Well-Construction, Hydrogeologic, and Ground-Water-Quality Data in the Vicinity of Belvidere, Boone County, Illinois

By Timothy A. Brown and Patrick C. Mills

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CONTENTS

PLATES

[Plates are in pocket]

Figures

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

Multiply	By	To Obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
inch per year (in/yr)	25.4	millimeters per year

Temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by use of the following equation:

$$°F = 1.8(°C) + 32$$

Abbreviated water-quality units used in this report: Chemical concentrations and water temperature are given in metric units. Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million.

Specific electrical conductance of water is expressed in microsiemens per centimeter at 25 degrees Celsius (µS/cm). This unit is equivalent to micromhos per centimeter at 25 degrees Celsius (µmho/cm), formerly used by the U.S. Geological Survey.

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

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Abstract

The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency, is studying the hydrogeology and water quality of aquifers in the vicinity of Belvidere, Boone County, Ill. This report presents available well-construction, hydrogeologic, and ground-water-quality data compiled into a geographic information system (GIS) data base for this study. General instructions on manipulation and suggested applications of the GIS data base are included. Three plates show the location and type of wells and distribution of ground-water-quality data within the study area. The data are intended to aid investigators in present and possible future hydrogeologic studies in the vicinity of Belvidere.

The data base contains information for 725 water-supply and monitoring wells and lithologic borings. The sources of the data and methodology utilized to develop the data base are discussed. Well-construction and hydrogeologic data include well-identification label, latitude and longitude of the well location, type of well, aquifer to which the well is open, total depth of the well, depth to water in the well, the screened or open interval, and owner information. Water-quality data are tabulated for concentrations of selected volatile organic compounds (VOC's) and semivolatile organic compounds, inorganic compounds, and total pesticide, and specific conductance. Data are provided on a floppy diskette accompanying the report.

About 78 percent of the wells in the data base are water-supply wells, including eight municipal water-supply wells. About 40 percent of the wells are open to the glacial drift aquifer, and 53 percent are open to the Galena-Platteville aquifer. The remaining wells are open to multiple-bedrock aquifers. Of the 157 wells and borings with available water-quality data, 59 percent are open to the glacial drift aquifer, 24 percent are open to the Galena-Platteville aquifer, and 17 percent are open to multiple-bedrock aquifers. VOC's have been detected in six municipal and three domestic wells. Maximum contaminant levels of four VOC's have been exceeded periodically in four municipal wells.

INTRODUCTION

Volatile organic compounds (VOC's) and other potentially hazardous industrial-use constituents (contaminants), such as semivolatile organic compounds (SVOC's) and trace metals, have been detected in the glacial drift and bedrock aquifers supplying water to the *municipal* (italicized terms are defined in appendix 1) and *private* water-supply *wells* within the study area in the vicinity of Belvidere, Boone County, Ill. (fig. 1). Known and suspected sources for the contaminants are numerous, including closed landfills and industrial facilities and currently operating industrial facilities. Because these contaminants have been detected in municipal and private wells, the U.S. Geological Survey (USGS), in cooperation with the U.S. Environmental Protection Agency (USEPA), is studying the hydrogeology and water quality of the aquifers underlying the Belvidere area. This study is intended (1) to determine the general distribution and migration pathways of contaminants in the aquifers

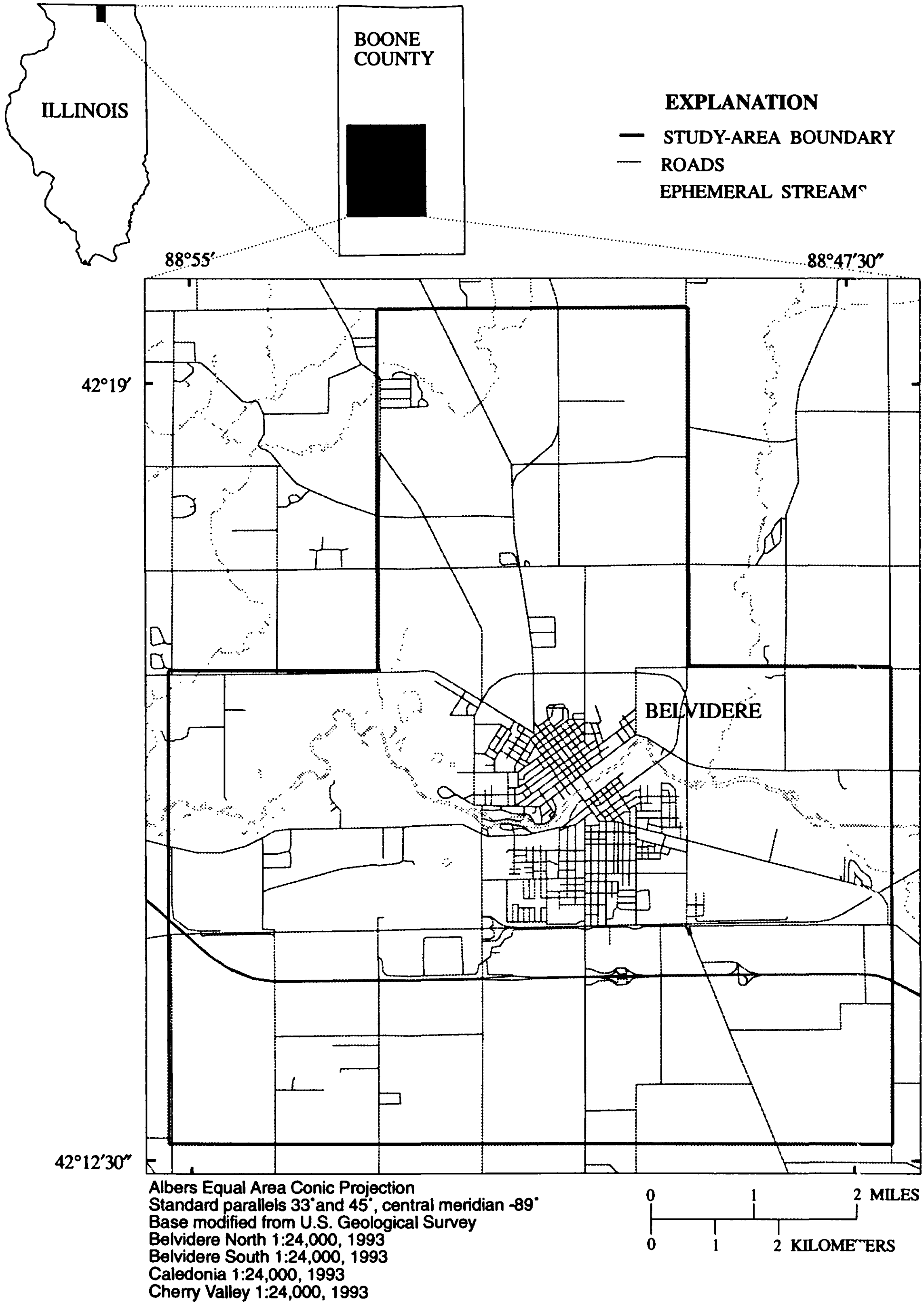


Figure 1. Location of study area in the vicinity of Belvidere, Ill.

and (2) to provide other investigators some of the hydrogeologic data necessary to evaluate ongoing or possible future localized ground-water-contamination problems in the regionalized context of the 56-mi^2 Belvidere area.

As part of this study, construction, hydrogeologic, and water-quality data for available wells and lithologic *borings* (hereafter referred to as wells because of the limited number of borings available) were collected. These data were used to determine the spatial distribution and temporal trends of historical water-quality data and to aid in selecting representative wells to be included in a planned water-level-measurement and water-quality-sampling effort. The available data and the data to be collected in the future can be utilized to formulate a conceptual model of the hydrogeology of the Belvidere area and as input to a numerical ground-water-flow model.

Purpose and Scope

This report presents and summarizes available construction, hydrogeologic, and water-quality data for 725 wells in the vicinity of Belvidere, Ill. The data, compiled into a data base using a geographic information system (GIS), are presented on three GIS-generated map plates and three data files provided on a floppy diskette accompanying the report. The report briefly describes the development, application, and limitations of the data base. A glossary of ground-water-well types and GIS terminology, a bibliography of the reference sources for the data, a listing and description of *items* included in the accompanying files, and two GIS-user programs also are included to aid the reader and users of the data base. The report is not intended as an operator's manual for the GIS data base. General familiarity with GIS and user experience with the specific GIS used for the data base are necessary for application of the data base.

Acknowledgments

The authors acknowledge the following people whom have contributed their time and knowledge to the study. Craig Thomas, Project Manager, U.S. Environmental Projection Agency, is recognized for his support and active participation during the study. Jim Grimes, Superintendent of the Belvidere Sewer and Water Department, is recognized for providing well-construction and water-quality data for the Belvidere municipal wells and information about other wells in the study area. Bill Hatfield, Boone County Health Department, is recognized for providing information about available water-quality data and for providing maps of the study area that were useful in identifying and verifying selected well locations.

DESCRIPTION OF THE STUDY AREA

The study area boundary in figure 1 represents the area of primary study interest and data collection. The area is roughly bounded by Orth Road to the north, Poplar Grove Road and Fern Hill Road to the east, Townhall Road and Wheeler Road to the west, and Huber Road to the south. Within this boundary, well-construction, hydrogeologic, and water-quality data for selected wells were compiled. Study-area boundaries were selected on the basis of the maximum area assumed to be affected by contaminant migration from known or suspected sources in the vicinity of Belvidere, Ill. Assumptions concerning the affected area were based on the (1) distribution of known and potential contaminant sources, (2) locations of high-capacity pumping wells in the area, and (3) general knowledge of the hydrogeologic setting. Data from a few additional wells outside the defined study area were included for study to ensure that the hydrogeologic effects of nearby natural hydrologic boundaries on ground-water flow and contaminant distribution were considered.

Area History

Belvidere, the county seat of Boone County, Ill., is a city of about 16,000 residents (Ryan, 1993). Since the late 1800's, Belvidere has had a mixed agricultural- and industrial-based economy. During the early to mid-1900's, notable local industries included the world's largest sewing machine manufacturing plant, a casket-hardware manufacturing facility, a machine-tool manufacturing facility, a brass-plating facility, a paper-container manufacturing facility, two food-processing plants, and a regional railroad-transfer station. Industrial facilities established after about 1950 include an automobile assembly plant, a foam-board-insulation manufacturing facility, a fertilizer distribution facility, and other small-scale manufacturing facilities.

In some cases, potentially hazardous wastes generated at the industrial facilities were disposed of on the grounds of the facilities or at one of three nearby landfills. Presently, one closed industrial facility and two of the three closed landfills are listed as National Priorities List (NPL) sites under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund. Environmental-contamination studies have been completed or are in progress at about 25 sites in the Belvidere area (pl. 1a). The studies range from small-scale leaking underground storage tank (LUST) studies and Superfund screening inspections of sites suspected as sources of ground-water contamination to large-scale (up to 1.5 mi^2) remedial investigations at the three Superfund sites.

