WATER LEVELS IN THE CALUMET AQUIFER AND THEIR RELATION TO SURFACE-WATER LEVELS IN NORTHERN LAKE COUNTY, INDIANA, 1985–92

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Prepared in cooperation with the
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To Obtain
inch (in.)	25.4	millimeter
inch per year (in/yr)	25.4	millimeter per year
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
mile (mi)	1.609	kilometer

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

$$°C = (°F - 32)\ 0.556$$

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

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Water Levels in the Calumet Aquifer and Their Relation to Surface-Water Levels in Northern Lake County, Indiana, 1985–92

By Theodore K. Greeman

Abstract

The U.S. Geological Survey made 2,328 water-level measurements at a total of 96 ground-water and surface-water sites in northern Lake County, Indiana, from August 1985 through September 1992. This report lists and summarizes the significance of the measurements. Northern Lake County is on the southern shore of Lake Michigan and includes the cities of East Chicago, Gary, Hammond, and Whiting. The study area is underlain by the unconfined Calumet aquifer and receives about 36 inches of precipitation per year.

The U.S. Geological Survey investigated ground-water levels and flow in the Calumet aquifer and the effect of Lake Michigan levels on ground-water and surface-water levels throughout the study area. Summary statistics of the water-level data were computed for each site.

Ground-water levels annually reach a maximum in June or July and a minimum in September or October. Measured ground-water fluctuations in the Calumet aquifer during the study period ranged from 0.40 to 5.01 feet, and the mean ground-water fluctuation was about 2.3 feet. The largest surface-water fluctuations were affected by record setting Lake Michigan levels. Mid-month daily averages for the data-collection period show that Lake Michigan fluctuated 4.14 feet. Water-level fluctuations on the Grand Calumet River were from 1.06 to 2.45 feet.

Analysis of water-level data indicates that the 1988 drought did not substantially affect water levels in the Calumet aquifer, but the deficit in precipitation reversed vertical flow gradients in ground water at three paired deep and shallow wells. High water levels in Lake Michigan during 1985–87 created long-term backwater effects on the Grand Calumet River as far as 11.0 miles upstream from Lake Michigan.

Analysis of water-level data from the data-collection network indicates that the water table normally slopes toward streams, ditches, sewers, the Indiana Harbor Canal, and Lake Michigan. The slope of the water table toward the Grand Calumet River is greatest in the winter and can decrease to being almost horizontal in the summer. Wells near streams respond quickly to nearby surface-water-level changes. Water-table maps indicate that sewers and dewatering systems are lowering ground-water levels in large areas. Ditches, the Grand Calumet River, and the Indiana Harbor Canal connect the Lake Michigan water level to large parts of the study area. The surface-water stage in the Indiana Harbor Canal, which functions as a ditch, can equal Lake Michigan's stage up to 3.75 miles inland from the lakeshore. Human activity, the stage of Lake Michigan, and the storage capacity of the Calumet aquifer combine to reduce vertical changes in the water table in the study area.

INTRODUCTION

Northern Lake County, Ind., (fig. 1), is on the southern shore of Lake Michigan and is accessible to major shipping routes. This area, which includes the cities of Gary, Hammond, East Chicago, and Whiting, is one of the most industrialized and urbanized regions in the United States. Large-scale industries in the area include steel mills, petrochemical refineries, chemical plants, coal-fired electric-generating plants, and factories. Before development, much of the area consisted of bogs and marshes separated by former beach ridges. As the area was developed, many wetlands were drained, most beach ridges were leveled, new drainage outlets were opened to Lake Michigan, and rivers were dredged. Large areas along the Lake Michigan shoreline and the low wetland areas were filled with slag, a by-product of steel production. Lake-fill land extends more than 2 mi into Lake Michigan in some places. Urban development in the study area has disrupted ground-water flow in the Calumet aquifer and altered surface-water drainage patterns in the study area (Watson and others, 1989, p. 30).

In many parts of the area, steel and petrochemical production has adversely affected the water quality (Fenelon and Watson, 1993, p. 70). The U.S. Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM) are involved in numerous investigations of ground-water and surface-water quality in this area.

The U.S. Geological Survey (USGS) began collecting water-level data in August 1985 from a network of ground-water- and surface-water-level monitoring sites (fig. 2) near the Grand Calumet River, the Indiana Harbor Canal, and Lake Michigan. A primary purpose of that study was to determine the potential for ground-water contaminants to enter Lake Michigan (Fenelon and Watson, 1993, p. 4). In addition to monthly and bimonthly measurements made at 78 sites, hourly water levels were recorded at 22 sites from August 1985 through October 1986. After several new wells were installed, quarterly measurements were made at 99 sites from October 1986 through August 1988. The USGS, in cooperation with IDEM, measured water levels in the network quarterly from October 1988 through September 1992.

Results of these previous investigations of contaminant loads in the Grand Calumet River and the Indiana Harbor Canal indicated that ground-water discharge is a contributor to the surface-water contaminant load (Crawford and Wangsness, 1987, p. 121; Fenelon and Watson, 1993, p. 70); however, additional analysis of water levels in the Calumet aquifer (fig. 3) and surface-water bodies nearby was necessary to determine ground-water flow directions. Interpretations of the changes in water levels are important for defining hydrologic conditions that affect engineered and natural restoration of ground- and surface-water quality.

Consequently, the USGS, in cooperation with IDEM, began a project in 1992 to analyze all ground-water and surface-water data collected in northern Lake County, Ind., from August 1985 through September 30, 1992. In addition to the hourly data, a total of 2,328 ground-water and surface-water measurements were made—about 25 measurements per site.

Purpose and Scope

This report presents an analyses of all the data collected from the ground-water and surface-water network. Analyses of these water-level data include (1) a statistical summary of water-level fluctuations measured at each site, (2) a hydrologic comparison of water levels during a drought, (3) a hydrologic comparison of water levels in relation to Lake Michigan levels, (4) an examination of the interaction of ground water and surface water, (5) a determination of where dewatering has lowered water-level altitudes, and (6) a comparison of water-table contour maps from several time periods. Data are reported in tables, hydrographs, and water-table maps.

Physical Setting

The study area (fig. 3) is entirely within the Calumet Lacustrine Plain physiographic area (Malott, 1922, p. 113). The Calumet Lacustrine Plain extends southward from the shoreline of Lake Michigan to the northern edge of the Valparaiso moraine, a distance of about 12 mi along the Indiana-Illinois State line and 3 mi along the Lake-Porter County line (fig. 3). Most areas of the Calumet Lacustrine Plain, which is the former bed of glacial Lake Chicago, have low relief. Relic shorelines capped by sand dunes represent successively lowered water levels of post-Pleistocene Lake Chicago (Hartke and others, 1975, p. 2). Some dune ridges rise 40 ft above the surrounding plain. Historically, major transportation routes through this area developed atop these dune ridges. Swampy areas formerly occupied the lowlands between the dunes. The study area is now largely drained, filled, and heavily urbanized (fig. 4). Many isolated areas, however, remain natural. Major land uses in the study area are discussed by Watson and others (1989, p. 8–11).

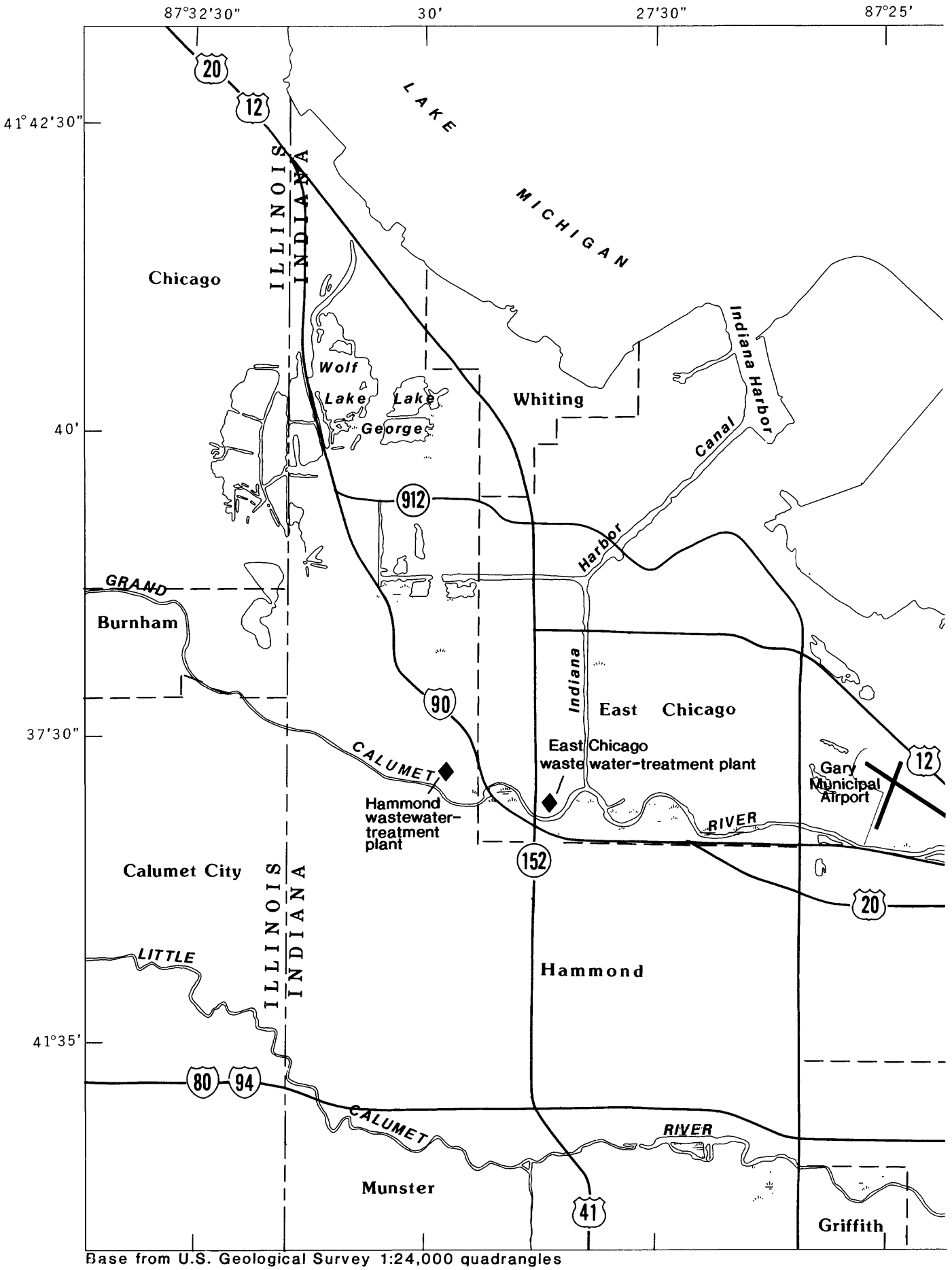
The area at the southern end of Lake Michigan receives about 36 in. of precipitation per year (National Oceanic and Atmospheric Administration, 1982) and has a continental climate characterized by hot humid summers and cold winters. Snowfall averages 30 to 40 in. annually. Precipitation is distributed evenly throughout the year; monthly averages range from 1.46 in. for February to 3.84 in. for June and July (National Oceanic and Atmospheric Administration, 1982). The mean January temperature is 24°F and the mean July temperature is 73°F (National Oceanic and Atmospheric Administration, 1982).

Hydrogeologic Setting of the Calumet Aquifer

The study area (fig. 3) is underlain by beach deposits consisting of wind- and water-deposited fine sand and silt, which comprise the unconfined Calumet aquifer (Hartke and others, 1975, p. 7). The aquifer extends south from Lake Michigan and underlies the northern third of Lake County. The Calumet aquifer also extends eastward into Porter County, Ind., in a narrow strip along Lake Michigan and west into Cook County, Ill. (Hartke and others, 1975, p. 7). The Calumet aquifer has been deposited from late Wisconsinan to the present. As a source of water, the Calumet aquifer is used only for domestic supply in unincorporated areas; municipal and industrial water supplies are withdrawn from Lake Michigan.

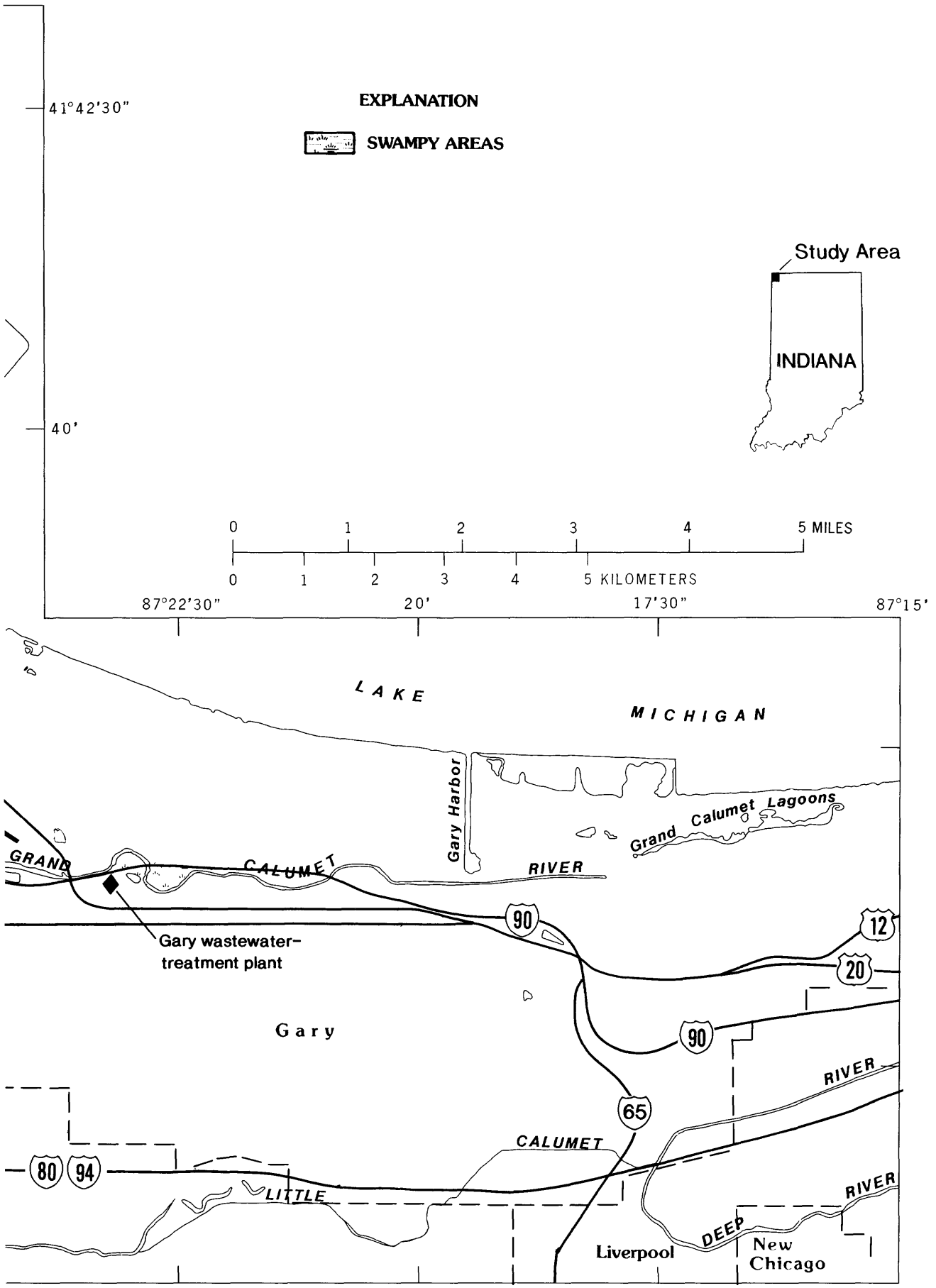
In northern Lake County, the thickness of the Calumet aquifer ranges from 0 to 65 ft (Watson and others, 1989, p. 18) and averages 20 ft (Hartke and others, 1975, p. 25). The aquifer is thickest in the eastern part of the study area (Watson and others, 1989, p. 18). Sand was exposed at the land surface throughout most of the area, although peat and muck filled some low areas. Much of the sand now is covered with fill materials that were placed on the ground to raise the land surface above the water table. Fenelon and Watson (1993, p. 18) report on several previous aquifer tests done as part of site-specific hydrologic investigations within the study area. They report the horizontal hydraulic conductivity of the aquifer ranges from less than 1 ft/d to 180 ft/d and averages 60 ft/d. One aquifer test reported by Fenelon and Watson indicated a vertical hydraulic conductivity of 3 to 4 ft/d and an estimated 15:1 ratio of horizontal to vertical hydraulic conductivity.

The estimated storage coefficient for the Calumet aquifer is 0.12 (Rosenshein and Hunn, 1968, p. 29). In an unconfined aquifer, the storage coefficient is equal to the specific yield; thus, the aquifer will yield about 12 percent water by volume. Evapotranspiration and runoff within the study area are estimated to be 25 in/yr, and recharge is about 12 in/yr (Hartke and others, 1975, p. 16). The 12 to 17 in/yr recharge estimates (Fenelon and Watson, 1993, p. 35), in conjunction with the low relief on the water table, are indicators of the relatively high permeability of the Calumet aquifer. Regional ground-water flow in the Calumet aquifer generally is toward the major streams, the Indiana Harbor Canal, and Lake Michigan. The Grand Calumet River and the Little Calumet River are the only streams draining the area; all other channels are artificial.



Base from U.S. Geological Survey 1:24,000 quadrangles

Figure 1. Surface water and cultural features in the study area.


EXPLANATION
SWAMPY AREAS
Study Area
INDIANA
41°42'30"
40'
0 1 2 3 4 5 MILES
0 1 2 3 4 5 KILOMETERS
87°22'30"
20'
17'30"
87°15'
LAKE MICHIGAN
Gary Harbor
Grand Calumet Lagoons
GRAND CALUMET RIVER
Gary wastewater-treatment plant
Gary
90
12
20
65
80
94
CALUMET RIVER
LITTLE CALUMET RIVER
DEEP
Liverpool
New Chicago

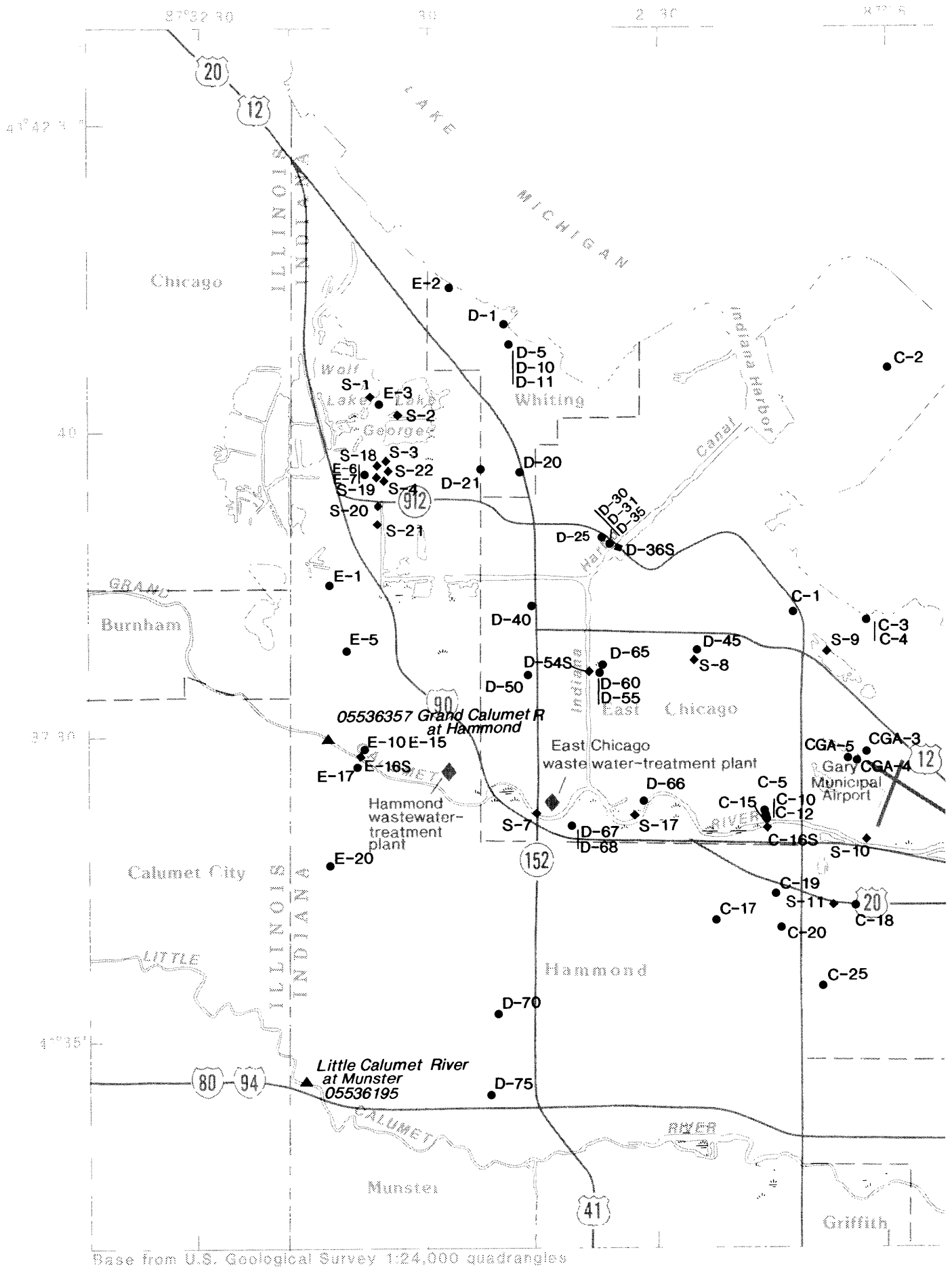
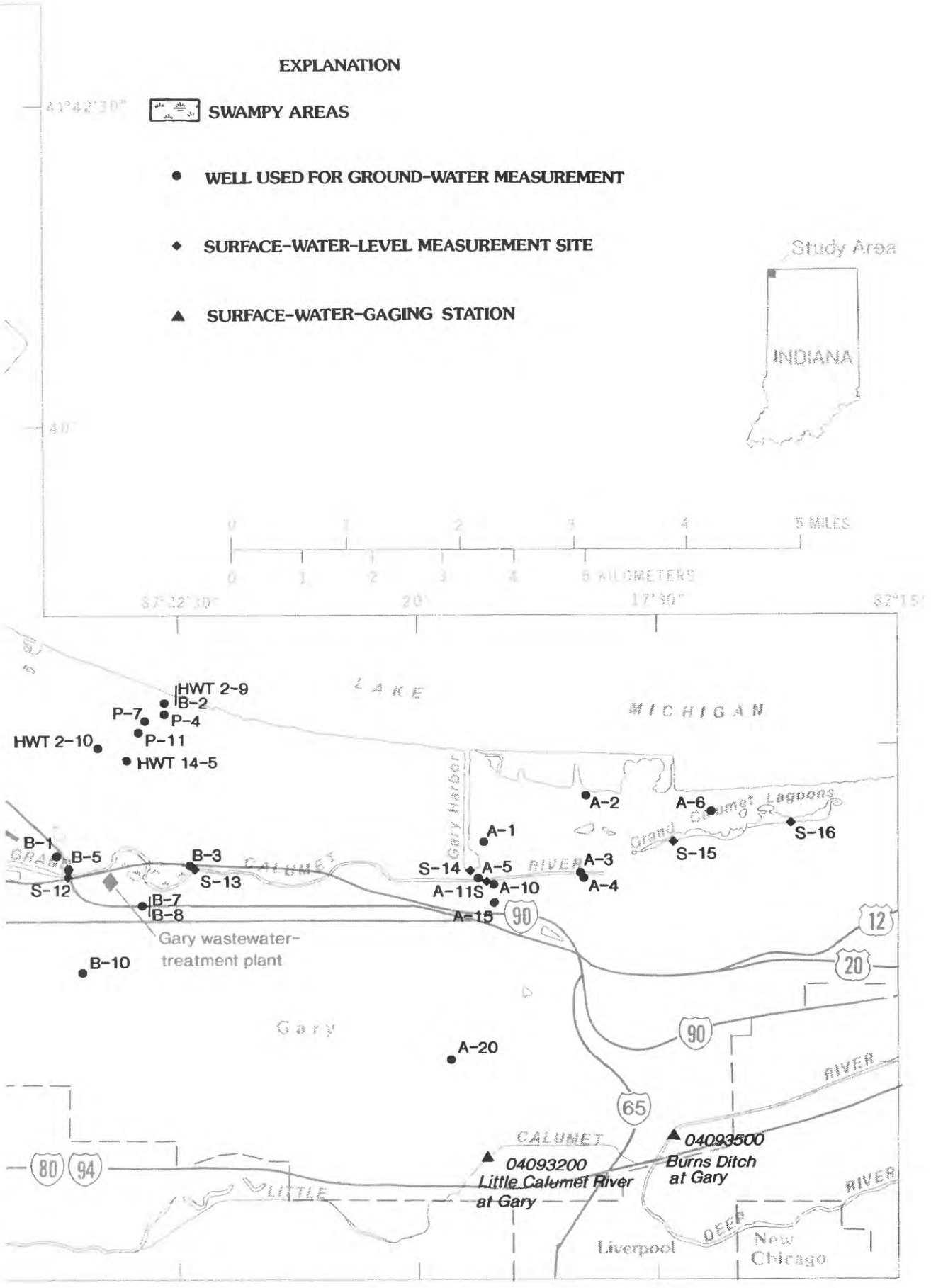


Figure 2. Locations of wells and surface-water sites, northern Lake County, Indiana.


