N7) with brownish tinge at 140.5-142.5 feet; dolomite is mottled medium-dark to dark gray (N4 to N3) in upper one foot and at 140.5-142.5 feet; dark to dark grayish black and brownish black (N3 to N2 and 5YR 2/1) along shaly partings and/or stylolites and hardground surfaces; leached blotches and mottlings of grayish orange (10YR 8/4) throughout. Dolomite is mostly medium crystalline but coarser in leached areas, fine to medium at 140.5-142.5, slightly fossiliferous including brachiopods and unidentifiable white silicified fragments (possibly crinoids); one receptaculites at 146.7 feet; other fossils include rare molds and vugs of gastropods and pelecypods; prominent fossil-moldic grainstone/packstone at 146.6-146.7, 147.7-147.85 feet; burrowed and bioturbated throughout, but more prominent in upper 3.5 feet and at 140.5-142.5 feet; rock has about 10-15% porosity mostly of vesicular and solution vug types; other less common pore types include fossil-moldic and selectively leached cylindrical burrows or borings; vesicular pores are mainly in mottles and blotches up to 2-3 inches across; these vesicular zones have developed into numerous solution vugs (2-3 inches across) due to intense leaching and dissolution; prominent leached zones with solution vugs at 127.8-128.0, 134.8, 136.1, 137.8, 142.7-144.0, 145.6, 147.2, 149.1-149.8 feet; interval at 140.5-142.5 feet is very slightly porous with less than 5% visible porosity. Paper-thin shaly partings and/or stylolites 2-5 inches apart occur throughout the unit; most of these partings are actually stylolites with accumulations of argillaceous residue along the surface; major shaly stylolitic zone at 129.6-129.8, 130.9-131.1, 132.7-132.7(?), 140.3-140.4, 140.5-140.6, 141.7-141.8, 142.4-142.5, 147.8-147.9 feet. Hardground surfaces at top and possibly at 140.6 feet; other surfaces could be subtle hardgrounds but could not be differentiated from stylolitic contacts. There is a white, chalky chert nodule, 2 inches across, at 147.3 feet; a 2-inch-thick, white, chalky chert bed occurs at 150.3 feet. Rock is broken into 2- to 10-inch pieces along stylolites and is broken into small pieces at 131.0-131.1, 137.1-137.2 feet; vertical fractures at 128.4-128.6, 132.8-132.9, 134.3-134.6, 136.3-136.5, 138.5-138.6, 143.7-143.8, 144.4-144.5, 149.6-149.7; healed vertical fractures at 141.0-141.1, 142.0-142.5, 149.9-150.0 feet.

127.0 to 150.5'

FARM:	Parson's Casket-Hdw. Co. #G127GP
COMPANY:	USGS-WRD-Urbana (USEPA)
DATE DRILLED:	April 15-16, 1991
ELEVATION:	+783.8' MSL (USGS)
LOCATION:	~ 180'NL, ~ 1285' WL
CORE NO:	C-13640
COUNTY NO:	22584

Study by Zakaria Lasemi and Michael Sargent, August 1992, revised March 1994.

Core logged at the ISGS Annex indoors, under fluorescent lights. Representative core pieces were slabbed prior to logging.

150.0 to 174.1 feet Dolomite, pale grayish orange (10YR 8/4) to light to very light brownish gray (5YR 6/1 to 5YR 7/1) mottled pinkish gray (5YR 8/1), medium light gray (N6) and light brownish gray (5YR 6/1) with leached mottlings and blotches of grayish orange (10YR 7/4); in part, slightly speckled dark gray (N3); brownish black to dusky yellowish brown (5YR 2/1 to 10YR 2/2) shaly partings and/or stylolites; dolomite is medium crystalline, becoming coarser in leached zones; very slightly fossiliferous including gastropod and pelecypod molds and vugs, and traces of ostrocodes, trilobites, brachiopods and bryozoans (?); possible folded *Isotilus* trilobite at 166.6 feet; fossil-moldic grainstone/packstone beds 1-2 inches thick at top, at 168.8, and 172.8. It is burrowed and bioturbated for the most part with numerous ghosts of burrow structures; burrow structures range from small elongate tubular and lenticular bodies ⅛ inch across to large branching features.

Rock is slightly pyritic in part; secondary dolomite cement in some vugs, e.g. 170.4, 170.8 feet; dolomite is porous and vesicular throughout with

20%+ porosity; pore types include: 1) vesicular porosity due to leaching of dolomite; this pore type accounts for most of the porosity; 2) dissolution vugs resulting from dissolution of dolomite; this is probably the more advanced stage of leaching of dolomite; solution vugs range mostly from ½ inch up to 2 inches across; 3) vuggy porosity (mostly fossil-moldic) ranging from pin-head and match-head up to ¼ inch across; this pore type is less common but occurs throughout the unit; major zones with large dissolution vugs occur at 2 inches below the top, at 152.4, 154.2-154.4, 156.2, 156.4, 158.8, and 166.6 feet; rock is very stylolitic throughout with paper-thin shaly partings; these partings or stylolites are usually spaced 2-4 inches apart in upper 8.0 feet, 2-8 inches apart in the middle, and 1-3 inches apart in lower 8.0 feet; hardground surfaces at 162.2 (?), 162.4 (?), 163.3, 165.5, 166.0, 167.9 feet, and at base; some of these surfaces, however, could be stylolite rather than hardground; hardground surface is generally dark gray and, in part, slightly pyritic; rock is broken into 2-12 inch pieces along stylolitic contacts; it is broken into small pieces at 156.0-156.2 feet; vertical fractures at 154.7-154.9, 155.1-155.3 feet.

174.1 to 194.4 feet Dolomite, pale yellowish brown to very light to light brownish gray (10YR 6/2 to 5YR 7/1 to 5YR 6/1) with leached blotches and mottlings of grayish orange (10YR 8/4); shaly partings/stylolites, brownish black to grayish brown (5YR 2/1 to 5YR 3/2); chert, is white (N9) to yellowish brown (10 YR 4/2) 174.1-177.6 and very light gray to light gray (N8 to N7) with some with yellowish gray (5Y 7/2) to very light brownish gray (5YR 7/1) tinge 177.6-188.4. Dolomite is medium crystalline, becoming coarser in leached areas and vugs, in part, fossiliferous (most vugs are from dissolution of shells, especially mollusks); burrowing and bioturbation are not prominent but appear to be present as very faint mottlings throughout; frequent vuggy, fossil-moldic grainstone/packstone beds, 1-3 inches thick and 0.5-1 feet apart, occur throughout the unit; pyrite (some framboidal) in some vugs (e.g. at 190.8 feet). Rock has about 10-15% porosity and includes: 1) fossil-moldic pores, pin-head to match-head up to ¼ inch across; 2) cylindrical vugs, 1/16-1/8 inch across, resulting from selective leaching of burrows;

3) vesicular porosity in leached areas; 4) dissolution vugs representing an advanced stage of leaching of dolomite, these are mostly ¼-1.5 inches across. A geopetal structure at 193.9 with secondary dolomite and pyrite; many vugs are lined with very light gray to light gray secondary dolomite rhombs (medium-coarse crystalline). Rock is very stylolitic throughout with stylolite/paper-thin shaly partings spaced 1-4 inches apart; some intervals contain swarms of stylolitic partings; these intervals include 182.9-183.1, 184.3-184.5, 186.4-187.4, 189.3-189.7, 193.4-193.6 feet. Rock contains chert beds 2-3 inches thick and chert nodules 1-4 inches across; chert beds at 180.6-180.8, 184.2-184.3, 184.8-185.0, 185.6-185.9 feet; chert nodules at 177.8, 178.5, 178.6, 177.4, 179.4, 182.5, 183.0, 183.2-183.6, 186.9, 187.1, 187.3, 187.7, and 188.4 feet. Chert is mostly chalky and porous; a few cherts have dense centers. Hardgrounds at top (177.6 feet) and at 178.2, 179.6, 185.2, 187.2, 191.0 feet, and at base (194.4 feet); hardground surfaces are medium dark gray and, in part, pyritic. Rock is broken into 2-10 inch pieces along stylolites; it is broken into small pieces at 181.5-181.7 and in chert bed at 185.6-185.8 feet. The unit is bounded at the top and base by prominent hardgrounds.

194.4 to 199.5 feet Dolomite, pale yellowish brown to light brownish gray to very light brownish gray (10YR 6/2 to 5YR 6/1 to 5YR 7/1), becomes, in part, light gray in the middle part of the unit; a few mottlings of medium dark gray (N4) throughout; shaly partings and/or stylolites, brownish black to grayish black (5YR 2/1 to N2); dolomite is mostly medium crystalline, becoming coarser in leached zones; it is very slightly fossil-moldic and, in part, shows very faint burrow mottling; a major burrow at the top extends ≈3 inches below the hardground surface; rock is, in part, vesicular and slightly vuggy with about 5-10% porosity; it is stylolitic throughout with paper-thin stylolites spaced 1-4 inches apart; in addition, stylolites and/or shaly partings, ≈⅛ inch thick, occur at 195.1, 196.1, 197.1, 197.8 feet; shaly zone at 197.8-197.9 feet; nodular at 199.1-199.2 feet due to compaction. A prominent hardground at top; the surface of the hardground is mineralized and very pyritic with a pyrite nodule ≈ 1 inch across. Rock is broken into 3-8- inch pieces along

stylolites and/or shaly partings; it is fractured along vertical joints at 197.8-198.0 and for 2 inches at the base; healed vertical fractures at 195.1-195.3, 194.9-195.2 feet.

PAM:BCAS\ZAK\G-127-GP.PGH

FARM: Parson Casket-Hardware Co. #G127SP
COMPANY: USGS-WRD-Urbana (USEPA)
CORE NO: C-13641
DATE DRILLED: April 7-8, 1991
ELEVATION: +783.5 feet MSL (USGS)
LOCATION: ~220 NL, ~1275' WL

Study by Zakaria Lasemi and Michael Sargent
August 1992

Most of the core was slabbed prior to logging to reveal textural features and sedimentary structures that were not visible due to the rough surface of the core. Logging was done indoors at the ISGS Annex under fluorescent lights with core examined both dry and wet.

300.0 to 306.2 feet Dolomite, light gray to very light brownish gray (N7 to 5YR 7/1) in upper half, becoming mostly very light brownish gray to light brownish gray (5YR 7/1 to 5YR 6/1) in lower half; it is strongly speckled and mottled medium dark gray (N4) throughout; shale partings and beds, mostly olive gray (5Y 3/2 to 5Y 4/1) in upper 3.5 feet becoming mostly blackish red to dusky red (5R 2/2 to 10R 3/2) in lower 2.7 feet. Dolomite is fine to very finely crystalline, slightly fossiliferous to, in part, fossiliferous; identifiable fossils include molluskan molds and vugs, trilobites, and brachiopods; prior to dolomitization, the rock probably was a lime mudstone

with a few wackestone beds. Trilobite fragments are especially abundant in some beds; most are dark gray in color. It is extensively burrowed and bioturbated throughout; most of the medium dark gray specks are actually the outer rims of burrows, which are mostly small lenticular bodies 1/16 to 1/4 inch across and up to 1 inch long; rock is very slightly vuggy (fossil-moldic) with less than 5% visible porosity. Vugs are pin-head to match-head up to ¼ inch across; except for these vugs, rock is dense for the most part; dolomitic shale beds, up to 1-inch thick and 1 to 3 inches apart, occur throughout the unit; compaction features such as flattenings of burrows parallel to the bedding and nodular fabric are very common in the shaly beds. Hardground at 305.3 feet. Rock is broken horizontally into 3- to 9-inch pieces along shaly partings; numerous healed vertical hairline fractures in upper 4 feet.

306.2 to 310.0 feet Dolomite, brownish gray (5YR 5/1) with mottlings of light to very light brownish gray and brownish gray (5YR 6/1 to 5YR 7/1 and 5YR 4/1), grayish red (5R 4/2); speckled and mottled medium dark gray (N4); slightly leached mottlings and blotches, moderate yellowish brown (10YR 6/4); shaly partings, dusky yellowish brown to dusky brown (10YR 2/2 to 5YR 2/2). Dolomite is fine to medium crystalline; in part it is slightly pyritic in some vugs; fossils are rare except for a few fossil-moldic vugs at base; it is burrowed and bioturbated throughout; bioturbation especially strong in upper 1.5 feet.

Rock is very slightly vuggy and slightly vesicular with about 5% porosity; dolomitic shale partings and/or stylolites up to ¼-inch-thick and 1 to 6 inches apart occur throughout the unit; top 4 inches contains grayish-red oval-shaped mottles, which are squashed and flattened burrows; these mottles are probably very argillaceous iron-rich dolomite (ankeritic); compaction features include very contorted shale beds, nodular fabric and flattened burrows; prominent nodular fabric 305.1-305.2, 305.3-305.4, and 308.8 feet. There is a prominent hardground at the top, below which is a ½-inch-thick, dark gray, mineralized, very pyritic zone; rock is broken into 3- to 12-inch pieces along shaly partings; healed vertical fracture 307.8 to 308.0 feet.

310.0 to 317.8 feet Dolomite, brownish gray to light brownish gray (5YR 5/1 to 5YR 6/1) with mottling of brownish gray (5YR 4/1), and very light brownish gray (5YR 7/1) to pinkish gray (5YR 8/1); mottled and speckled medium dark gray (N4); slightly leached mottles and blotches of grayish orange (10YR 7/4); shaly beds and partings of dusky brown to very dark yellowish brown (5YR 2/2 to 10YR 3/2), olive black (5Y 2/1) and blackish red (5R 2/2); dolomite is fine to medium crystalline; fossils are rare except for traces of trilobites and molluscan-fossil-moldic vugs up to ¼-inch across; rock is strongly burrowed and bioturbated, especially in upper 4.0 feet; burrow mottling includes mostly small cylindrical and lenticular bodies and large interconnected, branching bodies; many burrows have a dark gray rims. Rock is very slightly vuggy (fossil-moldic) and slightly vesicular due to partial leaching of dolomite; vesicular areas are small mottles and blotches up to 1 inch across in upper 4 feet,

becoming, in part, larger in lower part; vesicular porosity and leaching not very extensive; overall visible porosity probably ≈5%; some vugs lined with secondary dolomite; dolomitic shale partings are present throughout, up to ½-inch thick and spaced 2 to 5 inches apart; interval from 312.1 to 312.8 feet contains numerous shaly partings about 1 to 1.5 inches apart. Hardground (?) at 310.6 feet; compaction features such as flattened burrows and nodular fabric are common in shaly zones. Rock is broken into 2- to 12-inch pieces along shaly partings and/or stylolites; vertical fractures are absent. Upper and lower contacts are gradational.

317.8 to 329.7 feet Dolomite, very light brownish gray to light brownish gray to very pale yellowish brown (5YR 7/1 to 5YR 6/1 to 10YR 7/2) with mottling of medium-dark gray (N4), brownish gray (5YR 4/1) and grayish orange (10YR 6/4); shaly partings dusky brown to olive black (5YR 2/2 to 5Y 2/1); dolomite is mostly fine to medium crystalline; fossils are rare and include a few molds or fossil-moldic vugs of pelecypods and gastropods; the unit is strongly burrowed and bioturbated throughout; burrow mottling ranges from small lenticular and tubular bodies to large branching features; large branching burrows contain smaller lenticular burrows; many of these large burrows are argillaceous and compacted; dolomite is very slightly vuggy (fossil-moldic); some vugs up to ¼ inch across are lined by secondary dolomite, a few vugs are cylindrical and could be leached-out burrows or borings; rock is slightly viscular; overall visible porosity probably about 5%. Three types of argillaceous partings are present: 1) paper-thin shaly parings; these partings, mostly stylolitic, are present throughout but are most common in upper 6 to 7 feet; these are generally 2 to 5 inches apart, but they are very closely spaced (½ to 2 inches apart) at 319.5 to 320.8, 320.1 to 321.9 feet; 2) dolomitic shale beds up to ¼-inch thick and 3 to 4 inches apart most commonly occur in lower 5 feet; 3) argillaceous to very argillaceous dolomite bed up to 1-inch thick; these beds appears to be large branching burrows that are compacted. Very common compaction features such as flattened burrows, nodular fabric, and wispy lamination in shale beds, and in zones with closely spaced paper-thin shaly partings and/or stylolites, e.g. 319.4 to 320.8 feet; hardground at 322.1 feet; rock is broken into 3- to 18-inch pieces along stylolites and shaly partings; rock has no visible fractures.

329.7 to 332.3 feet Dolomite, brownish gray to light brownish gray (5YR 4/1 to 5YR 6/1) mottled medium dark gray (N4) and very light brownish gray (5YR 7/1), speckled and spotted medium dark gray to dark gray (N4 to N3); shaly partings, dusky brown to grayish brown (5YR 2/2 to 5YR 3/2). Dolomite is very fine to medium, very slightly sandy, becomes more sandy toward the base. It is burrowed and bioturbated throughout (fucoidal), but large branching burrows similar to those described in previous units are rare; rock is very slightly vuggy and slightly vesicular. Overall porosity less than 5%; shaly partings and/or stylolites are present throughout; these partings are mostly paper-thin but can be up to ⅛-inch thick; several partings may occur in 1-inch-thick shaly zone; shaly partings are spaced 1 to 2 inches apart; a ¼-inch-thick shale bed is present at the base of the unit; hardgrounds at the top of the unit and at 330.2, 331.4,

332.2 feet; rock is broken into 3- to 11-inch pieces along stylolites and/or shaly partings; there are no vertical fractures and no visible healed fractures.

332.3 to 334.2 feet Sandstone, light gray to very light gray (N7 to N8) to dusky yellowish brown (10YR 2/2) at 332.3 to 333.2 feet, becomes mostly light gray to very light gray with some dusky yellowish brown staining and mottling at 333.2 to 333.6 feet; the rest of the unit is dusky yellowish brown to dusky brown (10YR 2/2 to 5YR 2/2) to very dusky red (10R 2/2) with some light gray sandstone lenses; upper unit (332.3 to 333.2 feet) is thin wavy interbedded argillaceous sandstone and clean sandstone; middle unit (333.2 to 333.6 feet) is mostly massive, clean sandstone with small pockets of argillaceous and/or stained sandstone; basal unit is very argillaceous and shows lenticular bedding with isolated clean sandstone lenses; top 3 to 4 inches is very dolomitic; sandstone is fine to coarse, rounded to subrounded in coarser fraction, becomes angular to subangular in finer fraction; few phosphatic and pyritic clasts (coarse to granular up to ¼ inch) throughout; phosphatic pellets very common in upper 3 to 4 inches; rock is porous throughout, except for upper 3 to 4 inches that is dolomitic and less porous; all porosity is intergranular and averages to about 25 to 30%.

Rock is broken mechanically into 3- to 5-inch pieces along horizontal planes, top of the unit is undulatory; it is dark gray mineralized surface and contains abundant phosphatic pellets; this surface is probably a hardground. Another hardground at the base separates this member from the underlying Daysville Dolomite Member.