Hydrogeologic Setting

Belvidere is in a broad lowland valley that overlies the Troy Bedrock Valley. The Valley axis is about 1 mi northwest of the city limits (fig. 2). Surface drainage is to the Kishwaukee River, which generally flows westward through the center of Belvidere, and to three principal tributaries, Piscasaw, Beaver, and Coon Creeks (pl. 1a). Land-surface altitudes range from about 750 ft along the Kishwaukee River to about 850 ft in the uplands in the northern and southern parts of the study area.

Long-term (1951–80) annual precipitation at the nearest (about 15 mi away) National Weather Service (NWS) station, Rockford WSO AP, averages 37 in/yr (U.S. Department of Commerce, 1951–80). The long-term minimum annual precipitation is 23 in/yr, occurring in 1976, and the long-term maximum annual precipitation is 56 in/yr, occurring in 1973.

The geology and hydrogeology of the study area have been described by a number of authors. Willman and others (1975), Willman and Kolata (1978), and Berg and others (1984) provide geologic and (or) hydrogeologic descriptions of the study area at a county-scale perspective. Roy F. Weston, Inc. (1988), Goldberg-Zoino & Associates, Inc. (1992), Mills (1993a, b, and c), and Science Applications International Corporation (1993) provide detailed geologic and hydrogeologic descriptions of the study area based on site-specific studies at hazardous-waste sites in the immediate vicinity of Belvidere.

The general geologic and hydrogeologic stratigraphy underlying the Belvidere area is shown in figure 3. The stratigraphic nomenclature used in this report does not necessarily follow the usage of the USGS. The geologic stratigraphy is that of the Illinois State Geological Survey (ISGS) (Willman and others, 1975). The hydrogeologic stratigraphy is slightly modified from that of the Illinois State Water Survey (Woller and Sanderson, 1974) to account for the differences in the spatial scales of the two investigations and conditions of the two study areas.

In order of increasing age, the principal aquifers in the study area are the glacial drift aquifer(s) of Quaternary age, the Galena-Platteville and the St. Peter Sandstone aquifers of Ordovician age, and the Ironton-Galesville and Elmhurst-Mt. Simon aquifers of Cambrian age. Specific aquifers of Ordovician age are referred to collectively as the Ordovician aquifer. Specific aquifers of Ordovician and Cambrian age are referred to collectively as the Cambrian-Ordovician aquifer (fig. 3).

The glacial drift aquifer(s) is composed of sand and gravel deposits that are up to 260 ft thick within the axis of the Troy Bedrock Valley (fig. 2). Along the eastern flanks of the valley, near the city of Belvidere, the sand and gravel deposits generally are about 30–40 ft thick (Hunter and Kempton, 1967). In some locations, the sand and gravel deposits are interbedded with glacial tills or fine-grained deposits of glaciofluvial origin. If there is very limited hydraulic connection between the individual sand and gravel deposits, and the sand and gravel and fine-grained deposits are of sufficient areal extent, each sand and gravel deposit could be considered a separate glacial drift aquifer. In some locations, the glacial-drift deposits consist primarily of fine-grained deposits with little or no sand and gravel.

The water table generally follows land-surface topography. The water table is about 20 ft below land surface except where the shallow ground water discharges into the Kishwaukee River and its tributaries. Because of the shallow position of the aquifer, it is regarded as highly susceptible to contamination (Berg and others, 1984).

The glacial drift aquifer (or fine-grained glacial-drift deposits) overlies the Galena-Platteville aquifer throughout most of the study area. In the southernmost part of the study area, the glacial drift aquifer (or fine-grained glacial-drift deposits) overlies the Maquoketa Group of Ordovician age. In the study area, the Maquoketa Group consists of shale deposits that presumably hydraulically isolate the glacial drift aquifer from the underlying Galena-Platteville aquifer.

The Galena-Platteville aquifer primarily is composed of dolomite; a few limestone and shale units also are present (Berg and others, 1984). In northern Illinois, limestone composes less than 20 percent of the aquifer, with no limestone units reported in the study area (Willman and Kolata, 1978). In the study area, the aquifer ranges in thickness from about 0 ft in the axis of the Troy Bedrock Valley (fig. 2) to 300 ft outside of the Troy Bedrock Valley. Ground water flows through a network of subvertical to subhorizontal fractures; the fracture openings are often enlarged by solution. The network of fractures in the dolomite deposits readily allow preferential movement of contaminants within the aquifer (Mills, 1993a, b, c; Kay and others, 1994).

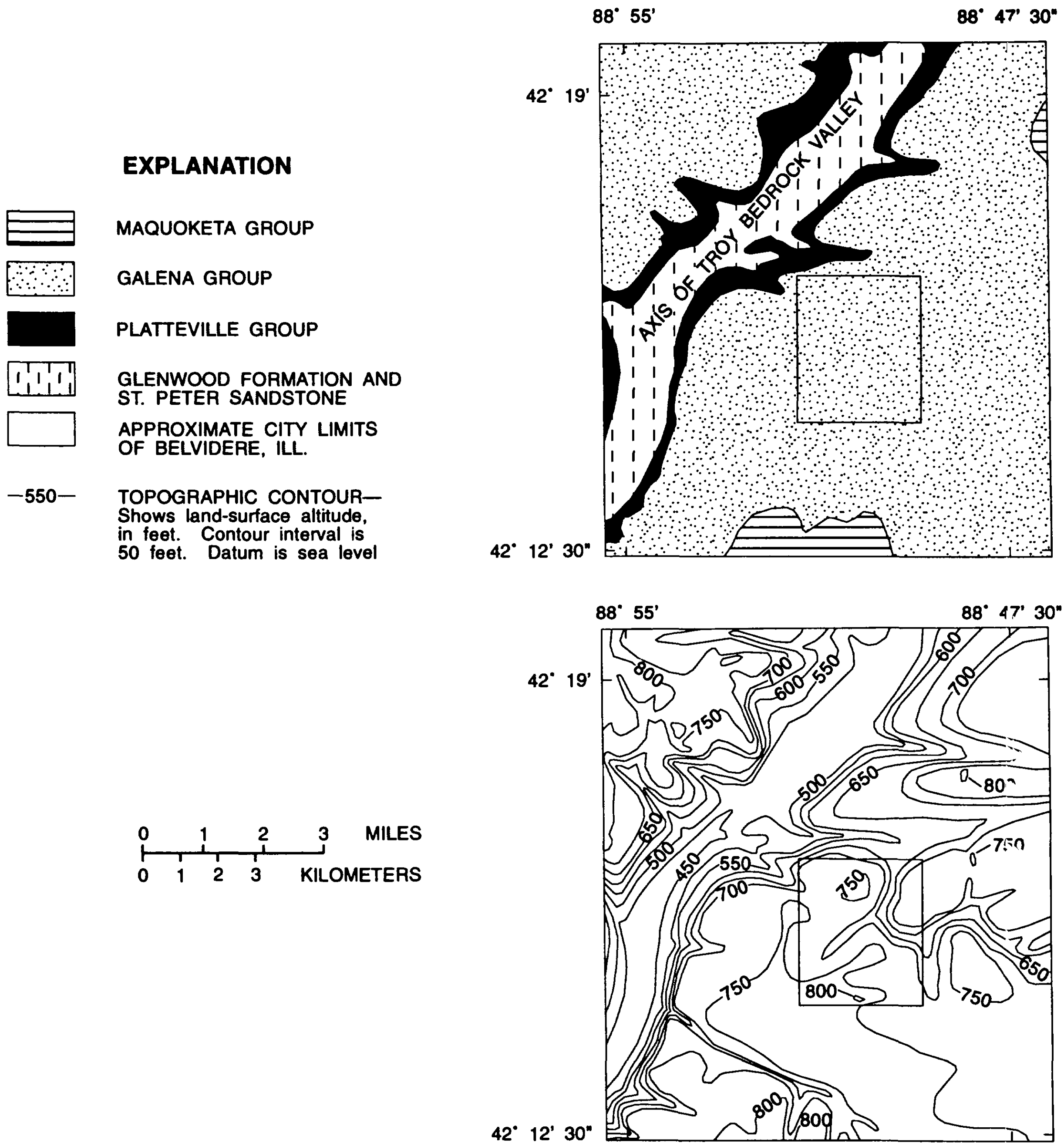


Figure 2. Surficial bedrock geology (A) and bedrock topography (B) in the vicinity of Belvidere, Ill. (modified from Berg and others, 1984, fig. 7 and fig. 10).

SYSTEM	SERIES	GROUP OR FORMATION	AQUIFER OR CONFINING UNIT			LOG[1]	THICK-NESS (FEET)	DESCRIPTION
QUATER-NARY	PLEISTOCENE	Undesignated	Glacial drift aquifer				0-260	Unconsolidated glacial deposits-pebbly clay (till), silt, sand and gravel Alluvial silts and sands along streams
							Fissure Fillings	Shale, sandy, brown to black
ORDOVICIAN	CINCINNATIAN	Maquoketa	Confining unit				0-80	Shale, silty, dolomitic, greenish gray, weak (Upper unit) Dolomite and limestone, white, light gray, interbedded shale (Middle unit) Shale, dolomitic, brown, gray (Lower unit)
	CHAMPLAINIAN	Galena	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						
		Glenwood	Con-fining unit				5-60	Shale, dolomite, sandstone; silty
		St. Peter Sandstone	St. Peter aquifer				185-385	Sandstone, fine to coarse grained; locally cherty red shale at base
CAMBRIAN	CROIXAN	Eminence	Eminence-Potosi aquifer				20-55	Dolomite, light colored, sandy, thin sandstones
		Potosi						Dolomite, fine-grained, gray to brown, drusy quartz
		Franconia	Franconia aquifer				70-85	Dolomite, sandstone and shale, glauconitic, green to red, micaceous
		Ironton	Ironton-Galesville aquifer				140-165	Sandstone, fine to coarse grained, well sorted; upper part dolomitic
		Galesville						
		Eau Claire	Confining unit				380-485	Shale and siltstone, dolomitic, glauconitic; sandstone, dolomitic, glauconitic
		Elmhurst Member	Elmhurst-Mt. Simon aquifer				1,600	Sandstone, coarse grained, white, red in lower half; lenses of shale and siltstone, red, micaceous
		Mt. Simon						
PRE-CAMBRIAN								Granitic rocks

[1]Unconformable stratigraphic boundaries not designated as such in figure.

Figure 3. Generalized geologic and hydrogeologic stratigraphy in the vicinity of Belvidere, Ill. (modified from Woller and Sanderson, 1974, fig. 1).

The Galena-Platteville aquifer overlies the Glenwood Formation, which consists of interbedded shale and argillaceous dolomite and sandstone. The thickness of the uppermost Harmony Hill Shale Member of the Glenwood Formation seems to affect the extent of hydraulic connection between the Galena-Platteville aquifer and the underlying St. Peter Sandstone aquifer (Kay and others, 1989, 1994; Mills, 1993b, c).

The St. Peter Sandstone aquifer is composed of well-rounded, well-sorted quartz arenite. The aquifer is pumped over a large area of northern Illinois, surpassed only by the pumpage from the two underlying Cambrian sandstone aquifers: the Ironton-Galesville aquifer and the Elmhurst-Mt. Simon aquifer. Approximate thicknesses of the three sandstone aquifers are given in figure 3. The tops of these aquifers are probably deep enough not to be appreciably affected by contamination. However, a study by Mills (1993a, b, c) indicates that VOC's may have migrated, under the possible influence of pumping at a nearby municipal well, into the upper part of the St. Peter Sandstone aquifer underlying a USEPA Superfund site in Belvidere, Ill.