EXPLANATION
SWAMPY AREAS
WELL USED FOR GROUND-WATER MEASUREMENT
SURFACE-WATER-LEVEL MEASUREMENT SITE
SURFACE-WATER-GAGING STATION
Study Area
INDIANA
0 1 2 3 4 5 MILES
0 1 2 3 4 5 KILOMETERS
LAKE MICHIGAN
HWT 2-9
B-2
P-7
P-4
HWT 2-10
P-11
HWT 14-5
Gary Harbor
A-2
A-6
Grand Calumet Lagoons
A-1
S-16
B-1
B-5
B-3
S-15
S-14
A-5
A-3
S-12
S-13
A-11S
A-10
A-4
B-7
B-8
A-15
90
12
20
Gary wastewater-treatment plant
B-10
Gary
A-20
RIVER
65
CALUMET
04093500
Burns Ditch at Gary
80
94
04093200
Little Calumet River at Gary
LITTLE
DEEP
RIVER
Liverpool
New Chicago

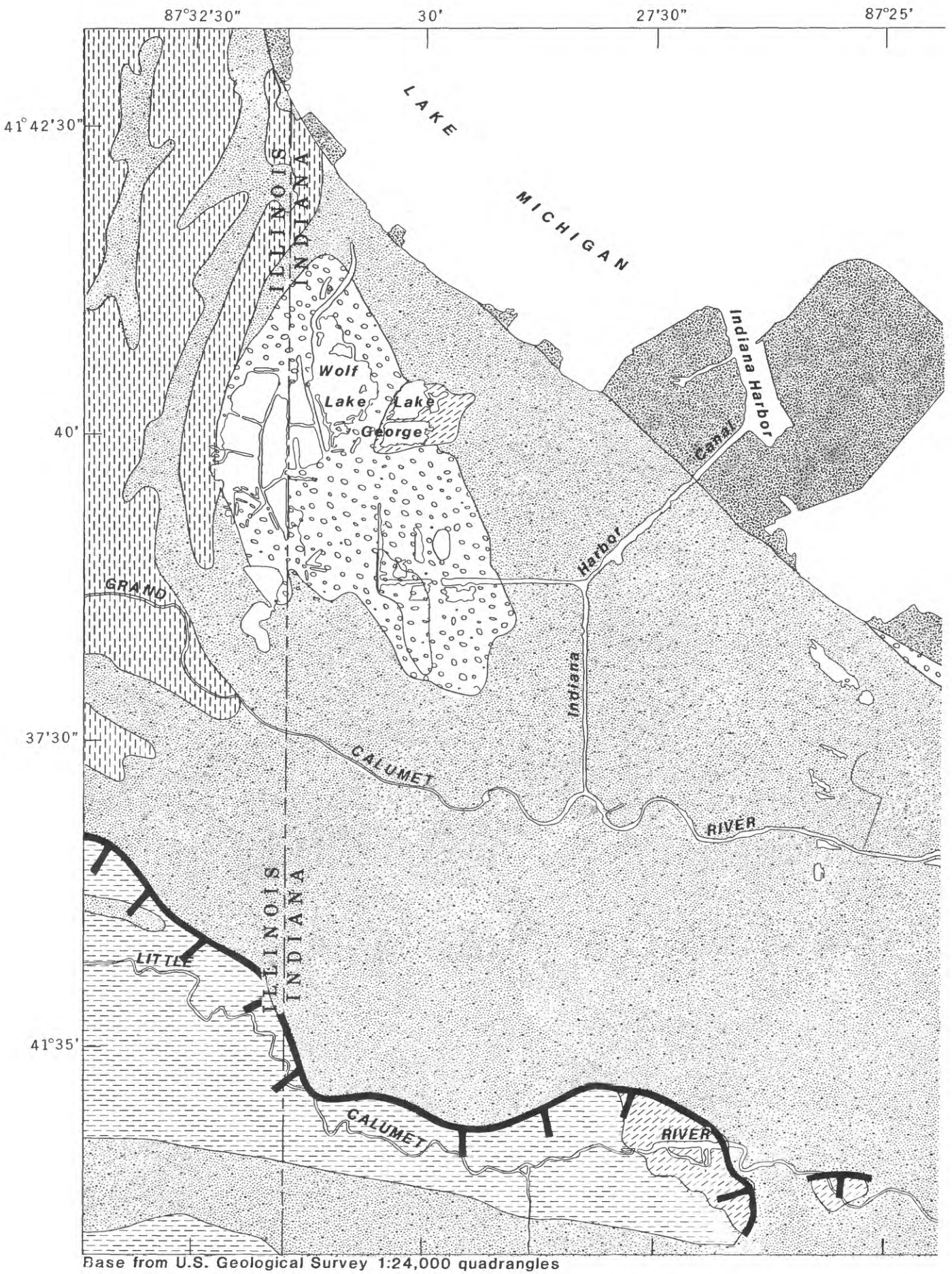
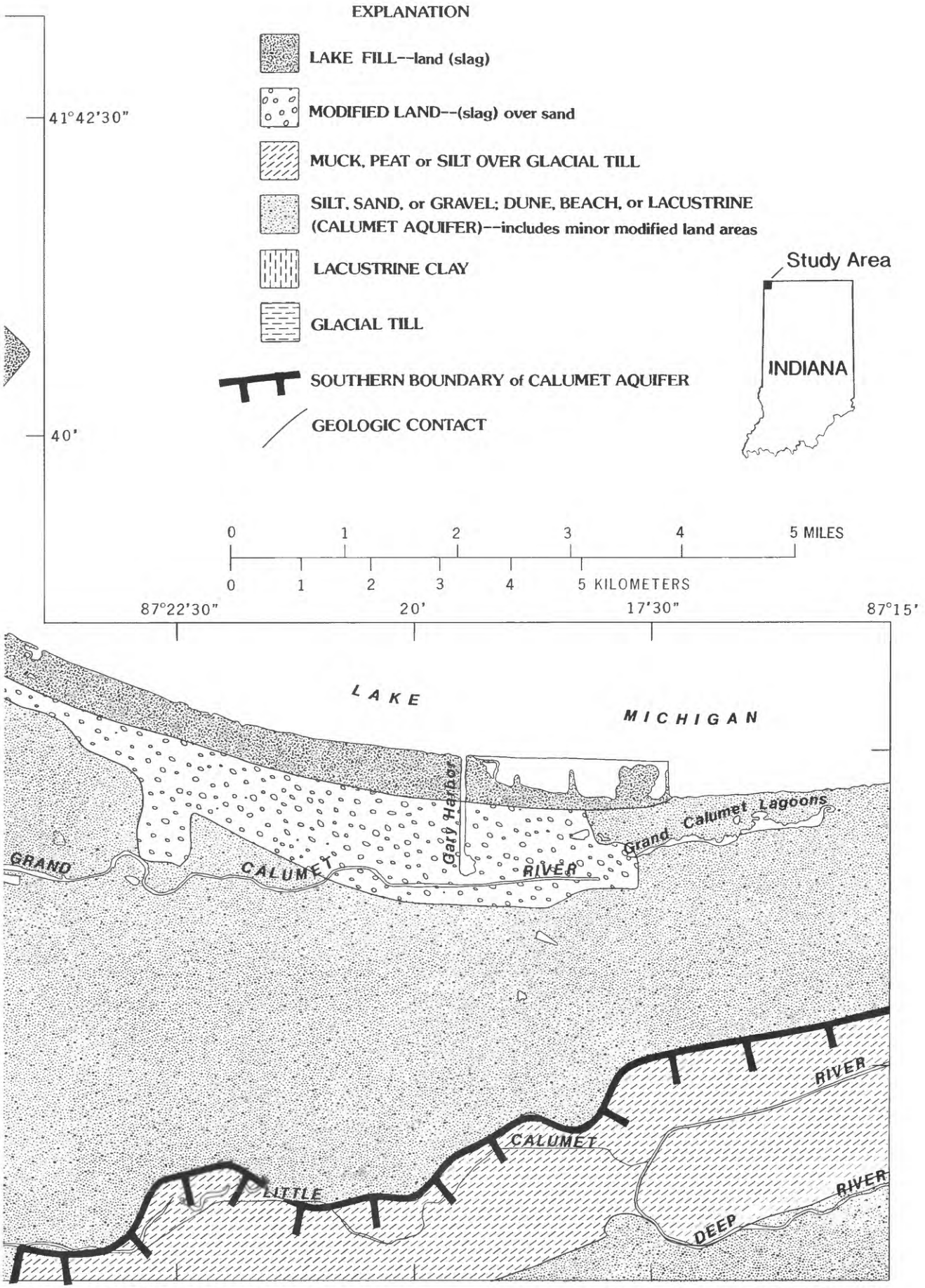


Figure 3. Surficial geology of the study area



Geology modified from Schneider and Keller (1970, fig.B)

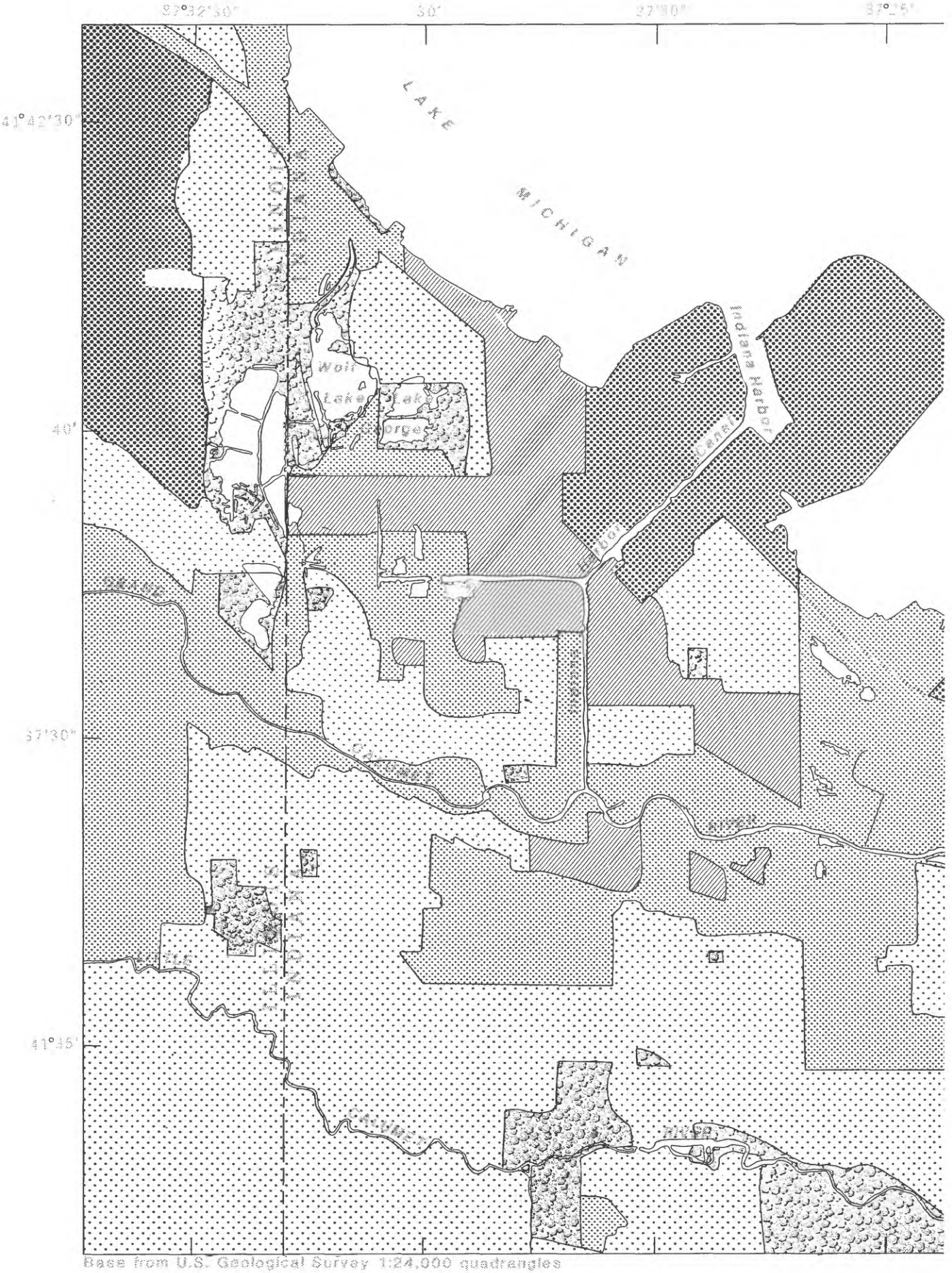
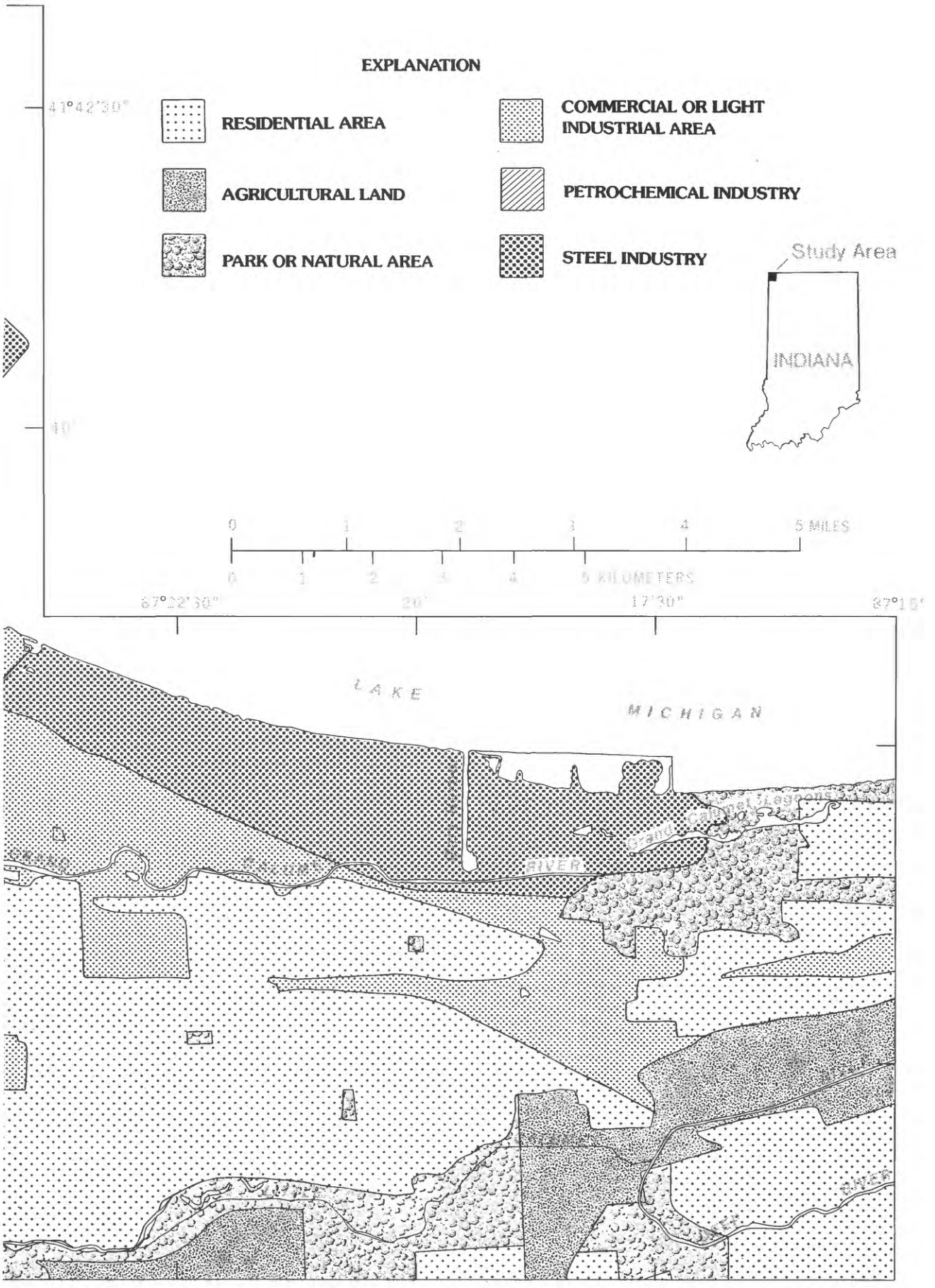


Figure 4. Major land uses in the study area.


EXPLANATION
RESIDENTIAL AREA
COMMERCIAL OR LIGHT INDUSTRIAL AREA
AGRICULTURAL LAND
PETROCHEMICAL INDUSTRY
PARK OR NATURAL AREA
STEEL INDUSTRY
Study Area
INDIANA
41°42'30"
41°40'
0 1 2 3 4 5 MILES
0 1 2 3 4 5 KILOMETERS
87°22'30"
20'
17'30"
87°15'
LAKE
MICHIGAN
RIVER

The Calumet aquifer is underlain by consolidated glacial till and lacustrine clay. Combined thickness of these deposits ranges from 50 to 130 ft in the study area (unpublished data on file at the USGS office in Indianapolis). The horizontal hydraulic conductivity of the till ranges from 0.0003 to 0.0006 ft/d and the vertical hydraulic conductivity of the till ranges from and 0.003 to 0.0002 ft/d (Fenelon and Watson, 1993, p. 18). The lacustrine clay separates the Calumet aquifer from the underlying carbonate-rock aquifer of Silurian and Devonian age. The carbonate-rock aquifer is composed of limestone and dolomite. The carbonate-rock aquifer is 300- to 400-ft thick and underlies the entire study area. The Silurian and Devonian carbonate-rock aquifer is little used as a water source in this area because most water is supplied by Lake Michigan.

Acknowledgments

The USGS acknowledges the assistance of the many Federal, State, municipal, and corporate entities who helped make this report possible:

American Oil Company, Whiting, Ind.

E.I. DuPont DeNemours & Co., East Chicago, Ind.

East Chicago, Ind., Parks Department

East Chicago, Ind., Public Schools

Gary, Ind., Airport Authority

Gary, Ind., Parks Department

Gary, Ind., Public Schools

Gary, Ind., Street Department

Hammond, Ind., Parks Department

Hammond, Ind., Public Schools

Indiana Department of Highways

Indiana Department of Natural Resources, Division of Nature Preserves

Indiana Toll Road Commission

Inland Steel Company, East Chicago, Ind.

Lake County Parks and Recreation

Lehigh Portland Cement Company, Gary, Ind.

National Park Service
Indiana Dunes National Lakeshore

Northern Indiana Public Service Company, Merrillville, Ind.

Phillips Pipeline Co., East Chicago, Ind.

U.S. Environmental Protection Agency, Region V

U.S. Steel (USX Corporation), Gary, Ind.

Whiting, Ind., Parks Department

Whiting, Ind., Public Schools

Whiting, Ind., Street Department

DATA-COLLECTION NETWORK

The data-collection network used by the USGS consisted of 70 observation wells and 30 surface-water sites in northern Lake County, Ind. (fig. 2). Measurement of the complete network took an average of 4 days. Measurements commonly began in the west and moved eastward through completion. Because of the need to schedule visits, wells on U.S. Steel (USX Corporation) property are commonly measured on day 2 of the field trip, and the USGS well on Inland Steel Company property was measured on day 3.

Ground-Water-Level Sites

During the summer and fall of 1985, 36 hand-driven observation wells were installed. The wells were constructed of 2-in.-inside-diameter, Type 304 stainless-steel pipe. The wells have 3-ft-long Type 304 stainless-steel screens with 0.006-in. continuous-slot, wire-wound openings and a drive point at the base. Screens were set just below the ground-water surface. In 1987, five more hand-driven observation wells of similar construction were installed.

Well C-17 was installed in 1986 in the Gibson Woods Nature Preserve, 1.2 mi southeast of the junction of the Indiana Harbor Canal and the Grand Calumet River (fig. 2). Well C-17 also is known as Lake County well #13 (LK-13) in the statewide observation-well network. Well C-17

is constructed of 6-in.-inside-diameter polyvinyl chloride (PVC) casing and a 5-ft-long PVC screen with 0.008-in. continuous-slot, PVC-wound opening. The well has a total depth of 23 ft, and the screen begins about 10 ft below the ground-water surface. Daily-mean water-level data for this well (reported as site #413559087270301, Lake County #13, LK-13) have been published in the annual USGS water resources data report for Indiana since 1986.

In 1987, 18 observation wells were drilled with a hollow-stem auger drill rig. The drilled wells were constructed of 2-in.-inside-diameter, Type 316L stainless-steel pipe, and have 5-ft-long Type 316L stainless-steel screens with 0.006-in. continuous-slot, wire-wound openings. These wells have a hollow, 2-ft-long blank stainless-steel casing below the screen, and total depth of these wells includes the 2.0 ft below the screen. Screens for most of the drilled wells were set near the middle of the Calumet aquifer.

Wells at 7 sites were paired and screened at different depths in the Calumet aquifer. Water-level data collected at the paired-well sites provide information on the vertical-flow gradients in the Calumet aquifer. An additional 10 non-USGS wells used in the observation-well network were installed before 1985 by means of numerous construction methods and materials (table 1).

Surface-Water-Level Sites

There are 30 surface-water sites in the water-level network monitored by the USGS (table 2). These include 1 Lake Michigan site, 3 inland-lake sites, 10 ditch sites, 1 sewer-measurement site, 2 Indiana Harbor Canal sites, 9 Grand Calumet River sites, 2 Calumet Lagoon sites, and 2 Little Calumet River sites (fig.2).

Six surface-water sites in the network are paired with two to four shallow wells. The wells were installed to form transects perpendicular to the Grand Calumet River or the Indiana Harbor Canal. These transects were designed to allow analysis of ground-water/surface-water interactions. The surface-water sites paired with wells are A-11S, C-16S, D-36S, D-54S, E-16S, and S-12.

An additional Lake Michigan site (S-23) has been included among the data reported here (table 2). Site S-23 is an hourly lake-level gage operated by the National Oceanic and Atmospheric Administration (NOAA) at Calumet Harbor, Ill. The NOAA gage, station 908–7044, is at latitude 41°43′48″N; longitude 87°32′18″W, 1.75 mi northwest of the study area. In general, one lake level per month is reported for site S-23 (tables 2 and 5). Lake levels for site S-23 are daily means of the hourly NOAA data. Measurement dates either correspond to the date when USGS site S-14 was measured or to the middle date of each month.

GROUND-WATER LEVELS AND THEIR RELATION TO SURFACE-WATER LEVELS

Summary statistics of the ground-water and surface-water data were computed (tables 3 and 4). Data presented for the data sets are the following: number of measurements, mean value, median value, standard deviation, minimum value, maximum value, and beginning and ending dates. Surface-water sites S-5 and S-6 are omitted from the data tables because the water-level data are unreliable.

Caution is advised in the comparison of sites with dissimilar numbers of measurements. The summary statistics are affected by the number of observations per site. If only a few measurements are made at a given site, then each measurement affects the summary statistics more than if more measurements had been made. Sites measured more than 45 times (C-17 and S-23) should not be compared with sites where the number of measurements was nearer to the overall average of 25 per site. The same is true of sites measured fewer than 15 times or less (C-18, D-65, CGA-5, S-3, S-4, S-7, S-16, S-17, S-18, S-19, S-20, S-21, S-22 and D-54S) because they are not representative (table 5, at back of report).