334.2 to 360.2 feet A series of cycles characterizes this member. The basal phase of each cycle includes: 1) a brecciated/conglomeratic zone, usually resting on a hardground or an exposure (soil horizon) surface; 2) a sandstone bed, gradational with basal unit, or 3) a very argillaceous silty dolomite to very dolomitic, argillaceous siltstone.

The basal phase of cycles fines upward and grades into more pure, though sandy, dolomite. When the basal phase is resting on a hardground, clasts of the underlying unit usually are incorporated into the basal phase of the next cycle. This suggests that the underlying unit was lithified prior to start of the next cycle. The top of a cycle is either a hardground or a brecciated zone, possibly a soil horizon in some cycles. The brecciated zone at the top of the cycle may contain pisolitic structures (?), laminated crusts, micritized grains, and other features compatible with exposure surfaces and soil formation. Two examples of such soil horizons can be found at 356.4 to 356.8 and 352.2 to 352.6 feet.

Colors are variable and include: 1) light gray and brownish gray to light brownish gray (N7 and 5YR 4/1 to

5YR 6/1) with some medium light gray (N6) and a little medium dark gray (N4) and pinkish gray (5YR 8/1) in more pure dolomite portion (at the top) of the cycles; the upper dolomite phase of the cycle, in some cases, has a greenish gray (5G 6/1) tinge; 2) light gray (N7) sandstone, some with light greenish gray (5G 8/1) tinge; 3) medium bluish gray to greenish gray (5B 5/1 to 5G 5/1) in very argillaceous silty dolomite to very dolomitic, argillaceous siltstone; 4) dusky yellowish brown to dusky brown (10YR 2/2 to 5YR 2/2) sandstone in burrows and fractures in upper 6 inches.

The unit is non-fossiliferous, but worm borings (scolithus) are fairly common, especially in the dolomitic upper phase of each cycle; rock is mostly dense throughout. Only slightly vuggy (worm borings) in upper phase of cycles; more vuggy in lower 4 feet; a vug about 1.5 inches across at 358.6 feet; overall visible porosity in dolomite is about 5% in lower 4.0 feet, becoming less than 5% elsewhere; sandstones within Daysville Dolomite are more porous (intergranular porosity) averaging about 20 to 30%; porous sandstone, however, comprises about 10% of the total thickness and occurs in 4 to 8 inch beds at 341.4 to 341.7, 343.0 to 343.6, 356.8 to 357.5 feet; sandstone bed at 354.9 to 355.9 feet is very dolomitic (dolomite cemented) with little porosity. Dolomite ranges from very sandy to sandy throughout, sand grains in dolomite range from very fine to coarse, coarse sands are well rounded. Rock is broken into 4- to 14-inch pieces in less argillaceous dolomite and into 1 to 7 inches in sandstone, siltstone and argillaceous dolomite. These horizontal breaks are mainly along stylolites or argillaceous beds, but a few are also mechanical; rock contains very few paper-thin stylolites;

vertical fractures at 338.3 to 339 353.8 to 354.0 feet; hairline vertical fractures at 335.6 to 335.8, 345.5 to 345.9, 354.0 to 354.2, 357.6 to 357.8 feet; horizontal and vertical fractures in upper 3 to 4 inches. The following is a list of the cycles recognized in Daysville Dolomite Member and upper part of Kingdom Sandstone Member (360.2 to 361.1 feet):

Cycle 1: 360.7 to 361.1 feet Brecciated at base, grades upward into a very sandy dolomite; sands are very fine to coarse, medium to coarse sands are well rounded; the unit is very pyritic especially in brecciated zone where pyrite fills cracks and fissures; some dark brown peloids/pellets, possibly phosphatic in dolomite; basal 2 inches is also very stylolitic and nodular; brecciated zone is probably a soil horizon (?).

Cycle 2: 358.0 to 360.7 feet This cycle starts with ≈6-inch-thick sandstone at base, grading upward into a very sandy dolomite to very dolomitic sandstone (≈4 inches thick); the rest of the unit is vuggy to slightly vuggy, sandy dolomite; sandstone is very fine to coarse; coarse sands are well rounded; it is dolomitic to very dolomitic and contains a few pyritic clasts and phosphatic pellets; sandstone becomes more dolomitic upward and grades into sandy dolomite; becomes less sandy near the top; dolomite, in part, peloidal; top of the cycle is marked by a hardground. There is also a dark brown (phosphatic ?) surface, possibly a hardground, at the contact between basal sandstone (Kingdom Sandstone Member) and upper unit, above the contact is ≈4 inches of very sandy

dolomite to very dolomitic sandstone that grades into upper sandy, vuggy dolomite, base of the Cycle 2, therefore, could be put at 360.2 feet which is also picked as the base of Daysville Dolomite Member. Slightly vuggy to vuggy in lower and upper parts. This cycle may contain a secondary cycle starting in the middle part of the dolomite where it becomes more peloidal and much less vuggy; a 3-inch zone at 1 inch below the top is slightly brecciated with white, micritic secondary dolomite in fissures and cracks; a little, coarse, brownish gray secondary dolomite also present; this zone is also pyritic with pyrite along thin cracks and fissures and a few ⅛- to ¼-inch pyrite masses.

Cycle 3: 357.4 to 358.0 feet Dolomite, intraclastic at base with dolomite clasts up to 1.5 inches; dolomite clasts are lithologically similar to underlying cycle. Basal intraclastic zone, grades into a very sandy, peloidal dolomite, becomes vuggy, less sandy, and less peloidal toward the top; about 2-inch-thick zone just below the top is dark gray and slightly pyritic.

Cycle 4: 356.6 to 357.4 feet Previous cycle grades into a sandstone in this cycle; sandstone is porous, slightly dolomitic, fine, moderately sorted, subangular; very slightly vuggy (worm borings); a dolomitic fine- to coarse-sandstone lens (≈ 3 inches across) in the middle part of the unit; becomes more dolomitic towards top; about 1 to 1.5 inches at top is very sandy, slightly pyritic dolomite; this zone is a possible soil horizon (exposure surface ?); there are poorly developed laminated casts, micritic pellets (micritized grains), and a few small, poorly developed pisolitic (?) grains; top of the unit is truncated (sharp contact) with a few small borings.

Cycle 5: 356.0 to 356.6 feet About 3 inches at base is brecciated/conglomeratic; with dolomite clasts in a sandy dolomite/very dolomitic sandstone matrix; clasts range from granule-size up to ¼-inch across; a few clasts up to 1.5 inches across near the base; one clast at base is bored. This basal unit is very pyritic ranging from very fine to masses ¼-inch across. The basal brecciated zone grades upward into a porous sandstone similar to that in previous cycle; sandstone becomes less porous and very dolomitic to very sandy dolomite just below the top (2 inches thick at 1 inch below the top); it is also shaly/stylolitic with numerous paper-thin shaly partings and/or stylolites; about 1 inch at top is slightly sandy, pinkish gray, very finely crystalline (micritic) dolomite with several clast-like light blue gray burrows filled with sandy dolomite.

Cycle 6: 355.2 to 356.0 feet Lower 3 inches is sandstone that is dolomitic, very fine to little coarse, slightly pyritic; grades upward into a very sandy dolomite, slightly pyritic at top; several pyrite granules and nodules (up to ¼ inch across) near the base; slightly peloidal near the base; a few worm borings near the base; contact between dolomitic sandstone and sandy dolomite in a poorly developed hardground with a very pyritic surface.

Cycle 7: 353.8 to 355.2 feet A 2- to 3-inch-thick, very fine to coarse dolomitic sandstone at the base grades

upward into a very sandy, argillaceous, finely crystalline dolomite; top 4 inches of the cycle is less sandy and, in part, slightly vuggy; a very dense, slightly sandy lithographic dolomite ≃1 inch thick near the top. This cycle may contain one or two smaller-scale cycles with somewhat burrowed or brecciated bases.

Cycle 8: 352.4 to 353.8 feet About 10 inches at the base is a dolomitic, very argillaceous sandy siltstone grading upward into argillaceous, very silty, sandy dolomite; this unit grades upward into a very fine, slightly sandy, argillaceous silty dolomite at the top; slightly pyritic to pyritic throughout; basal 1 to 2 inches is peloidal/intraclastic (granular); top of the cycles is a 1- to 3-inch-thick, well-developed soil horizon that is nodular and brecciated with laminated crusts, pisolitic (?) grains and micritized dolomite nodules.

Cycle 9: 351.8 to 352.4 feet The base of the cycle starts in the brecciated soil horizon in the underlying unit; lower 2 inches contains numerous laminated clasts (pisolitic); the whole unit is very peloidal, very sandy dolomite with few sandy layers up to ¼-inch thick in upper 4 to 5 inches of the cycle. It is also slightly pyritic throughout.

Cycle 10-14: 345.5 to 351.8 feet This cycle may actually be a continuation of Cycle 9. The top of the cycle at 345.5 feet is a prominent hardground. The whole cycle consists of 5 smaller cycles 0.8 feet to 2 inches thick. The cycle is very similar to Cycle 8 with dolomitic, very argillaceous sandy siltstone at base grading to silty, argillaceous sandy finely crystalline dolomite in the middle, and finely crystalline slightly argillaceous and silty, sandy to slightly sandy dolomite at top. Only the dolomite at top of the last cycle is slightly vuggy; some pyrite granules and disseminated pyrite throughout; lower 2 feet contains a few very pyritic lenses and laminae; contacts between cycles more or less gradational with distinct changes in lithology; bases of some cycles are nodular and could be mud cracks; top of the 4th cycle (or the base of third cycle) at 347.7 feet has well-developed mud cracks on bedding surface. Base of the smaller cycle includes:

a) **351.8 feet** ≈2 to 3 inches above base is very shaly
b) **349.5 feet** ≈2 to 3 inches above base is slightly nodular and shows soft-sediment deformation
c) **348.7 feet** 3 inches above base is well laminated, contorted, and shows evidence of soft-sediment deformation
d) **347.7 feet** well-developed mud cracks on bedding plane at base
e) **346.9 feet** nodular at base, possible mud cracks

Cycle 15: 343.7 to 351.8 feet Basal 5 inches above a hardground surface is conglomeratic with dolomitic sandstone matrix, there are a few dolomite clasts up to 1 inch across; these clasts are lithologically similar to the unit below the hardground; basal unit grades upward into a dolomitic sandstone about 6 inches

thick; sandstone is slightly porous, very fine to fine, slightly pyritic and contains a few phosphatic pellets; sandstone grades upward into a sandy to very sandy, argillaceous peloidal dolomite that is slightly pyritic, with some phosphatic pellets; dolomite becomes more pure and peloidal in upper 4 inches. Top of the cycle is marked by a hardground surface.

Cycle 16: 341.6 to 343.7 feet This cycle is essentially similar to Cycle 15; about 10 inches at base is dolomitic to slightly dolomitic sandstone; in part, porous sandstone that contains a few dolomite clasts up to ¼ inch across; sandstone is fine to very fine, slightly pyritic and slightly argillaceous; about 4 inches above the sandstone is argillaceous to very argillaceous, dolomitic sandstone that is burrowed with a nodular appearance. This sandstone grades upward into a very sandy, slightly argillaceous peloidal dolomite; it becomes less sandy and less argillaceous toward the top; this dolomite is very fine and brecciated at top, about 2 to 3 inches above the brecciated zone is a very sandy dolomite with several worm borings; this is a transition zone to the next cycle above; top of the cycle appears to be a soil horizon with a few pisolitic structures, brecciation and possible mud cracks (?); large cracks/fissures about ¼- to ½-inch wide extend about 2 inches below the top and are filled with sediment from overlying unit.

Cycle 17: 341.1 to 341.6 feet A transitional zone at base, about 2 inches thick is slightly conglomeratic, peloidal very sandy dolomite to very dolomitic sandstone; this grades into 3-inch-thick porous sandstone, fine to medium grained, slightly dolomitic with numerous worm borings; the rest of the unit at top is slightly sand to sandy dolomite that is slightly pyritic with several worm burrows and/or borings; many of these burrows are filled with micritic dolomite; top of the unit is marked with a prominent hardground.

Cycle 18: 339.8 to 341.1 feet Cycle starts with a dolomitic to very dolomitic sandstone in the basal 2 to 3 inches, sandstone contains clasts up to 2 inches across from underlying unit; sandstone grades upward into burrowed, in part, nodular, argillaceous, very dolomitic sandstone to very sandy, argillaceous dolomite that is peloidal, slightly pyritic and phosphatic (pellets); top 4 to 5 inches is less sandy and less argillaceous, very finely crystalline dolomite with mud crack features; sands in this dolomite are very fine to coarse; looks somewhat brecciated at top.

Cycle 19: 338.1 to 339.8 feet About 10 inches at the base is very argillaceous, sandy, very dolomitic siltstone/very argillaceous, very silty, sandy dolomite; it is brecciated at base and somewhat nodular above; it is slightly pyritic; this unit grades upward into a very finely crystalline dolomite that is slightly argillaceous. It is also slightly silty to sandy and contains numerous pyrite granules and framboids; contact with the cycle above is very sharp.

Cycle 20: 335.0 to 338.1 feet Basal 7 to 8 inches is nodular, argillaceous, sandy dolomitic siltstone with abundant dolomite clasts, mostly of granular size; it grades upward into a very finely crystalline dolomite

that is silty to sandy, argillaceous, and, in part, pyritic; spherical masses of pyrite framboids common throughout; top 10 inches is more pure dolomite that is very finely crystalline and slightly vuggy and slightly sandy; upper 1 to 1.5 inches is very light brownish gray to pinkish gray, very fine to lithographic; top of the cycle is a possible hardground (?).

Cycle 21: 334.2 to 335.0 feet This cycle is a very dolomitic, argillaceous sandstone; basal 1 to 2 inches is slightly conglomeratic with dolomite clasts of granule to pebble sizes; top of the cycle is marked by a prominent hardground; burrows and/or borings extend about 1 to 2 inches below the hardground surface and are filled with sandstone from above units upper 1 to 2 inches is pyritic with a few pyrite nodules up to ¼-inch across.

360.2 to 361.5 feet Sandstone and sandy dolomite; sandstone light gray with light greenish gray tinge (5G 6/1) in top 6 inches; sandstone at base (≈4 inches) is greenish gray to grayish purple to medium-light gray (5G 6/1 to 5P 4/2 to N6); the rest of the unit is sandy dolomite with pinkish gray (5YR 8/1) dolomite in brecciated zone to medium-light gray to medium-dark gray (N6 to N5) elsewhere; sandstone is bimodal and ranges from fine to coarse grained; coarser sands are rounded to well rounded; sandstone is slightly pyritic, dolomitic, slightly argillaceous, porous (≈10 to 15% porosity). Sandstone at base is fine to medium, moderately sorted, rounded to well rounded, slightly pyritic; top of this sandstone is dolomitic; this sandstone is also porous with about 20% porosity. The rest of the unit in the middle part of the member is a sandy dolomite that is brecciated at base. For more details on this dolomite unit see Cycle 1 described above under Daysville Dolomite Member. Top of Kingdom Member is dark brown, possibly phosphatic, and could be a hardground surface.

361.5 to 394.0 feet (recovered only ≃7 feet) Sandstone, very light gray to white (N8 to N9); in part, light greenish gray to grayish purple (5G 8/1 to 5P 4/2); mostly fine to medium, in part, with some coarse floating sands; some beds are mostly fine; it is subrounded in finer fraction, becoming rounded to well rounded in medium to coarse fraction; pyrite granules and/or framboids one present throughout but are more common in lower part; some greenish banding in the middle part between 374.0 to 380.0 feet. Sandstone is mostly friable and porous, and has about 20-30% intergranular porosity. Sandstone is broken horizontally into 1 to 5 inch pieces; it is powdered (loose sand) at 363.0 to 375.0 feet and broken into small pieces (1 to 3 inches) in some intervals. There is about 25.0 feet of core loss; core loss at 363.0 to 375.0 feet (only a small sample bag of loose sand recovered), 375.0 to 379.0 feet (≃2 feet core loss), and 379.0 to 394.0 feet (≃11 feet loss).

PAM:BCAS\ZAK\G-127-SP.PGH

COMPANY:	U.S. Geological Survey (USEPA)
FARM:	Parson's Casket-Hardware Co. #G128GP
DATE DRILLED:	1993
ELEVATION:	+785' ±3' GL (USGS)
LOCATION:	~550' SL, ~100' WL, Sec. 24-T44N-R3E
COUNTY:	Boone County, Illinois (Belvidere N Quad)
COUNTY NO:	22588
CORE NO:	C-13885

Detailed stratigraphic description by Michael L. Sargent and Zakaria Lasemi on February 1-4, 1994. Logged at Survey Annex; indoors, heated, fluorescent lights, transferred into 2-foot long core boxes. All data are in feet.

Dolomite, very pale orange (10YR 8/2) to very light gray (N8) with darker gray (N3) to dark greenish gray (5YG 4/1) and dark brownish gray (5YR 3/1) shale partings (some stylolite development), mostly medium crystalline with some fine. Numerous hardgrounds throughout that are generally characterized by becoming darker colored upward to a phosphatic and pyritic irregular nodular upper surface overlain by lighter colored dolomite; obvious hardgrounds at: 175.7, 176.1, 176.6, 190.3, 190.6, 191.0, 191.5, 193.7, 194.2, 194.8, 195.6, 195.8, 196.5, 196.9, 198.0, 198.8, 200.0, 200.5, 201.1, 203.0. Cherty with white (N9) to very light gray (N8) nodules and "beds"

(they cross entire core) from 177-185±, chert is gray and fossiliferous at 179.7 (possibly pelecypods, thin arc-shaped cross sections); slightly to very porous throughout, pores range from vesicular to thumb-hole size cavities (some are molds of fossils, others just look like cellulose sponge with its uneven pores); a few pores are partially lined with fine-grained pyrite, others with coarse sparkley dolomite crystals; visually estimated visible porosity ranges from 5% to 15 or 20%, overall it is probably 10% or a little more. Thin shaly beds and paper-thin shaly partings are dark gray (N3) to black and make up much less than 1% of rock, become more common downward, especially below ~190'; overall rock is only slightly fossiliferous, mostly preserved as molds, a little in cherts; some tubes and other trace fossil tubes and trails, etc.; gastropod and pelecypod molds at 185.4'. No vertical fracturing is apparent; core is broken (appears mechanically along shaly bedding and stylolites into pieces ranging from ~1 to ~9", no apparent modal size to pieces.

28.0' 175.0' 203.0'

Dolomite, very light gray to light gray (N8-N7) becoming interbedded with very light brownish gray (5YR 7/1), cycles become darker (to medium light gray, N6) upward toward much darker (greenish black 5GY 2/1) shaly parting; very fossiliferous to fossiliferous, several distinctly calc-arenitic zones from ~1" to >1 foot, some have distinct fossil molds and lighter-colored casts whereas others are now just coarse crystalline dolomite, fauna includes abundant bryozoans, many brachiopods, and molds of gastropods and pelecypods; porous purer dolomite zones interbedded with finer and denser argillaceous to shaly dolomites, pores range from subvisible to more than an inch (larger vugs may be washed-out zones of medium to coarse crystalline "spongy" dolomite, vugs are lined with clear to white euhedral crystalline dolomite; hardgrounds: the most prominent ones are the top and basal contacts, others range from subtle to distinct, subtle ones are darker colored dolomite below argillaceous to shaly dolomite, more prominent ones at 207.8 and 211.0, less prominent at 208.8; one small (~1.5") vertical fracture at 208.7.