In the vicinity of the study area, the assumed hydrologic boundaries for ground-water flow in the glacial drift aquifer are Piscasaw, Coon, and Mosquito Creeks to the east of Belvidere, Kishwaukee River and South Branch Kishwaukee River (about 2 mi west of the study area) to the west of Belvidere, and the upland areas north and south of Belvidere (pl. 1a). The Kishwaukee River, flowing through the study area, and the Troy Bedrock Valley, trending northeast to southwest (fig. 2), are assumed to be sinks for shallow ground-water flow in the glacial drift aquifer and possibly are sinks for shallow ground-water flow in the Galena-Platteville aquifer.

DESCRIPTION OF THE DATA BASE

The data base described herein is intended to be used by the USGS, as well as other investigators interested in the hydrogeology and water quality in the vicinity of Belvidere, Ill. With the possible use of the data base by other investigators, it is important that principal features of the development, application, and limitations of the data base be understood.

Data-Base Development

The data base was developed as a tool for the analysis of the hydrogeology and ground-water quality of the study area. In developing the data base, the objective was to assemble all readily available data so that the following information could be determined: (1) the hydrogeologic framework of the study area, (2) the approximate number of wells in the study area along with the areal and aquifer distribution of the wells, (3) the contaminant distribution in the aquifers and the number of wells affected by migrating contaminants, and (4) identification of the wells that may be most useful for evaluating ground-water flow and contaminant migration in the aquifers underlying the study area. The intended analytic use of the data base, especially graphical analysis and presentation of the data, and the large amount of data collected as part of the study resulted in the selection of a GIS for the data base.

The ARC/INFO[1] GIS, developed by Environmental Systems Research Institute, Inc., was selected as the specific GIS for development of the data base. The ARC/INFO system was selected because (1) a suite of analytical tools are provided that can be utilized to emphasize and interpret trends in the data and (2) it is the principal GIS in use by the USGS. This system also is available to many other potential users of the data base. A variation of the UNIX operating system is used in the USGS ARC/INFO system. This operating system was selected because it is the principal operating system utilized by the USGS for GIS applications. A complete discussion of the use of ARC/INFO is provided in the ARC/INFO user's guide (Environmental Systems Research Institute, Inc., 1992a).

The data base developed for this study consists of three INFO data files that contain the well-construction, hydrogeologic, and water-quality data and nine related spatial *coverages*. The coverages contain the spatial data that represent the surface features of maps generated from the data base. The coverages also contain the information necessary to link the data in the data base to their respective geographic locations.

The well-construction, hydrogeologic, and water-quality data for the 725 wells included in the INFO data files were obtained from several reference sources. The principal source for well-construction and hydrogeologic data was drillers' logs from the ISGS Records Section. The ISGS Records Section is a repository for drillers' logs for the State and contains logs for water wells and lithologic borings since about 1950. Drillers' logs also are available from the Illinois State Water Survey, including logs

[1]Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

before about 1950. These older logs were not included in the study because (1) most of the wells probably have since been abandoned, (2) hydrogeologic information is often not included in the logs, (3) substantial errors in the locational information are often present, and (4) because of the age of the logs, ownership information generally is not accurate. Other sources of well-construction, hydrogeologic, and water-quality data were the USGS Ground-Water Site Inventory (GWSI) data base, Superfund screening site inspection reports and remedial investigation reports, Illinois Environmental Protection Agency (IEPA) files on LUST sites, records from the Belvidere Municipal Sewer and Water Department, and information provided by the owners of wells in the study area. A bibliography of the data-reference sources is provided in appendix 2.

Generally, well and water-quality data included in the data base only represent those data available before January 1993. Most drillers' log data from the ISGS Records Section were obtained before September 1992 (generally representing wells constructed before January 1992). Data from the IEPA LUST files were obtained in October 1992. Data from the Belvidere Sewer and Water Department were obtained before December 1992. Available hydrogeologic reports utilized as sources of data generally were obtained before June 1992.

Of the 725 well-construction records in the data base, about 600 have sufficient owner or address information to allow field location of the wells. The ownerships and addresses were verified for approximately 380 of these wells.

The three INFO data files are named WELLINFO, QWDATA, and QWTYPE. Separate INFO data files were used to allow operations to be performed on the data files without affecting other files created and used in analysis with the ARC/INFO software, specifically the *feature-attribute table*. Data in the feature-attribute table must be kept in a specific order to maintain the link to the geographic locations.

The file WELLINFO contains ownership, well-construction, and hydrogeologic data. These data include the well-identification label and the type of well (PRI, signifies a private well; MUN, municipal well; MON, *monitoring well*; BOR, boring). Where available, the following are included: the well-owner's name, address, and telephone number; the year the well was installed; the altitude of the top of the well casing; the total depth of the well; the approximate depth to water in the well; the altitude of the water level in the well; the depth of the screened or opened interval of the well; the USGS code for the aquifer(s) to which the well is open (110QRNR signifies Glacial Drift; 365GLPV, Galena-Platteville; 365STPR, St. Peter Sandstone; 365ODVC, Ordovician; 365OVCB, Cambrian-Ordovician); notification if the abandonment of the well is confirmed (Y, yes; N, no); and notification if water-quality data are available for the well (Y, yes; N, no). The file WELLINFO also includes an alternate well-identification label for wells used in more than one hydrogeologic study. Notification of different identification labels for the same well ensures against the unintended duplication of inventoried wells and alerts the database user to the various site reports from which the well data were derived. The items in WELLINFO and the characteristics of each item are listed in appendix 3. An American Standard Code for Information Interchange (ASCII) format data file of WELLINFO is found on the floppy diskette accompanying the report.

The file QWDATA contains water-quality data obtained from sampling the wells. The water-quality data include the well-identification label, date(s) of sampling, the depth of the sample (if taken from a discretely packed interval in a bedrock well), laboratory-determined concentrations for 60 VOC's and SVOC's, 16 metals, chloride, nitrate, and total pesticide concentration, and specific conductance. If an analysis was not done for a specific constituent, the concentration for that constituent was assigned a value of −1. If the concentration of a constituent was below the detection limit of the analysis, or if a constituent was not detected, the concentration was assigned a value of 0. The VOC, SVOC, and total pesticide analytes included in QWDATA represent all synthetic organic compounds detected in ground water in the Belvidere study area. The metal analytes were selected on the basis of their potential hazard to health at concentrations above maximum contaminant levels (MCL's) and their association with current or past industrial activities in the Belvidere area. Chloride, nitrate, and specific-conductance data were included because of their usual association with industrial or waste-disposal activities. For sites with extensive, available water-quality data, only data from selected sample dates were included. The selected dates represent sampling periods when there were data for VOC's and SVOC's and (or) data for a majority of the selected inorganic analytes. The items in QWDATA and the characteristics of each item are listed in appendix 3. An ASCII format data file of QWDATA is on the floppy diskette accompanying the report.

The file QWTYPE contains the water-quality data condensed into three categories for each entry in the QWDATA file. The categories are organic constituents, inorganic constituents, and total pesticide concentration. If any constituent included in the respective category was detected, the category was assigned a value of 1. Similarly, if an analysis was done for any of the constituents in a category, and none were detected, the category was assigned a value of 0. If an analysis was not done for any of the constituents in a category, a value of –1 was assigned to the category. The purpose of this file is to simplify the mapped presentation of the data. The items in QWTYPE and the characteristics of each item are listed in appendix 3. An ASCII format data file of QWTYPE is on the floppy diskette accompanying the report.

Four USGS 1:24,000-scale topographic maps were used as the basis for the spatial coverages in the GIS. The maps include Belvidere North (1970; photorevised, 1993), Belvidere South (1969; photorevised, 1993), Caledonia (1970; photorevised, 1993), and Cherry Valley (1968; photorevised, 1993) quadrangles. Coverages for roads, hydrography, and railroads were converted from digital line graphs (DLG's) of the USGS maps. To meet study needs, data in the INFO data files and spatial coverages will be selectively updated as additional data (for new and previously listed entries) become available.

Study-area-boundary and LUST-site coverages were generated from latitude and longitude degree-minute-second (DMS) coordinates. Industrial and landfill site boundaries were obtained from reports and were manually digitized from paper copies of the USGS topographic maps. A well coverage was generated from Lambert Conformal Conic (Lambert) and DMS coordinates. The Lambert coordinates were used for well locations obtained from the ISGS Records Section; an algorithm utilized by the ISGS converts the township-range-section well location provided on the drillers' log to the Lambert coordinates. The DMS coordinates were digitized directly from the USGS maps for wells and LUST sites identified from sources other than the ISGS Records Section. The study-area boundary was generated by manually connecting the digitized corner points with arcs using the ARCEDIT program. The DMS and Lambert coordinates were *projected* to Albers Equal-Area Conic (Albers) coordinates and then generated into point coverages. The Albers projection is consistent with the projection of other available USGS coverages, including coverages for county and State boundaries.

The *root mean square (RMS) error* of the data digitized by the USGS was checked. The error was 0.003 or less, which is the customary standard for manual digitizing of 1:24,000 scale maps (Environmental Systems Research Institute, Inc., 1992a).

After the coverage for the wells was completed, the three INFO data files were linked to the coverage. The link was established between the feature-attribute table of the well coverage and the INFO data files by using *relates*. The relates are based on an item common to all of the files, the well-identification label. The separate INFO data files can also be related with the same procedure.

Whenever possible, the well-identification labels consisted of the 5-digit number assigned by the ISGS Records Section for wells in Boone County (for example, 00003). For wells without an apparent ISGS identification number, a unique label was assigned based on the source of the well data. Wells included in the USGS GWSI were assigned a 15-digit label based on the DMS location of the well (the first six digits denote degrees, minutes, and seconds of latitude, the next seven digits denote degrees, minutes, and seconds of longitude, and the last two digits (assigned sequentially) identify the wells or other sites within a 1-second grid). Monitoring wells or private water-supply wells used in site-specific studies were assigned the well-identification label provided in the bibliographic reference to the site (for example, MW01); an alphabetic prefix was assigned to the label (1) because monitoring wells at different sites often had nonunique labels and (2) to easily relate a well(s) to a specific study site (for example, BL1MW01, monitoring well 1 at Belvidere Municipal Landfill No. 1). Finally, wells with none of the above-described criteria for assigning an identification label were assigned a label based on the street name and address (for example, LA1025, 1025 Locust Avenue).

Data-Base Application

General guidelines, including principal commands and procedures, for maintaining and updating the INFO data files and spatial coverages are given below. Suggestions for additional applications of the data base also are provided.