Table 1. Characteristics of observation wells completed in the Calumet aquifer, northern Lake County, Indiana
[USGS, U.S. Geological Survey; n.a., not applicable; ?, not known; CA, screened in the Calumet aquifer; GAA, Gary Airport Authority; USX, USX Corporation; Auger, hollow-stem auger]

Well name	Well owner	Latitude/longitude	USGS site identifier	Date drilled (month–year)	Method of installation	Land surface, in feet above sea level	Screened interval, in feet below land surface	Screen and stainless-steel casing type	Relative vertical position of screen in aquifer
A-1	USGS	41°36′47″/87°19′19″	413647087191901	07–85	Auger	604	18-21	304	Top
A-2	USGS	41°37′06″/87°18′18″	413706087181800	06–87	Auger	603	34-39	316L	Middle
A-3	USGS	41°36′31″/87°18′20″	413631087182000	06–87	Hand driven	590	3-6	316L	Top
A-4	USGS	41°36′30″/87°18′21″	413630087182100	06–87	Auger	603	18-23	316L	Middle
A-5	USGS	41°36′29″/87°19′21″	413629087192102	12–85	Auger	601	18-21	304	Top
A-6	USGS	41°37′06″/87°17′01″	413706087170101	06–87	Hand driven	588	4-7	316L	Top
A-10	USGS	41°36′26″/87°19′19″	413626087191901	07–85	Hand driven	590	12-15	304	Top
A-15	USGS	41°36′17″/87°19′12″	413617087191201	07–85	Hand driven	591	2-5	304	Top
A-20	USGS	41°35′03″/87°19′35″	413503087193501	12–85	Auger	614		304	Top
B-1	USGS	41°36′37″/87°23′43″	413637087234301	08–85	Hand driven	585	9-12	304	Top
B-2	USGS	41°37′52″/87°22′35″	413752087223500	06–87	Auger	608	43-48	316L	Middle
B-3	USGS	41°36′33″/87°22′20″	413633087222000	06–87	Auger	594	18-23	316L	Middle
B-5	USGS	41°36′32″/87°23′40″	413632087234001	08–85	Hand driven	589	8-11	304	Top
B-7	USGS	41°36′17″/87°22′52″	413617087225202	06–87	Hand driven	596	8-11	316L	Top
B-8	USGS	41°36′17″/87°22′52″	413617087225201	06–87	Auger	596	32-37	316L	Bottom
B-10	USGS	41°35′44″/87°23′37″	413544087233700	12–85	Auger	607	17-20	304	Top
C-1	USGS	41°38′30″/87°26′00″	413830087260000	12–85	Auger	587	4-7	304	Top
C-2	USGS	41°40′31″/87°24′50″	414031087245000	06–87	Auger	594	13-18	316L	Top
C-3	USGS	41°38′28″/87°25′13″	413828087251301	06–87	Auger	589	23-28	316L	Middle
C-4	USGS	41°38′28″/87°25′13″	413828087251302	06–87	Auger	589	8-13	316L	Top

Table 1. Characteristics of observation wells completed in the Calumet aquifer, northern Lake County, Indiana—Continued

Well name	Well owner	Latitude/longitude	USGS site identifier	Date drilled (month–year)	Method of installation	Land surface, in feet above sea level	Screened interval, in feet below land surface	Screen and stainless-steel casing type	Relative vertical position of screen in aquifer
C-5	USGS	41°36′55″/87°26′20″	413655087275202	07–85	Hand driven	584	2-5	304	Top
C-10	USGS	41°36′50″/87°26′20″	413652087274901	07–85	Hand driven	584	1-4	304	Top
C-12	USGS	41°36′50″/87°26′20″	413650087262000	06–87	Auger	584	13-18	316L	Middle
C-15	USGS	41°36′48″/87°26′20″	413650087274802	07–85	Hand driven	583	1-4	304	Top
[1]C-17	USGS	41°35′59″/87°27′03″	413559087270301	07–86	Mud rotary	592	18-23	n.a.	Bottom
C-18	USGS	41°36′07″/87°25′22″	413607087252200	06–87	Auger	595	17-22	316L	Bottom
C-19	USGS	41°36′17″/87°26′20″	413617087262001	12–86	Hand driven	592	2-5	304	Top
C-20	USGS	41°35′57″/87°26′11″	413557087283901	07–85	Hand driven	593	3-6	304	Top
C-25	USGS	41°35′27″/87°25′43″	413527087254301	07–85	Hand driven	599	2-5	304	Top
CGA-3	GAA	41°37′22″/87°25′13″	n.a.	pre-1985	?	590	CA	n.a.	?
CGA-4	GAA	41°37′19″/87°25′19″	n.a.	pre-1985	?	591	CA	n.a.	?
CGA-5	GAA	41°37′22″/87°25′22″	n.a.	pre-1985	?	594	CA	n.a.	?
D-1	USGS	41°40′52″/87°29′12″	414052087291201	07–85	Hand driven	590	8-11	304	Top
D-5	USGS	41°40′44″/87°29′08″	414044087290801	07–85	Hand driven	588	2-7	304	Top
D-10	USGS	41°40′43″/87°29′08″	414043087290802	07–85	Hand driven	588	7-10	304	Top
D-11	USGS	41°40′43″/87°29′08″	414043087290801	06–87	Auger	588	17-22	316L	Middle
D-20	USGS	41°39′41″/87°29′00″	413941087290000	07–85	Hand	588	6-9	304	Top
D-21	USGS	41°39′41″/87°29′26″	413941087292600	06–87	Auger	584	13-18	316L	Middle
D-25	USGS	41°39′09″/87°28′03″	413804087291102	07–85	Hand driven	588	5-8	304	Top
D-30	USGS	41°39′07″/87°27′58″	413758087290702	07–85	Hand driven	586	6-9	304	Top
D-31	USGS	41°39′07″/87°27′58″	413907087275901	06–87	Auger	586	12-17	316L	Middle
D-35	USGS	41°39′06″/87°27′57″	413757087290601	07–85	Hand driven	586	4-7	304	Top
D-40	USGS	41°38′35″/87°28′51″	413835087245101	07–85	Hand driven	584	4-7	304	Top
D-45	USGS	41°38′12″/87°27′02″	413812087270201	07–85	Hand driven	586	6-9	304	Top
D-50	USGS	41°38′00″/87°28′54″	413800087285401	12–85	Hand driven	585	9-12	304	Top

Table 1. Characteristics of observation wells completed in the Calumet aquifer, northern Lake County, Indiana—Continued

Well name	Well owner	Latitude/longitude	USGS site identifier	Date drilled (month–year)	Method of installation	Land surface, in feet above sea level	Screened interval, in feet below land surface	Screen and stainless-steel casing type	Relative vertical position of screen in aquifer
D-55	USGS	41°37′58″/87°28′14″	413758087281401	07–85	Hand driven	585	5-8	304	Top
D-60	USGS	41°37′58″/87°28′10″	413758087281001	07–85	Hand driven	587	5-8	304	Top
D-65	USGS	41°37′59″/87°28′01″	413759087280101	07–85	Hand driven	584	1-4	304	Top
D-66	USGS	41°36′54″/87°27′40″	413654087274000	06–87	Auger	587	17-22	316L	Middle
D-67	USGS	41°36′47″/87°28′25″	413647087282502	06–87	Hand driven	589	4-7	316L	Top
D-68	USGS	41°36′47″/87°28′25″	413647087282501	06–87	Auger	589	18-23	316L	Middle
D-70	USGS	41°35′15″/87°29′14″	413515087291401	07–85	Hand driven	603	6-9	304	Top
D-75	USGS	41°34′35″/87°29′19″	413435087291901	07–85	Hand driven	601	5-8	304	Top
E-1	USGS	41°38′44″/87°31′04″	413844087310401	07–85	Hand driven	582	5-8	304	Top
E-2	USGS	41°41′05″/87°29′39″	414105087293900	06–87	Hand driven	585	3-6	316L	Top
E-3	USGS	41°40′13″/87°30′33″	414013087303300	06–87	Auger	585	8-13	316L	Middle
E-5	USGS	41°38′10″/87°30′52″	413810087305201	07–85	Hand driven	587	9-12	304	Top
E-6	USGS	41°39′38″/87°30′43″	413938087304301	06–87	Auger	586	17-22	316L	Bottom
E-7	USGS	41°39′38″/87°30′43″	413938087304302	06–87	Hand driven	586	2-5	316L	Top
E-10	USGS	41°37′22″/87°30′41″	413722087304101	07–85	Hand driven	586	6-9	304	Top
E-15	USGS	41°37′20″/87°30′42″	413720087304201	07–85	Hand driven	584	11-14	304	Top
E-17	USGS	41°37′19″/87°30′45″	413719087304501	07–85	Hand driven	584	5-8	304	Top
E-20	USGS	41°36′27″/87°31′05″	413627087310500	07–85	Hand driven	592	5-8	304	Top
HWT2-9	USX	41°37′52″/87°22′35″	n.a.	04–84	Auger	608	50-70	n.a.	Bottom
HWT2-10	USX	41°37′32″/87°23′22″	n.a.	04–84	Auger	589	24-44	n.a.	Bottom
HWT2-12S	USX	41°37′38″/87°22′48″	n.a.	n.a.	n.a.	601	24-29	n.a.	Top
HWT14-5	USX	41°37′22″/87°22′55″	n.a.	04–84	Auger	589	27-47	n.a.	Bottom
P-4	USX	41°37′44″/87°22′39″	n.a.	04–84	Auger	603	25-35	n.a.	Top
P-7	USX	41°37′38″/87°22′48″	n.a.	04–84	Auger	601	20-30	n.a.	Top
P-11	USX	41°37′34″/87°22′51″	n.a.	04–84	Auger	596	15-25	n.a.	Top

[1]Continuous recording water-level well (LK-13) operated by the USGS as part of a State ground-water-data network. Water levels are published in the U.S. Geological Survey water data reports, IN-87-1 to IN-92-1.

Table 2. Location and description of surface-water-stage measurement sites in northern Lake County, Indiana

Site name	Surface-water body	Latitude/longitude	USGS site identifier	Measurement location
S-1	Wolf Lake	41°40′16″/87°30′37″	4140160873037	Fishing pier in park, Hammond, Ind.
S-2	Lake George	41°40′06″/87°30′23″	4140060873023	125th Street, east of Calumet Avenue, Hammond, Ind.
S-3	Ditch	41°39′45″/87°30′30″	4139450873030	Ditch, north of 129th Street, on Calumet Avenue, Hammond, Ind.
S-4	Ditch	41°39′38″/87°30′30″	4139380873030	Ditch, 129th Street and Calumet Avenue, Hammond, Ind.
S-7	Grand Calumet River	41°36′51″/87°28′50″	4136510872850	At US 12 & 20 bridge (Indianapolis Boulevard), East Chicago, Ind.
S-8	Sewer	41°38′08″/87°27′05″	4138080872705	Sewer grate, Washington Park, East Chicago, Ind.
S-9	Lake (unnamed)	41°38′14″/87°25′40″	4138140872540	Mid-northshore, Gary, Ind.
S-10	Grand Calumet River	41°36′40″/87°25′13″	4136400872513	Confluence with drainage ditch, Gary, Ind.
S-11	Ditch	41°36′08″/87°25′34″	4136080872534	Ditch along US 20, east of Cline Avenue, Gary, Ind.
S-12	Grand Calumet River	41°36′28″/87°23′37″	4136280872337	At US 12 bridge (Industrial Highway), Gary, Ind.
S-13	Grand Calumet River	41°36′32″/87°22′18″	4136320872218	At Bridge Street bridge, Gary, Ind.
S-14	Lake Michigan	41°36′32″/87°19′24″	4136320871924	Gary Harbor, Ind., southern end of turning basin
S-15	West Calumet Lagoon	41°36′45″/87°17′26″	4136450871726	South side, USX Corporation, Gary, Ind.
S-16	East Calumet Lagoon	41°36′54″/87°16′07″	4136540871607	At Lake Street bridge, Miller, Ind.
S-17	Grand Calumet River	41°36′50″/87°27′42″	4136500872742	At Kennedy Avenue bridge, Hammond, Ind.
S-18	Ditch	41°39′44″/87°30′31″	4139440873031	Ditch, northwest of Calumet Avenue and 129th Street, Hammond, Ind.
S-19	Ditch	41°39′38″/87°30′32″	4139380873032	Ditch, west of Calumet Avenue on 129th Street, Hammond, Ind.
S-20	Ditch	41°39′27″/87°30′31″	4139270873031	Ditch, northwest of Calumet Avenue & Indiana Road 912, Hammond, Ind.
S-21	Ditch	41°39′24″/87°30′32″	4139240873032	Ditch, southwest of Calumet Avenue & Indiana Road 912, Hammond, Ind.
S-22	Ditch	41°39′39″/87°30′27″	4139390873027	Ditch, east of Calumet Avenue and north of 129th Street, Hammond, Ind.
S-23	Lake Michigan	41°43′48″/87°32′18″	908-7044	Gage at Calumet Harbor, Ill. (National Oceanic and Atmospheric Administration)
A-11S	Grand Calumet River	41°36′26″/87°19′18″	4136260871918	At Tennessee Street, USX Corporation, Gary, Ind.
C-16S	Grand Calumet River	41°36′47″/87°26′20″	4136470872620	E.I. Dupont DeNemours & Co., East Chicago, Ind.
D-36S	Indiana Harbor Canal	41°39′05″/87°27′56″	4139050872756	At Indiana Road 912, East Chicago, Ind.
D-54S	Indiana Harbor Canal	41°37′59″/87°28′14″	4137590872814	Phillips Petroleum, East Chicago, Ind.
E-16S	Grand Calumet River	41°37′19″/87°30′44″	4137190873044	Spohn School, Hammond, Ind.
--	Little Calumet River	41°34′19″/87°19′13″	04093200	USGS gage at Martin Luther King Jr. Avenue bridge, Gary, Ind.
--	Burns Ditch	41°34′30″/87°17′20″	04093500	USGS gage at Central Avenue bridge, near Gary, Ind.
--	Little Calumet River	41°34′07″/87°31′18″	05536195	USGS gage at Hohman Avenue bridge, Munster, Ind.
--	Grand Calumet River	41°37′28″/87°23′10″	05536357	USGS gage at Hohman Avenue bridge, Hammond, Ind.

Table 3. Summary statistics for ground-water-level measurements in the Calumet aquifer, northern Lake County, Indiana
[Water-level statistics are reported in feet above sea level; --, insufficient data]

Site or well name	Number of measurements	Mean	Median	Standard deviation	Minimum	Maximum	Period of record	
							Beginning (month–year)	End (month–year)
A-1	30	586.72	586.63	0.49	585.54	587.72	10-85	09-92
A-2	21	587.18	587.13	.27	586.73	587.59	06-87	09-92
A-3	20	588.47	588.48	.11	588.31	588.71	06-87	09-92
A-4	20	588.66	588.68	.15	588.34	588.99	06-87	09-92
A-5	28	585.82	585.82	.32	585.33	586.42	12-85	09-92
A-6	19	585.41	585.34	.47	584.58	586.23	07-87	09-92
A-10	29	585.71	585.66	.24	585.31	586.21	10-85	09-92
A-15	31	590.02	589.92	.56	589.15	591.55	10-85	09-92
A-20	32	595.68	595.77	.38	595.06	596.37	01-86	09-92
B-1	38	582.17	581.28	1.87	580.23	585.90	08-85	09-92
B-2	20	580.16	580.07	.59	579.46	581.62	06-87	09-92
B-3	19	584.34	584.39	.38	583.62	585.14	07-87	09-92
B-5	39	583.31	582.88	1.07	581.69	585.38	08-85	09-92
B-7	19	587.54	587.50	.57	586.34	588.57	06-87	09-92
B-8	19	587.53	587.48	.57	586.35	588.56	07-87	09-92
B-10	34	593.26	593.26	.75	591.74	595.14	12-85	09-92
C-1	35	583.02	582.94	.63	581.68	584.70	12-85	09-92
C-2	17	584.68	584.94	.65	583.44	585.46	07-87	09-92
C-3	20	580.63	580.56	.53	579.86	581.87	06-87	04-92
C-4	20	580.66	580.59	.52	579.93	581.87	06-87	09-92

Table 3. Summary statistics for ground-water-level measurements in the Calumet aquifer, northern Lake County, Indiana—Continued

Site or well name	Number of measurements	Mean	Median	Standard deviation	Minimum	Maximum	Period of record	
							Beginning (month–year)	End (month–year)
C-5	30	583.97	584.00	0.86	582.36	585.73	10-85	09-92
C-10	34	582.94	583.07	.64	581.33	584.19	10-85	09-92
C-12	19	582.58	582.76	.71	581.28	583.96	08-87	09-92
C-15	30	582.37	582.42	.51	580.97	583.40	10-85	09-92
C-17	86	589.65	589.81	1.31	586.90	591.91	07-86	09-92
C-18	12	590.72	590.83	.55	589.62	591.45	06-87	09-92
C-19	21	589.68	589.88	.61	588.39	590.62	12-86	09-92
C-20	32	592.40	592.63	1.67	587.61	594.71	08-85	09-92
C-25	32	596.80	596.78	.82	595.10	598.13	12-85	09-92
CGA-3	31	585.12	585.02	.39	584.63	586.26	10-85	09-92
CGA-4	31	584.88	584.83	.47	584.16	586.19	10-85	09-92
CGA-5	6	587.42	587.53	.59	586.36	588.16	10-85	03-86
D-1	37	582.22	582.18	.72	581.15	583.48	08-85	09-92
D-5	34	583.41	583.49	.48	582.23	584.12	08-85	09-92
D-10	39	583.24	583.26	.44	582.29	583.99	08-85	09-92
D-11	22	583.11	583.08	.50	582.30	584.01	06-87	09-92
D-20	38	583.74	583.75	.78	581.80	585.32	08-85	09-92
D-21	21	581.15	581.04	.64	580.07	582.88	07-87	09-92
D-25	33	583.23	583.35	.63	581.93	584.92	12-85	09-92
D-30	31	581.75	581.43	.75	580.61	583.24	12-85	09-92
D-31	21	581.22	581.13	.47	580.50	582.46	07-87	09-92
D-35	31	581.28	580.78	.98	580.01	582.92	12-85	09-92
D-40	34	582.47	582.52	.75	580.66	583.80	10-85	09-92
D-45	34	580.78	580.66	.54	579.73	582.64	10-85	09-92
D-50	28	578.03	578.00	.31	577.47	578.61	12-85	09-92

Table 3. Summary statistics for ground-water-level measurements in the Calumet aquifer, northern Lake County, Indiana—Continued

Site or well name	Number of measurements	Mean	Median	Standard deviation	Minimum	Maximum	Period of record	
							Beginning (month–year)	End (month–year)
D-55	37	581.45	581.28	1.06	579.81	582.88	10-85	09-92
D-60	34	582.46	582.52	.82	580.70	583.78	10-85	09-92
D-65	15	583.89	584.19	.71	581.74	584.69	10-85	07-88
D-66	20	581.74	581.74	.27	581.25	582.27	07-87	09-92
D-67	19	585.44	585.36	1.18	583.49	588.38	07-87	09-92
D-68	19	585.43	585.36	1.18	583.49	588.31	07-87	09-92
D-70	31	599.67	599.56	.82	598.48	602.29	01-86	09-92
D-75	33	596.43	596.39	.31	595.95	597.10	01-86	09-92
E-1	34	578.59	578.56	.52	577.62	579.52	12-85	09-92
E-2	21	580.94	580.89	.59	580.18	582.49	06-87	09-92
E-3	23	582.71	582.68	.60	581.71	583.98	06-87	09-92
E-5	34	581.19	581.17	.41	580.56	582.20	08-85	09-92
E-6	22	584.41	584.42	.58	583.07	585.31	06-87	09-92
E-7	23	584.45	584.48	.60	583.06	585.44	06-87	09-92
E-10	38	581.96	582.03	.62	580.42	583.24	10-85	06-92
E-15	33	581.64	581.79	.53	580.62	582.48	10-85	09-92
E-17	16	581.52	581.52	.25	580.93	581.97	10-85	03-88
E-20	36	587.97	587.90	.64	586.79	589.34	08-85	09-92
HWT2-9	29	580.83	580.28	1.00	579.55	582.44	12-85	09-92
HWT2-10	29	587.69	587.91	.89	585.55	589.16	12-85	09-92
HWT2-12S	1	584.95	584.95	--	584.95	584.95	06-92	06-92
HWT14-5	29	584.62	584.57	.56	583.08	586.26	12-85	09-92
P-4	29	583.19	583.19	.63	581.97	584.25	12-85	09-92
P-7	18	584.79	584.72	.50	584.14	585.99	12-85	06-92
P-11	28	585.63	585.54	.48	584.81	586.89	12-85	09-92

Table 4. Summary statistics for surface-water-level measurements in northern Lake County, Indiana
[Water-level statistics are reported in feet above sea level]

Site name	Number of measurements	Mean	Median	Standard deviation	Minimum	Maximum	Period of record	
							Beginning (month–year)	End (month–year)
S-1	33	583.31	583.21	0.35	582.82	584.18	03-86	09-92
S-2	29	582.16	582.32	.56	581.12	582.93	05-86	06-92
S-3	7	582.15	582.02	.26	581.95	582.66	06-86	01-89
S-4	8	582.13	582.03	.24	581.94	582.65	06-86	01-89
S-7	13	582.49	582.33	.53	581.38	583.23	12-85	12-86
S-8	25	579.78	579.89	.30	579.12	580.17	01-86	09-92
S-9	17	585.69	585.79	.60	584.05	586.58	08-87	09-92
S-10	34	582.33	582.33	.63	581.22	583.17	11-85	09-92
S-11	16	590.07	590.12	.31	589.28	590.52	08-87	09-92
S-12	36	582.67	582.79	.61	581.56	583.80	08-85	09-92
S-13	15	583.09	583.05	.54	582.39	584.20	10-88	09-92
S-14	22	580.56	580.27	1.23	579.01	582.81	09-85	09-92
S-15	19	587.08	587.00	.18	586.80	587.60	08-87	09-92
S-16	2	589.00	589.00	.34	588.76	589.24	08-87	07-88
S-17	13	582.43	582.41	.37	581.81	582.94	12-85	12-86
S-18	8	582.67	582.59	.27	582.37	583.16	06-86	01-89
S-19	9	582.78	582.74	.24	582.30	583.09	06-86	01-89
S-20	8	582.35	582.31	.58	581.24	583.14	06-86	01-89
S-21	4	582.65	582.59	.24	582.46	582.97	06-86	11-87
S-22	7	582.29	582.08	.45	582.03	583.27	06-87	01-90
S-23	89	580.51	580.12	1.20	578.58	583.10	06-85	09-92
A-11S	28	585.76	585.65	.30	585.45	586.51	12-85	09-92
C-16S	31	582.16	582.08	.48	580.97	583.42	12-85	09-92
D-36S	28	580.83	580.59	1.27	578.91	583.05	01-86	09-92
D-54S	13	581.49	582.27	1.33	579.12	582.83	12-85	09-92
E-16S	31	580.58	580.45	.66	579.41	581.60	12-85	09-92

Water-Level Fluctuations

Ground-water levels in the USGS data-collection network commonly reached an annual maximum in June or July, the months of maximum precipitation (National Oceanic and Atmospheric Administration, 1982). Another peak in ground-water levels during February and March of most years was related to the spring thaw. Annual minimum ground-water levels commonly occurred in September or October, although the minimum has occurred earlier and later within the data set. The effects of evapotranspiration can be seen in hourly ground-water-level data collected at well C-17 (also called LK-13). During the day, water is absorbed by the plant roots and transpired into the atmosphere from the leaves. The hydrograph in figure 5 shows how this activity lowers the water level several hundredths of a foot each day. At night, the plant activity stops, and water levels rebound somewhat.

Analysis of USGS ground-water-level data, collected from August 1985 through September 1992 (table 5, at back of report), indicates that ground-water fluctuations (total difference between highest and lowest water levels measured) in the Calumet aquifer ranged from a minimum of 0.40 ft at well A-3 to a maximum of 5.01 ft at well C-17. The mean ground-water fluctuation measured in the study area was about 2.3 ft. Although the water levels in two wells (B-1 and C-20) fluctuated more than 5.50 ft, the lowest water levels at both wells were affected temporarily by nearby dewatering projects.