Top boundary is placed at a strong hardground where there is a significant color change from very light gray and light gray (N8-N7) more argillaceous and shaly, and finer grained below to very pale orange (10YR 8/2) and more pure above. The Decorah is absent at this locality (represented stratigraphically by the hardground) so Dunleith rests directly on the Platteville.

10.9 203.0 213.9

Dolomite, very light brownish gray (5YR 7/1) with a little darker gray mottling at the hardground surface marking the top, vuggy (~ ¼-½") at top, subtle dark gray stylolites toward base.

0.5 213.9 214.4

Dolomite, pale yellowish brown (10YR 7/2) with some a little darker (10YR 6/2), argillaceous to shaly zones of dark yellowish brown (10YR 4/2); mostly fine to very finely crystalline with irregular patches of medium spongy sugary dolomite; very slightly fossiliferous throughout; some chert as a bed at ~219.7 and as small nodules as at 216.7, 218.7, and 220.9, faintly mottled medium and light gray (N8 and N6); upper ~ 4 feet contains vertical fractures up to ~ ¼" wide and up to ~ 1" high, partially lined with finely crystalline dolomite, some very slightly pyritic; lower 4+ feet is mostly dense except ~.8' of vuggy dolomite 221.4-222.2±, which is also more fossiliferous containing bryozoans, and pelecopod molds.

8.8 214.4 223.2

Dolomite, medium light gray to light gray (N6 to N7) mottled with grayish orange (10YR 7/4), streaky mottled pale brown (5YR 5/2) in a couple inches at base (225.7-225.9) a few shaly partings of moderate brown (5YR 3/4) dolomitic shale; chert nodule at 224.9-

225.0, white mottled light gray (N9 and N7); fine to very finely crystalline; mostly dense with a few scattered vugs, pin-head to ~ ⅜" with some interconnected to form 1" long openings; very slightly fossiliferous, probably ¼" ostracodes? and a palmatazoan columnal on shaly bedding plane at 225.0, more fossils on bedding plane at 225.25, unidentifiable fossils as thin white streaks at 225.5. Contact with the underlying Nachusa Dolomite at 225.9 is placed at a hardground where major porosity, grain-size and color changes occur in the dolomite.

2.7 223.2 225.9

Dolomite, grayish orange (10YR 7/4) with mottling and interbeds of pale yellowish brown (10YR 6/2) and pale yellowish orange (10YR 8/6), few argillaceous to shaly partings are moderate yellowish brown (10YR 5/4); chert as bed at 231.4 is very light gray mottled with light gray (N8 with N7), ~ 1" nodule at 235.0; dolomite is medium to finely crystalline, some very fine in branching burrow fillings; moderately porous throughout with irregular shaped streaks and patches of spongy porous dolomite, large vugs (~ 1") at 227.0 and 226.4-226.6 lined with medium-crystalline euhedral dolomite, large vugs show extensive interconnection, at six places vertical fractures split the core; several zones are extensively burrowed with branching (interconnected) burrow systems most obvious in top 1 foot (225.9-227.0±) and at 231.1-233.2; several prominent calcarenitic beds 1-2 inches thick with fossil moldic porosity up to ~ ¼ inch, fossils include brachiopods, bryozoans, pelecopods, and unidentified. Lower contact with Grand Detour is gradational and arbitrary; rock below becomes slightly more argillaceous, much less porous, and finer grained.

9.2 225.9 235.1

Dolomite, very pale orange (10YR 8/2) in upper 7-8 feet to pale yellowish brown (10YR 6/2) in next 2-3 feet to yellowish brown (10YR 5/2) in basal 3-4 feet of this section, which is 235.1-248.6; shaly partings are moderate yellowish brown (10YR 5/4) to dark yellowish brown (10YR 4/2); coarsens gradationally from very fine at top to medium crystalline in lower ~6 feet above 248.6 (this evidence could be used to argue for including this section of rock in the Nachusa); upper fine-grained rock is very argillaceous and becomes much purer dolomite downward as unit coarsens; slightly porous throughout, top fine-grained part has minimal visible porosity but instantly soaks-up water from a spray bottle indicating substantial inter-crystalline porosity, slightly more vuggy in lower part especially 244.5±-248.6, vugs reach maximum of 1 inch across in this lower zone; very slightly fossiliferous including brachiopods and echinoderm fragments and possibly some bryozoan fragments; extensive burrowing in the lower part causes a mottled appearance, burrows in argillaceous zone create a nodular appearance as at 246.5± and 240.2-240.3' some thin healed vertical fractures at 243.5, core is shattered to rubble 247.0-247.5± (was probably mechanical due to jamming of core barrel); no visible hardgrounds within this section; sharp contact at base where dolomite overlies an argillaceous and shaly zone, the dolomite below is grayer and more extensively burrowed.

13.5	235.1	248.6

Dolomite, upper 1.5'± looks very similar to the underlying Stillman Dolomite Member including the occurrence of numerous shale partings; upper 1.5'± is medium light gray (N6) mottled with pinkish gray (5YR 8/1), shaly partings are olive gray (5Y 4/1), below this 1.5' is pale yellowish brown (10YR 6/2) with mottling and some interbeds of grayish orange (10YR 7/4), shaly partings in this interval are few and yellowish brown (10YR 5/2), also a couple thin white (N9) mottled calcarenitic zones; upper zone is very fine and the rest ranges from fine to medium; porosity is common and vuggy

throughout with vugs up to about ¾ inches, some may be fossil molds; three prominent ~1" calcarenitic zones at ~250.0, 250.2, and 256.3, some fossil fragments appear to be bryozoans; few brachiopods, echinoderms and bryozoans throughout; upper ~1.5' zone has a colored pattern that looks like a diffuse burrowed pattern, only minor burrow mottling below; strong dark shale parting at 250 may have been ¼-⅜" or more thick originally; traces of pyrite in a few vugs. At 251.0' an ~½" gravelly mud is stuck to the core. This could be a K-bentonite or possibly a mud-filled joint, but it is most likely where this piece of core was dropped in mud at the drill site and not cleaned off. Both core ends at this point appear to match.

7.9	248.6	256.5

Dolomite, medium light gray mottled with light gray and pinkish gray (N6 with N7 and 5YR 8/1), with numerous shaly partings of olive gray (5Y 4/1), one thin (¼-½" thick) oxidized ocherous zone at 257.7 is dark yellowish orange (10YR 6/6); extensively burrow mottled throughout, however, the intensity diminishes to near zero at base (265.5); numerous shaly partings spaced from ~½ or ¼" to as much as 3 inches apart throughout unit, these also diminish in frequence and prominence toward base; mostly all very fine to sublithographic throughout; porosity is limited to a few scattered vugs, mostly small (<¼"), a few are lined white medium-crystalline dolomite; rare fossil fragments scattered throughout. Lower contact with Cowen Dolomite Member is gradational and exact placement arbitrary; here it is based upon the decline of burrow mottling (fucoids) and accompanying decline in frequency and prominence of shaly partings.

9.0	256.5	265.5

Dolomite, pale yellowish brown (10YR 6/2) to pinkish gray (5Y 8/1) with some interbeds of dark yellowish brown (10YR 4/2) and shaly beds and partings of dark yellowish brown (10YR 4/2) to dusky brown (5YR 2/2); some dark gray speckling (may be burrow mottling) throughout; mostly fine to very fine with some fine to medium interbeds; mostly dense with few beds of vesicular dolomite, very slightly vuggy throughout, most vugs are pin-head to elongate (slash-like) openings (vertical boring tubes) and a very few larger vugs (only a couple per foot, maximum); prominent calcarenitic bed ~ 1" thick showing much fossil-moldic porosity at 277.0'; fossils are rare but include scattered crinoid stems and brachiopods, abundant horizontal trace fossils on many of the shaly bedding planes; a few widely spaced thin (~ 1") argillaceous zones in the upper part (265.5-274.3) give way to shaly zones of argillaceous dolomite interlaminated with reddish-brown shales in lower part (274.3-280.7); vertical fractures intersected by core at 276.3-277.0. Lower contact is somewhat subjective but is placed at a strong wavy shale bedding plane where the closely spaced shaly interbeds of the Mifflin give way to widely spaced shale interbeds of the Cowen Member; Willman and Kolata (1978) show a prominent hardground a short distance below the top of the Mifflin so this contact is placed about 2 feet above the uppermost strong hardground in Mifflin, which contains numerous prominent hardgrounds; Cowen has none.

15.2 265.5 280.7

Dolomite and interbedded shales, dolomite is light to medium light gray (N7 and N6) with some interbeds of pale yellowish brown (10YR 6/2) and mottling of pinkish gray (5YR 8/1), some grayish orange (10YR 7/4) near the base; shaly interbeds and partings constitute ~ 15% of section and are dark greenish gray to greenish black (5GY 4/1 to 5GY 2/1) in the darker gray dolomite, dark yellowish brown (1)YR 4/2) partings occur in the upper two feet transitional to Cowen Dolomite Member and in the lower two feet, which is transitional to the Pecatonica; dolomite is finely speckle mottled with a mixture of shades of gray; mostly finely crystalline, especially where argillaceous, interbedded with numerous very coarsely crystalline calcarenitic interbeds up to about 6 inches thick, calcarenites contain many fossil fragments and fossil-moldic porosity, one large (1" diameter) straight cephalapod mold through the core at

287.8' and smaller cephalapods elsewhere, also trilobite fragments, bryozoans and brachiopods throughout; shaly beds are generally spaced at intervals up to about 1" but several calcarenitic beds space the shales up to about 6 inches (most are less than 2" thick); visible porosity is generally absent, however, the calcarenitic beds are vuggy, mostly <¼", and scattered vugs elsewhere; trace fossils (horizonal burrows) on most shaly bedding planes. Prominent hardgrounds at 282.9 (the uppermost strong one), 284.1, 285.3, 285.6, 285.7, 285.9, 286.2, 289.3, 289.5, 292.0, 302.3, and at 305.4, the basal contact with Pectonica Dolomite. Basal contact is placed at this strong (actually a double hardground) at the top of the Pecatonica.

24.7 280.7 305.4

Dolomite, brown (10Yr 6/2) mottled with pale yellowish grayish orange (10YR 7/4) and medium light gray (N5); streaks of dark reddish brown (10R 3/4) mostly in upper 1.5 feet ±; olive black shaly partings (5Y 2/1) in middle and lower parts, tops of hardground surfaces are very dark gray; mostly fine with patches of medium crystalline that is very finely porous (spongy); porosity is slightly vesicular in the upper 4.5 feet becomes mostly dense with scattered vuggy pores in coarser calcarenitic beds; becomes more vuggy in lower two feet; some beds are slightly fossiliferous but barely recognizable; prominent hardgrounds at top of formation, 305.4, and at 309.2, 309.6, 310.0±, hardground at top of formation is intensively bored with traces up to ~ ½ inch deep; lower couple feet and upper 2.5 feet are moderately burrow mottled with dark gray.

5.63 305.4 311.03

NOTE: Footages in the bottom box are not quite correct. The markings indicate that the box contains 305.8 to 311.03, which is 5.23 feet. Actually, the box contains nearly 8 feet of core, so footages may be off by about 2.5 feet at this depth.

PAM:STAFF\SARGENT\G128GP.SS

APPENDIX 4. METHODS FOR LABORATORY ANALYSIS OF POROSITY, BULK DENSITY, AND PARTICLE DENSITY OF ROCK CORES

[Methods modified from Vince Gutowski, Eastern Illinois University, written commun., 1987; Blake and Hartge (1986a, 1986b); Danielson and Sutherland (1986).]

1. Select approximately 0.25-foot long core samples from core box. Label the top of selected core samples (side closest to land surface is minimum depth) with “T” and sample number. Use a permanent marker. Wrap the core section in aluminum foil or place in plastic sandwich bag.
2. Obtain a laboratory-data record form and fill in the appropriate information on form when conducting the porosity analysis.
3. Using a precision scale, such as a Mettler balance, remove the cores from the aluminum foil or plastic bags and measure the initial weight (Wi, in grams—xxx.xx) of the solid core samples (save, but do not weigh any small fragments that have broken off the core during handling). The scale should be calibrated, leveled, and zeroed before weighing the core samples.
4. Place the core samples with the long axis upward in a small, metal sample canister. Place the canisters that contain the core samples in a laboratory oven. Desiccate (dry) the samples for a minimum of 48 hours at 110°C (degrees Celsius).
5. Place the desiccated core samples (and contained fragments) on the scale and determine the dry weight of the samples (Wd, in grams—xxx.xx).
6. Fill a vacuum jar about three-fourths full of de-ionized water (or tap water, if deionized water is unavailable). Avoid agitation (aeration) of the water.
7. Check the vacuum pump for proper volume and quality (moisture free) of the pump oil. Replacement oil should be engineered specifically for use in vacuum pumps. Properly dispose of the used oil.
8. Attach a cartridge of properly dried desiccant (such as Drierite) to the vacuum pump. Unhydrated desiccant should appear light gray and translucent. Hydrated desiccant is dark colored and nearly opaque. Hydrated desiccant can be reconditioned by heating 1–2 hours at 200–225 °C.
9. Place the core samples in the vacuum jar, ensuring the cores are fully submersed in the water. Cores should be placed in the vacuum jar in the metal canisters or plastic bags to contain any fragments that may break off during saturating. The fragments must later be weighed along with the saturated cores. Submerse any remaining core samples in a water-filled container while the first set of samples are in the vacuum jar.
10. Saturate the core samples under vacuum for a minimum of 8 hours. Saturate the core samples in water under ambient atmospheric pressure or under vacuum with the pump turned off for a minimum of 48 hours. If air bubbles are noted in the water or emanating from the core samples while under vacuum (with pump turned on), continue pumping under vacuum until no bubbles are observed. There may be some air bubbles trapped under the cores or between the metal canisters or plastic bags; these air bubbles can be released by gently shaking or rotating the vacuum jar.
11. After saturating in water, remove the core samples and gently remove excess water from the surface of the cores by hand wiping; avoid siphoning water from the interior of the cores.
12. Weigh the saturated cores (Ws, in grams—xxx.xx) and any fragments of the cores collected in the metal sample canisters or plastic bags.
13. Mount appropriately sized displacement chamber (smallest chamber in which the core sample will fit) vertically on a laboratory ring stand. Fill with de-ionized or tap water to a level above the discharge spigot. Open the drainage spigot and let the water level equilibrate to the level of the open spigot.
14. Empty and dry a collection vessel (graduated cylinder or glass flask) of an appropriate size to collect all water discharged from the displacement chamber when a core sample is fully submersed in the chamber (generally about 100 milliliters, but run a test sample first).
15. Slowly lower a saturated core sample into the displacement chamber. There should be no loss of water over the top of the chamber or oscillation of the water surface, thus, allowing an excess volume of water to discharge through the spigot. Determine the volume of all core samples in one run of samples. After each measurement, cover the individual

collection vessel with laboratory sealing tape (to prevent evaporation of the water) and label the vessel with the
sample number.

16. Measure the volume (Vt, in milliliters—xx.xx; = Vt, in cubic centimeters) of the displaced water. Measure using a 10 milliliter pipette; measurements should be accurate to +/– 0.05 milliliters.
17. Place the saturated cores in the brass-wire harness attached to the triple-beam balance (calibrate and zero the balance before measurements are made) and lower into a water-filled vessel until fully submersed. Record the saturated weight in water (Ww, in grams—xxx.xx). If the weight exceeds the 600-gram limit of the balance, estimate the total weight and note the assumed accuracy of the estimate on the laboratory record form.
18. Estimate the relative volume (AVp) of vesicles and vugs (diameter greater than 0.25 inch) on the surface of the cores:

    1 - smooth
    2 - slightly vesicular
    3 - moderately vesicular
    4 - very vesicular, slightly vuggy
    5 - moderately vuggy
    6 - very vuggy.

19. Use the collected data in the following formulas to obtain estimates of porosity, bulk density, and particle density of the lithologic cores:

    Wp (weight of water in pores = Vp, volume of water in pores, in cubic centimeters): Wp = Ws – Wd
    Porosity (P, in percent): P = Vp/Vt
    Bulk Density (BD, in grams/cubic centimeter): BD = Wd/Vt
    Particle Density (PD, in grams): PD = Wd/(Wd–Ww)

20. If an additional volume of pores (AVp) is recorded for individual core samples, adjusted values of porosity should be determined.

References

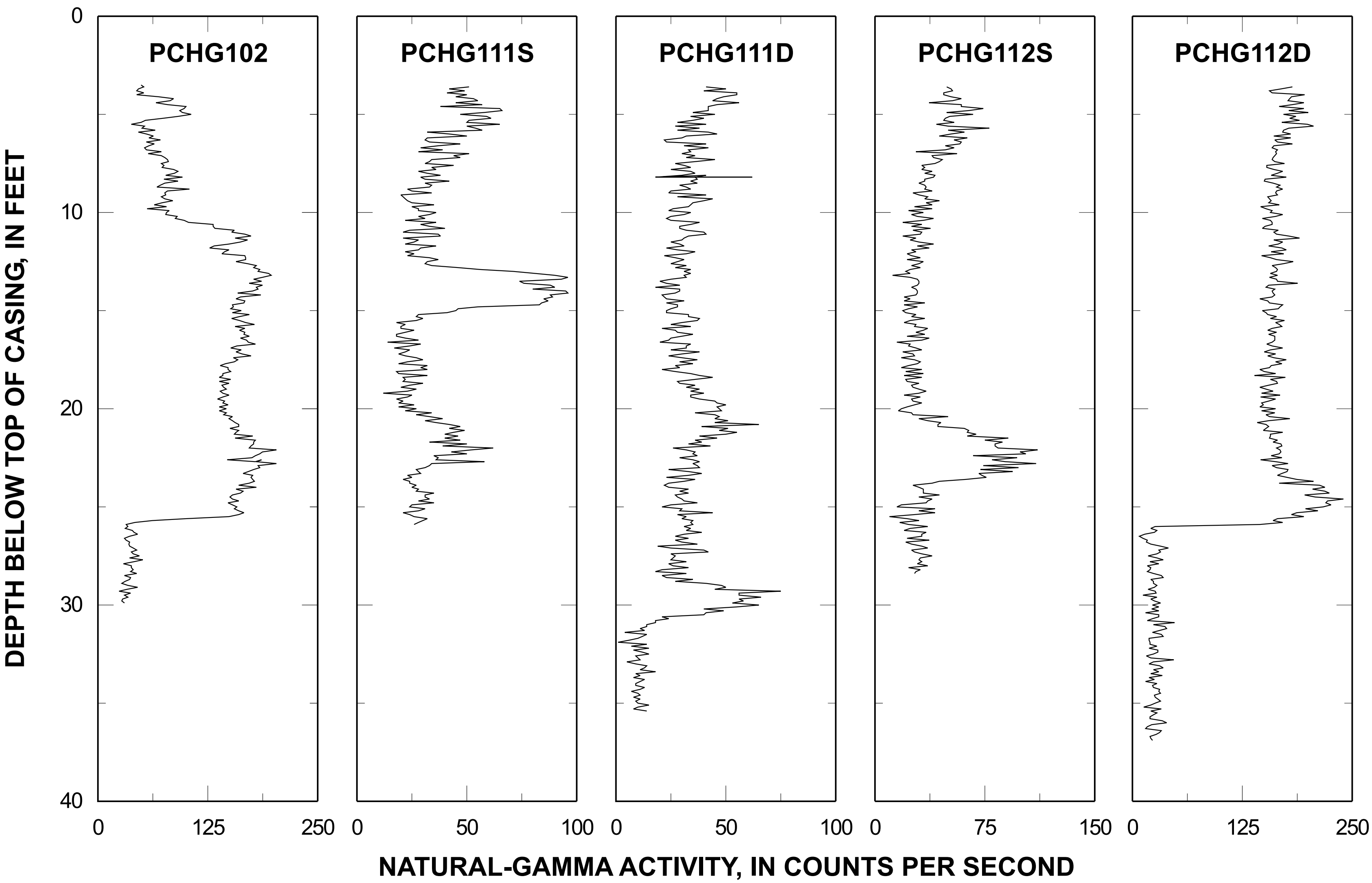
Blake, G.R., and Hartge, K.H., 1986a, Bulk density, *in* Klute, Arnold, ed., Methods of soil analysis: Madison, Wis., American Society of Agronomy, p. 363-366.