The INFO data files are maintained and updated with the INFO program. Well-construction, hydrogeologic, or water-quality data already in the data files can be changed with the UPDATE command. The user is prompted for the record of information to change. After the record number is entered, the information for that record is displayed, followed by an input prompt. If a new record needs to be appended to one of the data files (for example, a new well site), the ADD command is used. The user is prompted in INFO for all items defined in the data-file record. If it is determined that a new category of data for the wells needs to be added (for example, an additional VOC), the ADDITEM command is used from the ARC prompt. More information on these commands is available in the INFO Reference Manual (Environmental Systems Research Institute, Inc.,

1991) or ARC Command References (Environmental Systems Research Institute, Inc., 1992b).

The Belvidere ground-water data base will be utilized for data analysis in the study (1) to interactively view and query the data and (2) to generate maps of well locations and types and contaminant distributions. The process of using the data base was automated with a series of *macros*. The macros, written in the Arc Macro Language (AML), allow users unfamiliar with ARC/INFO to easily view the data or generate map files. The menu system for data query allows the user to view the data on a graphics terminal simultaneously with its map location. The map programs provide an easy way to generate maps and allow standard formatting for maps. In addition, maps can easily be regenerated if the data base is updated. Listings of the programs used to create the maps are included in appendix 4.

The macros must be executed from within the ARC program because the macros were written in AML. The &RUN command executes the program files. The syntax of this command is as follows: &RUN <AML filename> {arguments}. The syntax of the query command is &RUN QUERY.AML 9999. The argument 9999 signifies that ARC is running in an UNIX *X-window* environment. A blank ARCPLOT display window and the main menu appear on the screen (fig. 4) when the program is executed.

The menu is used to draw any of the spatial coverages available in the data base. The coverages are represented by symbols consistent with those on the hard-copy maps (pls. 1 and 2). Once a coverage has been drawn by selecting the appropriate command from the DRAW column, it can be queried by selecting the appropriate name from the QUERY column. The user is able to query the well, industrial and landfill site, and LUST-site coverages. The names of the industrial, landfill, and LUST sites can be obtained in this manner. A new menu appears on the screen (fig. 5) when the user chooses to query the well data.

Various *widgets* on the well-data menu allow the user to select and display the well data. All of the widgets are activated with the left button of the computer mouse. Any number of wells can be selected from the map display, after which the data for each well can be viewed. The well location(s) of interest is selected by pressing the SEL MANY button and then positioning the cursor with the computer mouse on the well symbols displayed on the map. If more than one well location is selected, the user can move through the selected *stack* with the NEXT button. It is possible to move back to the beginning of the stack by pressing the FIRST button when the end of the stack is reached. If the location of a well is unknown, but the well-identification label is known, the well can be selected by pressing the SEL ID button. The user is prompted for the well-identification label. The well data is displayed after the well-identification label has been entered. Pressing the WHERE button shows the location corresponding to the information being shown. If it is unclear which well location is highlighted, the REFRESH button on the main menu will redraw the map in the display window showing only the current well location. To see the locations of the rest of the wells, the SHOW ALL button must be pressed. This is recommended prior to selecting new well locations.

If water-quality data are available at a well location, the DATE field at the top of the WATER-QUALITY DATA section of the menu will be filled. All of the water-quality records have a sample date; however, not all of the entries have a sample depth, so it is the date field that indicates if water-quality data are available. The scroll list shows all of the items contained in the QWDATA data file. The user can scroll through the list and choose any item of interest. An arrow to the right of the list points to the value for the item. Many of the wells have been sampled on more than one occasion or at more than one depth. As a result, the QWDATA file has multiple records for these wells. When a well location is selected, all of the related records are also selected; that is, records for different sampling dates or depths. To move through the selected stack, the NEXT and FIRST buttons are used in the manner previously explained.

The ARC/INFO graphics files to produce plates 1a and 2 can be automatically generated by executing the proper AML. The AML file names are BELVMAP.AML and DATAMAP.AML. The file BELVMAP.AML is used to generate the map composition and graphics file for plate 1a, which shows the location of all wells included in the INFO data file, WELLINFO. The file DATAMAP.AML is used to generate the map composition and graphics file for plate 2, which shows well locations where water-quality data are available (that is, wells included in the INFO data file, QWDATA). The programs generate a map composition and then plot the composition into an ARCPLOT graphics file. The graphics file can then be sent to a plotter to obtain a hard copy of a map.

If a pen-type plotter is used, it must be properly configured prior to sending the graphics file. The plotter is configured by selecting and manually loading the desired pens and paper into the plotter. It is important to put the correct pen color in the appropriate slot on the plotter. If the proper pens are not used, colors will differ between the plotter and terminal. The standard is for black to be pen No. 1, the pen in the first slot. Red is 2, green 3, and blue 4. Pen

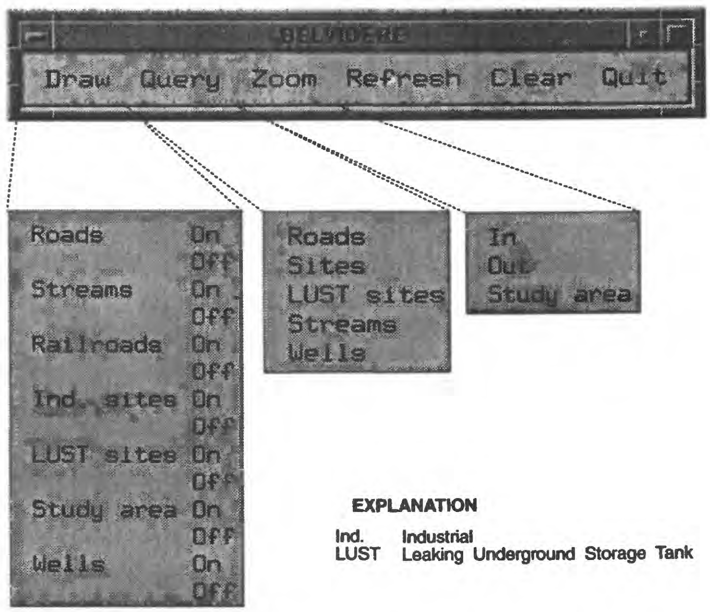
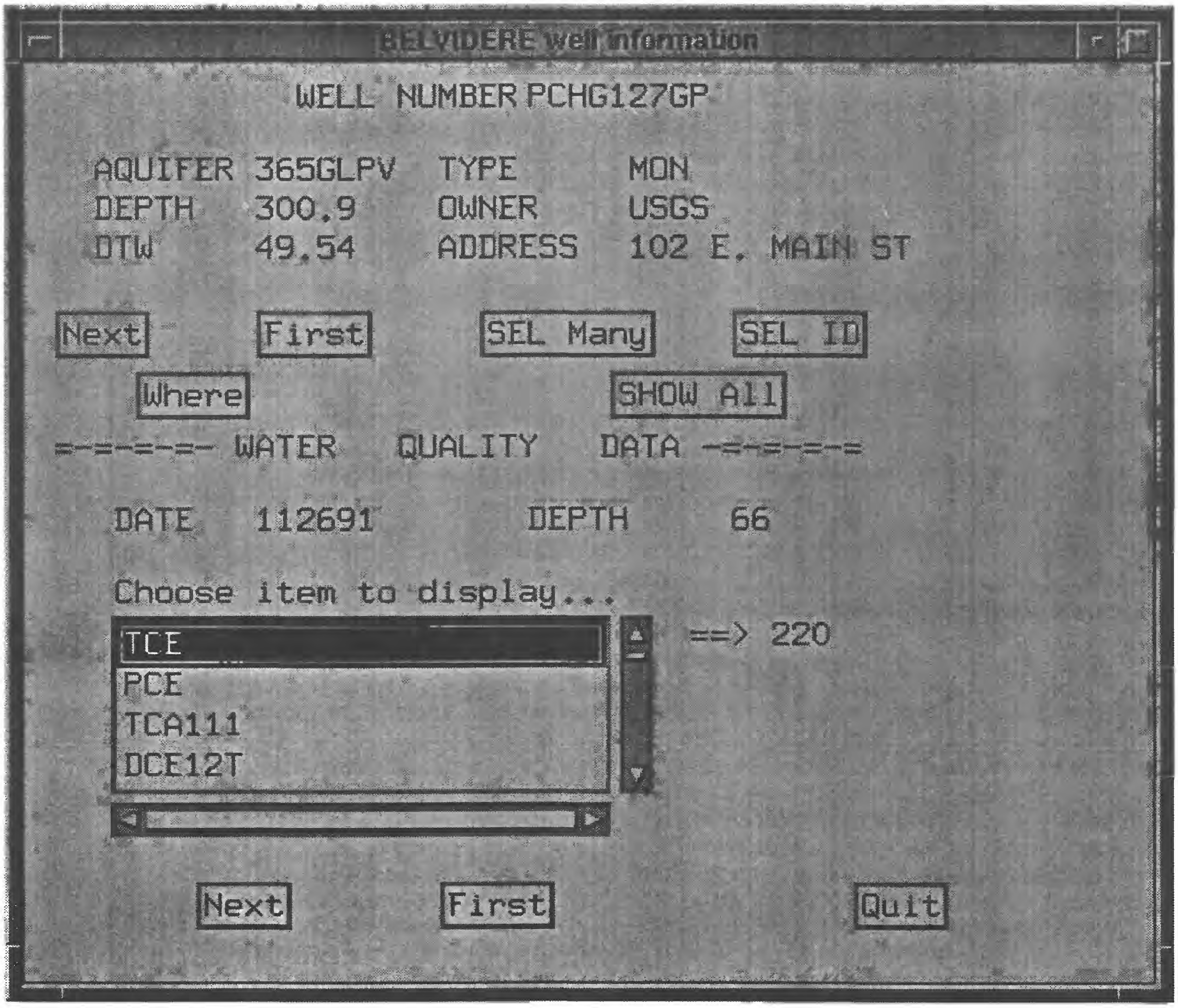


Figure 4. Main menu for query of the data base for the ground-water study in the vicinity of Belvidere, Ill.



EXPLANATION

PRI	Private
DTW	Depth to Water
WELLNUM	Well Identification Label
TCE	Trichloroethene
PCE	Tetrachloroethylene
TCA111	1,1,1-Trichloroethane
DCE12T	1,2-Dichloroethene (total)

Figure 5. Subordinate menu of the data base for query of construction, hydrogeologic, and water-quality data associated with a selected well.

No. 5 can be any other color that it is readily visible (orange, for example).

Once the plotter has been configured, the graphics file can be sent to the plotter. From the ARC prompt, the command PLOT <graphics file> {plotter name} is issued. This command transmits the file to the plotter defined by the ARC system variable {plotter name}.

Other possible uses of the data base include plotting potentiometric maps and as a pre- and post-processor to digital ground-water models, such as MODFLOW (McDonald and Harbaugh, 1988) or MODPATH (Pollock, 1989). Water-level data for each well location can be input into the *TIN* module of ARC/INFO. This allows quick computation of the potentiometric contours.

Once this interpretation has been done, the data can be input into the *GRID* module. Programs are available utilizing GRID to set up data input files for the MODPATH program. Similarly, programs are available that convert the output of MODFLOW and MODPATH into ARC coverages (Sonenshein, 1992). The spatial coverages can then be presented in map form as an overlay of the base maps already prepared. The overlay coverages will greatly aid in determining ground-water-flow direction and possible contaminant sources.