Surface-water-level data collected during the same 7-year period indicate that surface-water fluctuations (total difference between highest and lowest water levels measured) were greatest on Lake Michigan and on sites hydraulically connected to the lake. During the study period, the total fluctuation measured on Lake Michigan at USGS site S-14 (at the southern end of Gary Harbor) was 3.80 ft.

The greatest fluctuation in surface-water level within the USGS network data was 4.14 ft, measured at site D-36S on the Indiana Harbor Canal. Although site D-36S is about 2.5 mi inland from the open water of Lake Michigan, the Indiana Harbor Canal is hydraulically connected to the lake. The measured surface-water fluctuation at another Indiana Harbor Canal site, D-54S, was 3.71 ft during the data-collection period. Site D-54S is 3.75 mi inland from the lake; however, water levels are nearly equivalent to lake level. Wind and ship traffic in the Indiana Harbor Canal can cause rapid changes in the surface-water level. Although site D-54S is upstream from the navigational limit of ship traffic, the site still may be affected by that traffic. Measurements were not attempted when boats were passing.

The water-level fluctuation in Lake Michigan was slightly greater at the NOAA site S-23 (Calumet Harbor, Ill.) than at the USGS Lake Michigan site S-14. Mean daily water levels for site S-23 indicate that lake levels fluctuated 4.52 ft from August 1985 through September 1992. The larger fluctuation at site S-23 is due partly to the greater number of measurements (89) than the number of measurements (22) at site S-14 (table 3).

Analysis of the USGS surface-water data collected from August 1985 through September 1992 indicates that, overall, fluctuations were the greatest at the downstream sites on the east branch of the Grand Calumet River. These sites, however, are influenced by backwater effects when the level of Lake Michigan is high. Of the eight sites on the Grand Calumet River (east and west branches), only the most upstream site on the east branch (A-11S) was unaffected by backwater from Lake Michigan. Stage fluctuations on the east branch of the Grand Calumet River also are influenced by continuous industrial outfalls and the Gary wastewater-treatment facility, which is 1,000 ft upstream from site S-12 (Crawford and Wangsness, 1987, p. 32). Stage fluctuations at the two west branch Grand Calumet River sites also are affected by discharges from the East Chicago and Hammond wastewater-treatment facilities (Crawford and Wangsness, 1987, p. 35).

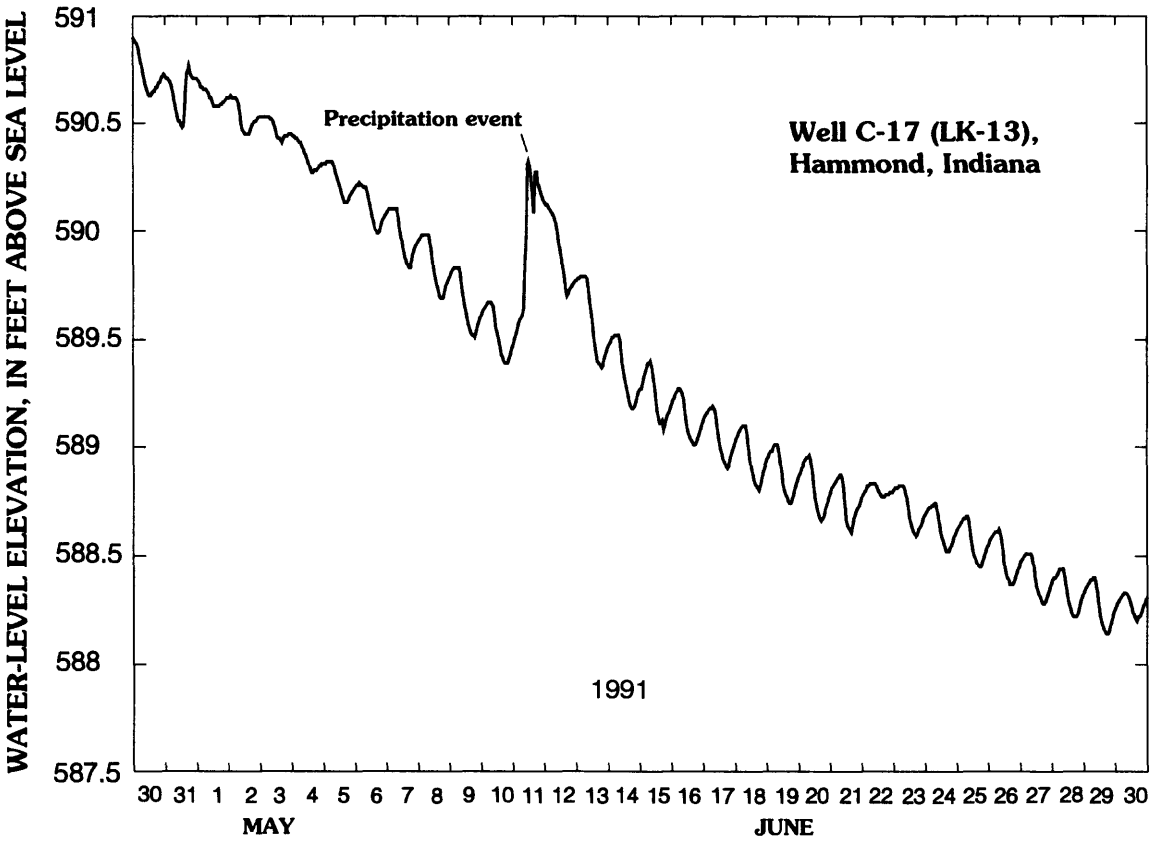


Figure 5. Ground-water hydrograph showing the daily effects of evapotranspiration.

Stage fluctuations at the six sites on the east branch of the Grand Calumet River (A-11S, C-16S, S-10, S-12, S-13, and S-17) ranged from 1.06 to 2.45 ft during the study period. Stage fluctuations at the two sites on the west branch of the Grand Calumet River (S-7 and E-16S) ranged from 1.85 to 2.19 ft during the study period.

The low magnitude of the fluctuations in the Grand Calumet River is a result of several circumstances:

1. Most of the flow in the river is industrial or municipal effluent, discharged at a fairly constant rate.
2. The relief of the basin is low (highest point is only 50 ft above Lake Michigan).
3. Precipitation infiltrates directly into the Calumet aquifer.
4. The Grand Calumet River is hydraulically connected to the Calumet aquifer system, and response in one is seen in the other.
5. The hydraulic conductivity of the aquifer stabilizes the rate of discharge to the surface water.

The stability of the aquifer is such, that unless a major recharge event occurs during data collection (such as the 3.00-in. rainfall on November 27, 1990, which raised ground-water levels more than 1.0 ft in well C-17), ground-water levels should vary less than 0.2 ft in a 4-day data-collection period. Thus, the data within

most sets can be used as if they were collected simultaneously. Variation at sites affected by evapotranspiration can be as much as 0.4 ft in 4 days, however. The levels of Lake Michigan can vary significantly over short periods, and hourly lake-level data may be necessary to determine whether surface-water levels in the Indiana Harbor Canal and the Grand Calumet River were affected.

Changes Induced by Drought

Below-average precipitation was reported throughout Indiana from October 1987 through September 1988. The below-average precipitation allowed ground-water levels in most areas of the State to decline to record lows (Fowler, 1992, p. 30). Although northwestern Indiana was especially hard hit, water levels in the Calumet aquifer were not significantly affected by the drought of 1988. Only 40 percent of the network wells registered record low water levels during the drought. Record low water levels were reported for wells A-5, A-6, B-1, B-5, C-1, C-5, C-10, C-12, C-15, C-18, C-19, C-25, CGA-3, D-20, D-60, D-65, D-67, D-68, D-70, E-1, E-3, E-6, E-7, E-10, E-20, P-4, P-7, and P-11 (fig. 2).

During the drought of 1988, the deficit in precipitation coincided with reversals of normal vertical flow gradients in many areas of the Calumet aquifer. This reversal was observed in most sets of paired deep and shallow wells. Water levels in two sets of paired wells (deep|shallow), D-11|D-10, and D-31|D-30, best illustrate the reversal of normally upward flow gradients (figs. 6A and 6B). Water levels at paired well site E-6|E-7 best illustrate the reversal of normally downward flow gradients during the drought of 1988 (fig. 6C). Water levels in D-68|D-67, another set of paired wells about 1,000 ft from the Grand Calumet River, indicate that normally horizontal flow gradients were affected only slightly in 1988 (fig. 6D). Screen depths for these wells are listed in table 1. Vertical flow gradients in paired USGS wells in the Calumet aquifer generally are less than 0.15 ft. The lack of larger differences in vertical gradients indicates the moderate to high vertical hydraulic conductivity. Greater differences would indicate decreased vertical hydraulic conductivity within the aquifer because of silt and clay. During the study period, monthly precipitation ranged from 0.07 in. (February 1987) to 9.45 in. (August 1990), as recorded at Hobart, Ind., 6 mi south of Lake Michigan and 2.5 mi southeast of the study area (fig. 7).

Water levels in the remaining wells were lower at other times during the study period. More than 25 percent of the wells had record low water levels in 1992. Other years when several record low water levels were observed were 1986 and 1991. Explanations of why the drought of 1988 had such a small effect on water levels in the Calumet aquifer are conjecture. The most probable explanation, however, is that the Calumet aquifer is little used as a water supply and that the tremendous volume of water stored in the aquifer creates stability.

Record low water levels were observed at 11 surface-water sites during the drought of 1988: S-1, S-2, S-3, S-4, S-9, S-16, S-18, S-19, S-20, C-16S, and E-16S. Eight of the affected surface-water sites are in the Wolf Lake and Lake George area and near the Indiana-Illinois State line (fig. 2). The three other surface-water sites are east of the Indiana Harbor Canal. The effect of the drought of 1988 on Lake Michigan levels is unclear. Lake levels (Calumet Harbor gage) rose about 1.0 ft during the first 5 months of 1988 before declining during the remainder of the year (Jeff Oyler, National Oceanic and Atmospheric Administration, written commun., 1992).

Changes Induced by Lake Michigan

Lake Michigan was at record high levels from fall 1985 through summer 1986 (fig. 8). Historical maximum monthly-mean lake levels were established each month during this period. The maximum daily-mean lake level at Calumet Harbor, Ill., was 583.50 ft on October 25, 1986 (Jeff Oyler, National Oceanic and Atmospheric Administration, written commun., 1992). Since 1986, the level of Lake Michigan has dropped to slightly below the normal pool level of 580 ft. The minimum daily-mean lake level during the

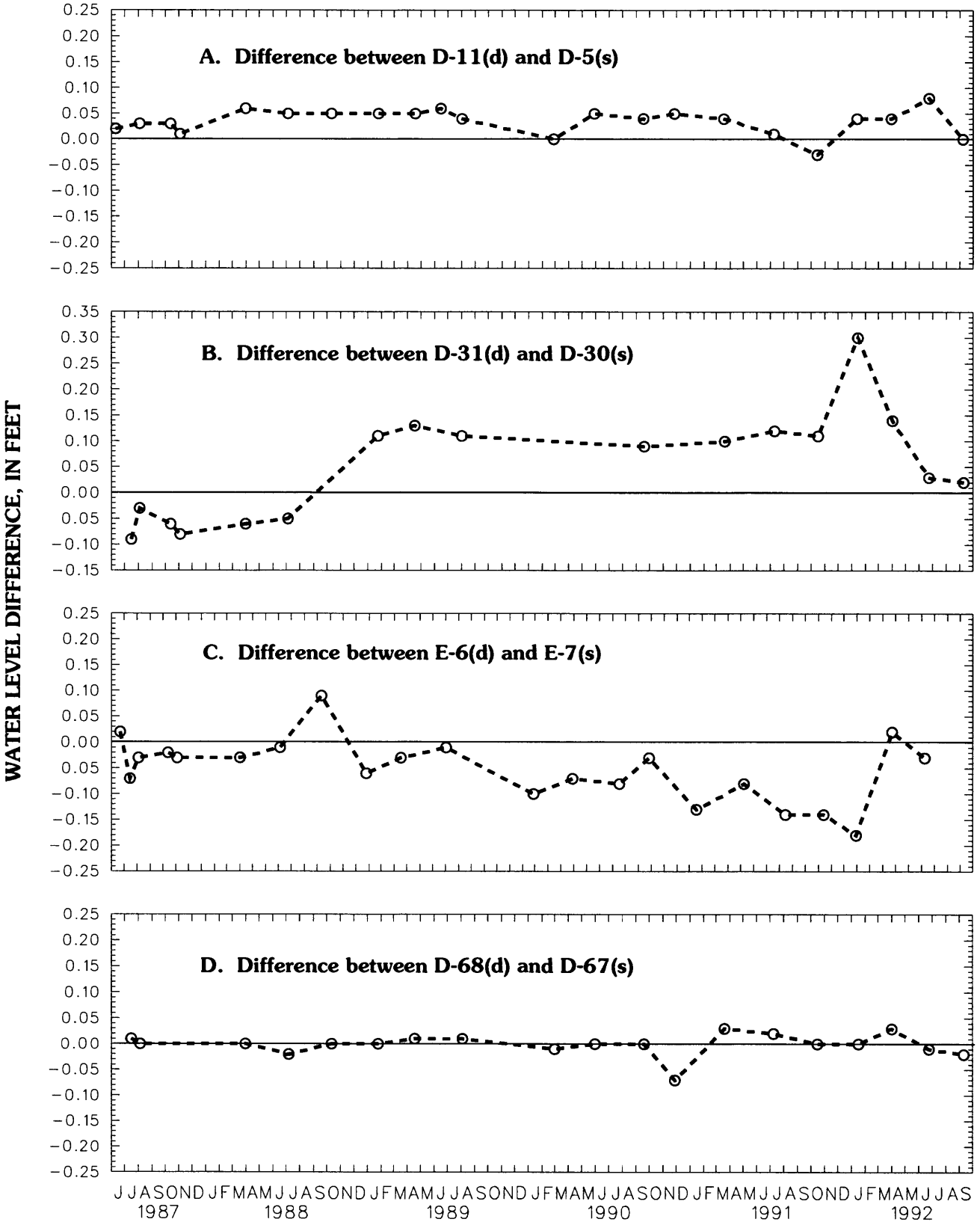


Figure 6. Difference in water levels between deep (d) and shallow (s) wells, northern Lake County, Indiana. (Differences greater than zero indicate upward vertical flow. Differences less than zero indicate downward vertical flow.)

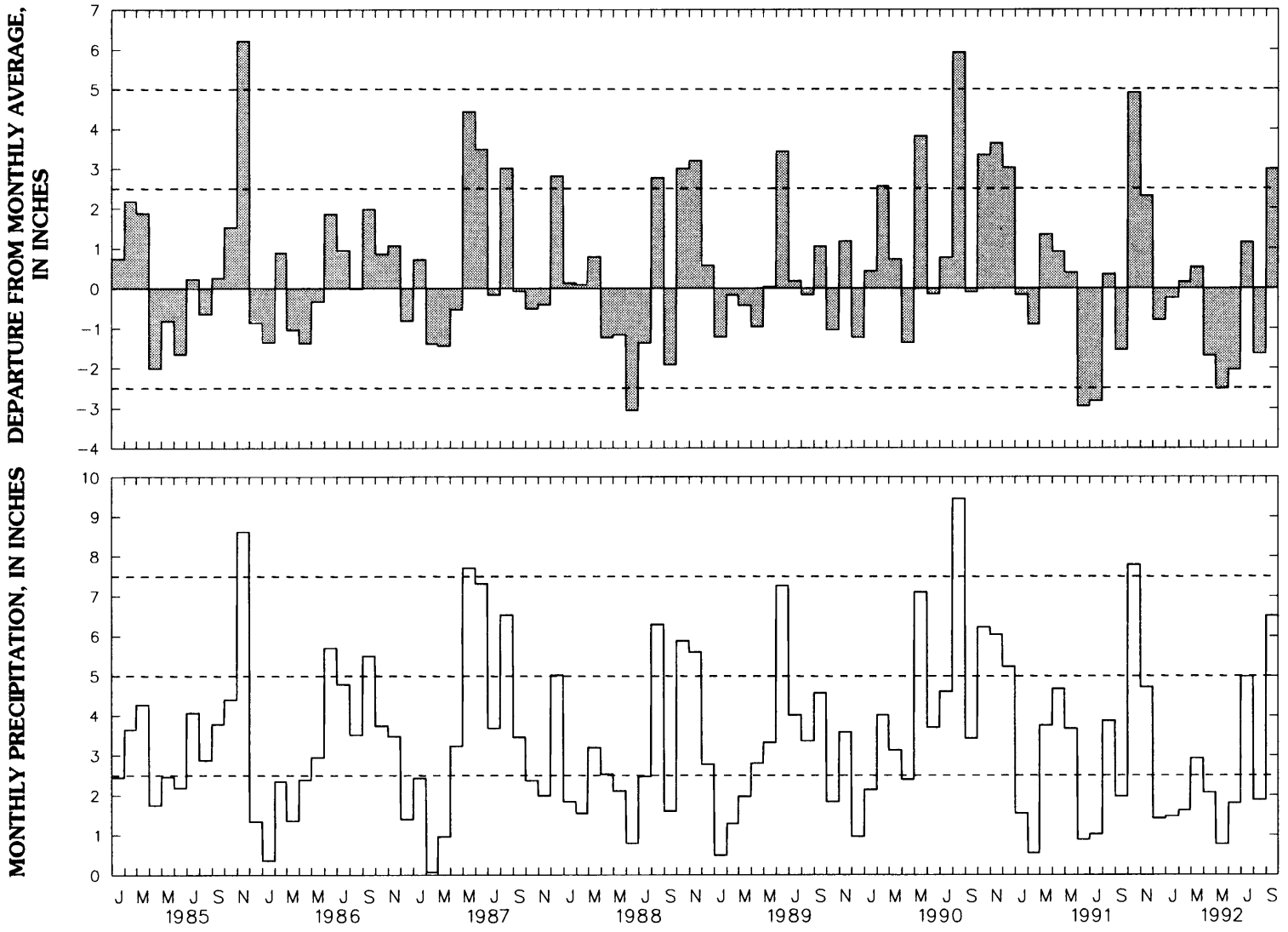


Figure 7. Precipitation data for Hobart, Indiana.

study period was 578.05 ft on January 2, 1990 (Jeff Oyler, National Oceanic and Atmospheric Administration, written commun., 1992).

The high levels of Lake Michigan during 1985–87 created long-term backwater effects on the east branch of the Grand Calumet River. Backwater effects on the east branch are interpreted in the data as far upstream as site S-13, about 11.0 mi upstream from Lake Michigan (fig. 2). The rise in Lake Michigan decreased the surface-water gradient and the velocity of the east branch of the Grand Calumet River.

Similarly, the surface water is the base level of the water table. When the base level (surface water) of the ground-water system rises, the water-table slope decreases, thus reducing ground-water velocity and discharge. In this way, a prolonged rise in Lake Michigan level can result in a rise in ground-water levels, especially near backwater areas. The distance away from a stream where the ground water will rise depends on the length of time that the lake is high. If the lake level remained high indefinitely, the ground water would reestablish the previous slope at the higher level. USGS network data do not indicate a basin-wide rise in ground-water levels in response to high lake levels during 1985–87. This is probably because sewers and ditches drain large areas of the basin.

West of the Indiana Harbor Canal diversion, backwater effects on the west branch of the Grand Calumet River were observed as far west as the East-West Toll Road (Interstate 90) bridge. The west branch of the Grand Calumet River, however, is very different from the east branch. Before the diversion was built, the Grand Calumet River was not connected to Lake Michigan through the Indiana Harbor Canal. When the level of Lake Michigan is below approximately 582.00 ft, a surface-water divide develops in the west branch of the Grand Calumet River in the swampy area near the East-West Toll Road bridge (figs. 11 and 12). East of the swampy area, when the lake level is below 582.00 ft., flow is eastward toward the Indiana Harbor Canal diversion and Lake Michigan. West of the Toll Road, flow is consistently westward into Illinois. This drainage divide shifts east and west in response to changes in Lake Michigan level, discharge of industrial and municipal effluent to the river, storm runoff, and wind direction and velocity (Crawford, 1987, p. 3; Fenelon and Watson, 1993, p. 24).

In 1986, when Lake Michigan was above 582.00 ft, water-level data at surface-water sites S-7, S-23, D-36S, D-54S, and E-16S indicate that the drainage divide in the west branch of the Grand Calumet River was absent. During 1986, Lake Michigan was draining to the Illinois River Basin through the Indiana Harbor Canal and to the west branch of the Grand Calumet River.

In addition to long-term lake-level fluctuations, seiches (temporary buildups of lake water near the shore because of local atmospheric pressure and wind) can cause short-term fluctuations of more than 3 ft within a few hours. Hourly Lake Michigan levels from the NOAA gage at Calumet Harbor, Ill., for July 20, 1987, indicate a 2.23-ft rise in lake level in 3 hours; an even larger fluctuation is noted for February 7 and 8, 1987, when Lake Michigan rose 3.77 ft in 13 hours (Jeff Oyler, National Oceanic and Atmospheric Administration, written commun., 1992).

Although long-term water-level changes in Lake Michigan immediately affect levels in the Indiana Harbor Canal and parts of the Grand Calumet River, seiche (short-term) fluctuations are not fully transported upstream. Short-term seiche fluctuations are damped out by surface-water/ground-water interaction. Although smaller in amplitude, seich-induced fluctuations in water level were reported 7 river miles upstream from Lake Michigan at site C-16S, on the east branch of the Grand Calumet River (Fenelon and Watson, 1993, p. 24).

Ground-Water/Surface-Water Interaction

The ground-water and surface-water systems are hydraulically connected. The moderate water-level fluctuation of surface-water bodies not affected by Lake Michigan further indicates the connection with the ground water. In a ground-water model simulation, Fenelon and Watson (1993, p. 37) achieved a reasonable flow balance with a 1-ft-thick riverbed having a vertical hydraulic conductivity of 1 ft/d. Water levels in

wells near the Indiana Harbor Canal respond virtually immediately to changes in surface-water level. Analysis of water-level data from the data-collection network indicates that the water table normally slopes toward streams, ditches, sewers, the Indiana Harbor Canal, and Lake Michigan. In the vicinity of ground-water/surface-water transects, the water table near the river is nearly flat in the summer but increases in slope during the winter. The steepest slope noted in water-table mapping was less than 20.0 ft/mi.

Data collected hourly at transects A-11S-5-10-20; C-5-10-15-16S; D-25-30-35-36S; D-54S-55-60-65; and E-10-15-16S indicated that evapotranspiration was significant at densely vegetated sites (Fenelon and Watson, 1993, p. 29). Further, evapotranspiration and lack of precipitation seem to have induced local reversals in the slope of the water table at two transect sites. Ground-water troughs as much as 1 ft below the level of nearby surface water were inferred from summer 1986 data. These troughs formed adjacent to the Grand Calumet River (C-16S) near wells C-5, C-10, and C-15, and adjacent to the Indiana Harbor Canal (D-45S)near wells D-55, D-60 and D-65. Fenelon and Watson (1993, p. 29) report that the low point of these troughs can move as much as 500 ft inland from the river. Examination of the transect data collected since Lake Michigan returned to near-normal levels indicate that troughs in the water table may no longer be present at these two sites.

Changes Induced by Dewatering

Ground-water levels in large parts of the study area are lowered by sewers, ditches, pumping, and remedial-action dewatering. Ground-water flow into leaky sewer lines can lower ground-water levels in isolated spots or in widespread areas. Two areas where the ground-water altitude is maintained below an altitude of 580 ft are noted in figures 8 through 13. The first area is near well E-1, south of Wolf Lake, near the Indiana-Illinois State line in Hammond (fig. 2). The second area is near well D-50, north of the west branch of the Grand Calumet River and west of the Indiana Harbor Canal in East Chicago. Another area dewatered by leaky sewers is near well D-45, east of the Indiana Harbor Canal in East Chicago, where the ground-water surface is lowered to an altitude of 580 to 582 ft above sea level. One model of the ground-water-flow system suggests the natural flow-system water levels were 5 to 10 ft higher than today (Watson and others, 1989, p. 37). Although other areas may be dewatered by leaky sewers, the effect is not detectable in data from the water-level network.