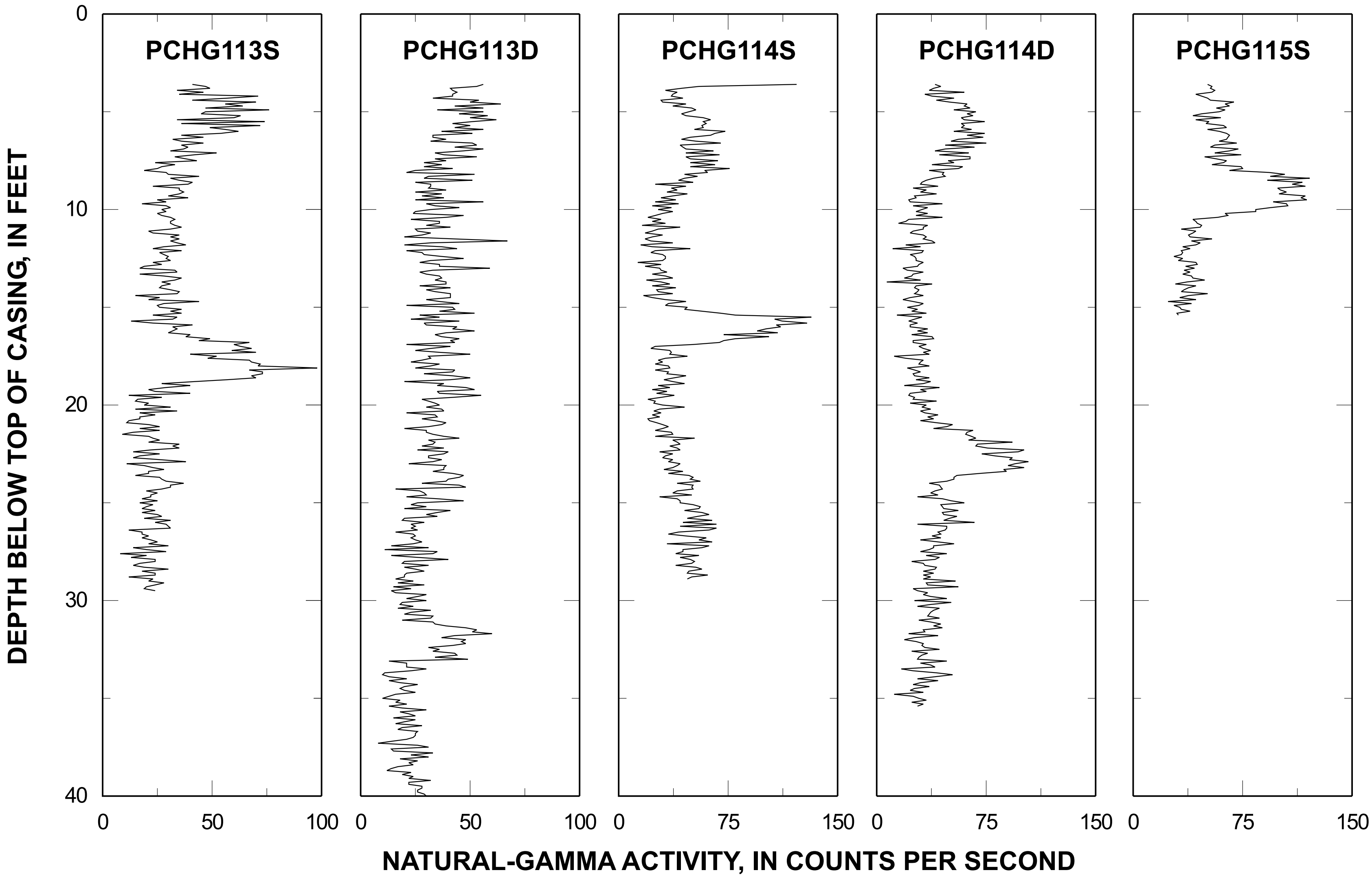
———1986b, Particle density, *in* Klute, Arnold, ed., Methods of soil analysis: Madison, Wis., American Society of Agronomy, p. 377-380.

Danielson, R.E., and Sutherland, P.L., 1986, Porosity, *in* Klute, Arnold, ed., Methods of soil analysis: Madison, Wis., American Society of Agronomy, p. 143-144.

APPENDIX 5. GEOPHYSICAL LOGS OF SELECTED BOREHOLES AND WELLS IN BELVIDERE, ILL.

[See appendix 1 for list of abbreviations used in appendix 5.]


PCHG102
PCHG111S
PCHG111D
PCHG112S
PCHG112D
DEPTH BELOW TOP OF CASING, IN FEET
0
10
20
30
40
0
125
250
0
50
100
0
50
100
0
75
150
0
125
250
NATURAL-GAMMA ACTIVITY, IN COUNTS PER SECOND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PCHG113D
PCHG114S
PCHG114D
PCHG115S
DEPTH BELOW TOP OF CASING, IN FEET
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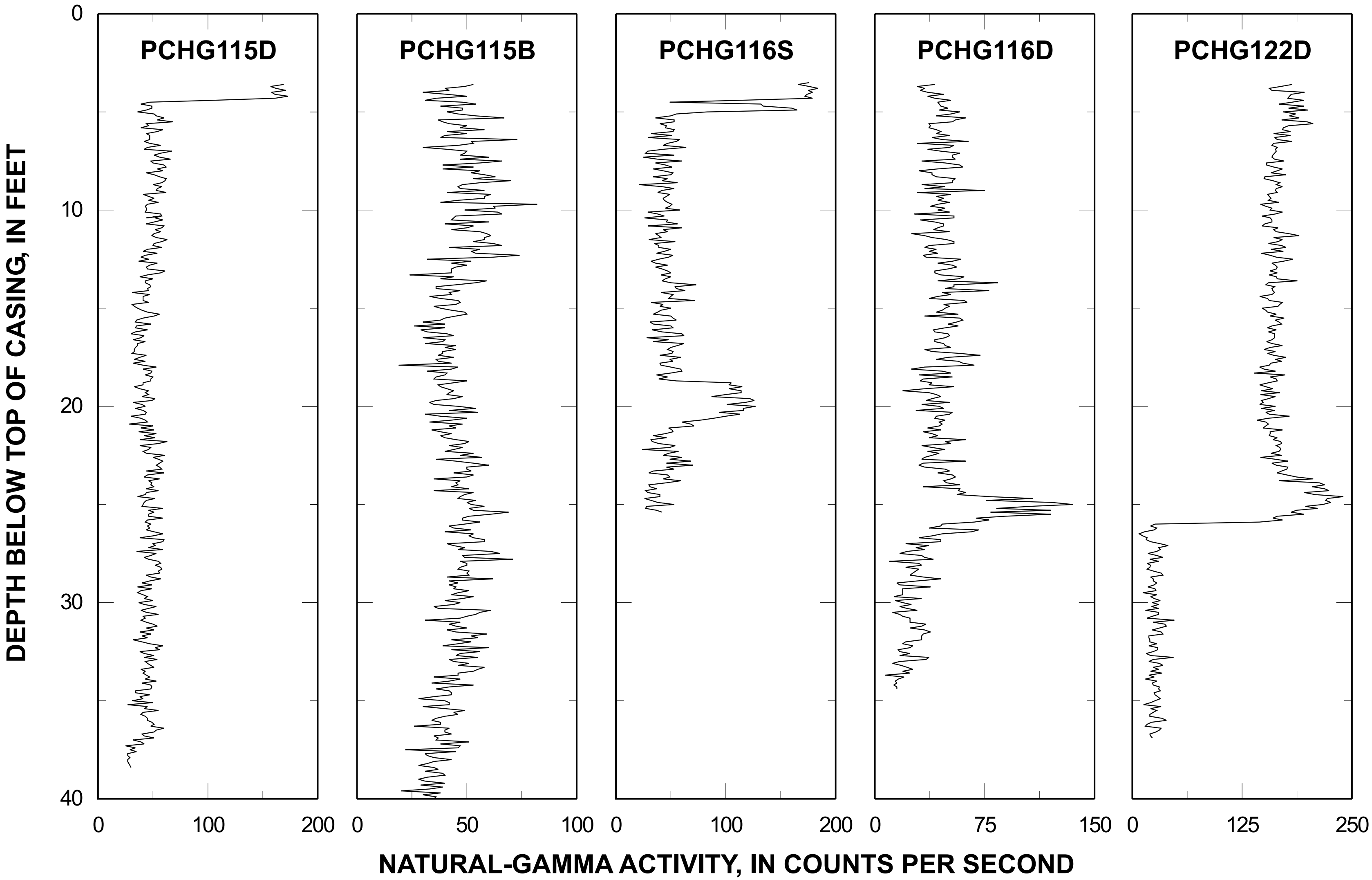
10
20
30
40
0 50 100
0 50 100
0 75 150
0 75 150
0 75 150
NATURAL-GAMMA ACTIVITY, IN COUNTS PER SECOND


PCHG115D
PCHG115B
PCHG116S
PCHG116D
PCHG122D
DEPTH BELOW TOP OF CASING, IN FEET
0
10
20
30
40
0
100
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0
100
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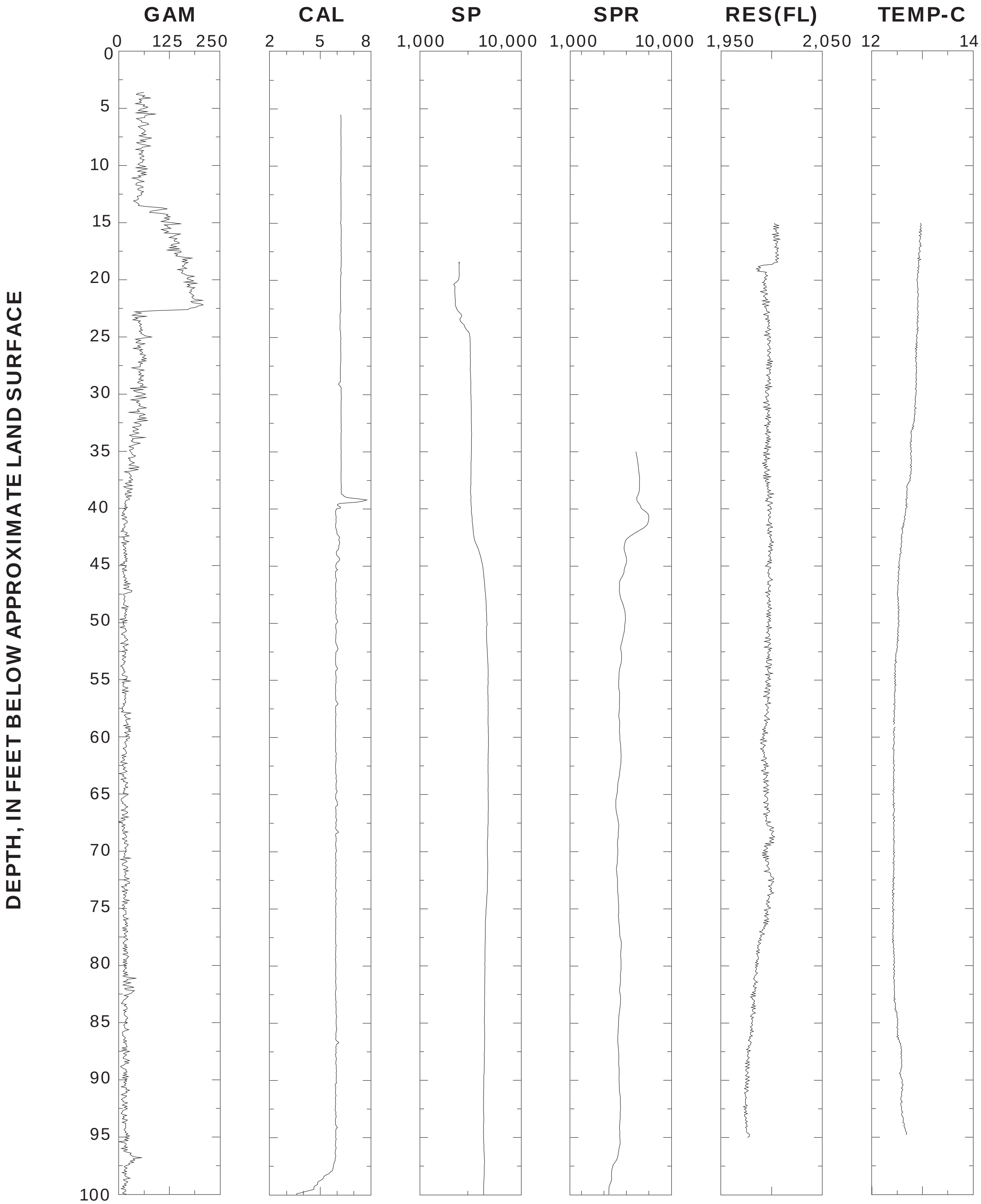
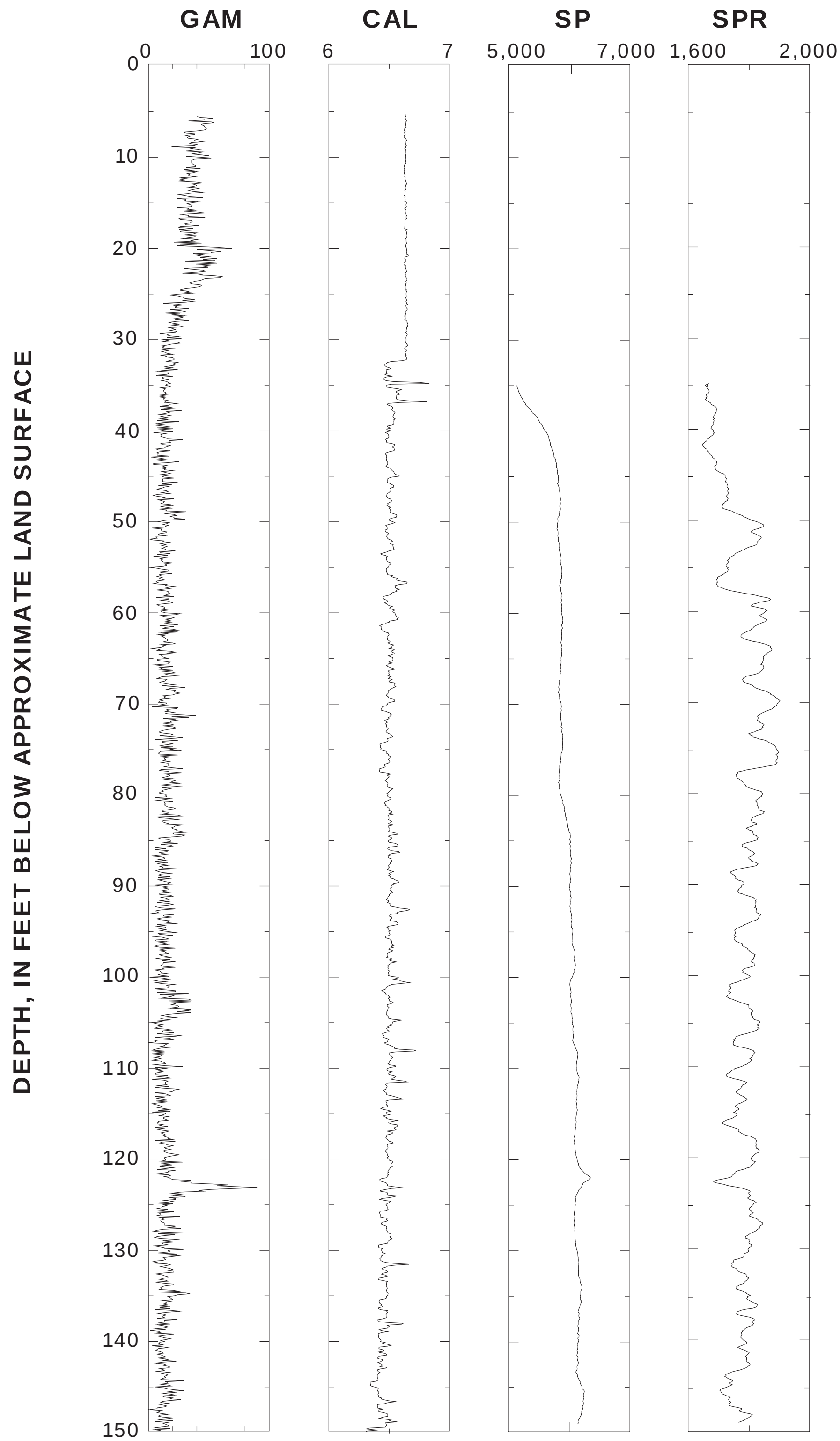
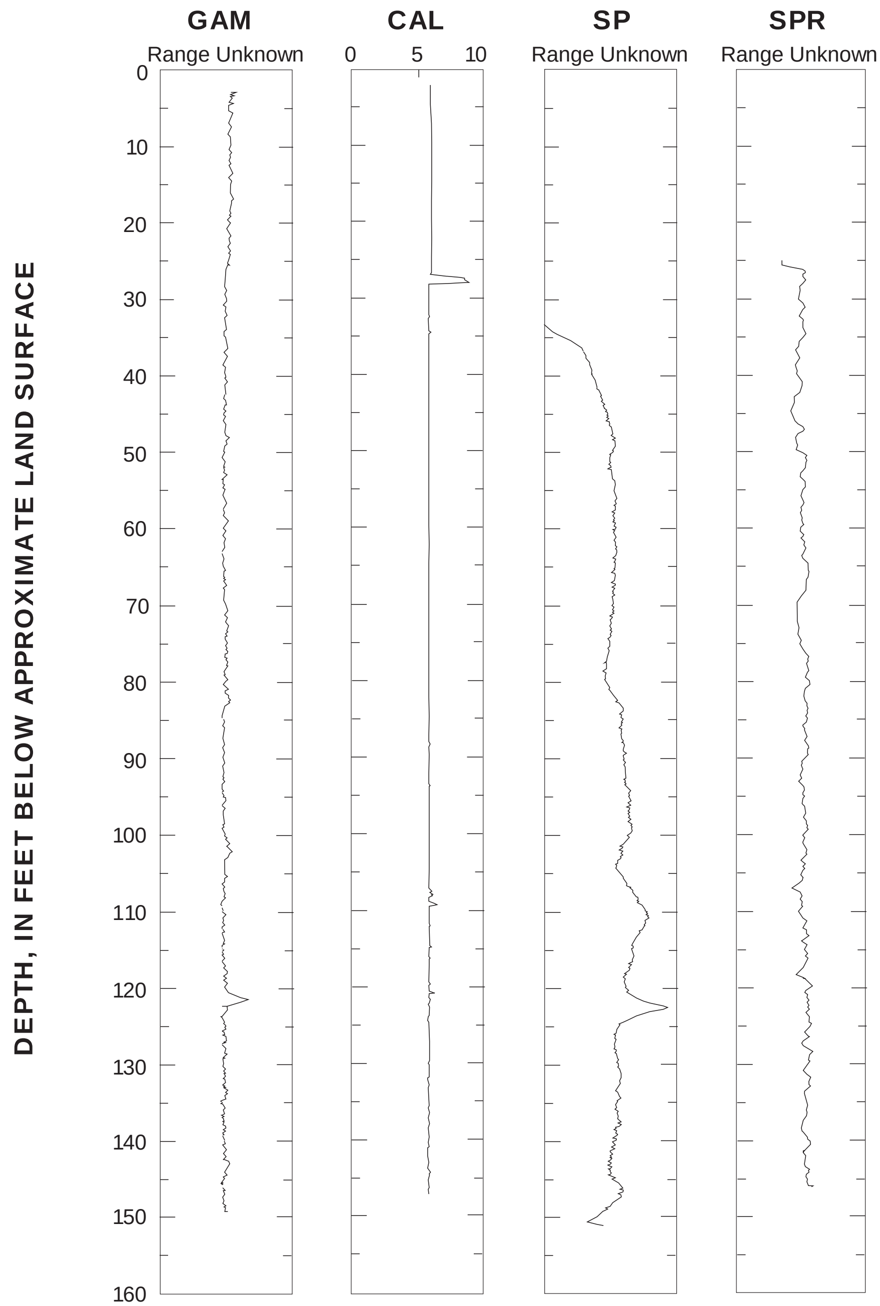
75
150
0
125
250
NATURAL-GAMMA ACTIVITY, IN COUNTS PER SECOND