Data-Base Limitations

Some limitations associated with the completeness and accuracy of well-related and spatial-coverage data are included in the data base. An exhaustive search for all sources of well data and verification of the accuracy of the data were not done because such a search and verification was beyond the scope of the study. However, the well-related data included in the data base are considered to (1) represent the majority of data available for the study area and (2) provide sufficient data to properly characterize the hydrogeology and water quality of the aquifers underlying the study area.

Most well-ownership and well-location data obtained from drillers' logs supplied by the ISGS Records Section have not been verified. Inaccuracies in the hydrogeologic data from the logs also may be present. Monitoring-well and municipal-well ownership and location data generally are accurate. Inclusion of the name, address, and telephone number in the data base generally signifies that the ownership and location of a well was verified during the development of the data base. As previously mentioned, abandonment of wells is indicated in the INFO data file, WELLINFO, only if abandonment status is confirmed. It is likely that some wells included in WELLINFO as actively used wells are abandoned and the source files have not been updated.

The potential for duplication of some well records is present because the wells were identified from many different sources. Although attempts were made to identify and eliminate duplicate records, identification and elimination of all duplicate well records was difficult because of inaccuracies in map locations of the wells, changes in well ownership, and use of different well-identification labels for the different sources.

Several limitations related to the water-quality data are included in the data base. (1) A listing of "not analyzed" (signified by a value of –1) in the INFO data file QWDATA may, in some cases, represent constituents for which analyses were done but not detected. It is suspected that, in some of the reference sources, only data for detected analytes are presented. (2) Whereas the concentration data for metals generally represent dissolved concentrations, in some cases, total concentrations may be presented. Documentation to make this determination was not always included in the reference sources.

The analytic data included in QWDATA represent a wide range of concentrations. Because of the variety of detection and reporting levels and the large number of analytes, detection and reporting levels are not included in the data base. Because of the exclusion of detection and reporting levels for the water-quality data, caution should be applied in trend analyses for analytes with consistently low concentrations.

Limitations of the spatial-coverage data included in the data base are related to the completeness and accuracy of the road and hydrography coverages. The USGS 7.5-minute topographic maps, the basis for the road and hydrography coverages, originally were prepared during 1968–70. Between 1968 and 1993, many new roads were built, old roads were rerouted, and the geometry of stream drainage in the area also changed. Most of these changes were incorporated into the USGS 7.5-minute topographic maps updated in 1993. However, more recent changes may have occurred that make the data inaccurate. Road- and hydrography-location data have been updated in the data base only in selected areas to aid in identifying well locations.

The well locations obtained from the ISGS Records Section were located with information from the drillers' logs. This information is often approximate. At some map locations, there is an error of up to 1 second in latitude and (or) longitude. This error represents a distance of about 60 ft (at 1:24,000 scale), which is relatively minor when compared to the size of the study area and the scale of the maps presented, but may be apparent when relating the location of a well to a nearby road. Subsequently, a well may be shown on the maps on the wrong side of a road. For such cases, if the actual relative location of the well was known, the mapped location of the well was accurately plotted.

Data Archive

Well-construction, hydrogeologic, and water-quality data included in the INFO files, WELLINFO, QWDATA, and QWTYPE are provided on a high density floppy diskette. The data files are provided in ASCII format because of their large size. This format allows the data to be easily transported into a variety of computer-based data bases and spreadsheets. The diskette can be read with a DOS-compatible personal computer. The files require about 570 kilobytes of disk space. Items in the WELLINFO, QWDATA, and QWTYPE files and the characteristics of each item are listed in appendix 3.

WELL-CONSTRUCTION, HYDROGEOLOGIC, AND GROUND-WATER-QUALITY DATA

The well-construction and hydrogeologic data associated with 725 wells and borings and the water-quality data associated with about 157 wells and borings are presented and summarized in the following sections of this report. Review of the data is useful in (1) providing a general representation of the spatial distribution of available data and a preliminary understanding of the extent of aquifer contamination and (2) identifying locations in need of additional (new or updated) data in order to accomplish the objectives of the study.

The summary statistics should be considered as approximate representations of the well data. Much of the data, including classification of aquifer and well types, was based solely on inspection and interpretation of information included on unverified drillers' logs for private wells. The subcategories for private well types included in the following section of this report are not included in the well types shown on the plates because of the high potential for error associated with classification of well types.

Well-Construction and Hydrogeologic Data

The location of wells included in the WELLINFO data file are shown on plates 1a and 1b. Locations of abandoned wells are not shown. In addition to the well location and well-identification label, the type of well (municipal, *industrial*, or private water-supply well; monitoring well; or boring); the aquifer(s) the well is open to; and industrial, landfill, and LUST sites with available water- or soil-chemistry data are shown on plate 1a. Ten areas where wells are clustered (subdivisions, industrial sites, and landfills) and the well-identification labels that cannot be easily shown at the larger scale of plate 1a are detailed on plate 1b.

Of the wells and borings included in the study, 567 (about 78 percent) are water-supply wells, 130 (about 18 percent) are monitoring wells, and 28 (about 4 percent) are borings. Of the water-supply wells, 559 (about 99 percent) are private and 8 (about 1 percent) are municipal. The private wells include 530 (about 95 percent) *domestic*, 17 (about 3 percent) industrial, 10 (about 2 percent) *commercial*, and 2 *institutional wells*. Of the 559 private wells, 19 (about 3 percent) are assumed to be abandoned based on failed attempts to locate the wells.

The monitoring wells identified in the study primarily are clustered around seven sites. Three of the sites are landfills, two of which are Superfund sites. Three of the sites are industrial, one of which is a Superfund site and one a LUST site. Twenty-seven monitoring wells distributed among three small LUST sites, such as gasoline stations, were also identified. Of the 130 monitoring wells, 6 are assumed to be abandoned based on failed attempts to locate the wells and indications from the referenced investigative reports.

Most private wells are in areas near or beyond the city limits of Belvidere. The municipal water system was established about 1890, and some private wells drilled in the urbanized inner part of the city apparently have been abandoned. Only about 30 domestic, 9 industrial, and 4 commercial wells were identified within the city limits of Belvidere; attempts at locating these wells indicated that about 30 (about 70 percent) may still be in use.

Of the 725 wells and borings, 290 (40 percent) of the wells are open to the glacial drift aquifer and 380 (about 52 percent) are open to the Galena-Platteville aquifer. Only 6 wells are open to the St. Peter Sandstone aquifer, 17 wells are open to the Ordovician aquifer (Galena-Platteville and St. Peter Sandstone aquifers), and 9 wells are open to the Cambrian-Ordovician aquifer. No aquifer information is available for 22 of the wells.

Only 16 nonindustrial private wells in the Belvidere area are open to aquifers deeper than the Galena-Platteville aquifer; those wells are open to either the St. Peter Sandstone aquifer or the

Ordovician aquifer. Of the 17 industrial wells, 7 are open to the glacial drift aquifer and 2 are open to the Galena-Platteville aquifer. Six industrial wells are open to the Ordovician aquifer and two to the Cambrian-Ordovician aquifer. One municipal well is open to the glacial drift aquifer (well No. 9, designated BMW9 in the data base), one to the Ordovician aquifer (BMW5), one to the St. Peter Sandstone and deeper units of the Cambrian-Ordovician aquifer (BMW8), and five to the Galena-Platteville aquifer and deeper units of the Cambrian-Ordovician aquifer (BMW2, BMW3, BMW4, BMW6, BMW7).

A preliminary understanding of ground-water flow in the study area based on available data follows. Reported water levels from wells range from about 1 to 155 ft below land surface. The water table is near or below the bedrock surface in the south-central part of the study area, where the bedrock is nearest land surface. Depth to water generally increases with well depth and aquifer depth; however, no conclusions can be made regarding the extent of hydraulic connection between the aquifers. Results from site studies indicate that the extent of hydraulic connection between aquifers may vary locally. Caution should be used when comparing water levels in the aquifers because of the variety in well construction, techniques and conditions of measurement, and dates of measurement.

Ground-Water-Quality Data

The wells included in the QWDATA data file are shown on plate 2. In addition to the base features shown on plate 1a, the location of the 157 wells and borings (refer to pls. 1a and 1b for well-identification labels) with available water-quality data, the categories of constituents for which analyses have been performed (organic compounds, inorganic constituents, and pesticides), and whether or not the constituents have been detected are shown on plate 2.

In reviewing trends in the spatial distribution of the data, it is important to remember that the data were not collected concurrently during 1970–92. Water-quality data are primarily available for monitoring wells installed as part of hydrogeologic studies at industrial, landfill, and LUST sites. In addition to the water-quality data from 111 monitoring wells, data are available from 8 municipal, 29 domestic, and 1 institutional water-supply well(s) and 8 borings. Ninety-three (about 59 percent) of the wells with water-quality data are open to the glacial drift aquifer. Of the wells with available water-quality data open to bedrock aquifers, 38 (about 24 percent) are open to the Galena-Platteville aquifer and 26 (about 17 percent) are open to multiple bedrock aquifers.

Available water-quality data indicate that the highest percentage of detections of constituents and the highest concentrations of the constituents are in ground water sampled from monitoring wells in the immediate vicinity of industrial, landfill, or LUST sites (pl. 2). The data indicate that VOC's have been detected in 6 of 8 Belvidere municipal water-supply wells and 18 private water-supply wells. Recent information indicates VOC's also may have been detected in the remaining two municipal wells (Craig Lawler, Belvidere Sewer and Water Department, written commun., 1993).

The MCL for only four constituents—trichloroethene (TCE), tetrachloroethylene (PCE), dichloromethane, and benzene—have been exceeded at municipal wells. TCE was detected in wells No. 2 and No. 3 (identified as BMW2 and BMW3, respectively, in the data base); PCE was detected in wells No. 2, No. 3, and No. 6 (BMW6); dichloromethane was detected in well No. 5 (BMW5); and benzene was detected in well No. 4 (BMW4). Well No. 2 has not been used as a municipal water source since 1990 because the MCL's for TCE were consistently exceeded. Well No. 3 has not been used since 1992 because the MCL's for PCE were consistently exceeded. The MCL's have been exceeded only once at wells No. 4, No. 5, and No. 6. The MCL (which legally applies only to public-water supplies) for only one constituent, trichloroethene, has been exceeded in three domestic wells. On the basis of the available data compiled in the data base, no other constituents, including SVOC's, pesticides, metals, or nitrate, were detected at levels near MCL's in the municipal or private water-supply wells. See appendix 5 for a complete list of MCL's established under USEPA drinking-water regulations.

It is reported that two domestic wells were abandoned near a closed metal-plating facility because of elevated concentrations of heavy metals in water samples (Illinois Environmental Protection Agency, 1987). It is also reported that one industrial well may have been abandoned because of elevated concentrations of VOC's (Clay Simonson, Illinois Department of Public Health, oral commun., 1993).

Hazardous constituents have been detected mostly in the glacial drift aquifer; however, this may be because the majority of monitoring wells were installed in the glacial drift aquifer. Hazardous constituents also have been detected in the wells open to the Galena-Platteville aquifer, the St. Peter Sandstone aquifer, and the Cambrian-Ordovician aquifer.