In areas where land-surface elevations are less than 10 ft above the surface of Lake Michigan, sewer lines may have been constructed below the ground-water surface. For these sewers to drain, lift stations must raise their contents. Dewatering occurs when ground-water infiltrates the sewer lines and is pumped to sewage-treatment facilities. During the period of maximum levels of Lake Michigan, ground-water levels near well D-45 were slightly lower than during periods of normal lake level. Sewers are the most likely cause for this minor lowering of ground-water levels in 1986 and 1987. Water-levels in well D-45 indicate that leaky-sewer dewatering was more effective during periods of high ground-water levels.

Ditches are another method used to drain large areas and former wetlands in the study area. Many roads, railroads, airports, and light industrial areas in the study area are drained by ditches. Because sand is at the surface in most of the area, precipitation infiltrates quickly, and ditching is used mainly to lower ground-water levels. In the western half of the area and north of the Grand Calumet River, ditches drain the west end of the Gary airport; railroad grades; and numerous interstate, Federal, State, and local highways and roads. In addition, the Indiana Harbor Canal functions as a ditch when the level of Lake Michigan is normal. Hydraulic gradients in ditched areas are approximately 2 ft/mi, whereas gradients approach 8 ft/mi in similar but unditched areas.

Most construction and earth-moving operations in the area require dewatering. Well B-1 was installed near an operating sand borrow pit. Initial water-level data indicated that flow was from the Grand Calumet River toward well B-1.

In April 1988, the dewatering system was not operating; ground-water levels had rebounded nearly 4 ft, and flow at well B-1 was toward the Grand Calumet River. By July 1988, however, ground-water levels at B-1 were again lower than the river, indicating that dewatering had resumed. Water levels near well B-1 rose slowly from July 1988 through September 1990, finally returning to normal in 1991. From 1991 through September 1992, ground-water-flow directions were again normal, indicating that the sand-mining operation was finished.

Dewatering for sewer construction in February 1986 is recorded in the data from well C-20. The sewer construction apparently was completed by late March because water levels appear to have recovered by April 1986.

Another use of dewatering in the study area is to restrict the movement of contaminants across property boundaries and to recover soluble and insoluble contaminants from the aquifer. Dewatering wells can be arranged to create ground-water-flow barriers, preventing contaminants from moving away from the source. Dewatering also can be used to create a depression in the ground-water surface, under the source of contamination. Floating contaminants then can be recovered from the depression. Large areas in Whiting are dewatered for collection of hydrocarbons from beneath a major refinery (Gregory D. Skannal, American Oil Company, oral commun., 1992).

Water-Table Configuration

During August 1985–September 1992, monthly precipitation in the study area ranged from 0.07 in. (February 1987) to 9.45 in. (August 1990), as recorded at Hobart, Ind. (National Oceanic and Atmospheric Administration, 1987, p. 3; National Oceanic and Atmospheric Administration, 1990, p. 3); the level of Lake Michigan ranged from 577.00 ft (1800 hours, November 29, 1989) to 584.21 ft above sea level (1700 hours, August 26, 1986) at Calumet Harbor, Ill. (Jeff Oyler, National Oceanic and Atmospheric Administration, written commun., 1992). Yet, maps of the water table (figs. 8 through 13) show that water-level changes were minor and that the configuration of the water table remained nearly stable throughout the study period.

The combined effects of sewers, ditches, the Indiana Harbor Canal, and dewatering systems have stabilized water-table fluctuations in several areas. The water-table altitude was nearly constant east and west of the Indiana Harbor Canal in Gary, East Chicago, and Hammond, Ind. Another area where the water table was stable was north and east of Lake George in Whiting and Hammond.

Comparison of water-table maps from various dates (figs. 8 to 13), shows that most of the changes were south of the Grand Calumet River. Of particular interest in the area north of the Grand Calumet River is the relation of ground-water levels to the stage of Lake Michigan, the position of the 585-ft contour line from Gary Harbor to the Indiana Harbor Canal, and the areas where ground-water levels are below the 582.5-ft contour line in Hammond, Whiting, and East Chicago. Of particular interest in the area south of the Grand Calumet River is the area where water levels exceed an elevation of 595 ft above sea level, including the presence or absence of water levels at elevations greater than 600 ft.

The 585-ft contour line west of the Indiana Harbor and the 585-ft contour line in the peninsular lake-fill area east of the Indiana Harbor (figs. 8, 9, 10, 12 and 13) are based on water-level data from sources other than the USGS well network (Richard A. Harris, American Oil Company, written commun., 1992; Tom Barnett, Inland Steel Company, written commun., 1993). A water level at an elevation greater than 585 ft is indicated at USGS well C-2 in figure 11.

Figure 8 shows the water table for May 1986 when Lake Michigan was at a record high level. The lake level extends west to within 0.8 mi of the Indiana-Illinois State line through the west limb (Lake George arm) of the Indiana Harbor Canal. Ground-water and surface-water levels also were high during May 1986. A small depression due to pumping is indicated at well HWT14-5, about 3 mi west of Gary Harbor. (This depression in the water table also is present in figs. 9, 12, and 13).

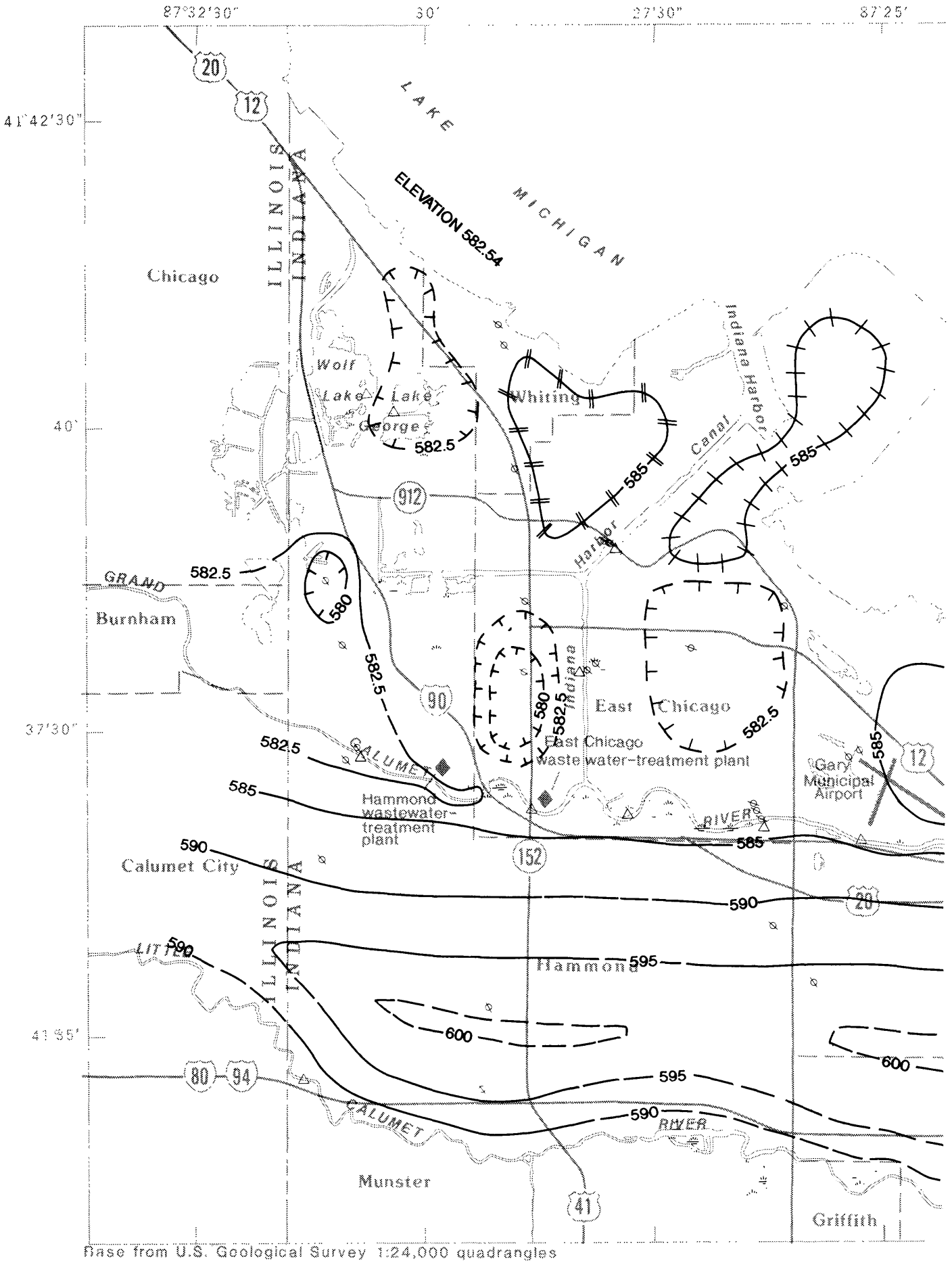
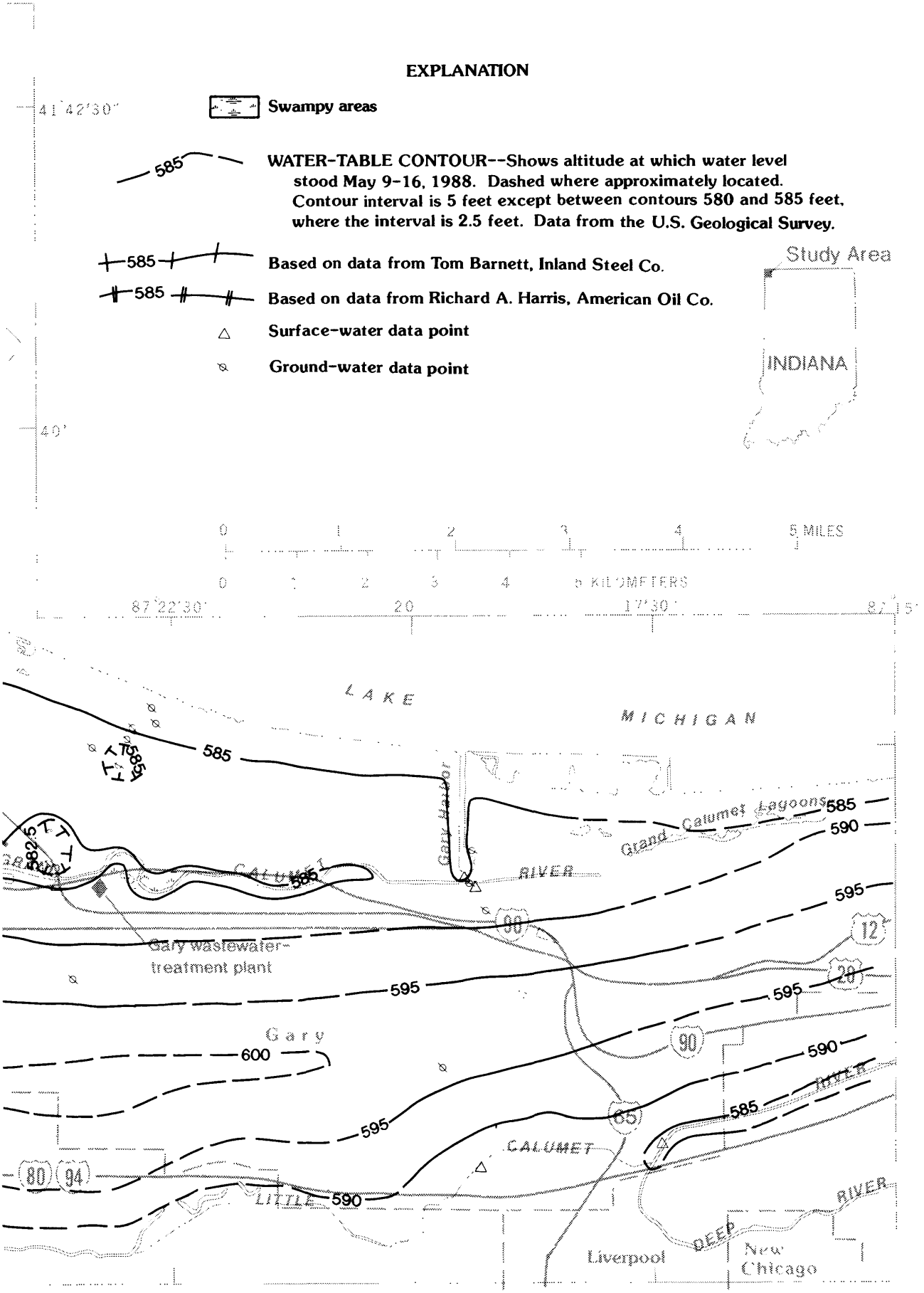


Figure 8. Water table in the Calumet aquifer, May 9–16, 1986. (Level of Lake Michigan during the preceding 5 months was below average.)



is at record high, and ground-water levels are above average. Precipitation

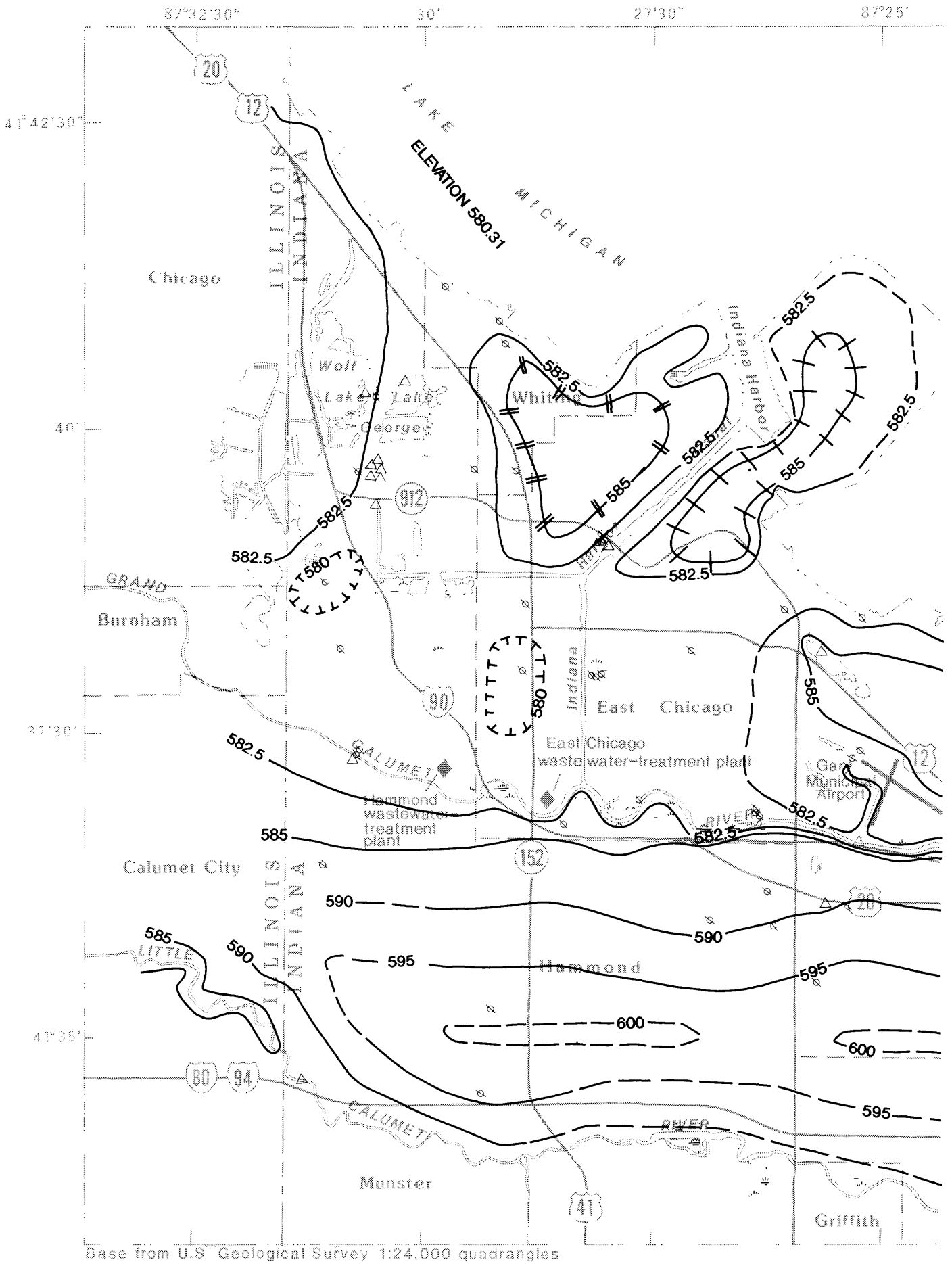
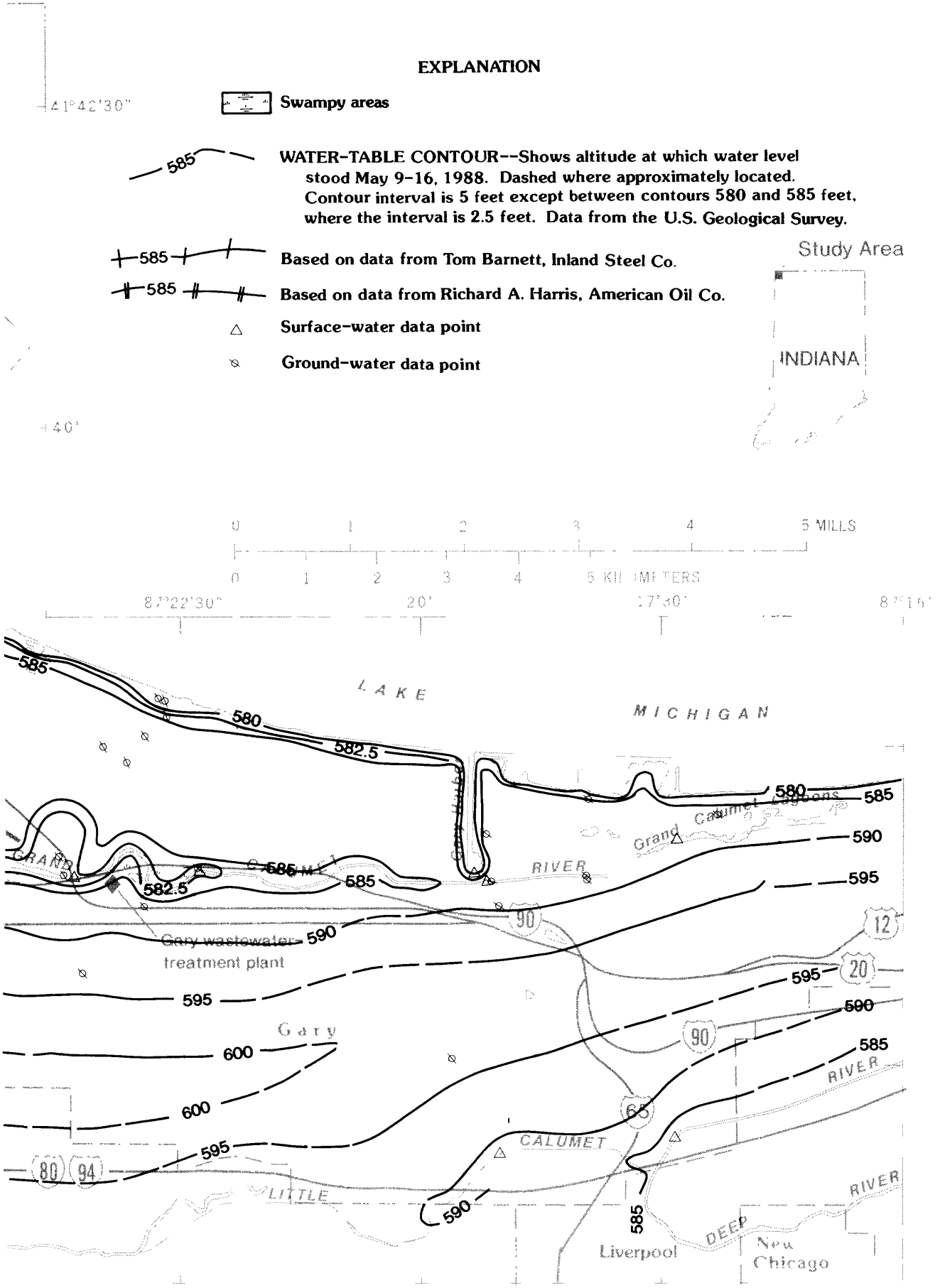


Figure 9. Water table in the Calumet aquifer, July 5–7, 1988. (Level of Lake Michigan during peak of 1988 drought. Precipitation was below normal by approximately 7 inches



of Lake Michigan was below normal, lowest in the data set, and ground-water January and February was above average.)

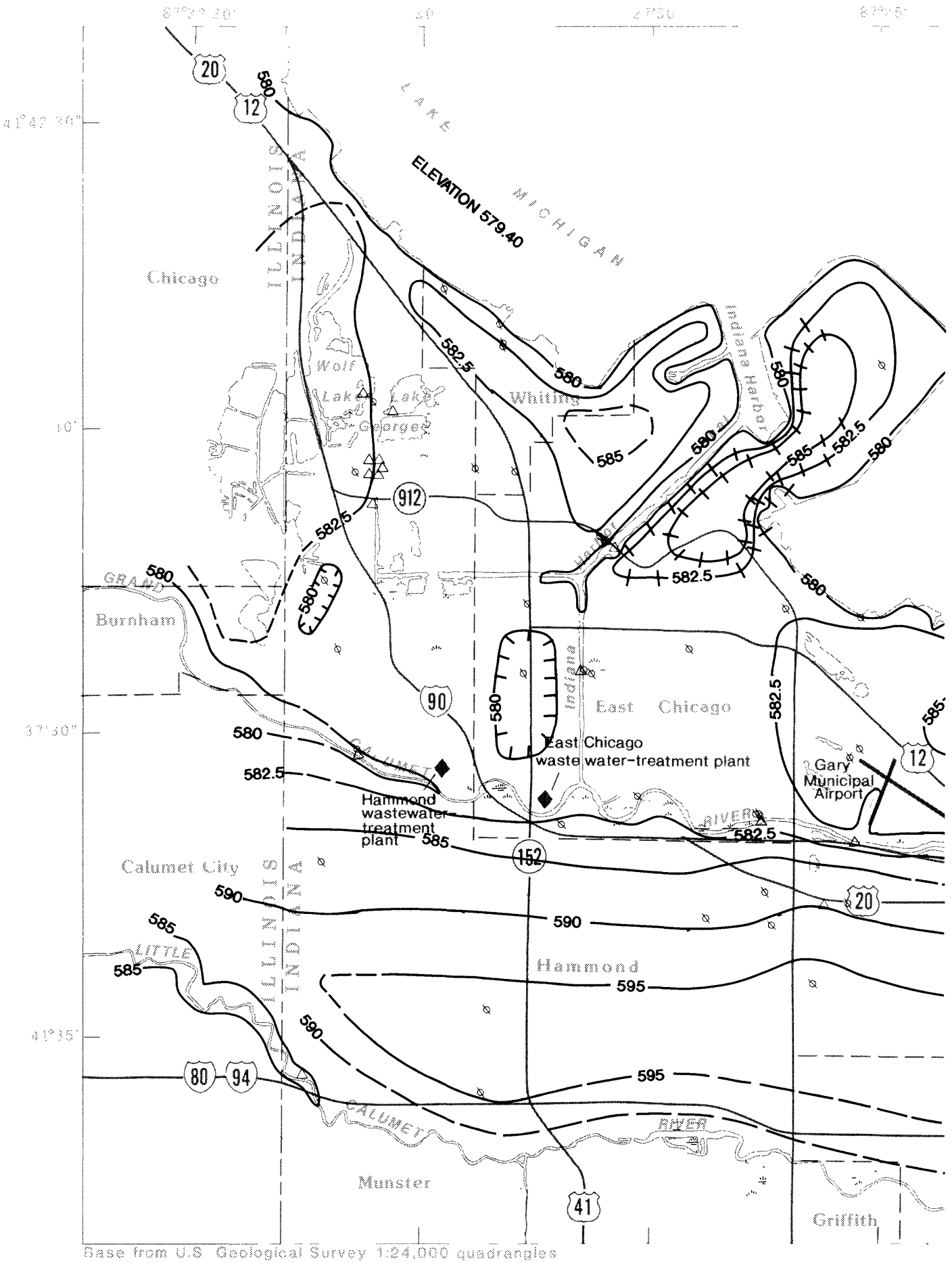
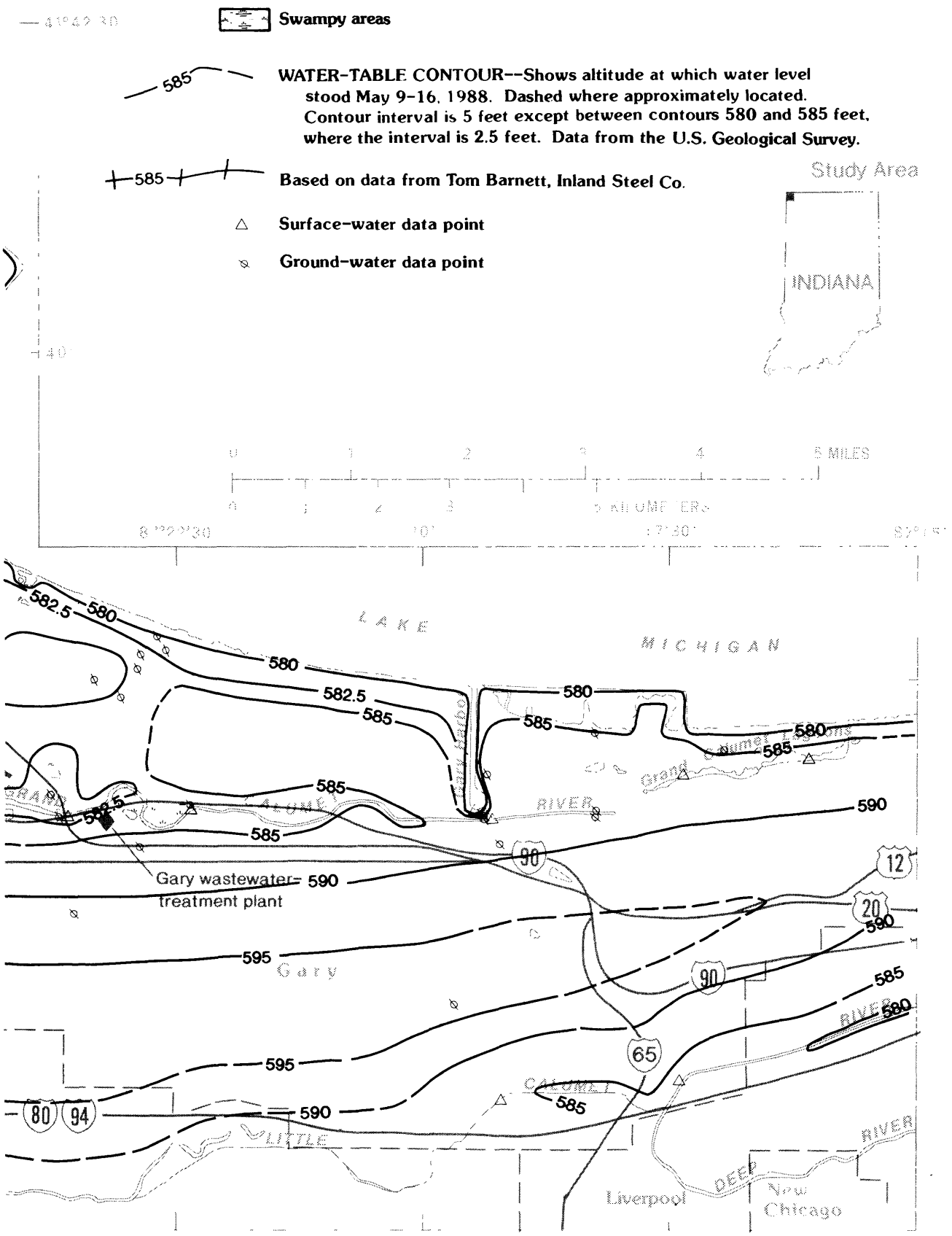