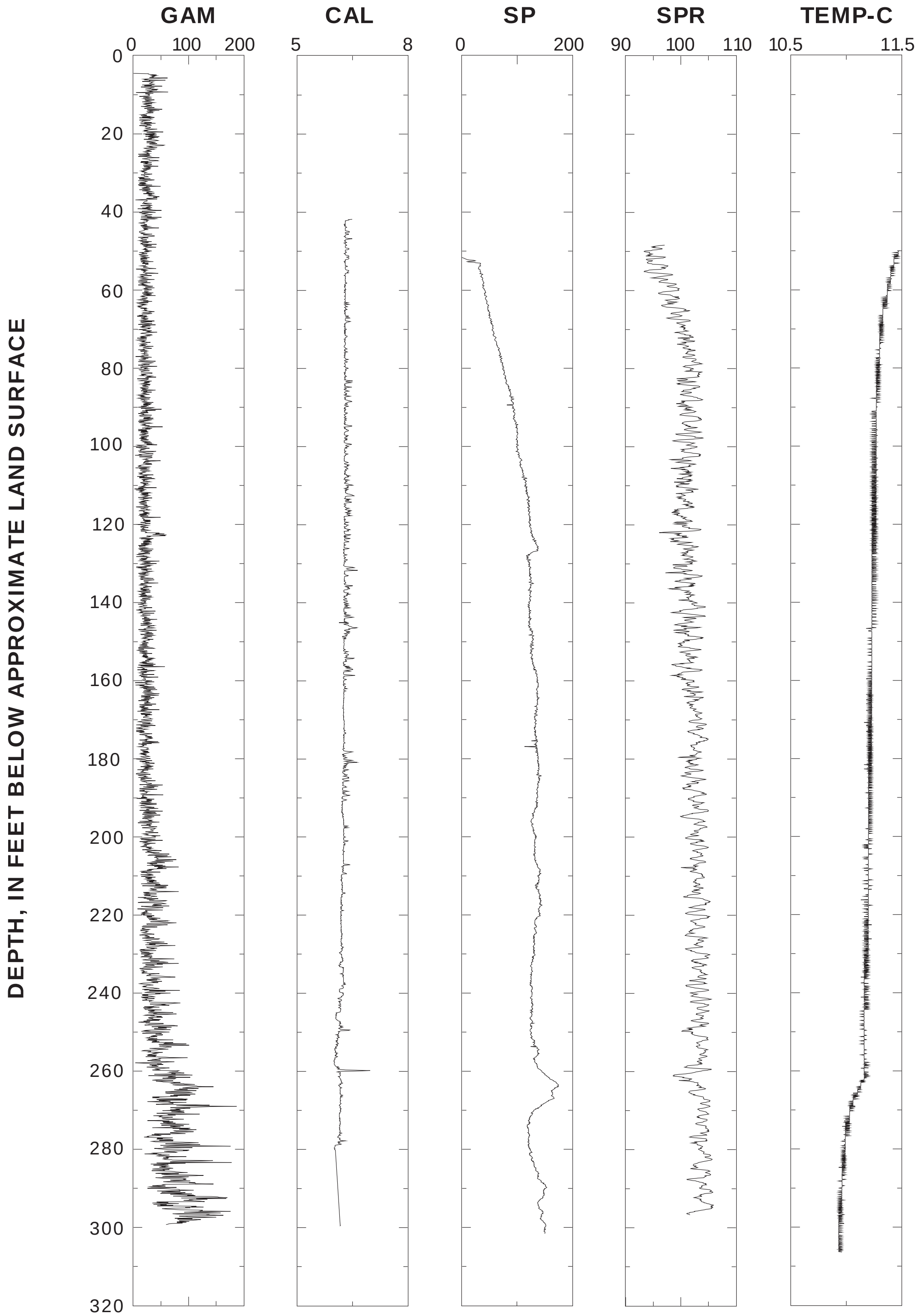
BOREHOLE PCHG115BD



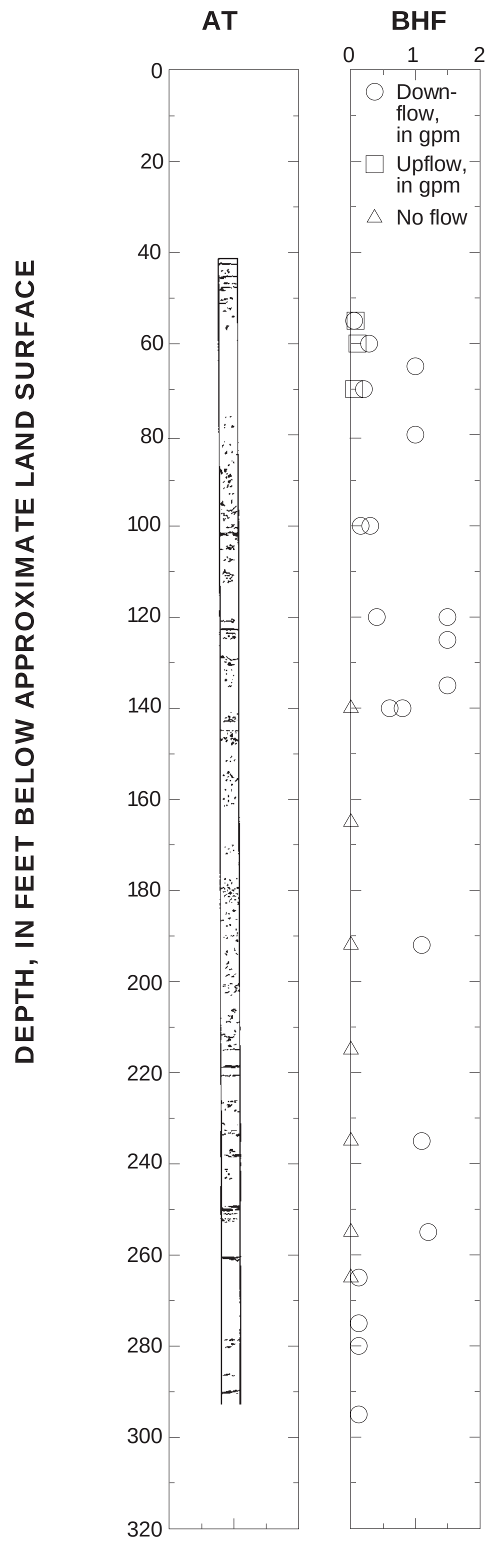
BOREHOLE PCHG125BD



BOREHOLE 126BD



BOREHOLE PCHG127GP



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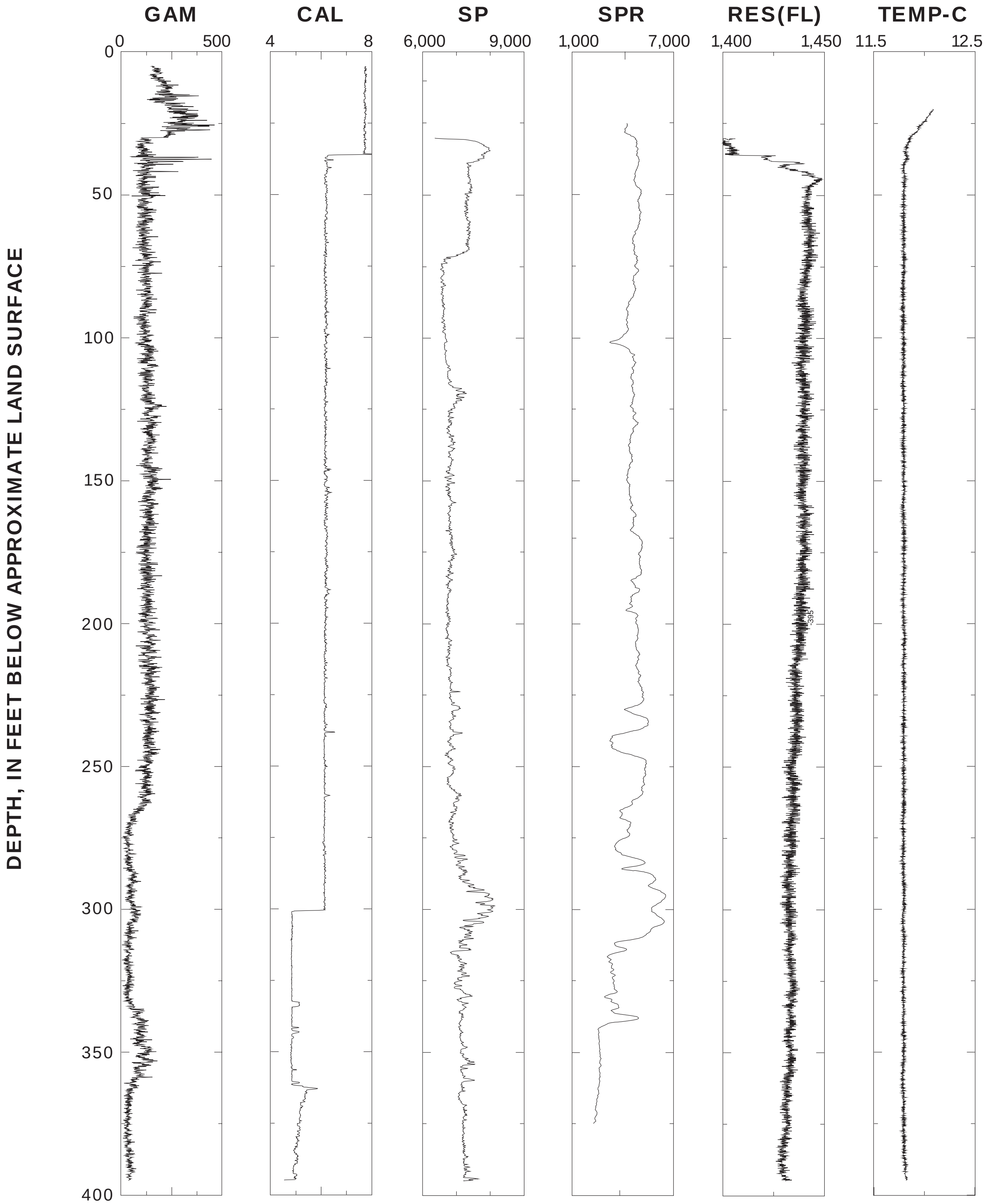

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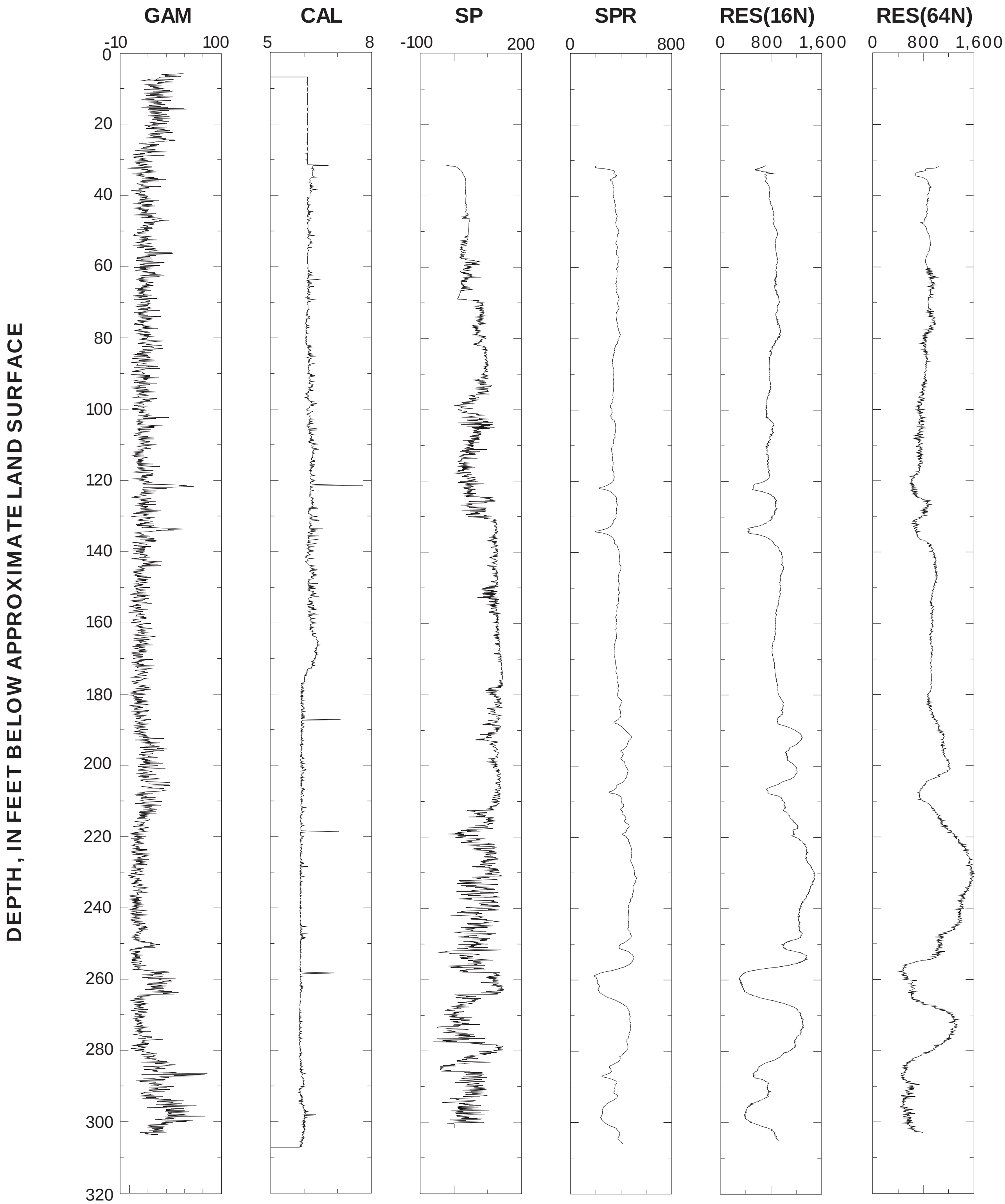