SUMMARY AND CONCLUSIONS

The U.S. Geological Survey, in cooperation with the U.S. Environmental Protection Agency, is studying the hydrogeology and water quality of the aquifers underlying Belvidere, Boone County, Ill. Available well-construction, hydrogeologic, and ground-water-quality data related to 725 water-supply and monitoring wells and geologic borings are compiled into a geographic information system (GIS) data base. Well-construction and hydrogeologic data include type of well, well-identification label, owner information, total depth of the well, depth to water in the well, the aquifer to which the well is open, and the screened or open interval. Water-quality data are tabulated for concentrations of selected volatile organic compounds (VOC's), semivolatile organic compounds, inorganic compounds, and total pesticide and specific conductance. Data are provided on a floppy diskette accompanying the report.

The data are intended to aid investigators in present and possible future hydrogeologic studies in the vicinity of Belvidere, Ill. Various programs were written to allow users unfamiliar with the ARC/INFO GIS to easily access the data and generate maps to visually interpret the data. A number of limitations associated with the data base are present. Most notably, an exhaustive search for well records was not completed, and ownership, address, and spatial-location data were not verified for all of the wells and borings in the data base. The location and type of wells and distribution of ground-water-quality data within the study area are shown on three plates.

Available data indicate that about 78 percent of the wells included in the data base are water-supply wells, including eight municipal water-supply wells. About 40 percent of the wells are open to the glacial drift aquifer, and 53 percent are open to the Galena-Platteville aquifer. The remaining wells are open to multiple-bedrock aquifers. Of the 157 wells and borings with available water-quality data, 59 percent are open to the glacial drift aquifer, 24 percent are open to the Galena-Platteville aquifer, and 17 percent are open to multiple-bedrock aquifers. VOC's have been detected in six municipal and three domestic wells. Maximum contaminant levels of four VOC's have been exceeded periodically in water from four municipal wells.

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APPENDIXES 1–5

APPENDIX 1. GLOSSARY OF TERMS ASSOCIATED WITH GROUND-WATER-WELL TYPES AND GEOGRAPHICAL INFORMATION SYSTEMS (GIS) AND THE ARC/INFO GIS

Ground-water-well types

Boring	Boring refers to test boreholes drilled primarily to obtain geologic or hydrogeologic information.
Commercial well	Wells where water is used by a business establishment that does not fabricate or produce a product.
Domestic well	Wells where water is used to supply household needs, principally for drinking, cooking, washing, and sanitary purposes, but including watering a lawn and caring for a few pets. Limited use wells in public facilities such as parks are also considered domestic wells.
Industrial well	Wells where water use is within a plant that manufactures or fabricates a product.
Institutional well	Wells where water is used in the maintenance and operation of institutions such as large schools, universities, hospitals, rest homes, or similar installations.
Monitoring well	Observation wells installed for the primary purpose of monitoring the quality of the water obtained from the well.
Municipal well	Public supply wells where water is pumped and supplied to several homes, and the quality of the water must meet minimum safety and sanitary requirements.
Private well	Any well not classified as a boring or a municipal or monitoring well.

Geographical information systems (GIS) and the ARC/INFO GIS

Coverage	An ARC/INFO digital map layer.
Feature-attribute table	An INFO file created in ARC that contains feature attributes for the spatial data represented in the associated coverage. This file links attributes to the map features.
GRID	An ARC/INFO software product that provides a raster geoprocessing system. GRID supports a Map Algebra spatial language that allows sophisticated spatial modeling and analysis.
Item	A defined field of information that makes a column in a table. INFO files can be considered as tables of information.
Macro	A computer program, consisting of a sequence of commands, written in an interpreted computer language. A macro allows many commands to be executed as a single command.
Projection	A method of transforming locations on the spherical surface of the Earth to locations on a two-dimensional surface.
Record	A record is a row of information in a table. INFO files can be considered as tables of information.
Relate	A relational operator that temporarily associates data files based on a common item. In ARC/INFO, a relate can support one-to-one and one-to-many associations.
RMS error	Root Mean Square error. A statistical representation of the error introduced when registering a map on a digitizer.
Stack	In a one-to-many relation, the group of related records in another data file associated to a single record in the current data file.
TIN	Triangulated Irregular Network. A set of adjacent nonoverlapping triangles used to represent the facets of a surface.

Widget	A predefined user interface component or object, such as a scroll bar, dialog box, or button, available as part of the *X-Window System.*
X-Window System	A network-based graphical user interface system developed by the Massachusetts Institute of Technology and adopted as an industry standard.

APPENDIX 2. BIBLIOGRAPHY OF DATA REFERENCES FOR THE DATA BASE OF WELL-CONSTRUCTION, HYDROGEOLOGIC, AND WATER-QUALITY DATA IN THE VICINITY OF BELVIDERE, ILL.

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APPENDIX 3. LISTING AND DESCRIPTION OF ITEMS IN THE INFO DATA FILES WELLINFO, QWDATA, AND QWTYPE

[COL, starting column; WDTH, the internal width of the field; OPUT, the external width of the field; TYP, the type of data field—C, character string, N, number with decimal, I, integer, F, floating-point; N.DEC, the number of decimal places in the field; WELLNUM, well-identification label; --, not applicable; LAT, latitude; LONG, longitude; TYPE, code for the type of well; AQUIFER, U.S. Geological Survey code for the aquifer to which the well is open; TOTDEPTH, total depth of the well; DTW, depth to water, in feet; DTWS, code for source of DTW data; TOP, top of open interval; BOTTOM, bottom of open interval; TOC, estimated altitude of well casing (feet above sea level); HEAD, estimated altitude of water surface in well (feet above sea level); YEAR, year well was constructed; OWNER, well owner's name; ADDRESS, well owner's address of residence; CITY, well owner's city of residence; PHONENUM, well owner's phone number; ABANDONED, code for status of well; WQD, code indicating if water-quality data are available; ALTID, alternate well-identification label; ft, feet; µg/L, micrograms per liter; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; ORGANICS, code for organic constituents; INORGANICS, code for inorganic constituents; PESTS, code for total pesticide concentrations]

DATA FILE NAME: WELLINFO
20 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC
1	WELLNUM	15	15	C	--
16	LAT	6	6	C	--
22	LONG	7	7	C	--
29	TYPE	3	3	C	--
32	AQUIFER	7	7	C	--
39	TOTDEPTH	8	8	N	2
47	DTW	8	8	N	2
55	DTWS	4	4	C	--
59	TOP	8	8	N	2
67	BOTTOM	8	8	N	2
75	TOC	8	8	N	2
83	HEAD	8	8	N	2
91	YEAR	4	4	I	--
95	OWNER	16	16	C	--
111	ADDRESS	24	24	C	--
135	CITY	16	16	C	--
151	PHONENUM	10	10	I	--
161	ABANDONED	1	1	C	--
162	WQD	1	1	C	--
163	ALTID	15	15	C	--

DATA FILE NAME: QWDATA
85 ITEMS: STARTING IN POSITION 1

COL	ITEM NAME	COMPOUND NAME	UNITS	WDTH	OPUT	TYP	N.DEC	ALTERNATE ITEM NAME
1	WELLNUM	--	--	15	15	C	--	--
16	DATE	--	--	6	6	I	--	--
22	DEPTH	--	ft	8	8	N	2	--
30	TRICHLOROETHENE	Trichloroethene	µg/L	8	8	N	2	TCE
38	PCE	Tetrachloroethylene	µg/L	8	8	F	2	--
46	TCA111	1,1,1-Trichloroethane	µg/L	8	8	F	2	--
54	DCE12T	1,2-Dichloroethene(total)	µg/L	8	8	F	2	--
62	DCE12-T	trans-1,2-Dichloroethene	µg/L	8	8	F	2	--
70	DCE12-C	cis-1,2-Dichloroethene	µg/L	8	8	F	2	--
78	DCA11	1,1-Dichloroethane	µg/L	8	8	F	2	--
86	DCE11	1,1-Dichloroethene	µg/L	8	8	F	2	--
94	DCA12	1,2-Dichloroethane	µg/L	8	8	F	2	--
102	TCA112	1,1,2-Trichloroethane	µg/L	8	8	F	2	--
110	TCA1122	1,1,2,2-Trichloroethane	µg/L	8	8	F	2	--
118	TCFM	Trichlorofluoromethane	µg/L	8	8	F	2	--
126	BENZENE	Benzene	µg/L	8	8	F	2	--
134	CHLOROBENZENE	Chlorobenzene	µg/L	8	8	F	2	CHLBEN
142	ETHYLBENZENE	Ethylbenzene	µg/L	8	8	F	2	ETHBEN
150	CHLOROETHANE	Chloroethane	µg/L	8	8	F	2	CHLETH
158	XYLENE-TOTAL	Xylene (total)	µg/L	8	8	F	2	XYLEN-T