Figure 10. Water table in the Calumet aquifer, October 11–13, 1988. (Level of Lake the preceding 3 months was near average.)



Michigan was normal, and ground-water levels were low. Precipitation during

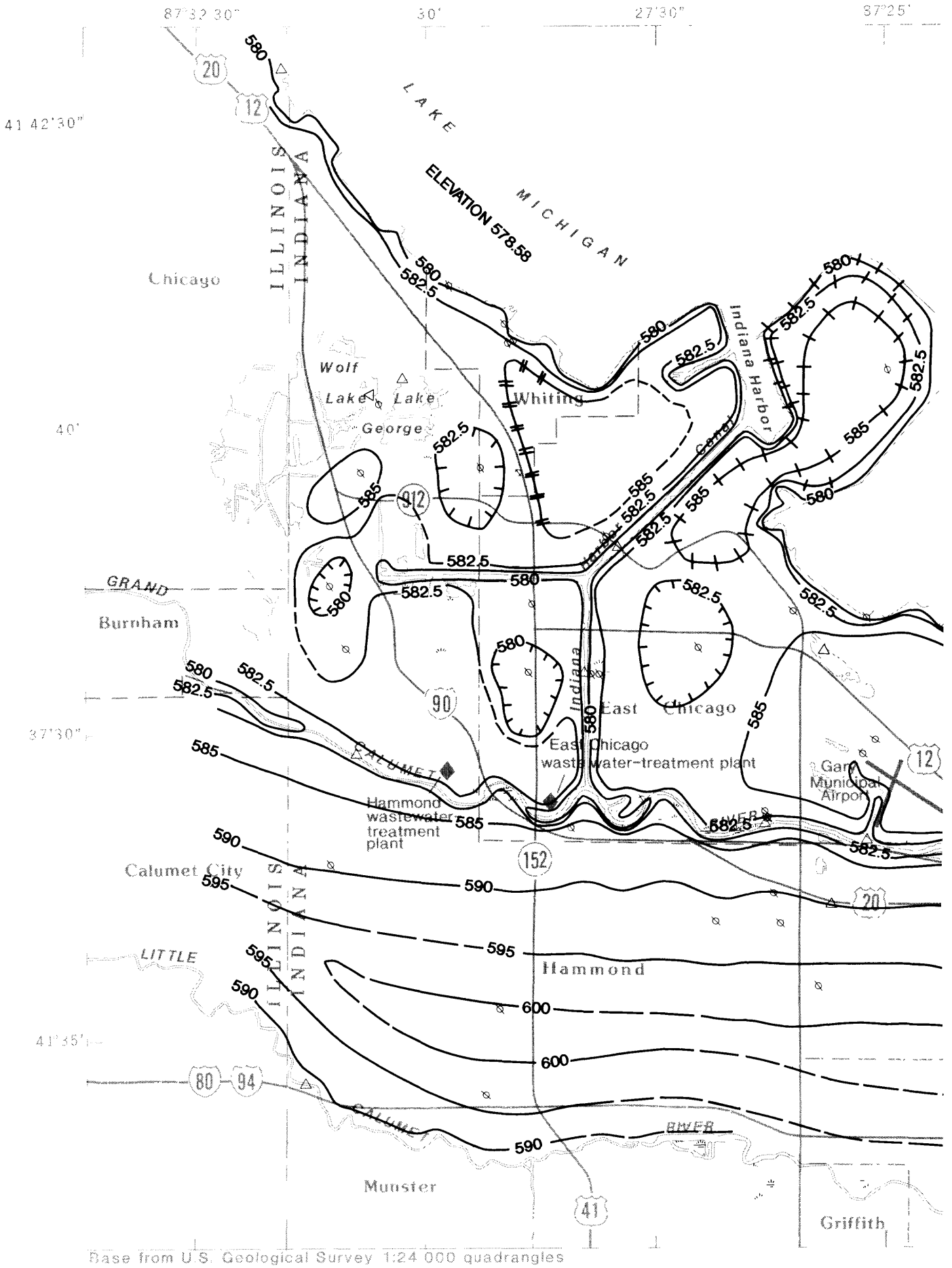
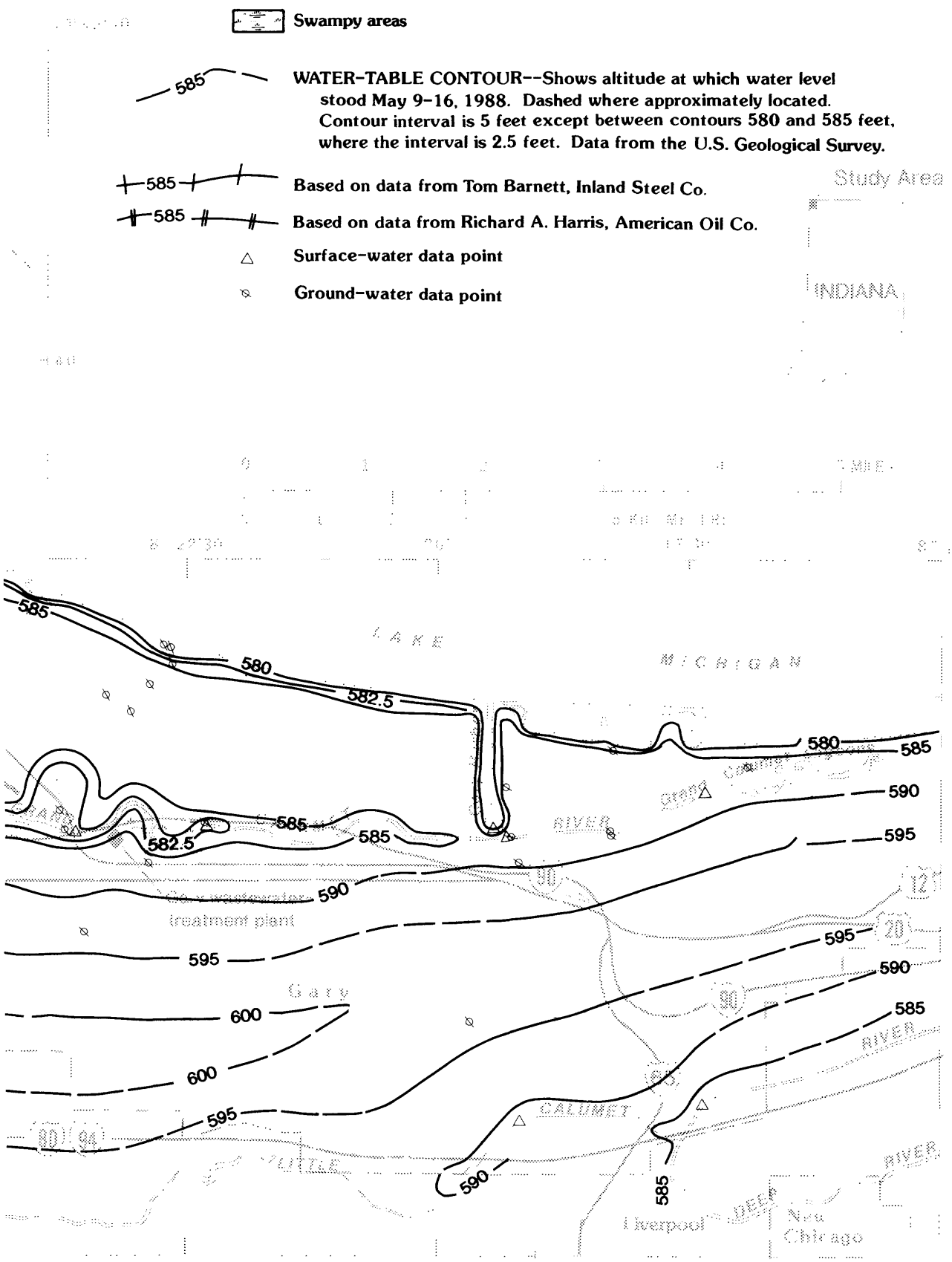
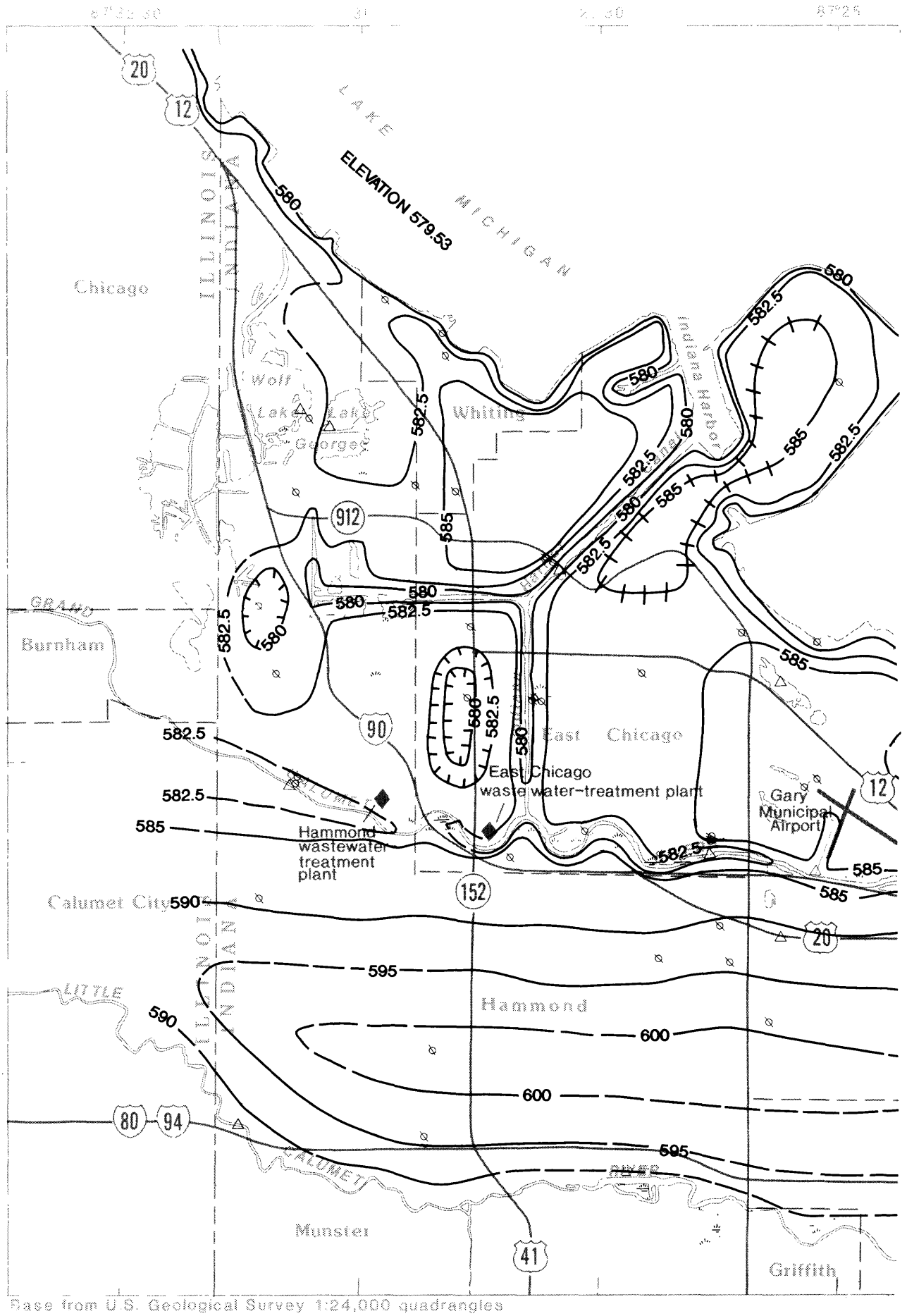


Figure 11. Water table in the Calumet aquifer, February 26–March 1, 1990. (Level levels were average. Surface-water levels were above average. Precipitation during

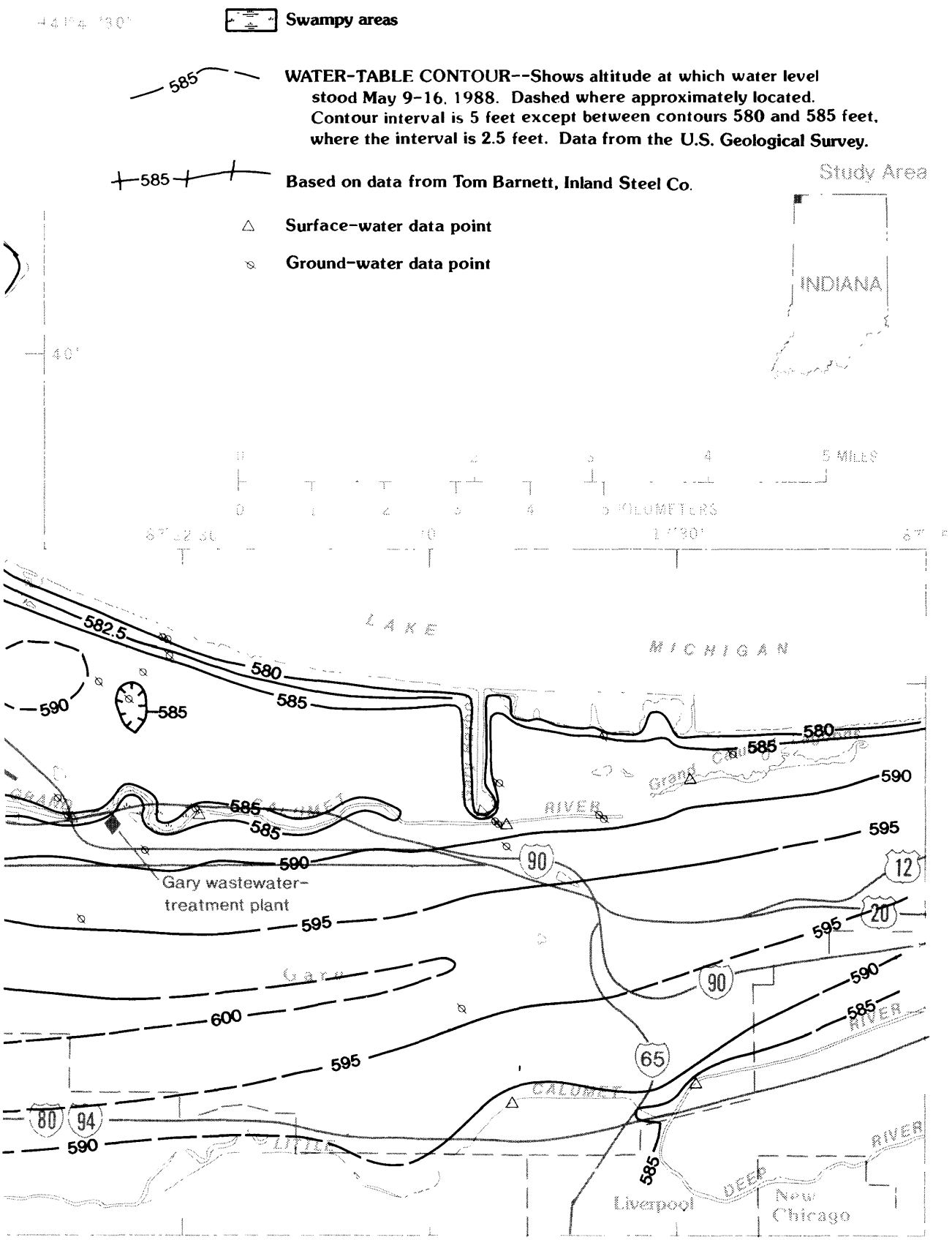


of Lake Michigan was below normal, lowest in the data set, and ground-water January and February was above average.)



Base from U.S. Geological Survey 1:24,000 quadrangles

Figure 12. Water table in the Calumet aquifer, November 26–29, 1990. (Level of levels were high. Precipitation was above average, with an excess of more than



Lake Michigan is near normal, and both ground-water and surface-water

12 inches measured during preceding 4 months.)

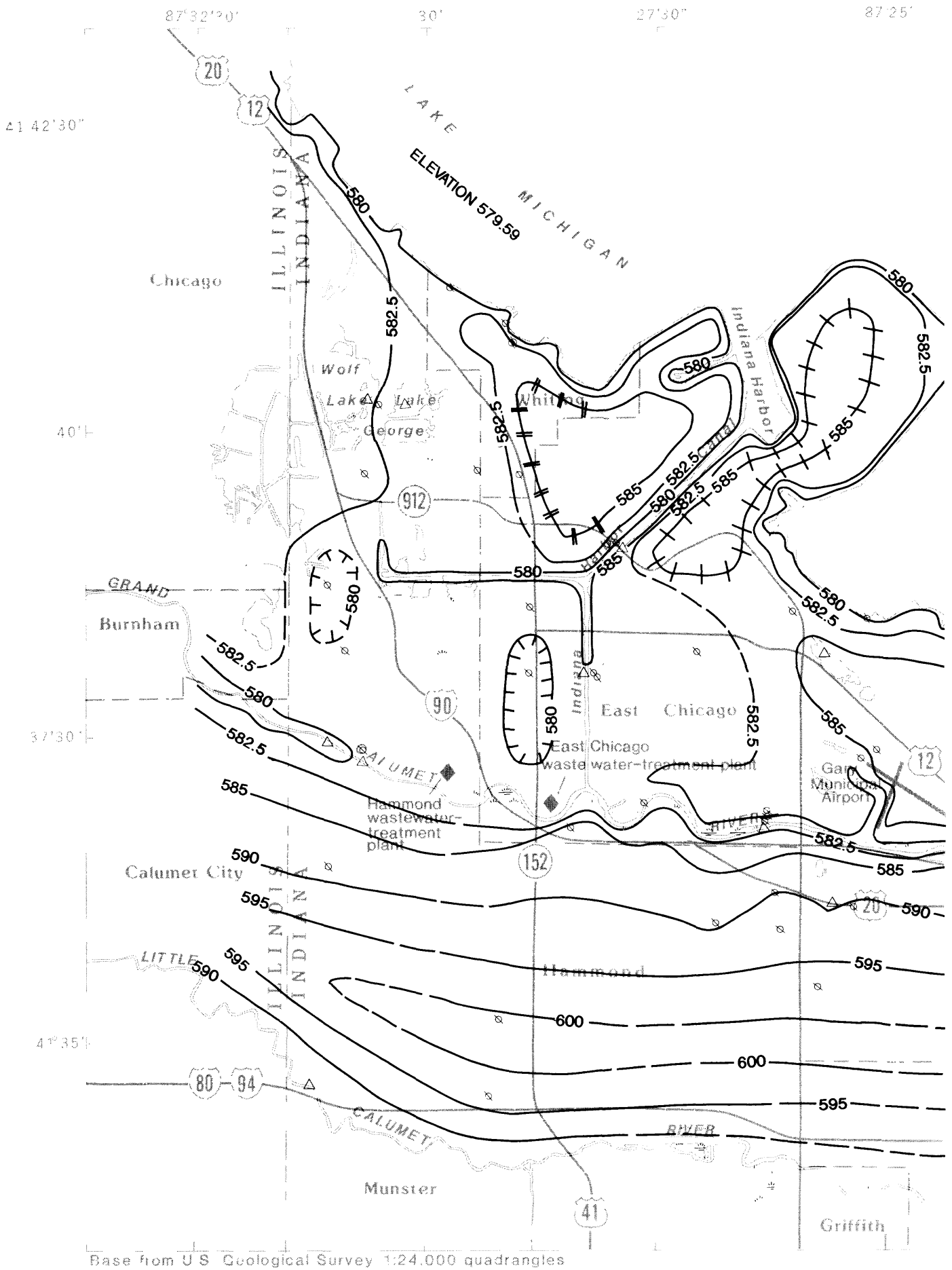
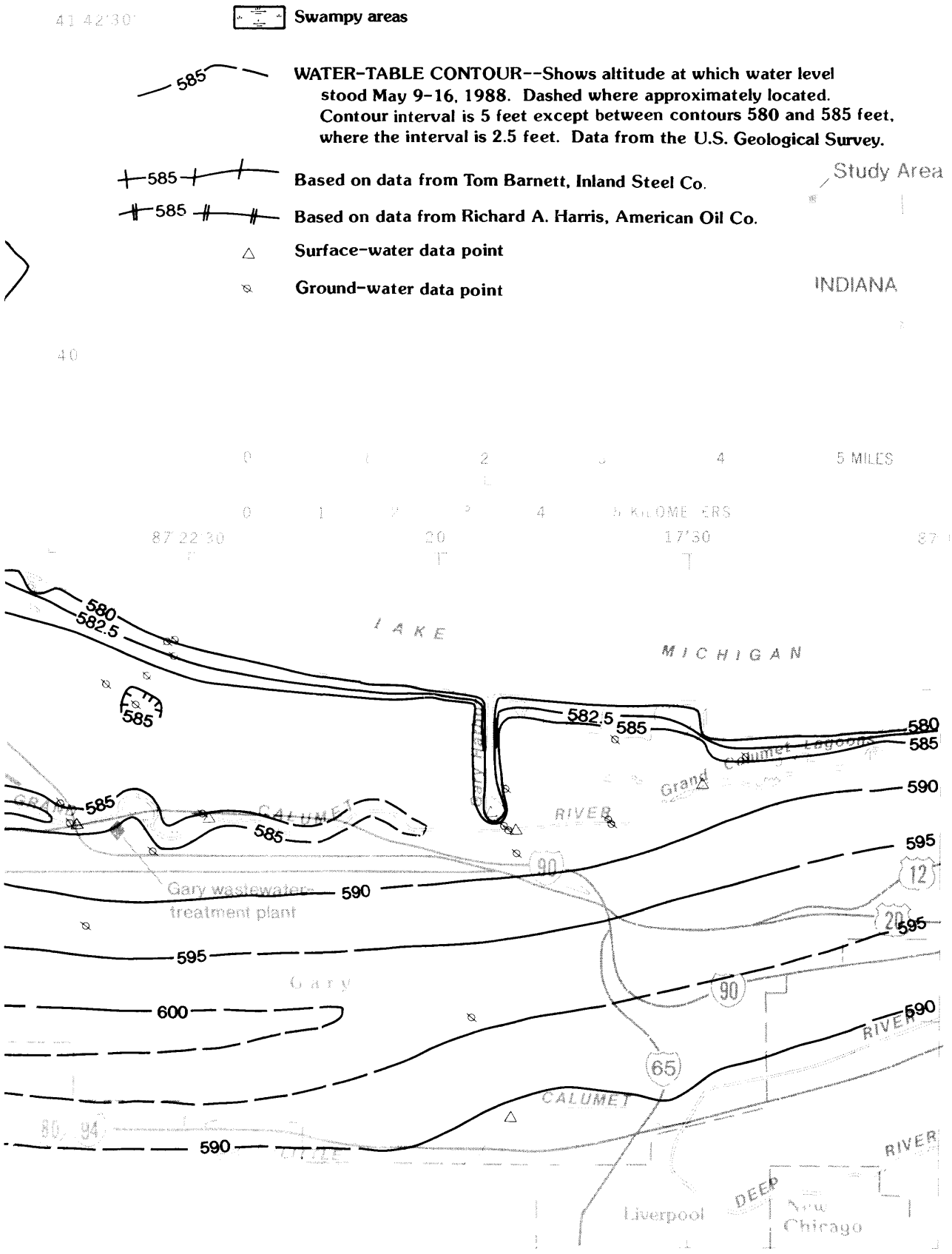


Figure 13. Water table in the Calumet aquifer, September 8–11, 1992. (Level of Lake Precipitation was heavy during the period of data collection).