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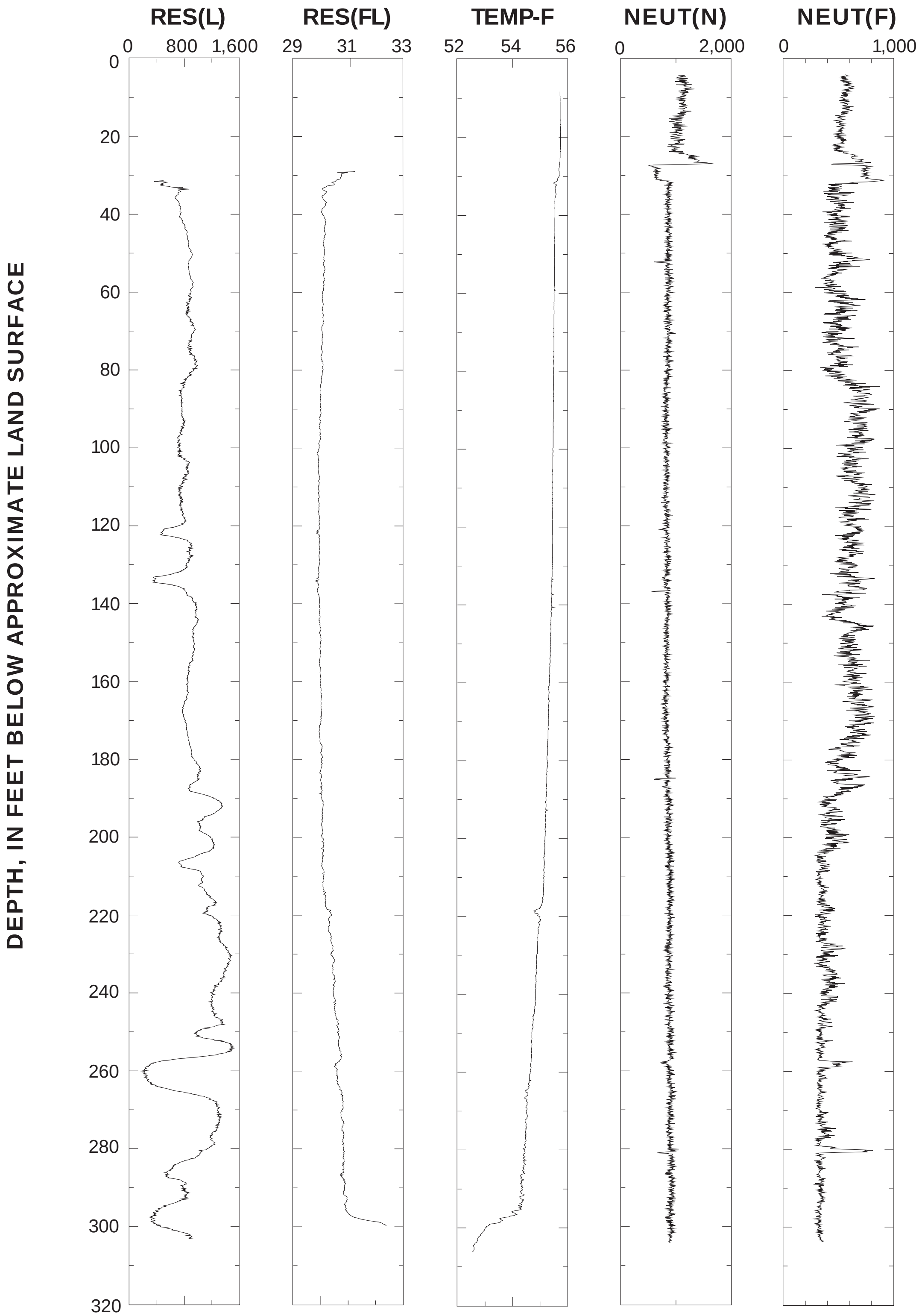

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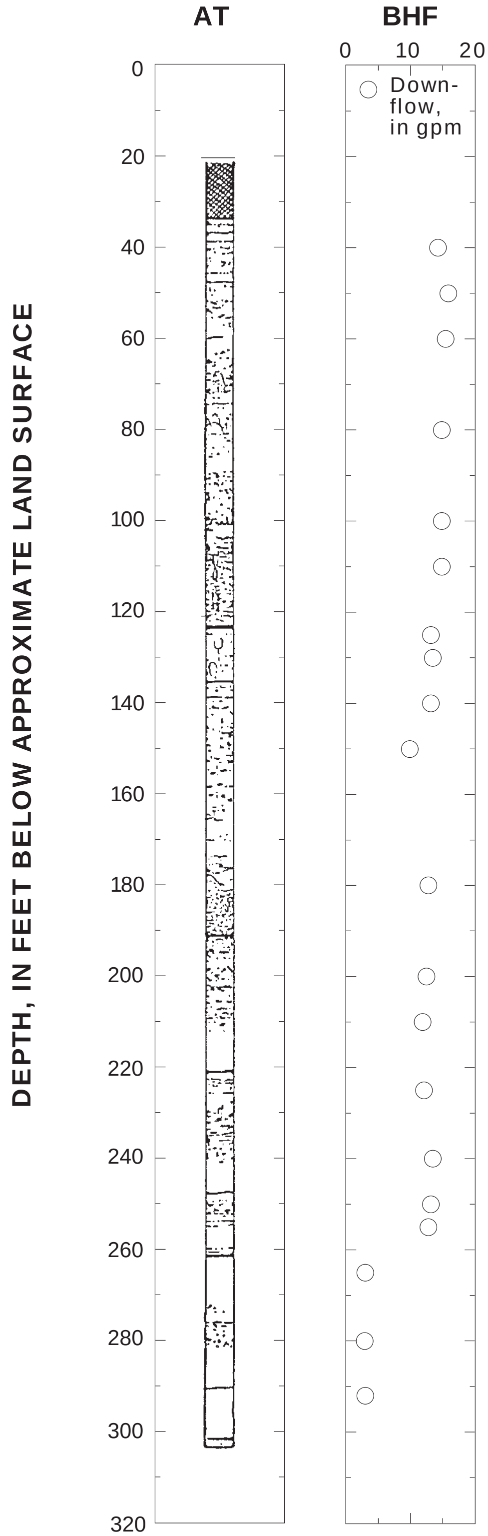

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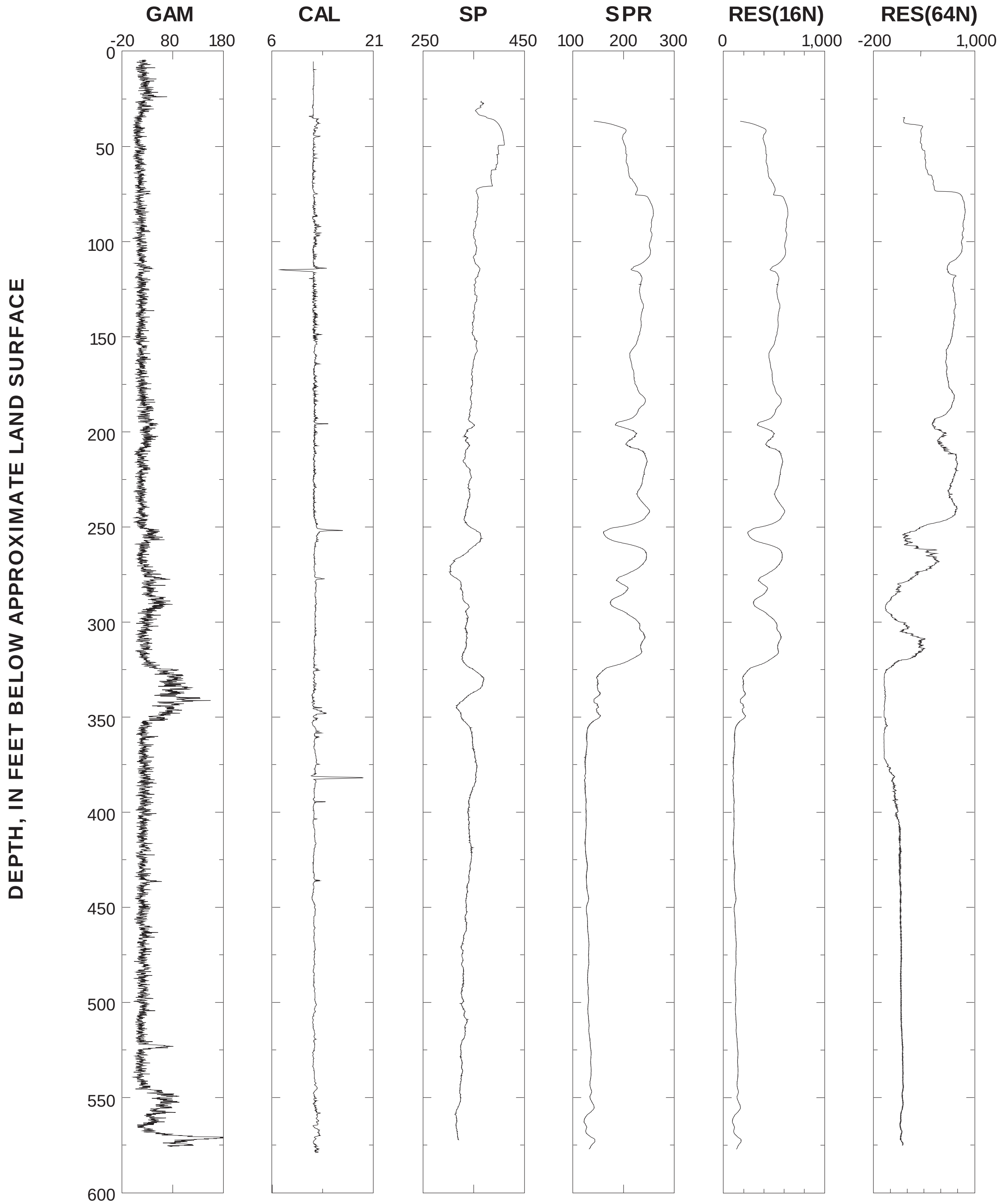
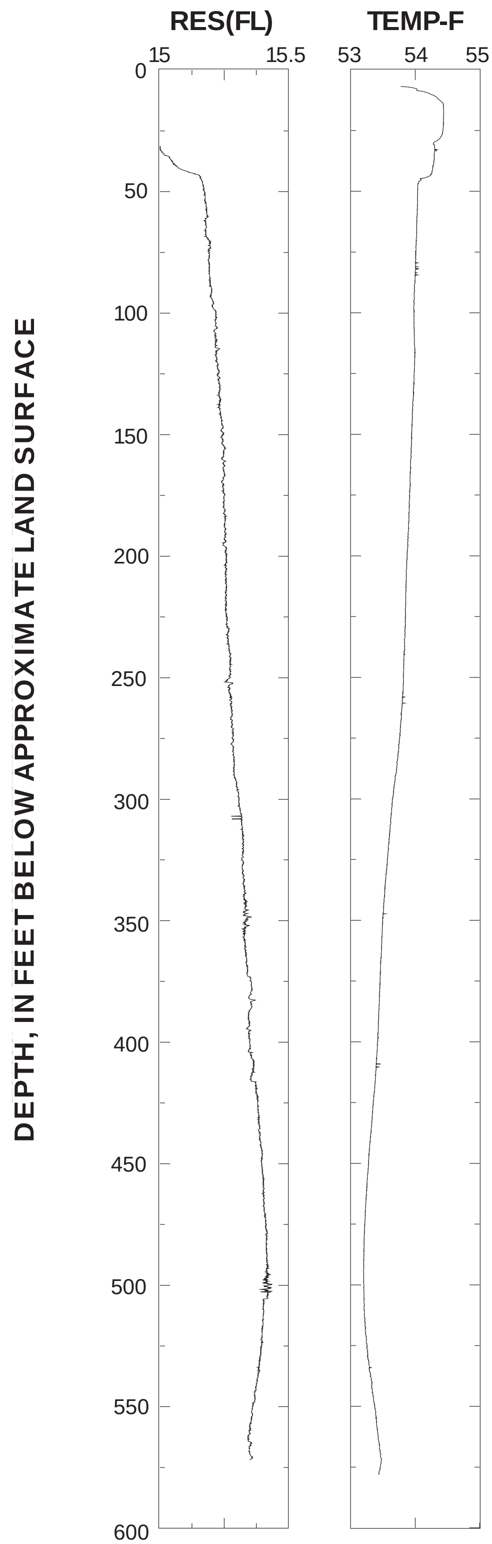
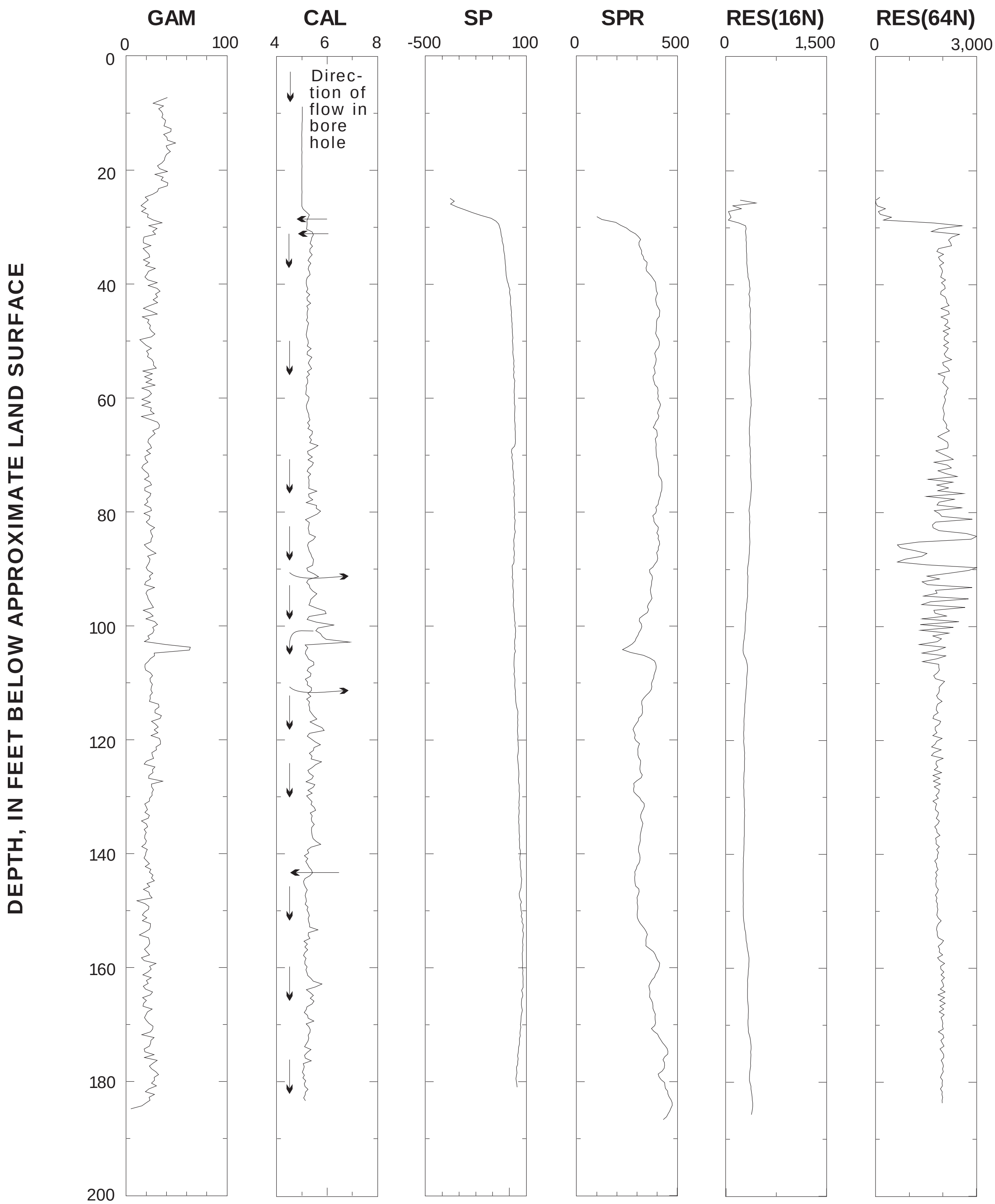


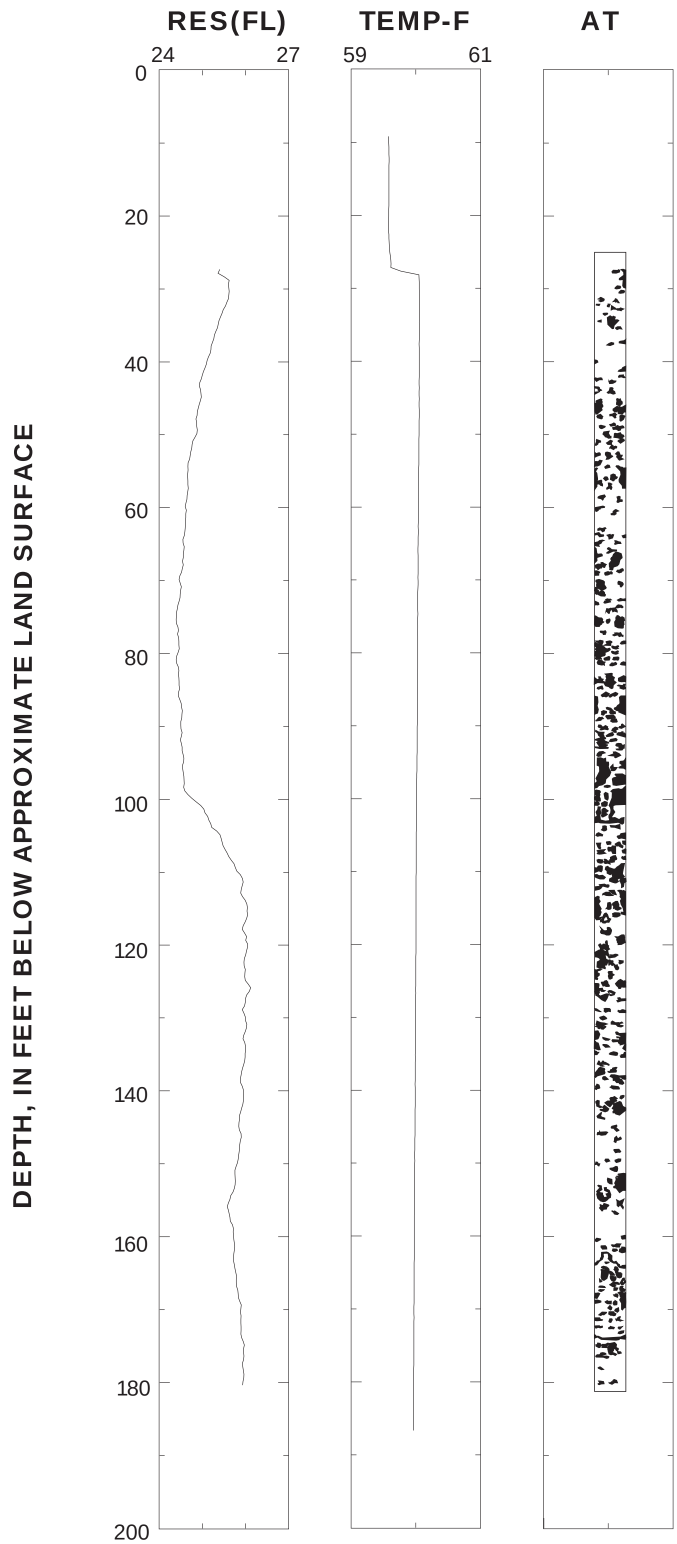
BOREHOLE 00305



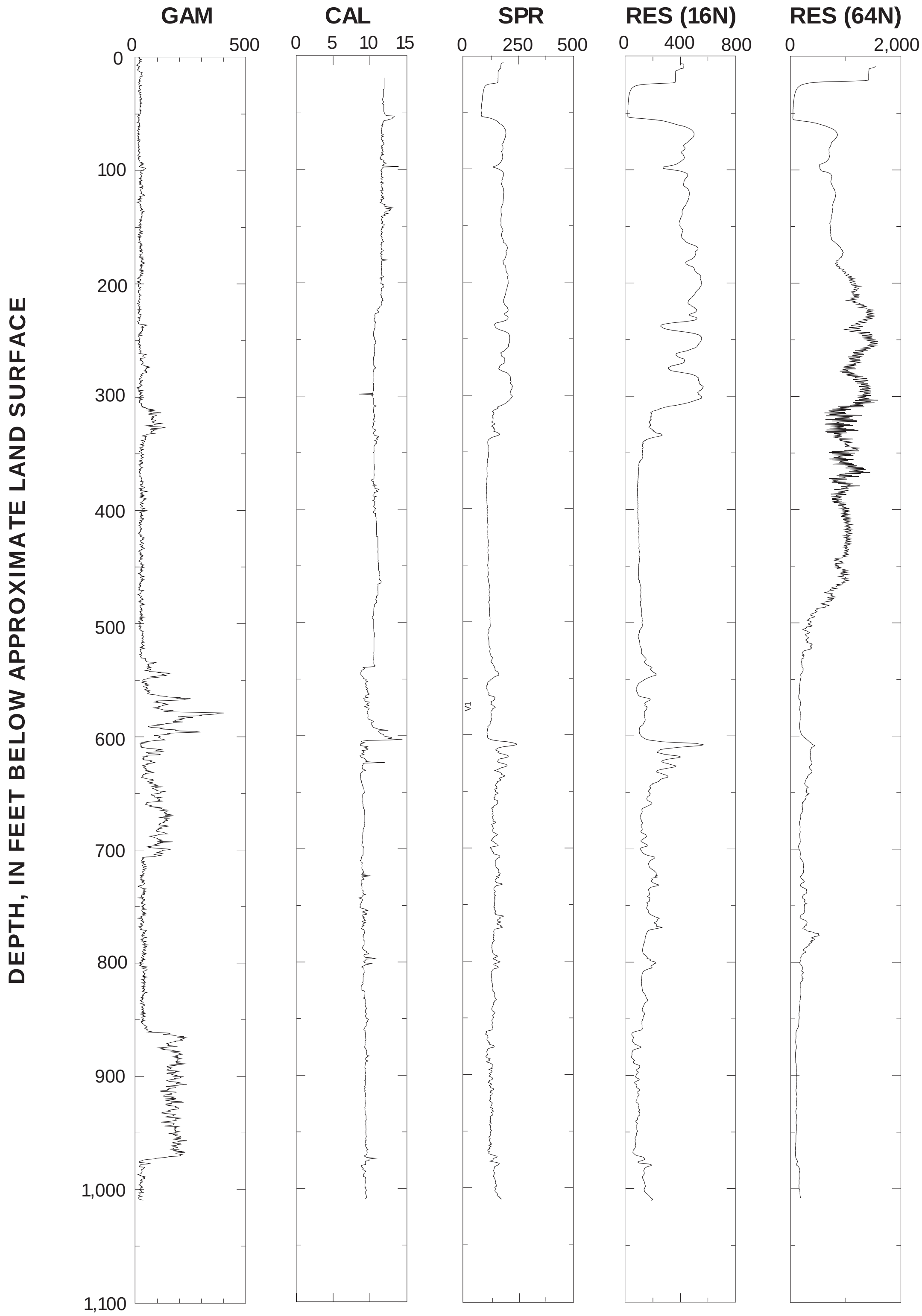
BOREHOLE 00305 (Continued)