COL	ITEM NAME	COMPOUND NAME	UNITS	WDTH	OPUT	TYP	N.DEC	ALTERNATE ITEM NAME
166	XYLENE-MP	Xylene (m+p)	µg/L	8	8	F	2	XYL-MP
174	XYLENE-O	Xylene (o)	µg/L	8	8	F	2	XYL-O
182	METHYLENECHLORID	Methylene chloride	µg/L	8	8	F	2	METCHL
190	TOLUENE	Toluene	µg/L	8	8	F	2	TOL
198	CHLOROMETHANE	Chloromethane	µg/L	8	8	F	2	CHLMET
206	DICHLOROMETHANE	Dichloromethane	µg/L	8	8	F	2	DCHLMET
214	METHYLETHER	Methyl ether	µg/L	8	8	F	2	METETH
222	VINYLCHLORIDE	Vinyl chloride	µg/L	8	8	F	2	VINCHL
230	TETRACHLORIDE	Carbon tetrachloride	µg/L	8	8	F	2	CTETCHL
238	BROMOFORM	Bromoform	µg/L	8	8	F	2	BROFRM
246	CHLOROFORM	Chloroform	µg/L	8	8	F	2	CHLFRM
254	ACETONE	Acetone	µg/L	8	8	F	2	--
262	CARBONDISULFIDE	Carbon disulfide	µg/L	8	8	F	2	CDISULF
270	ML42PEN	4-Methyl-2-pentanone	µg/L	8	8	F	2	--
278	HEXAN2	2-Hexanone	µg/L	8	8	F	2	--
286	STYRENE	Styrene	µg/L	8	8	F	2	--
294	PROPANE	Propane	µg/L	8	8	F	2	--
302	DCPRO12	1,2-Dichloropropane	µg/L	8	8	F	2	--
310	DCPRT13	trans-1,3-Dichloropropene	µg/L	8	8	F	2	--
318	BRDICLM	Bromodichloromethane	µg/L	8	8	F	2	--
326	CLDIBME	Chlorodibromomethane	µg/L	8	8	F	2	--
334	DICHDIFM	Dichlorodifluoromethane	µg/L	8	8	F	2	--
342	BUTAN2	2-Butanone	µg/L	8	8	F	2	--
350	ACENAPHTHENE	Acenaphthene	µg/L	8	8	F	2	ACENAP
358	ACENAPHTHYLENE	Acenaphthylene	µg/L	8	8	F	2	--
366	ANTHRACENE	Anthracene	µg/L	8	8	F	2	--
374	BZA-ANTHRACENE	Benzo(a)anthracene	µg/L	8	8	F	2	BZA-ANT
382	BZA-PYR	Benzo(a)pyrene	µg/L	8	8	F	2	--
390	BZB-FLU	Benzo(b)fluoranthene	µg/L	8	8	F	2	--
398	BZG-PER	Benzo(g,h,i)perylene	µg/L	8	8	F	2	--
406	BZK-FLU	Benzo(k)fluoranthene	µg/L	8	8	F	2	--
414	BUBZPHT	Butylbenzylphthalate	µg/L	8	8	F	2	--
422	CHRYSENE	Chrysene	µg/L	8	8	F	2	--
430	DIBENZOFURAN	Dibenzofuran	µg/L	8	8	F	2	--
438	DI-N-BUT	Di-n-butylphthalate	µg/L	8	8	F	2	--
446	FLUORANTHENE	Fluoranthene	µg/L	8	8	F	2	--
454	FLUORENE	Fluorene	µg/L	8	8	F	2	--
462	INDENOP	Indeno(1,2,3-cd)pyrene	µg/L	8	8	F	2	--
470	ML2NAP	2-Methylnaphthalene	µg/L	8	8	F	2	--
478	NAPHTHALENE	Naphthalene	µg/L	8	8	F	2	--
486	PHENANTHRENE	Phenanthrene	µg/L	8	8	F	2	--
494	STODSOL	Stoddard solution	µg/L	8	8	F	2	--
502	PHENOL	Phenol	µg/L	8	8	F	2	--
510	BNA-ADD	Base-neutral-acid, other	µg/L	8	8	F	2	--
518	PESTICIDES	Total pesticide	µg/L	8	8	F	2	--
526	SC	Specific conductance	µS/cm	6	6	I	--	--
532	ARSENIC	Arsenic	mg/L	11	11	N	6	--
543	BARIUM	Barium	mg/L	11	11	N	6	--
554	BERYLLIUM	Beryllium	mg/L	11	9	N	6	--
565	CADMIUM	Cadmium	mg/L	11	11	N	6	--
576	CHROMIUM	Chromium	mg/L	11	11	N	6	--
587	COBALT	Cobalt	mg/L	11	11	N	6	--
598	COPPER	Copper	mg/L	11	11	N	6	--
609	CYANIDE	Cyanide	mg/L	11	11	N	6	--
620	LEAD	Lead	mg/L	11	11	N	6	--
631	MERCURY	Mercury	mg/L	11	11	N	6	--
642	NICKEL	Nickel	mg/L	11	11	N	6	--
653	SELENIUM	Selenium	mg/L	11	11	N	6	--
664	SILVER	Silver	mg/L	11	11	N	6	--
675	THALLIUM	Thallium	mg/L	11	11	N	6	--

COL	ITEM NAME	COMPOUND NAME	UNITS	WDTH	OPUT	TYP	N.DEC	ALTERNATE ITEM NAME
686	VANADIUM	Vanadium	mg/L	11	11	N	6	--
697	ZINC	Zinc	mg/L	11	11	N	6	--
708	CHLORIDE	Chloride	mg/L	8	8	F	2	--
716	NITRATE	Nitrate	mg/L	8	8	F	2	--
724	ALTID	--	--	15	15	C	--	--

```
DATA FILE NAME: QWTYPE
6 ITEMS: STARTING IN POSITION    1
```

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC
1	WELLNUM	15	15	C	--
16	DEPTH	8	8	N	2
24	DATE	6	6	I	--
30	ORGANICS	4	4	I	--
34	INORGANICS	4	4	I	--
38	PESTS	4	4	I	--

APPENDIX 4. LISTING OF THE SELECTED ARC/INFO ARC MACRO LANGUAGE (AML) PROGRAMS

<u>BELVMAP</u>

```
/*---------------------------------------------------------------------------
/*
/* Command name: BELVMAP
/* Language: AML
/*
/*::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/*
/* Purpose: THIS AML IS USED TO MAP SELECTED WELLS FOR THE BELVIDERE AREA
/* STUDY AND SELECTED INDUSTRIAL AND LANDFILL SITES.
/*
/*::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/*
/* Arguments:
/* Variable name,    I/O,    Type,    Definition
/*    ------------------------------------------------------------------------
/*::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/*
/* History:
/*Author/Site,                  Date,                Event
/*    ------------------------------------------------------------------------
/*    Timothy Brown/Urbana, IL    5/92              Original coding
/*---------------------------------------------------------------------------
AP
DISPLAY 9999 2
&IF [EXISTS BELVMAP -DIRECTORY] &THEN KILLMAP BELVMAP
  MAP BELVMAP
  MAPEX MAPBASE
  MAPUNITS METERS
  MAPSC 24000
  PAGESIZE 28 26
MAPPOSITION UL UL

  LINESYMBOL 69
BOX 0.2 0.2 27.8 25.8

  TEXTSET FONT.TXT
  TEXTSYM 6
MOVE 22. 24
  TEXTSIZE 28 PT
TEXT 'BELVIDERE AREA STUDY'

MOVE 23.2 23.5
  TEXTSIZE 14 PT
TEXT 'BELVIDERE, ILLINOIS'

MOVE 23.5 21.5
  TEXTSIZE 10 PT
TEXT 'EXPLANATION'

MBEGIN                         /* Define the map features
  LINESET CARTO.LIN
  LINESYM 111
ARCS STUDYAREA
  LINESET PLOTTER.LIN
  LINESYM 1
ARCS MAPBASE
```

```
ARCS ROADS
  LINECOLOR 4
  RESEL STREAMS LINE INT NE 'Y'
ARCS STREAMS
  ASEL STREAMS LINE
  LINESYMBOL 85
ARCS RAIL
  LINESYMBOL 1
  LINECOLOR 2
ARCS SITES
POLYGONSHADES SITES 66
ANNOTEXT MAPBASE
ANNOTEXT SITES
ANNOTEXT ROADS
ANNOTEXT STREAMS
ANNOTEXT RAIL
  MARKERSET HIWAY.MRK
POINTMARKER HIWAY_PTS SYM
  TEXTSIZE 10 PT
  MARKERSET BSA.MRK
  MARKERSYM 32
  MARKERSIZE .08
POINTS LUST_SITES

RELATE RESTORE WELLDAT.REL
  RESELECT WELLS POINT WD//ABANDONED EQ 'N'
  MARKERSIZE .09
POINTMARKERS WELLS CODE

ANNOTEXT WELLS IDS
ANNOTEXT WELLS DETAIL

MEND                           /* End of map feature definition

MBEGIN                             /* rake scale
  LINESYM 1
  LINECOLOR 1
  TEXTCOLOR 1
&R RAKE.AML 2 0.5 12 # 12.5 1.0
MEND                                /* End of rake scale

 /* Explanation
  TEXTSIZE 10 PT
  KEYBOX .3 .2
  KEYPOSITION 22. 19.4
KEYMARKER WELL.LEG NOBOX
  KEYPOSITION 22. 21
KEYSHADE SITE.LEG NOBOX
  KEYPOSITION 22. 20.6
  KEYBOX .3 0
KEYLINE LINE.LEG NOBOX
  MOVE 22. 11.5
  TEXTSIZE 18 PT
TEXT E

  MBEGIN                            /* Define the index map
  MAPLIMITS 22 0.2 27.8 4.5
MAPEX STATE_OUTLINE
  MAPUNITS METERS
  MAPSC AUTOMATIC
  MAPPOSITION CEN CEN
ARCS STATE_OUTLINE
ANNOTEXT STATE_OUTLINE
ARCS BOONE
```

```
ARCS MAPBASE
  SHADESET COLOR.SHD
POLYGONSHADES MAPBASE 14
MEND                             /* End of index map definition

MAP END

DISPLAY 1040
BELVMAP.GRA
PLOT BELVMAP
Q

&RETURN
```

DATAMAP

```
/*-------------------------------------------------------------------------
/*
/* Command name: DATAMAP
/* Language: AML
/*
/*::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/*
/* Purpose: THIS AML IS USED TO MAP THE DISTRIBUTION OF CONTAMINANTS IN THE
/* BELVIDERE STUDY AREA AND SELECTED INDUSTRIAL AND LANDFILL SITES.
/*
/*::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/*
/* Arguments:
/* Variable name,    I/O,    Type,    Definition
/*    ----------------------------------------------------------------------
/*::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/*
/* History:
/*Author/Site,                 Date,                 Event
/*    ----------------------------------------------------------------------
/*    Timothy Brown/Urbana, IL    5/92                Original coding
/*-------------------------------------------------------------------------
AP
DISPLAY 9999 2

&IF [EXISTS DATAMAP -DIRECTORY] &THEN KILLMAP DATAMAP
  MAP DATAMAP
  MAPEX MAPBASE
  MAPUNITS METERS
  MAPSC 24000
  PAGESIZE 28 26
MAPPOSITION UL 0.5 26

  LINESYMBOL 69
BOX 0.2 0.2 27.8 25.8

  TEXTSET FONT.TXT
  TEXTSYM 6
MOVE 22.25 24
  TEXTSIZE 28 # PT
TEXT 'BELVIDERE AREA STUDY'

MOVE 23.45 23.5
  TEXTSIZE 14 # PT
TEXT 'BELVIDERE, ILLINOIS'
```

```
MOVE 23.55 22.8
  TEXTSIZE 10 # PT
TEXT 'Wells with water quality data'

MOVE 23.75 21.25
  TEXTSIZE 10 # PT
TEXT 'EXPLANATION'

MBEGIN /**************** Define the map features ******************
  LINESET CARTO.LIN
  LINESYM 111
ARCS STUDYAREA
  LINESET PLOTTER.LIN
  LINESYM 1
ARCS MAPBASE
ARCS ROADS
  LINECOLOR 4
  RESEL STREAMS LINE INT NE 'Y'
ARCS STREAMS
  ASEL STREAMS LINE
  LINESYMBOL 85
ARCS RAIL
  LINESYMBOL 1
  LINECOLOR 2
ARCS SITES
POLYGONSHADES SITES 66
ANNOTEXT MAPBASE
ANNOTEXT SITES
ANNOTEXT ROADS
ANNOTEXT STREAMS
ANNOTEXT RAIL
  MARKERSET HIWAY.MRK
POINTMARKER HIWAY_PTS SYM
  TEXTSIZE 10 PT
  MARKERSET BSA.MRK
  MARKERSYM 32
  MARKERSIZE .08
POINTS LUST_SITES

/***** Reselect wells with the following properties *****
RELATE RESTORE WELLDAT.REL
  RESELECT WELLS POINT WD//WQD EQ 'Y'
  MARKERSIZE .09
POINTMARKERS WELLS CODE
  ASEL WELLS POINT

/************* WATER QUALITY DATA *************
  RESEL WELLS POINT DT//ORGANICS = 1
  MARKERSYM 103
  MARKERSIZE .14
POINTS WELLS
  ASEL WELLS POINT
  RESEL WELLS POINT DT//INORGANICS = 1
  MARKERSYM 104
  MARKERSIZE .14
POINTS WELLS
  ASEL WELLS POINT
  RESEL WELLS POINT DT//PESTS = 1
  MARKERSYM 105
  MARKERSIZE .14
```

```
POINTS WELLS
  ASEL WELLS POINT
  RESEL WELLS POINT DT//ORGANICS = 0
  MARKERSYM 106
  MARKERSIZE .14
POINTS WELLS
  ASEL WELLS POINT
  RESEL WELLS POINT DT//INORGANICS = 0
  MARKERSYM 107
  MARKERSIZE .14
POINTS WELLS
  ASEL WELLS POINT
  RESEL WELLS POINT DT//PESTS = 0
  MARKERSYM 108
  MARKERSIZE .14
POINTS WELLS
  ASEL WELLS POINT
mend /**************** End of map feature definition ********************

MBEGIN                            /* Begin rake scale
  LINESYM 1
  LINECOLOR 1
  TEXTCOLOR 1
&R RAKE.AML 2 0.5 12 # 9.0 1.0
MEND                              /* End rake scale

/*EXPLANATION
  TEXTSIZE 10 # PT
  KEYBOX .25 .2
KEYPOSITION 22.25 21
KEYSHADE SITE.LEG NOBOX
KEYPOSITION 22.25 20.6
  KEYBOX .25 0
KEYLINE LINE.LEG NOBOX
  KEYBOX .25 .2
KEYPOSITION 22.25 19.8
KEYMARKER DATA.LEG NOBOX


MBEGIN                       /* Begin index map
MAPLIMITS 21.5 1 28 5.5
MAPEX STATE_OUTLINE
  MAPUNITS METERS
  MAPSC AUTOMATIC
MAPPOSITION CEN CEN
ARCS STATE_OUTLINE
ANNOTEXT STATE_OUTLINE
ARCS MAPBASE
POLYGONSHADES STUDYAREA 73
MEND                         /* End index map

DISPLAY 1040
DATAMAP.GRA
PLOT DATAMAP
Q
END
&RETURN
```