Michigan is near normal, and ground-water levels were average.

South of the Grand Calumet River, water levels greater than 600 ft are mapped in two areas on the basis of local hydraulic gradients and land-surface configuration; however, the contour lines are dashed because ground-water-level data are unavailable to confirm this interpretation.

Figure 9 shows the water table in July 1988 when Lake Michigan was at normal level and ground-water levels were low. As in figure 8, water levels greater than 600 ft are mapped in two areas south of the Grand Calumet River on the basis of local hydraulic gradients. The 600-ft contour lines are dashed because ground-water-level data are unavailable to document this interpretation.

Figure 10 shows the water-table surface in October 1988 when Lake Michigan was again at normal level and the ground-water levels were again low. No 600-ft contour is indicated on this figure because of the decrease in the width of the ground-water divide above the 595-ft contour south of the Grand Calumet River.

Figure 11 shows the water table in March 1990 when Lake Michigan was at a low level and ground-water levels were about average. The 600-ft contour line is shown south of the Grand Calumet River in the map for March 1990 on the basis of water-level data for well D-70 (the 600-ft contour in figs. 12 and 13 also is based on data for well D-70).

Figure 12 shows the water levels in November 1990 after a period of heavy precipitation. Although Lake Michigan was at normal level, water levels at Wolf Lake and Lake George are high. This is the only water-table map in which the 585-ft contour level is exceeded west of the Indiana Harbor Canal in Whiting, Ind. Ground-water levels are below an altitude of 582.5 ft above sea level only in sewered areas.

Figure 13 shows the water table in September 1992 when Lake Michigan was at normal level, and the ground-water levels also were about average. Heavy rains fell midway through the September 1992 measurement, and some of the mapped water levels may indicate this precipitation.

SUMMARY AND CONCLUSIONS

This report lists and summarizes 2,328 measurements of ground-water and surface-water levels from a network of 96 sites in northern Lake County, Ind., made from August 1985 through September 1992. The study of the ground-water and surface-water flow in the vicinity of the Grand Calumet River and the Indiana Harbor Canal was done to provide information needed to determine the potential for ground-water contaminants to enter Lake Michigan. Data are reported in tables and in six water-table maps. Each of the six maps represents a particular time period and particular set of hydrologic conditions. Data presented in this report are stored in the USGS National Water Information System (NWIS) data base.

Ground-water levels in the study area commonly reached an annual maximum in June or July. A smaller peak in ground-water levels occurred during February and March of most years. Minimum ground-water levels occurred in September or October in most years. The regional ground-water flow in the Calumet aquifer is generally toward the major streams, the Indiana Harbor Canal, and Lake Michigan. Local ground-water flow is toward ditches, leaky sewers, and dewatering systems.

The greatest surface-water-level fluctuations are at sites hydraulically connected to Lake Michigan. Within the data, a maximum surface-water fluctuation of 4.14 ft was measured in the Indiana Harbor Canal 1.6 mi inland from the lake. The measured fluctuation of Lake Michigan at the USGS network site was 3.80 ft. Water-level fluctuations on the east branch of the Grand Calumet River ranged from 1.06 ft (upstream) to 2.45 ft (downstream) during the 7 years of data collection. The low magnitude of these fluctuations is the result of (1) the high proportion of effluent in the river and the fairly constant rate of effluent discharge; (2) the low relief of the basin; (3) infiltration of precipitation directly into the Calumet aquifer; (4) the high hydraulic conductivity of the aquifer, which stabilizes the rate of discharge; and (5) the hydraulic connection between the Grand Calumet River and the Calumet aquifer. Similarly, ground-water fluctuations in the Calumet aquifer have ranged from a minimum of 0.40 ft (near the

Grand Calumet River at east end) to a maximum of 5.01 ft (0.80 mi south of the Grand Calumet River, east of the canal). The mean ground-water fluctuation was about 2.3 ft.

Below-average precipitation was reported throughout Indiana from October 1987 through September 1988. Although most of northwestern Indiana was affected, the 1988 drought did not severely affect water levels in the Calumet aquifer. The drought of 1988, however, did reverse vertical flow gradients in several areas of the Calumet aquifer.

Lake Michigan was at record high levels from fall 1985 through summer 1986. Since 1986, the level of Lake Michigan has dropped to slightly below the normal pool level of 580 ft. High lake levels created backwater effects about 11.0 mi upstream from Lake Michigan on the east branch of the Grand Calumet River. Similar backwater effects on the west branch of the Grand Calumet River were observed as far west as the East-West Toll Road (Interstate 90) bridge (1.2 mi west of the Indiana Harbor Canal). When the level of Lake Michigan is below approximately 582.00 ft, a surface-water divide develops in the west branch of the Grand Calumet River near the East-West Toll Road bridge. In early 1986, Lake Michigan stage exceeded 582.00 ft above sea level, and water-level data indicate that the lake was draining into the Illinois River drainage basin through the Indiana Harbor Canal and the west branch of the Grand Calumet River. Water levels in the Indiana Harbor Canal and parts of the Grand Calumet River reflect water-level changes in Lake Michigan. Previous authors have reported that these changes are virtually immediate.

The stability of water levels in the Calumet aquifer is such that, unless a major recharge event occurs or Lake Michigan's level changes significantly during data collection, water levels should vary less than 0.2 ft in a 4-day data-collection period. Thus, the data within most sets can be treated as if collected simultaneously.

In the vicinity of ground-water/surface-water transects, the water table near the river is nearly flat in the summer but increases in slope during the winter. The steepest slope noted in water-table mapping was less than 20.0 ft/mi. Much of the study area has ground-water flow gradients of less than 2 ft/mi.

Ground-water levels in large parts of the study area are lowered by sewers, ditches, pumping, and remedial-action dewatering. In sewered areas, leaky sewer lines can lower ground-water levels in isolated spots or widespread areas. Sewers also allow dewatering below the level of Lake Michigan. Ditches also have been effective in dewatering large areas. The Indiana Harbor Canal, which functions as a ditch when the level of Lake Michigan is normal, extends the lake level over 3.75 miles inland from the shore. Ground-water gradients in ditched areas are lower than in naturally drained areas. Shallow ground water throughout the area necessitates dewatering for construction and earth-moving operations. Large areas in Whiting, Ind., are dewatered to collect floating contaminants and to prevent soluble contaminants from escaping property boundaries.

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SUPPLEMENTAL DATA

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992
[Water level is in feet above sea level]

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
A-1	10/24/85	586.85	12/17/85	587.46	02/06/86	586.72	02/18/86	586.67	03/17/86	586.58
	03/31/86	586.60	05/16/86	586.80	06/09/86	587.15	07/24/86	587.72	09/22/86	587.10
	11/25/86	587.32	02/25/87	586.77	08/04/87	587.30	03/31/88	586.58	07/06/88	586.49
	10/13/88	586.41	01/25/89	586.46	04/19/89	586.42	08/03/89	587.12	02/27/90	586.00
	05/30/90	586.78	09/18/90	587.27	11/27/90	586.46	03/19/91	586.25	07/10/91	586.49
	10/16/91	586.19	01/14/92	587.34	03/31/92	586.60	06/23/92	586.04	09/09/92	585.54
A-2	06/26/87	587.13	07/08/87	587.02	08/04/87	586.90	03/31/88	586.96	07/06/88	587.49
	10/13/88	586.93	01/25/89	587.01	04/19/89	586.88	08/03/89	587.14	02/27/90	587.12
	05/30/90	587.47	09/18/90	587.59	11/27/90	587.59	03/19/91	587.59	07/10/91	587.28
	10/16/91	587.23	01/14/92	587.27	03/31/92	587.09	05/13/92	586.80	06/23/92	586.73
	09/09/92	587.49								
A-3	06/25/87	588.52	06/26/87	588.48	07/09/87	588.43	08/04/87	588.53	03/31/88	588.48
	07/06/88	588.44	10/13/88	588.32	01/25/89	588.50	04/19/89	588.43	08/03/89	588.52
	02/27/90	588.35	05/30/90	588.58	11/27/90	588.71	03/19/91	588.67	07/10/91	588.51
	10/16/91	588.40	01/14/92	588.53	03/31/92	588.43	06/23/92	588.31	09/09/92	588.31
A-4	06/26/87	588.69	07/15/87	588.61	08/05/87	588.52	03/31/88	588.64	07/06/88	588.60
	10/13/88	588.48	01/25/89	588.70	04/19/89	588.72	08/03/89	588.67	02/27/90	588.56
	05/30/90	588.85	09/18/90	588.74	11/27/90	588.85	03/19/91	588.99	07/10/91	588.74
	10/16/91	588.53	01/14/92	588.73	03/31/92	588.69	06/23/92	588.55	09/09/92	588.34
A-5	12/17/85	586.40	02/06/86	585.60	02/18/86	585.65	03/17/86	585.67	03/31/86	585.65
	05/16/86	586.00	09/22/86	585.71	11/25/86	585.85	02/26/87	585.42	06/26/87	586.42
	08/04/87	585.95	03/31/88	585.41	07/06/88	585.33	10/13/88	585.39	01/25/89	585.44
	04/19/89	585.45	08/03/89	586.20	02/27/90	585.61	05/30/90	586.31	09/18/90	585.87
	11/27/90	585.88	03/19/91	586.04	07/10/91	586.06	10/16/91	585.79	01/14/92	585.89
	03/31/92	585.55	06/23/92	586.35	09/09/92	585.96				
A-6	07/14/87	585.57	08/05/87	585.19	03/30/88	585.32	07/07/88	584.61	10/12/88	584.58
	01/24/89	585.23	04/20/89	585.33	08/03/89	585.34	02/27/90	585.21	05/30/90	586.04
	09/18/90	585.89	11/27/90	585.88	03/19/91	586.23	07/10/91	585.38	10/16/91	585.52
	01/14/92	586.01	03/31/92	585.58	06/23/92	584.94	09/11/92	584.88		

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
A-10	10/24/85	585.95	12/17/85	585.88	02/06/86	585.64	02/18/86	585.60	03/17/86	585.59
	03/31/86	585.59	05/15/86	585.86	09/22/86	585.85	11/25/86	585.66	02/26/87	585.39
	06/26/87	586.21	08/04/87	586.08	03/31/88	585.47	07/06/88	585.98	10/13/88	585.56
	01/25/89	585.40	04/19/89	585.48	08/03/89	586.05	02/27/90	585.31	05/30/90	585.89
	09/18/90	585.70	11/27/90	585.76	03/19/91	585.76	07/10/91	586.00	10/16/91	585.62
	01/14/92	585.59	03/31/92	585.39	06/23/92	585.90	09/09/92	585.55		
A-15	10/24/85	589.54	12/10/85	591.15	03/06/86	589.74	03/20/86	589.79	03/31/86	589.84
	05/09/86	589.69	06/09/86	589.99	07/24/86	590.43	08/04/86	590.23	08/19/86	589.90
	09/25/86	589.58	12/30/86	590.03	02/25/87	589.52	08/04/87	589.92	03/31/88	589.97
	07/05/88	589.28	10/13/88	589.30	01/25/89	589.84	04/19/89	590.11	08/03/89	589.94
	02/27/90	589.80	05/30/90	591.15	09/18/90	590.38	11/27/90	590.83	03/19/91	591.55
	07/10/91	590.49	10/16/91	589.77	01/14/92	590.39	03/31/92	589.92	06/24/92	589.51
	09/09/92	589.15								
A-20	01/03/86	595.41	02/03/86	595.29	02/07/86	595.15	02/17/86	595.13	03/06/86	595.06
	03/20/86	595.18	03/31/86	595.10	05/16/86	595.21	08/13/86	595.46	08/27/86	595.37
	11/25/86	595.40	02/24/87	595.38	07/06/87	595.95	08/05/87	595.72	12/17/87	595.61
	04/01/88	595.81	07/07/88	595.78	10/12/88	595.59	01/25/89	595.80	04/19/89	595.96
	08/03/89	595.91	02/27/90	595.85	05/30/90	596.37	09/18/90	596.05	11/27/90	596.08
	03/19/91	596.29	07/10/91	596.02	10/16/91	595.85	01/14/92	596.18	03/31/92	596.03
	06/24/92	595.96	09/09/92	595.76						
B-1	08/28/85	580.29	10/24/85	580.49	11/11/85	580.93	11/27/85	581.95	12/04/85	582.03
	12/17/85	581.76	01/03/86	581.23	02/03/86	580.69	02/17/86	580.71	03/06/86	580.85
	03/20/86	581.20	03/31/86	581.06	05/09/86	580.67	06/09/86	581.11	07/24/86	581.33
	08/04/86	581.06	08/19/86	580.72	09/25/86	580.42	12/30/86	582.40	02/26/87	580.57
	08/04/87	580.61	04/01/88	584.18	07/05/88	580.23	10/11/88	580.63	01/26/89	580.82
	04/20/89	581.60	08/01/89	581.89	02/27/90	581.72	05/30/90	583.35	09/20/90	583.17
	11/28/90	585.15	03/20/91	585.90	07/10/91	585.51	10/17/91	585.23	01/15/92	585.39
	04/01/92	585.44	06/24/92	584.90	09/10/92	585.22				
B-2	06/25/87	581.62	07/08/87	581.39	08/04/87	581.14	03/31/88	580.24	07/06/88	580.17
	10/13/88	579.86	01/25/89	579.56	04/19/89	579.46	08/03/89	580.13	02/27/90	579.73
	05/30/90	580.19	09/18/90	580.17	11/27/90	579.55	03/19/91	579.97	07/10/91	580.43
	10/16/91	580.06	01/14/92	580.08	03/31/92	579.80	06/23/92	579.88	09/09/92	579.73
B-3	07/14/87	584.48	08/04/87	584.30	03/31/88	584.54	07/06/88	583.90	10/11/88	583.85
	01/24/89	584.10	04/20/89	584.39	08/03/89	584.53	02/27/90	584.24	05/30/90	584.90
	09/18/90	584.59	11/27/90	584.71	03/20/91	584.56	07/10/91	585.14	10/16/91	584.17
	01/15/92	583.96	04/01/92	584.04	06/24/92	584.40	09/09/92	583.62		

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
B-5	08/28/85	582.25	10/17/85	585.38	10/24/85	582.36	11/11/85	582.52	11/27/85	583.55
	12/04/85	583.52	12/17/85	583.37	01/03/86	582.88	02/03/86	582.42	02/17/86	582.42
	03/06/86	582.52	03/20/86	583.57	03/31/86	582.80	05/09/86	582.48	06/09/86	582.78
	07/24/86	583.07	08/04/86	582.84	08/19/86	582.53	09/25/86	582.23	12/30/86	582.67
	02/26/87	582.24	04/01/88	582.53	07/05/88	581.92	10/11/88	581.69	01/26/89	582.43
	04/20/89	582.85	08/01/89	583.09	02/27/90	582.89	05/30/90	583.90	09/20/90	583.69
	11/28/90	585.35	03/20/91	585.10	07/10/91	585.04	10/17/91	584.59	01/15/92	584.94
	04/01/92	584.98	05/13/92	584.75	06/24/92	584.36	09/10/92	584.46		
B-7	06/22/87	587.94	08/04/87	587.33	03/31/88	587.50	07/07/88	586.84	10/11/88	586.75
	01/26/89	587.46	04/20/89	587.77	08/03/89	587.74	02/27/90	587.76	05/30/90	588.57
	09/19/90	588.12	11/26/90	588.07	03/20/91	588.39	07/10/91	587.58	10/16/91	587.39
	01/15/92	587.48	04/01/92	587.34	06/24/92	586.87	09/09/92	586.34		
B-8	07/14/87	587.56	08/04/87	587.31	03/31/88	587.48	07/07/88	586.83	10/11/88	586.73
	01/26/89	587.43	04/20/89	587.74	08/03/89	587.73	02/27/90	587.85	05/30/90	588.56
	09/19/90	588.10	11/27/90	588.16	03/20/91	588.37	07/10/91	587.69	10/16/91	587.39
	01/15/92	587.47	04/01/92	587.35	06/24/92	586.89	09/09/92	586.35		
B-10	12/10/85	593.67	01/03/86	593.23	02/03/86	592.74	02/17/86	592.68	03/06/86	592.99
	03/20/86	593.28	03/31/86	593.40	05/09/86	592.97	06/09/86	593.23	07/24/86	593.25
	08/04/86	592.99	08/19/86	592.60	09/25/86	591.88	12/30/86	594.30	02/25/87	592.77
	07/13/87	593.63	08/05/87	592.96	04/01/88	593.64	07/05/88	592.58	10/11/88	591.83
	01/24/89	593.42	04/19/89	593.99	08/03/89	593.39	02/27/90	593.51	06/01/90	594.78
	09/19/90	593.94	11/27/90	594.09	03/20/91	595.14	07/10/91	593.64	10/17/91	592.60
	01/17/92	593.58	04/01/92	593.71	06/24/92	592.81	09/09/92	591.74		
C-1	12/09/85	583.45	01/06/86	582.76	02/03/86	582.46	02/17/86	582.64	03/08/86	582.91
	03/20/86	583.26	03/31/86	582.94	05/09/86	582.50	06/09/86	583.23	07/24/86	582.94
	08/04/86	582.64	08/19/86	582.27	09/25/86	582.57	12/30/86	584.38	02/27/87	582.80
	06/24/87	583.26	07/07/87	583.02	08/04/87	582.68	03/31/88	583.64	07/05/88	582.14
	10/11/88	581.68	01/24/89	582.71	04/18/89	582.98	08/01/89	582.91	02/28/90	583.58
	05/31/90	583.89	09/19/90	583.33	11/28/90	584.70	03/20/91	584.27	07/11/91	583.08
	10/17/91	582.70	01/17/92	583.04	04/02/92	583.30	06/23/92	582.13	09/10/92	583.03
C-2	07/07/87	583.55	08/04/87	583.47	08/04/87	583.44	12/07/88	583.98	01/24/89	584.99
	04/18/89	584.73	08/01/89	584.96	02/28/90	585.02	05/31/90	585.06	09/19/90	585.12
	11/28/90	584.97	03/20/91	584.94	07/11/91	584.78	10/17/91	584.91	01/15/92	585.39
	04/01/92	585.46								

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
C-4	06/24/87	581.87	07/09/87	581.62	08/04/87	581.56	03/31/88	580.87	07/05/88	580.58
	10/11/88	580.38	01/24/89	580.01	04/18/89	580.61	08/01/89	580.77	02/28/90	580.50
	05/31/90	580.86	09/19/90	580.69	11/28/90	579.93	03/20/91	580.74	07/11/91	580.55
	10/17/91	580.08	01/17/92	580.46	04/02/92	580.63	06/23/92	580.24	09/10/92	580.23
C-5	10/25/85	583.58	11/27/85	584.67	12/06/85	584.59	02/20/86	585.39	03/21/86	584.51
	04/01/86	583.69	05/15/86	583.98	08/13/86	583.13	12/16/86	584.26	02/24/87	583.99
	07/21/87	583.04	08/05/87	582.74	12/17/87	585.17	03/30/88	584.74	03/31/88	584.81
	07/06/88	582.36	01/25/89	583.61	04/19/89	584.10	08/04/89	582.99	03/01/90	584.27
	05/31/90	584.42	09/20/90	583.69	11/28/90	585.73	03/21/91	585.12	07/11/91	583.27
	10/17/91	583.21	01/17/92	584.01	04/01/92	584.36	06/24/92	582.99	09/10/92	582.81
C-10	10/25/85	582.96	11/27/85	584.19	12/06/85	583.41	12/18/85	583.26	01/08/86	583.17
	02/04/86	583.68	02/20/86	583.49	03/07/86	583.41	03/21/86	583.32	04/01/86	583.30
	05/15/86	583.21	08/13/86	582.80	12/16/86	583.29	02/24/87	583.12	07/21/87	582.35
	08/05/87	582.22	12/17/87	583.20	03/30/88	583.53	07/06/88	581.37	10/13/88	581.33
	01/25/89	582.86	04/19/89	583.00	08/04/89	582.14	03/01/90	583.03	05/31/90	583.03
	09/20/90	582.61	11/28/90	583.91	03/21/91	583.37	07/11/91	582.38	10/17/91	582.41
	01/17/92	582.89	04/01/92	583.11	09/10/92	582.71				
C-12	08/05/87	582.25	03/31/88	583.42	07/06/88	581.28	10/13/88	581.28	01/25/89	582.76
	04/19/89	582.93	08/04/89	582.10	03/01/90	582.91	05/31/90	583.00	09/20/90	582.58
	11/28/90	583.96	03/21/91	583.41	07/11/91	582.33	10/17/91	582.30	01/17/92	582.79
	04/01/92	583.09	06/24/92	581.99	09/10/92	582.98				
C-15	10/25/85	582.51	11/27/85	582.82	12/06/85	582.95	02/04/86	582.91	02/20/86	582.78
	03/21/86	582.53	04/01/86	583.40	05/15/86	582.87	08/13/86	582.93	12/17/86	582.64
	02/24/87	582.55	08/05/87	582.37	12/17/87	582.54	03/30/88	582.58	07/06/88	580.97
	10/13/88	581.20	01/25/89	582.24	04/19/89	582.26	08/04/89	581.82	03/01/90	582.20
	05/31/90	582.21	09/20/90	582.11	11/28/90	582.62	03/21/91	582.42	07/11/91	582.12
	10/17/91	581.92	01/17/92	582.17	04/01/92	582.39	06/24/92	581.72	09/10/92	582.43