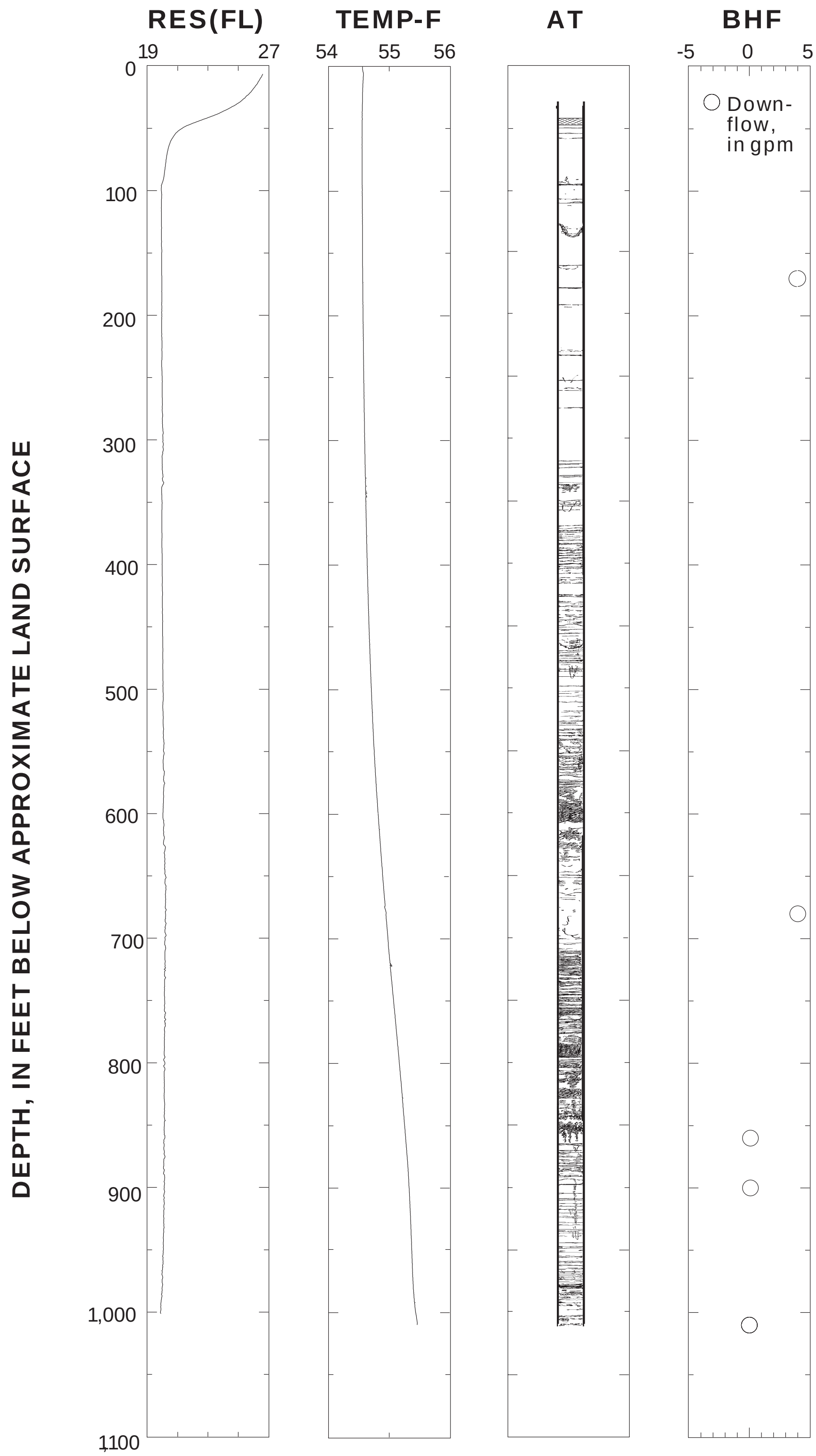
BOREHOLE 00436



BOREHOLE 00436 (Continued)


GAM
CAL
SPR
RES (16N)
RES (64N)
0
500
0
5
10
15
0
250
500
0
400
800
0
2,000
DEPTH, IN FEET BELOW APPROXIMATE LAND SURFACE
0
100
200
300
400
500
600
700
800
900
1,000
1,100

WELL BMW2



WELL BMW2 (Continued)

APPENDIX 6. DATA AND INTERPRETATIONS FROM AZIMUTHAL SQUARE-ARRAY DIRECT-CURRENT RESISTIVITY SURVEYS IN AND NEAR BELVIDERE, ILL.

Summary Of The Interpretations And Modeling Of Three Azimuthal Square Array D. C. Resistivity Data Sets Collected At Or Near The Parson's Casket Hardware Superfund Site, Belvidere, Illinois

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The following presents a summary of the results of the analysis of azimuthal square-array direct-current resistivity (SAR) data collected at three sites in northern Illinois near the Parson's Casket Hardware Superfund site in Belvidere.

INTERPRETATION OF AZIMUTHAL DATA

SAR data supplied by Illinois District personnel were interpreted using anisotropic analysis methods described in Lane and others (1995). A spreadsheet was used to convert the raw field resistance values into apparent resistivities for each azimuthal array. The apparent resistivities were plotted on a 360° (degrees) polar diagram for graphical interpretation. The spreadsheet also was used to calculate the primary axis of anisotropy, which can be interpreted as parallel to the primary fracture direction. The resistivity anisotropy also was calculated with the spreasheet. Under the assumption that the observed anisotropy is induced by a single set of similarly oriented steeply dipping fractures, the secondary (fracture) porosity was then calculated. Analytical interpretation of anisotropic resistivity data is appropriate in areas with a single set of fractures. Departures from a single fracture direction degrade the analysis but are reasonably valid if one fracture set has a dominant response. For example, an ideal SAR data set when plotted on a polar diagram appears elliptical in shape. The ellipse has one dominant axis of anisotropy because of fracturing, with the maximum and minimum resistivities in perpendicular directions. The presence of other directions of fracturing can modify and distort the ellipse. Some of the SAR data discussed here depart from the single fracture model, indicating the presence of multiple sets of fractures. The graphical interpretations allow the interpretation of multiple directions of fracturing. The anlytical method allows identification of the primary fracture strike, and a secondary porosity that should be viewed as a first-order approximation. A tabulated summary of interpreted data and a short discussion is given for each of the three sites.

Site 1
Parson's Casket (BEL)

[--, not analyzed or no comments]

Square size (meters)	Visual azimuth(s) (degrees)	Calculated azimuth (degrees)	True anisotropy (ratio)	Secondary porosity (percent)	Comments
4.22	120, [1]030, [1]165	[2]91.70	[2]1.1506	--	--
6	075, [1]165	83.28	1.2992	15.22	090° (degrees) assumed for secondary porosity calculations
8.5	090, [1]165	91.10	1.3937	14.62	Several azimuths with similar minimum values
12	090, [1]165	94.86	1.4427	15.09	Several azimuths with similar minimum values
14.4	090, [1]165	96.19	1.4447	15.03	Five azimuths between 40.0 and 46.1 ohm-meters (with the maximum of 143.8 ohm-meters
24	060, [1]120, [1]165	[2]93.07	1.3307	[2]9.19	Two distinct feature directions; 105° assumed for secondary porosity calculations; values may be low becasue of the shape of the square
34	045, [1]135	[2]87.58	[2]1.1852	--	--
48	045, [1]135	[2]121.43	[2]1.0861	--	--
68	--	--	--	--	Square was not collected

[1]Secondary azimuth.
[2]May not be accurate (especially if there are multiple azimuths).

The data collected at this site were difficult to process and model. The data for each azimuthal array display an irregular, nonanisotropic pattern. The maximum and minimum resistivities are not perpendicular in any of the arrays. The data may indicate the presence of cultural noise, and (or) the presence of fractures in multiple orientations.

Increased numbers of measurements at each position and azimuth would have increased the usefulness of the field data. The raw data values are low and did not stabilize for some of the position. A larger number of measurements (six or eight, as opposed to four) could have provided a more accurate mean value. The drift in the data may be related to the presence of electrical noise at the site.

Site 2
At the interchange of Stone Quarry Road and U.S. Route 20 (SQR)

[--, not analyzed or no comments]

Square size (meters)	Visual azimuth(s) (degrees)	Calculated azimuth (degrees)	True anisotropy (ratio)	Secondary porosity (percent)	Comments
4.22	000	10.55	1.0438	2.20	Azimuth is 000° (degrees). It is corroborated by the dip in 015° and the high values of 090° and 105°
6	000, [1]120	122.50	1.0187	1.08	Azimuth 000° is less resistive than 120°, and 090° is more resistive than 030°. The values of the 015° and 105° azimuths assist in the 000° azimuth. 000° is assumed for calculating the specific porosity
8.5	135	153.81	1.0187	.54	May be closer to 150° or 165°
12	135	123.94	1.0266	.46	--
14.4	135	125.55	1.0261	.46	--
24	135, [1]030, [1]090	135.93	1.0141	.20	--
34	--	--	--	--	Unable to obtain meaningful azimuthal data
48	030, [1]105, [1]060	[2]104.55	[2]1.0097	[2].08	105° assumed for secondary porosity calculations
68	60, [1]135	[2]105.20	[2]1.0261	--	The secondary maximum, 105°, is perpendicular to the maximum 015°

[1]Secondary azimuth.
[2]May not be accurate (especially if there are multiple azimuths).

These data were originally collected on May 22, 1996, but the 000° azimuth data accidentally were deleted. Azimuths 000° and 015° were recollected on June 27, 1996. There is a static difference in the values of the azimuthal data collected on the two different dates. The data for the 000° azimuth were normalized by comparing the difference in the 000° and 015° azimuths collected on June 27, 1996 and applying this difference to the data collected on May 22, 1996. The values of 000° are approximated by comparing them to the two different versions of 015°. This azimuth is, at best, uncertain, and possibly incorrect. No parts of the interpretation are based solely on the 000° or 090° azimuths.

Data sets sqrB000.dat and sqrX000.dat were collected on the same day. The purpose of sqrB000.dat was to help determine the reproducibility of the data. All data matches up well except the beta square 4. The X-resistance value is roughly double the B-resistance value. This difference is not reflected in the alpha or gamma values and may be the result of cultural interference, field error, or an increase in the injected current.

The data at this site seems to be more precise than that collected at the Parson’s Casket Hardware Superfund site, but taking six or eight measurements would have improved the usefulness of and assistance with the interpretation of the field data.

Site 3
In a cornfield immediately north of the Irene Road Quarry (IRQ)

[--, no comments]

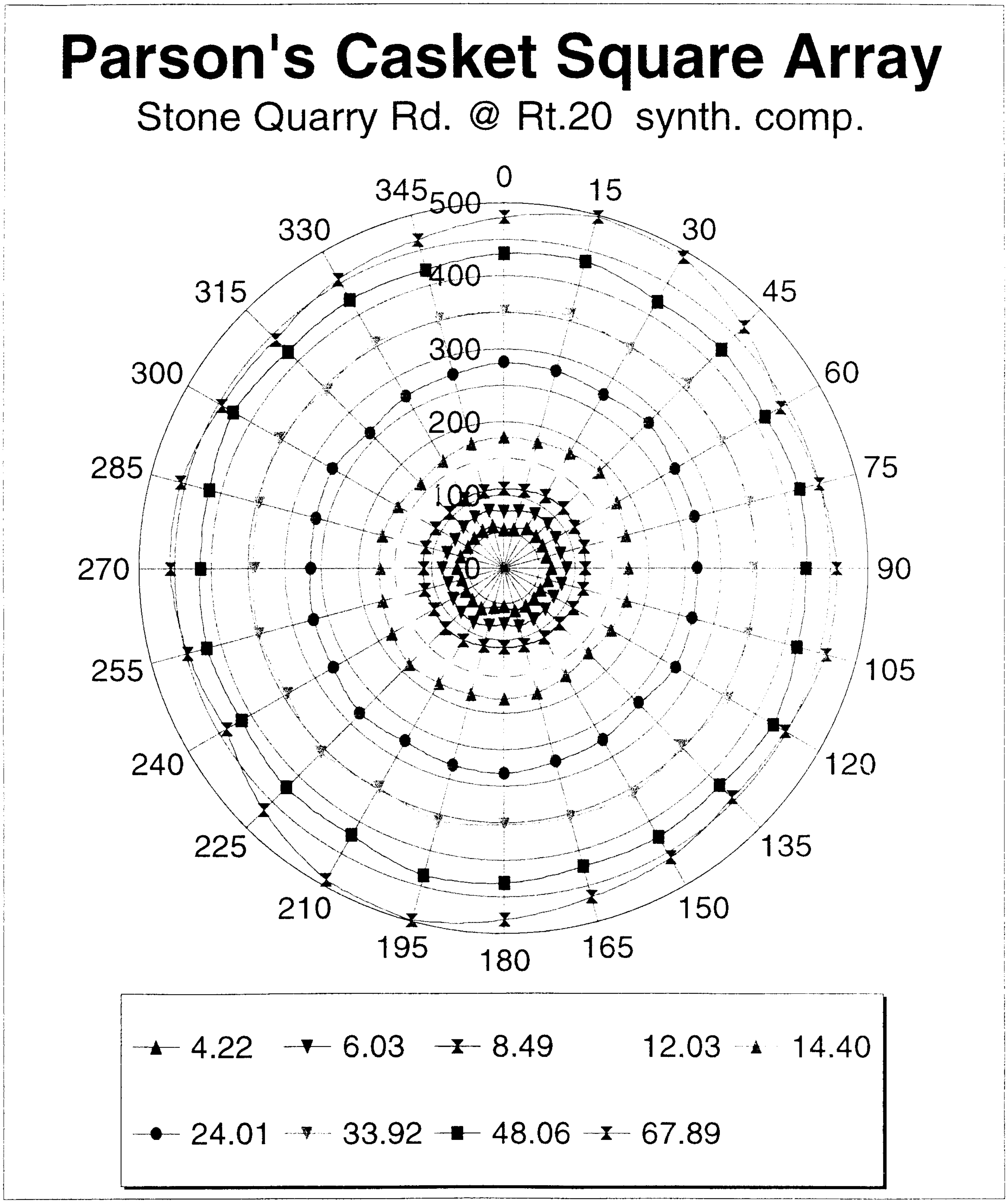
Square size (meters)	Visual azimuth(s) (degrees)	Calculated azimuth (degrees)	True anisotropy (ratio)	Secondary porosity (percent)	Comments
4.22	045	62.05	1.0388	1.35	--
6	060, [1]015, [1]120	67.20	1.0294	.82	Actual orientation between 045° (degrees) and 060°
8.5	060	56.85	1.0283	.52	Actual orientation between 045° and 060°
12	060, [1]015, [1]120	53.66	1.0406	.55	Actual orientation between 045° and 060°
14.4	045, [1]015, [1]120	51.16	1.0466	.55	Actual orientation between 045° and 060°
24	045	51.66	1.0639	.51	No obvious secondary features
34	045	45.66	1.0565	.40	--
48	045	34.57	1.0443	.26	--
68	150	160.50	1.0557	.32	The true azimuth is probably between 150° and 165°. This may be a feature created by the quarry or possibly a layer of different material

[1]Secondary feature.

The data from this site may reflect the effects of the adjacent quarry (within about 520 feet). The blasting and (or) removal of quarried material could alter the stress field and create openings in fracture sets that might not be representative of regional conditions.