APPENDIX 5. U.S. ENVIRONMENTAL PROTECTION AGENCY DRINKING-WATER REGULATIONS ESTABLISHED UNDER GUIDELINES OF THE SAFE DRINKING WATER ACT OF 1986

[All values in milligrams per liter unless noted otherwise. --, no established regulation; TT, treatment technique; pCi/L, picocurie per liter; mrem, milliroentgen equilvalent man per year; MFL, million fibers per liter; CU, Color Unit; TON, Threshold Odor Number; PS, performance standard 0.5–1.0 nephelometric turbidity units (NTU)]

Constituent or Property	Primary drinking-water regulation[1]				Secondary drinking-water regulation[2]	
	MCLG[3]	MCL[4]	Proposed MCLG[3]	Proposed MCL[4]	SMCL[5]	Proposed SMCL[5]
Inorganic Constituents and Nutrients						
Aluminum	--	--	--	--	0.05 to 0.2	--
Antimony	0.006	0.006	--	--	--	--
Arsenic	--	.05	--	--	--	--
Asbestos, MFL[6]	7	7	--	--	--	--
Barium	2	2	--	--	--	--
Beryllium	0	.001	--	--	--	--
Cadmium	.005	.005	--	--	--	--
Chloride	--	--	--	--	250	--
Chromium	.1	.1	--	--	--	--
Copper	1.3	TT	--	--	1	--
Cyanide	.2	.2	--	--	--	--
Fluoride	4	4	--	--	2	--
Iron	--	--	--	--	.3	--
Lead	0	TT	--	--	--	--
Manganese	--	--	--	--	.05	--
Mercury	.002	.002	--	--	--	--
Nickel	.1	.1	--	--	--	--
Nitrate (As N)	10	10	--	--	--	--
Nitrate + Nitrite (As N)	10	10	--	--	--	--
Nitrite (As N)	1	1	--	--	--	--
Selenium	.05	.05	--	--	--	--
Silver	--	--	--	--	.1	--
Sulfate	--	--	400/500	400/500	250	--
Thallium	.0005	.002	--	--	--	--
Total Dissolved Solids	--	--	--	--	500	--
Zinc	--	--	--	--	5	--
Organic Compounds						
Acrylamide	0	TT	--	--	--	--
Alachlor	0	.002	--	--	--	--
Aldicarb	--	--	.001	.003	--	--
Aldicard Sulfone	--	--	.001	.002	--	--
Aldicard Sulfoxide	--	--	.001	.004	--	--
Atrazine	.003	.003	--	--	--	--
Benzene	0	.005	--	--	--	--
Benzo (a) pyrene	0	.0002	--	--	--	--
Carbofuran	.04	.04	--	--	--	--
Carbon Tetrachloride	0	.005	--	--	--	--
Chlordane	0	.002	--	--	--	--
2,4-D (2,4-Dichloro-phenoxyacetic Acid)	.07	.07	--	--	--	--
Dalapon	.2	.2	--	--	--	--
Di (2-ethylhexyl) adipate	.5	.5	--	--	--	--
Di (2-ethylhexyl) phthalate	0	.006	--	--	--	--

Constituent or Property	Primary drinking-water regulation[1] MCLG[3]	MCL[4]	Proposed MCLG[3]	Proposed MCL[4]	Secondary drinking-water regulation[2] SMCL[5]	Proposed SMCL[5]
Dibromochloropropane (DBCP)	0	.0002	--	--	--	--
p-Dichlorobenzene	.075	.075	--	--	--	--
o-Dichlorobenzene	.6	.6	--	--	--	--
1,2-Dichloroethane	0	.005	--	--	--	--
1,1-Dichloroethylene	.007	.007	--	--	--	--
cis-1,2-Dichloroethylene	.07	.07	--	--	--	--
trans-1,2-Dichloroethylene	.1	.1	--	--	--	--
Dichloromethane (methylene chloride)	0	.005	--	--	--	--
1,2-Dichloropropane	0	.005	--	--	--	--
Dinoseb	.007	.007	--	--	--	--
Diquat	.02	.02	--	--	--	--
Endothall	.1	.1	--	--	--	--
Endrin	.002	.002	--	--	--	--
Epichlorohydrin	0	TT	--	--	--	--
Ethylbenzene	.7	.7	--	--	--	--
Ethylene Dibromide (EDB)	0	.00005	--	--	--	--
Glyphosate	.7	.7	--	--	--	--
Heptachlor	0	.0004	--	--	--	--
Heptachlor Epoxide	0	.0002	--	--	--	--
Hexachlorobenzene	0	.001	--	--	--	--
Hexachlorocyclopentadiene	.05	.05	--	--	--	0.008
Lindane	.0002	.0002	--	--	--	--
Methoxychlor	.04	.04	--	--	--	--
Monochlorobenzene	.1	.1	--	--	--	--
Oxamyl (vydate)	.2	.2	--	--	--	--
Pentachlorophenol	0	.001	--	--	--	--
Pichloram	.5	.5	--	--	--	--
Polychlorinated Biphenyls (PCB's)	0	.0005	--	--	--	--
Simazine	.004	.004	--	--	--	--
Styrene	.1	.1	--	--	--	--
2,3,7,8-Tetrachlorodibenzo-P-Dioxin (TCDD, dioxin)	0	5×10^{-8}	--	--	--	--
Tetrachloroethylene	0	.005	--	--	--	--
Toluene	1	1	--	--	--	--
Toxaphene	.05	.05	--	--	--	--
2,4,5-Trichlorophenoxy-propionic Acid (silvex)	.05	.05	--	--	--	--
1,2,4-Trichlorobenzene	.07	.07	--	--	--	--
1,1,1-Trichloroethane	.2	.2	--	--	--	--
1,1,2-Trichloroethane	.003	.005	--	--	--	--
Trichloroethylene	0	.005	--	--	--	--
Trihalomethanes, total[7]	--	.1	--	--	--	--
Vinyl Chloride	0	.002	--	--	--	--
Xylenes (Total)	10	10	--	--	--	--
Microbiological						
Giardia Lamblia[8]	0	TT	--	--	--	--
Legionella[8]	0	TT	--	--	--	--
Total Coliforms (including Fecal Coliform and E. Coli)	0	[8]--	--	--	--	--
Viruses[9]	0	TT	--	--	--	--
Radioactivity						
Beta Particle and Photon emitters	--	[10]4 mrem	0 pCi/L	4 mrem	--	--
Alpha emitters	--	15 pCi/L	0 pCi/L	15 pCi/L	--	--
Radium-226 + 228	--	5 pCi/L	--	--	--	--
Radium-226	--	--	0 pCi/L	20 pCi/L	--	--

Constituent or Property	Primary drinking-water regulation[1] MCLG[3]	MCL[4]	Proposed MCLG[3]	Proposed MCL[4]	Secondary drinking-water regulation[2] SMCL[5]	Proposed SMCL[5]
Radioactivity—Continued						
Radium-228	--	--	0 pCi/L	20 pCi/L	--	--
Radon	--	--	0 pCi/L	300 pCi/L	--	--
Uranium	--	--	0 pCi/L	20 µg/L	--	--
Miscellaneous Properties						
Color	--	--	--	--	15 CU	--
Corrosivity	--	--	--	--	non-corrosive	--
Foaming Agents	--	--	--	--	.5	--
Odor	--	--	--	--	3 TON	--
pH	--	--	--	--	6.5–8.5 (standard units)	--
Standard plate count	--	TT	--	--	--	--
Total dissolved solids (TDS)	--	--	--	--	500	--
Turbidity	--	PS	--	--	--	--

[1] From Pontius (1993).

[2] From Pontius (1992).

[3] MCLG, Maximum Contaminant Level Goal. Nonenforceable health goal that is to be set at the level at which no known or anticipated adverse effects on the health of person occur and that allows an adequate margin of safety. Formerly called Recommended Maximum Contaminant Level (RMCL).

[4] MCL, Maximum Contaminant Level. Enforceable, health-based regulation that is to be set as close to the MCLG as is feasible. The definition of feasible means the use of best technology, treatment techniques, and other means that the Administrator of U.S. Environmental Protection Agency finds, after examination for efficacy under field conditions and not solely under laboratory conditions are generally available (taking cost into consideration).

[5] SMCL, Secondary Maximum Contaminant Level. Contaminants that affect the aesthetic quality of drinking water. At high concentrations or values, health implications as well as aesthetic degradation also may be present. SMCL's are not Federally enforceable but are intended as guidelines for the States.

[6] Fiber length greater than 10 micrometers.

[7] The sum of the concentrations of bromodichloromethane, dibromochloromethane, tribromomethane, and trichloromethane.

[8] MCL is based on presence/absence of total coliforms in sample rather than on an estimate of coliform density. No more than 5 percent of the samples per month may be positive. (For systems collecting fewer than 40 samples per month, no more than 1 sample per month may be positive.)

[9] Treatment-technique requirements have been established.

[10] Average annual concentrations assumed to produce a total body (or organ) dose of 4 mrem/yr—tritium 20,000 pCi/L (strontium-90, 8 pCi/L).

REFERENCES

Pontius, F.W., 1992, A current look at the Federal drinking water regulations: Journal of the American Water Works Association, v. 84, no. 3, p. 36–50.

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