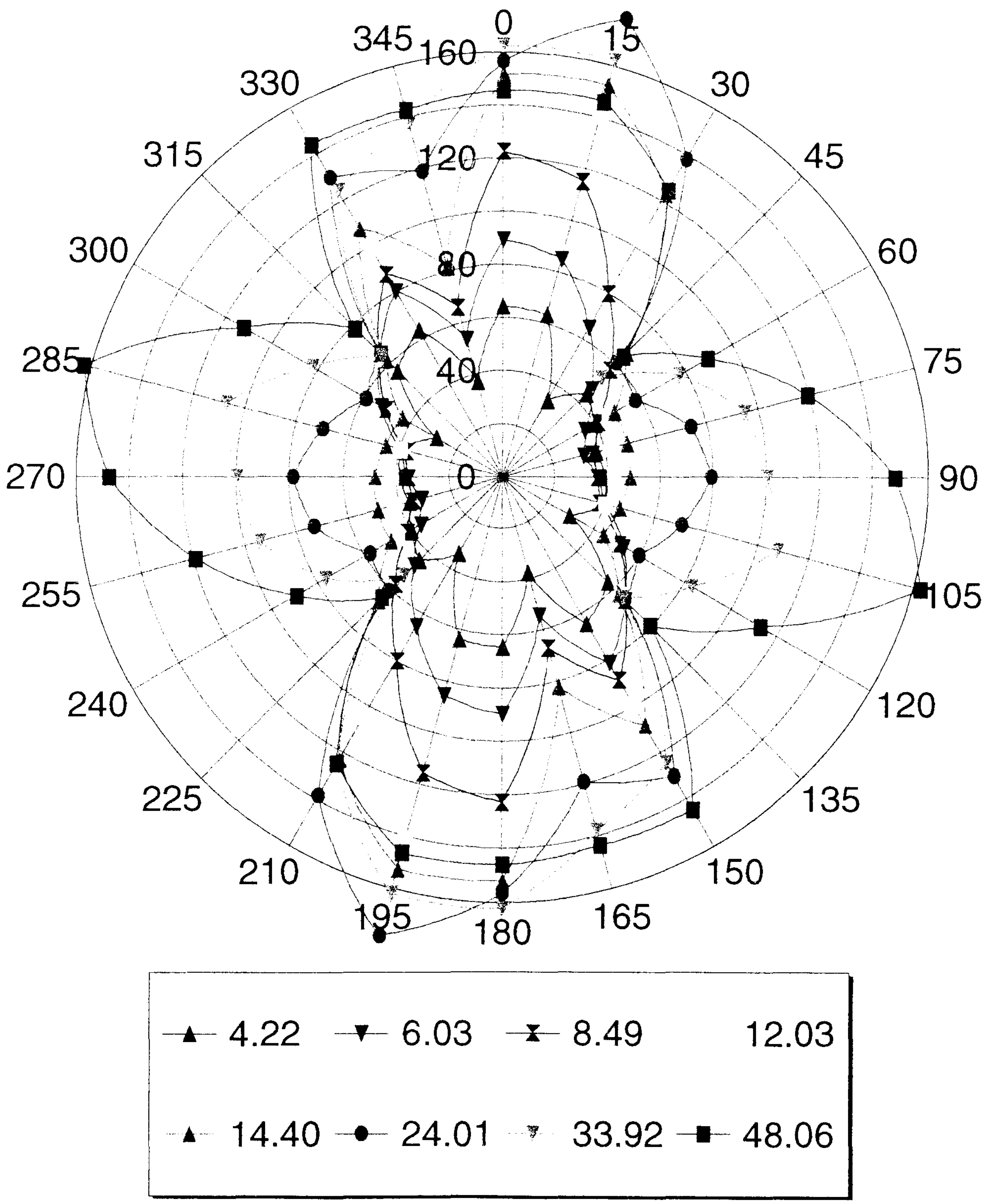
REFERENCES

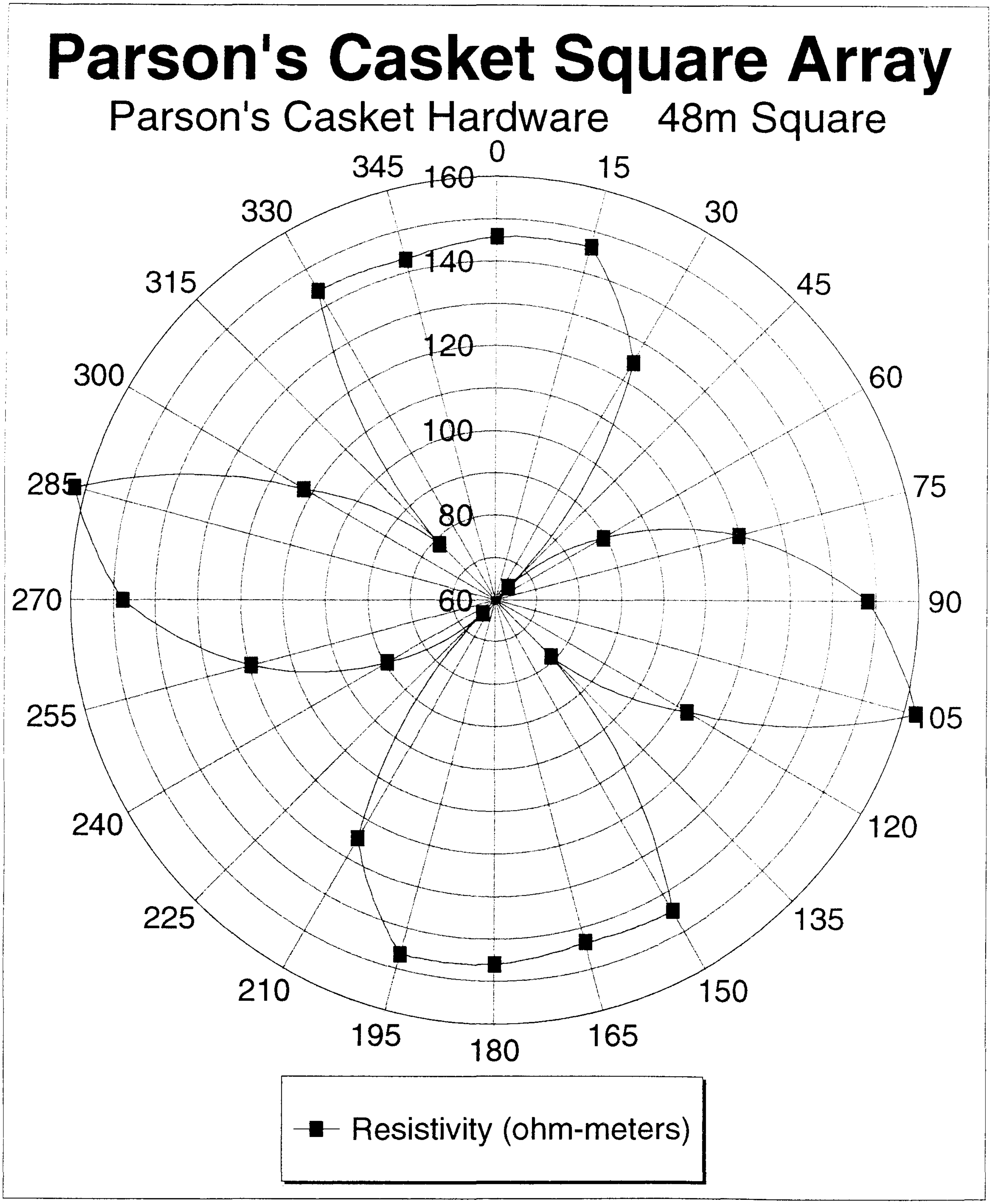
Lane, J.W., Haeni, F.P., and Watson, W.M., 1995, Use of a square-array direct-current resistivity method to detect fractures in crystalline bedrock in New Hampshire: Ground Water, v. 33, no. 3, p. 476–485.


Parson's Casket Square Array
Stone Quarry Rd. @ Rt.20 synth. comp.
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
315
330
345
500
400
300
200
100
0
4.22
6.03
8.49
12.03
14.40
24.01
33.92
48.06
67.89

Belvidere, Ill. Square Array

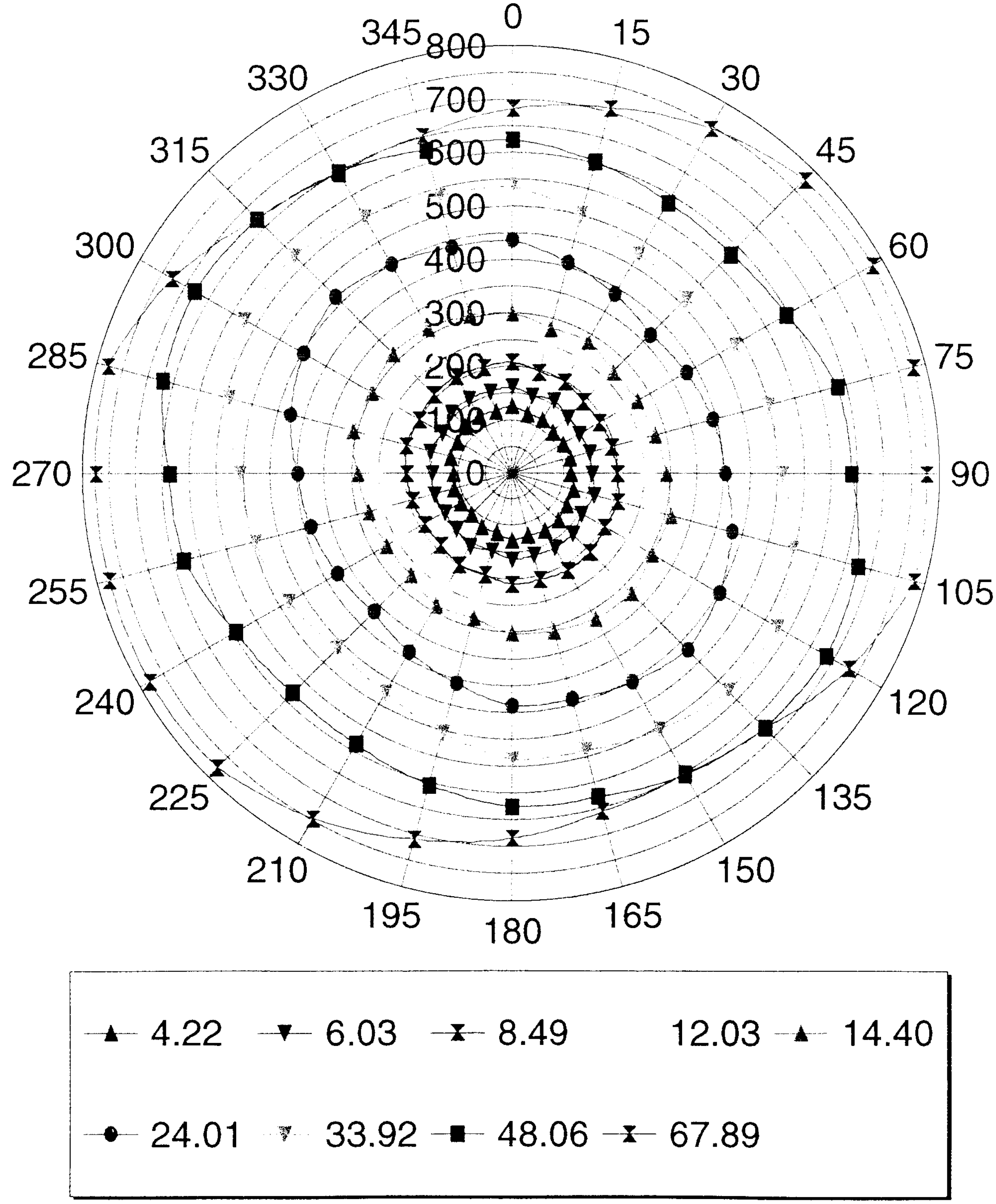
Parson's Casket Hardware Composite

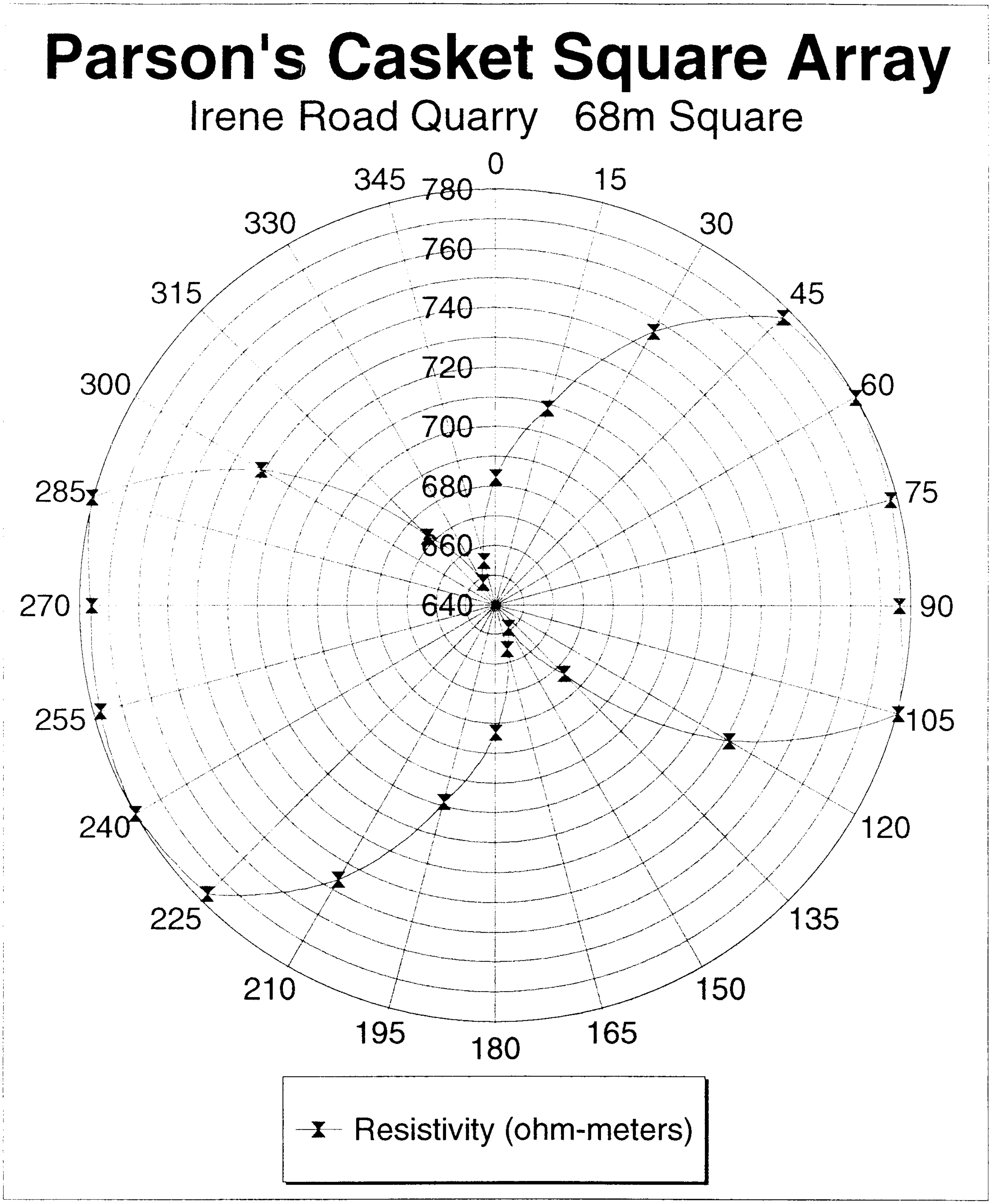


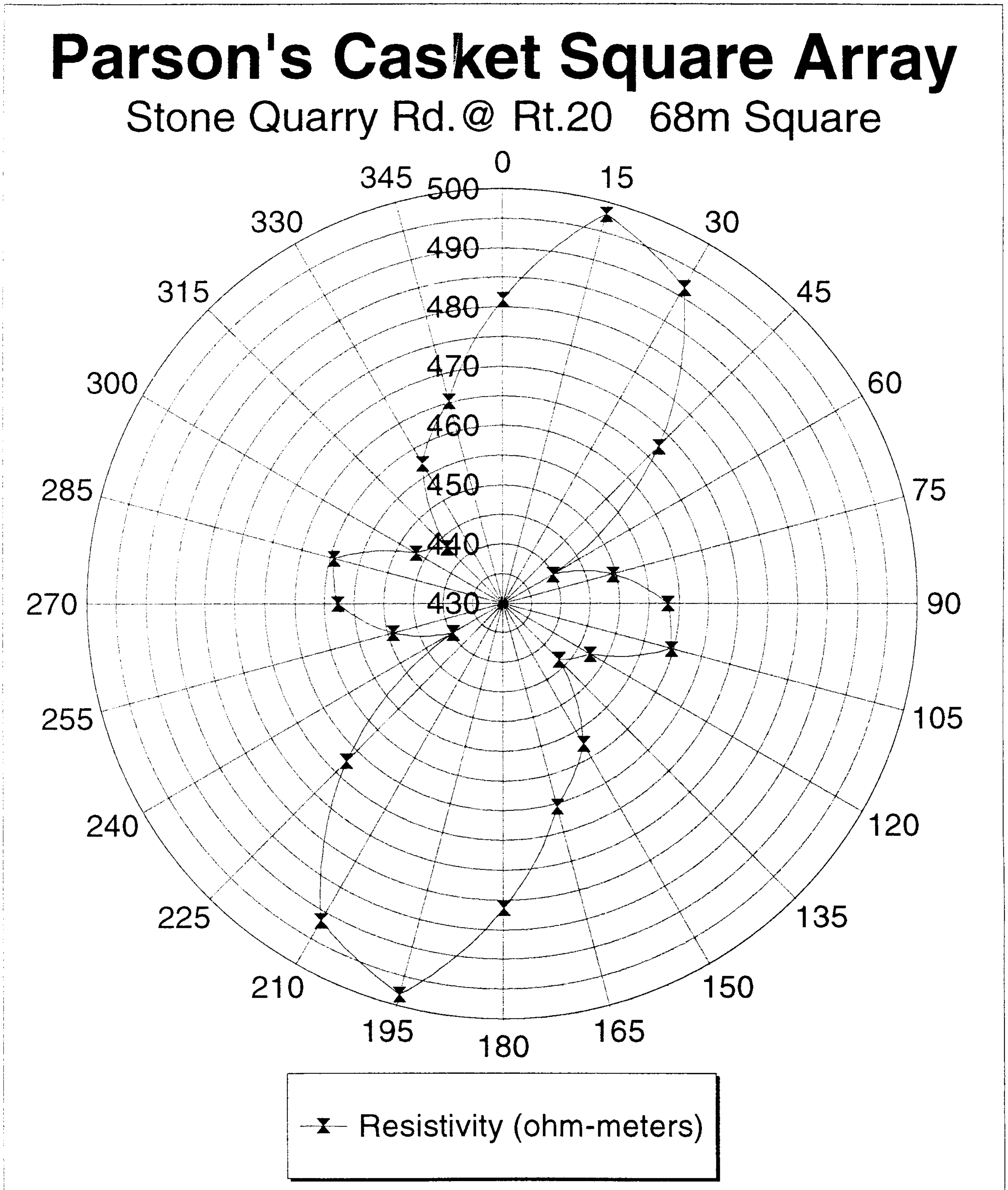

Parson's Casket Square Array
Parson's Casket Hardware 48m Square
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
315
330
345
160
140
120
100
80
60
Resistivity (ohm-meters)

Parson's Casket Square Array

Irene Road Quarry   Composite




Parson's Casket Square Array
Irene Road Quarry 68m Square
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
315
330
345
780
760
740
720
700
680
660
640
Resistivity (ohm-meters)


Parson's Casket Square Array
Stone Quarry Rd.@ Rt.20 68m Square
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
270
285
300
315
330
345
500
490
480
470
460
450
440
430
Resistivity (ohm-meters)