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
C-17	07/20/86	588.10	08/15/86	587.35	09/15/86	586.90	10/15/86	588.45	11/15/86	588.60
(LK-13)	12/15/86	589.76	01/15/87	590.10	02/15/87	589.87	02/28/87	590.55	03/15/87	589.93
	04/15/87	590.81	05/15/87	589.42	06/15/87	589.66	07/15/87	588.60	08/05/87	587.59
	08/15/87	587.88	09/15/87	588.53	10/15/87	588.54	11/15/87	588.88	12/15/87	590.42
	01/15/88	589.43	02/15/88	591.91	03/31/88	590.99	04/15/88	591.04	05/15/88	589.82
	06/15/88	588.36	07/07/88	587.72	07/15/88	587.47	08/15/88	588.33	09/15/88	587.18
	10/12/88	587.01	11/15/88	589.80	12/15/88	589.47	01/26/89	590.32	01/26/89	590.32
	02/15/89	590.00	03/15/89	590.85	04/19/89	590.54	05/15/89	589.83	06/15/89	590.88
	07/15/89	588.62	08/04/89	588.74	08/05/89	588.83	08/15/89	588.76	09/15/89	589.25
	10/15/89	587.91	11/15/89	590.46	12/15/89	589.29	01/15/90	589.60	02/15/90	590.20
	02/29/90	590.94	03/15/90	591.20	04/15/90	590.96	05/15/90	591.58	05/31/90	591.12
	06/15/90	590.50	07/15/90	589.74	08/15/90	590.45	09/20/90	589.04	10/15/90	590.57
	11/15/90	590.64	11/30/90	591.70	12/15/90	591.55	01/15/91	591.02	02/15/91	591.21
	03/20/91	591.57	04/15/91	591.90	05/15/91	591.16	06/15/91	589.40	07/10/91	588.01
	08/15/91	587.58	09/15/91	587.69	10/17/91	588.30	11/15/91	590.21	12/15/91	590.77
	01/17/92	590.16	02/15/92	590.88	03/15/92	590.83	04/01/92	590.77	04/15/92	590.82
	05/12/92	589.80	06/24/92	588.45	07/15/92	588.45	08/15/92	587.68	09/10/92	589.17
C-18	06/24/87	591.45	07/14/87	590.95	08/04/87	590.29	04/01/88	591.08	07/07/88	590.10
	10/12/88	589.62	01/24/89	591.42	04/19/89	590.75	05/12/92	591.07	06/24/92	590.92
	09/10/92	590.58								
C-19	12/15/86	590.06	02/27/87	589.98	08/04/87	588.90	04/01/88	590.25	07/07/88	588.58
	10/12/88	588.39	01/26/89	590.15	04/18/89	590.00	08/04/89	589.57	03/01/90	590.17
	05/31/90	589.88	09/20/90	589.73	11/29/90	590.62	03/21/91	590.20	07/11/91	588.94
	10/17/91	589.68	01/17/92	589.95	05/12/92	589.82	06/24/92	589.47	09/10/92	590.03
C-20	08/28/85	592.64	12/05/85	593.69	02/04/86	592.63	02/19/86	588.64	03/04/86	587.61
	03/21/86	588.94	04/01/86	590.57	05/10/86	592.01	06/10/86	592.81	08/05/86	591.84
	08/20/86	591.37	09/26/86	591.45	12/31/86	593.28	02/25/87	593.53	07/16/87	592.63
	08/04/87	591.73	03/31/88	594.03	07/07/88	591.60	10/12/88	590.98	01/26/89	593.59
	04/19/89	593.83	08/04/89	592.88	02/28/90	593.92	09/20/90	593.45	11/29/90	594.71
	03/20/91	594.61	07/11/91	592.27	10/17/91	592.68	01/17/92	593.82	04/01/92	593.96
	06/24/92	592.62	09/10/92	592.49						
C-25	12/05/85	597.62	01/03/86	596.37	02/04/86	596.84	02/19/86	597.64	03/04/86	597.08
	03/21/86	597.41	04/03/86	596.88	05/12/86	596.15	06/10/86	597.81	08/05/86	596.12
	08/20/86	596.13	09/26/86	596.05	12/31/86	596.73	02/27/87	596.40	08/04/87	595.84
	03/31/88	597.93	07/07/88	595.10	10/12/88	595.76	01/24/89	597.08	04/18/89	597.10
	08/04/89	596.62	02/28/90	598.04	06/01/90	597.04	09/20/90	596.36	11/29/90	598.13
	03/21/91	597.82	07/11/91	595.39	10/17/91	596.64	01/17/92	596.68	04/01/92	597.11
	06/24/92	595.71	09/10/92	597.99						

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
CGA-3	10/24/85	584.81	12/05/85	585.15	02/03/86	584.88	02/17/86	584.98	03/06/86	584.98
	03/31/86	584.98	05/09/86	584.80	06/09/86	585.00	07/24/86	584.81	08/04/86	584.73
	08/19/86	584.70	09/25/86	584.77	12/30/86	585.02	02/27/87	585.04	08/04/87	584.71
	04/01/88	585.56	07/05/88	584.77	10/11/88	584.63	01/26/89	585.25	04/20/89	585.36
	08/01/89	585.14	02/27/90	585.69	09/20/90	585.46	11/28/90	586.26	03/20/91	585.93
	07/10/91	585.26	10/17/91	584.96	01/15/92	585.50	04/01/92	585.59	06/24/92	585.09
	09/09/92	585.04								
CGA-4	10/24/85	584.16	12/05/85	584.83	02/03/86	584.51	02/17/86	584.74	03/06/86	584.72
	03/20/86	584.83	03/31/86	584.66	05/09/86	584.44	06/09/86	584.78	07/24/86	584.57
	08/04/86	584.45	08/19/86	584.30	09/25/86	584.34	12/30/86	584.84	08/04/87	584.49
	04/01/88	585.41	07/05/88	584.57	10/11/88	584.19	01/26/89	585.08	04/20/89	585.20
	08/01/89	584.94	02/27/90	585.50	09/20/90	585.27	11/28/90	586.19	03/20/91	585.79
	07/10/91	585.07	10/17/91	585.00	01/15/92	585.29	04/01/92	585.41	06/24/92	584.88
	09/09/92	584.70								
CGA-5	10/24/85	586.36	12/05/85	588.16	02/07/86	587.29	03/06/8	587.56	03/20/86	587.51
	03/31/86	587.62								
D-1	08/25/85	583.48	10/24/85	582.74	01/06/86	582.67	02/03/86	582.53	02/19/86	582.67
	03/04/86	582.58	03/21/86	582.91	04/03/86	582.76	05/09/86	582.73	06/10/86	583.16
	07/24/86	583.30	08/04/86	583.12	08/19/86	583.08	09/25/86	583.10	12/30/86	582.94
	02/25/87	582.89	02/27/87	582.93	08/04/87	582.39	10/13/87	582.18	11/04/87	581.83
	03/31/88	581.76	07/05/88	581.56	10/11/88	581.40	01/25/89	581.35	04/18/89	581.55
	08/02/89	581.77	02/26/90	581.40	05/29/90	582.16	09/17/90	581.91	11/26/90	581.47
	03/18/91	581.78	07/09/91	581.51	10/15/91	581.18	01/13/92	581.25	03/30/92	581.65
	06/23/92	581.34	09/08/92	581.15						
D-5	08/28/85	583.22*	10/24/85	583.50*	12/11/85	584.12*	01/06/86	583.30*	02/04/86	583.19*
	02/19/86	583.32*	03/04/86	583.41*	03/21/86	583.56*	04/03/86	583.52*	05/09/86	583.34*
	06/10/86	583.88*	07/24/86	584.06*	08/04/86	583.80*	08/19/86	583.49*	09/25/86	583.51*
	12/30/86	583.34*	02/25/87	583.51*	06/10/87	584.09*	06/11/87	584.08*	08/04/87	583.51*
	10/13/87	583.27*	03/31/88	583.15*	06/15/89	584.05*	06/15/89	583.51**	02/26/90	583.15*
	05/29/90	583.88*	09/17/90	583.62*	11/26/90	583.34*	03/18/91	583.69*	07/09/91	582.23*
	10/15/91	582.49*	01/13/92	582.59*	06/23/92	582.51*	09/08/92	582.67*		

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
D-10	08/28/85	583.22	10/24/85	583.46	12/11/85	583.97	01/06/86	583.23	02/04/86	583.15
	02/16/86	583.23	03/04/86	583.44	03/21/86	583.43	04/03/86	583.40	05/09/86	583.27
	06/10/86	583.75	07/24/86	583.87	08/04/86	583.69	08/19/86	583.40	09/25/86	583.47
	12/30/86	583.26	02/25/87	583.41	06/11/87	583.99	08/04/87	583.42	10/13/87	583.19
	11/04/87	582.87	03/31/88	583.10	07/05/88	582.56	10/11/88	582.66	01/25/89	582.86
	04/18/89	583.00	06/15/89	583.95	08/02/89	583.29	02/26/90	583.12	05/29/90	583.82
	09/17/90	583.49	11/26/90	583.25	03/18/91	583.55	07/09/91	582.29	10/15/91	582.51
	01/13/92	582.56	03/30/92	583.00	06/24/92	582.46	09/08/92	582.65		
D-11	06/11/87	584.01	08/04/87	583.45	10/13/87	583.22	11/04/87	582.88	03/31/88	583.16
	07/05/88	582.61	10/11/88	582.71	01/25/89	582.91	04/18/89	583.05	06/15/89	584.01
	08/02/89	583.33	02/26/90	583.12	05/29/90	583.87	09/17/90	583.53	11/26/90	583.30
	03/18/91	583.59	07/09/91	582.30	10/15/91	582.48	01/13/92	582.60	03/30/92	583.04
	06/23/92	582.54	09/08/92	582.65						
D-20	08/28/85	583.78	10/24/85	584.02	12/05/85	584.47	01/06/86	583.63	02/03/86	583.58
	02/19/86	584.36	03/04/86	584.42	03/21/86	584.24	04/03/86	584.04	05/09/86	584.61
	06/10/86	584.81	07/24/86	584.68	08/04/86	584.34	08/19/86	584.04	09/25/86	584.25
	12/30/86	583.55	02/25/87	583.14	07/16/87	584.12	08/04/87	583.72	10/13/87	583.55
	11/04/87	583.48	03/31/88	583.07	07/05/88	583.11	10/11/88	581.80	01/24/89	582.04
	04/18/89	581.99	08/02/89	583.02	02/28/90	584.56	05/31/90	584.48	09/19/90	583.94
	11/28/90	585.32	03/18/91	582.77	07/09/91	584.04	10/15/91	583.54	01/13/92	583.61
	04/02/92	583.60	06/23/92	583.22	09/08/92	583.22				
D-21	07/17/87	581.22	08/04/87	580.89	10/13/87	581.04	11/04/87	581.08	03/31/88	582.07
	07/05/88	580.61	10/11/88	580.84	01/24/89	581.37	04/18/89	581.08	08/02/89	581.10
	02/28/90	582.21	05/31/90	581.17	09/19/90	580.97	11/28/90	582.88	03/18/91	581.74
	07/09/91	581.04	10/15/91	580.87	01/13/92	580.78	04/02/92	580.92	06/23/92	580.23
	09/08/92	580.07								
D-25	12/05/85	584.65	01/07/86	583.41	01/15/86	583.43	01/23/86	583.37	02/17/86	583.41
	03/08/86	583.65	03/22/86	583.77	03/31/86	583.44	05/15/86	583.27	08/13/86	583.62
	01/14/87	583.74	02/23/87	583.41	08/04/87	583.22	10/13/87	583.35	11/04/87	583.04
	12/17/87	583.38	03/31/88	583.10	07/05/88	582.51	10/11/88	582.39	01/24/89	582.77
	04/18/89	582.76	08/02/89	583.02	02/28/90	583.44	05/31/90	583.88	09/19/90	583.17
	11/26/90	584.92	03/20/91	583.56	07/11/91	581.93	10/17/91	582.24	01/15/92	582.74
	04/02/92	582.91	06/23/92	582.15	09/10/92	582.79				

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
D-30	12/05/85	583.24	01/06/86	582.45	01/15/86	582.38	01/23/86	582.49	02/17/86	582.44
	03/08/86	582.43	03/22/86	581.43	03/31/86	581.73	05/15/86	582.81	08/13/86	583.04
	11/24/86	582.97	02/23/87	582.44	07/16/87	582.37	08/04/87	582.21	10/13/87	581.58
	11/04/87	581.43	12/17/87	581.72	03/31/88	581.43	07/05/88	581.10	01/24/89	580.93
	04/18/89	581.00	08/02/89	581.30	09/19/90	581.13	03/20/91	581.21	07/11/91	581.25
	10/17/91	580.61	01/15/92	581.21	04/02/92	581.12	05/12/92	580.90	06/23/92	580.86
	09/10/92	581.19								
D-31	07/16/87	582.46	08/04/87	582.24	10/13/87	581.64	11/04/87	581.51	03/31/88	581.49
	07/05/88	581.15	10/11/88	580.77	01/24/89	580.82	04/18/89	580.87	08/02/89	581.19
	02/28/90	580.98	05/31/90	581.32	09/19/90	581.04	11/28/90	581.38	03/20/91	581.11
	07/11/91	581.13	10/17/91	580.50	01/15/92	580.91	04/02/92	580.98	06/23/92	580.83
	09/10/92	581.21								
D-35	12/05/85	582.82	01/06/86	582.48	01/15/86	582.01	01/23/86	582.20	02/17/86	582.47
	03/08/86	581.93	03/22/86	581.74	03/31/86	582.40	05/15/86	582.58	08/13/86	582.92
	11/25/86	582.63	02/23/87	582.16	08/04/87	582.23	11/04/87	580.95	12/17/87	581.08
	03/31/88	580.77	07/05/88	580.78	10/11/88	580.35	01/24/89	580.37	04/18/89	580.33
	08/02/89	580.56	05/31/90	580.13	09/19/90	580.47	11/28/90	580.67	03/20/91	580.21
	07/11/91	580.78	10/17/91	580.19	01/15/92	580.01	04/02/92	580.45	06/23/92	580.56
	09/10/92	580.46								
D-40	10/24/85	582.47	12/05/85	583.55	01/06/86	582.45	02/03/86	582.62	02/19/86	583.30
	03/04/86	582.97	03/21/86	583.15	04/03/86	582.70	05/10/86	582.66	06/10/86	583.41
	07/24/86	583.10	08/04/86	582.92	08/19/86	582.87	09/25/86	583.16	12/30/86	582.92
	02/26/87	582.49	08/04/87	582.32	03/30/88	583.49	07/06/88	582.19	10/11/88	581.55
	01/24/89	582.56	04/18/89	582.61	08/02/89	582.40	02/28/90	582.29	05/29/90	582.12
	09/19/90	581.51	11/28/90	583.80	03/20/91	582.32	07/09/91	581.59	10/15/91	581.05
	01/13/92	582.20	04/02/92	581.60	06/23/92	580.66	09/08/92	581.05		
D-45	10/24/85	580.44	12/13/85	581.20	01/06/86	580.69	01/15/86	580.58	02/03/86	580.38
	03/07/86	580.72	03/20/86	580.95	03/31/86	580.84	05/09/86	580.47	06/09/86	580.61
	07/24/86	580.59	08/04/86	580.31	08/19/86	580.18	09/25/86	580.31	12/30/86	579.73
	02/26/87	580.58	08/05/87	580.37	03/31/88	581.26	07/06/88	580.48	10/12/88	580.36
	01/24/89	580.90	04/18/89	580.03	08/01/89	580.87	02/28/90	581.55	05/29/90	581.49
	09/20/90	580.88	11/28/90	582.64	03/21/91	581.60	07/11/91	580.55	10/15/91	580.78
	01/17/92	581.04	04/01/92	581.24	06/23/92	580.63	09/10/92	581.22		

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
D-50	12/13/85	578.22	03/22/86	578.61	04/03/86	578.42	05/10/86	578.10	06/10/86	578.25
	08/05/86	577.95	08/20/86	577.84	09/26/86	577.76	12/31/86	578.26	02/25/87	577.79
	08/04/87	577.79	03/30/88	578.03	07/06/88	577.72	10/11/88	577.54	01/24/89	577.81
	04/18/89	578.03	08/02/89	577.93	02/28/90	578.45	05/29/90	578.44	09/19/90	577.94
	11/28/90	578.35	03/20/91	578.51	07/09/91	578.01	10/15/91	578.35	01/13/92	577.99
	04/02/92	577.87	06/23/92	577.51	09/08/92	577.47				
D-55	10/24/85	582.27	10/29/85	582.34	11/05/85	582.64	11/12/85	582.88	11/27/85	582.73
	12/05/85	582.60	12/12/85	582.54	01/06/86	582.20	02/05/86	582.66	02/19/86	582.28
	03/07/86	582.45	03/21/86	582.27	04/03/86	582.58	05/15/86	582.70	08/14/86	582.65
	11/25/86	582.61	02/24/87	582.16	08/05/87	582.01	12/17/87	581.28	03/30/88	580.88
	07/06/88	580.68	10/12/88	580.23	01/24/89	580.33	04/19/89	580.43	08/04/89	580.59
	02/28/90	579.81	05/29/90	581.08	09/19/90	580.53	11/28/90	579.81	03/20/91	580.24
	07/11/91	580.85	10/18/91	580.18	01/17/92	580.26	04/02/92	580.46	06/23/92	580.45
	09/10/92	580.36								
D-60	10/29/85	582.76	11/05/85	582.99	11/11/85	583.49	11/27/85	583.78	12/05/85	583.62
	01/06/86	583.00	02/05/86	583.19	02/19/86	583.16	03/21/86	583.40	04/03/86	583.22
	05/15/86	583.18	08/14/86	582.99	12/16/86	583.46	02/24/87	583.05	07/22/87	582.57
	08/05/87	582.37	12/17/87	582.85	03/31/88	582.62	07/06/88	581.17	10/12/88	580.70
	01/24/89	581.89	04/19/89	582.11	08/04/89	581.81	02/28/90	581.97	05/29/90	582.48
	09/19/90	581.93	11/28/90	582.08	03/20/91	582.48	07/11/91	581.71	10/18/91	581.41
	01/17/92	581.96	04/02/92	582.19	06/23/92	581.28	09/10/92	580.79		
D-65	10/24/85	583.50	10/29/85	583.92	11/05/85	583.75	11/11/85	584.27	11/27/85	584.23
	03/21/86	584.32	04/03/86	584.23	05/15/86	584.02	08/14/86	583.55	11/25/86	584.22
	02/24/87	584.19	08/05/87	583.21	12/17/87	584.69	03/30/88	584.45	07/06/88	581.74
D-66	07/15/87	582.27	08/05/87	582.24	03/30/88	581.74	07/05/88	581.41	10/13/88	581.26
	01/25/89	581.75	04/19/89	581.66	08/04/89	581.76	03/01/90	581.77	05/31/90	581.81
	09/20/90	581.63	11/28/90	582.15	03/21/91	582.04	07/11/91	581.71	10/17/91	581.66
	01/17/92	581.74	04/01/92	581.78	06/24/92	581.25	09/10/92	581.64		
D-67	07/16/87	585.16	08/05/87	584.52	03/31/88	586.24	07/07/88	584.05	10/12/88	583.49
	01/25/89	585.49	04/18/89	585.63	08/04/89	585.17	03/01/90	586.15	05/31/90	586.53
	09/19/90	585.36	11/28/90	588.38	03/20/91	587.29	07/09/91	584.57	10/17/91	584.79
	01/17/92	585.52	04/01/92	585.91	06/23/92	583.87	09/11/92	585.15		
D-68	07/16/87	585.17	08/05/87	584.52	03/31/88	586.24	07/07/88	584.03	10/12/88	583.49
	01/25/89	585.49	04/18/89	585.64	08/04/89	585.18	03/01/90	586.14	05/31/90	586.53
	09/19/90	585.36	11/28/90	588.31	03/20/91	587.32	07/09/91	584.59	10/16/91	584.79
	01/17/92	585.52	04/01/92	585.94	06/24/92	583.86	09/11/92	585.13		

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
D-70	01/07/86	599.26	02/04/86	599.56	02/20/86	600.26	03/04/86	599.77	03/22/86	600.12
	04/01/86	599.70	05/10/86	599.16	06/09/86	599.38	08/05/86	598.82	08/20/86	598.53
	09/26/86	598.71	12/31/86	599.60	02/25/87	599.46	08/04/87	598.87	03/31/88	600.65
	07/06/88	598.81	10/12/88	598.48	01/25/89	599.72	04/18/89	599.90	08/02/89	599.48
	02/28/90	600.67	05/31/90	600.24	09/20/90	599.36	11/28/90	602.29	03/21/91	601.13
	07/11/91	598.94	10/16/91	599.35	01/15/92	600.32	04/02/92	600.30	06/24/92	599.01
	09/11/92	600.07								
D-75	01/07/86	595.98	01/24/86	596.09	02/04/86	596.09	02/20/86	596.49	03/04/86	596.39
	03/22/8	596.60	04/01/86	596.44	05/10/86	596.22	06/09/86	596.70	08/05/86	596.31
	08/20/86	596.12	09/26/86	596.43	12/31/86	596.30	02/25/87	596.18	02/26/87	596.19
	08/04/87	596.27	03/31/88	596.94	07/06/88	596.15	10/12/88	596.20	01/25/89	596.30
	04/18/89	596.46	08/02/89	596.62	02/28/90	596.88	05/31/90	596.76	09/20/90	596.39
	11/28/90	597.09	03/21/91	597.10	07/11/91	596.16	10/17/91	596.47	01/15/92	596.34
	04/02/92	596.66	06/24/92	595.95	09/11/92	596.98				
E-1	12/13/85	579.09	01/06/86	578.61	02/04/86	579.22	02/19/86	579.45	03/04/86	579.17
	03/21/86	579.39	04/03/86	579.05	05/09/86	578.49	06/10/86	578.94	07/24/86	578.46
	08/04/86	578.48	08/19/86	578.39	09/25/86	577.87	12/30/86	578.83	02/27/87	578.93
	08/04/87	577.89	10/13/87	577.89	03/31/88	578.90	07/06/88	577.79	10/12/88	577.62
	01/25/89	578.52	04/17/89	578.34	08/02/89	577.91	02/26/90	578.50	05/29/90	578.86
	09/17/90	578.15	11/26/90	578.51	03/18/91	579.52	07/09/91	578.74	10/15/91	578.01
	01/13/92	578.86	03/30/92	579.06	06/23/92	578.80	09/08/92	577.83		
E-2	06/09/87	582.49	07/14/87	582.14	08/04/87	581.72	10/13/87	581.46	11/03/87	581.05
	03/31/88	580.99	07/05/88	580.81	10/11/88	580.61	01/25/89	580.29	08/02/89	580.74
	02/26/90	580.75	06/01/90	580.89	09/17/90	581.02	11/26/90	580.35	03/18/91	580.77
	07/09/91	580.90	10/15/91	580.33	01/13/92	580.18	03/30/92	581.04	06/23/92	580.92
	09/08/92	580.36								
E-3	06/22/87	582.54	07/13/87	582.58	08/04/87	582.05	10/13/87	582.39	11/04/87	582.70
	03/31/88	583.98	07/05/88	581.71	10/11/88	582.30	01/25/89	582.94	04/17/89	582.84
	08/02/89	582.77	02/26/90	583.91	05/29/90	583.28	09/17/90	582.30	11/26/90	582.89
	03/18/91	583.82	07/09/91	582.30	10/15/91	582.68	01/13/92	582.78	03/30/92	583.11
	06/23/92	582.17	09/08/92	582.19						

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date meaaured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
E-5	08/28/85	580.57	10/25/85	580.76	12/13/85	581.66	01/06/86	580.96	02/04/86	580.86
	02/19/86	581.23	03/04/86	581.13	03/22/86	581.46	04/03/86	581.39	05/09/86	581.02
	06/10/86	581.21	08/04/86	580.95	08/19/86	580.73	09/25/86	580.56	12/30/86	581.11
	02/25/87	580.88	08/04/87	580.98	03/31/88	581.58	07/06/88	580.71	10/12/88	580.62
	01/25/89	581.24	04/17/89	581.39	08/02/89	581.30	02/26/90	581.96	05/29/90	581.92
	09/17/90	581.33	11/26/90	581.49	03/18/91	582.20	07/09/91	581.30	10/15/91	581.09
	01/13/92	581.39	03/30/92	581.72	06/23/92	581.05	09/08/92	580.79		
E-6	06/22/87	584.72	07/15/87	584.85	08/04/87	583.83	10/13/87	584.22	11/04/87	584.48
	03/31/88	585.30	07/05/88	583.07	10/11/88	584.25	01/25/89	584.61	04/17/89	584.42
	08/02/89	584.30	02/26/90	585.26	05/29/90	584.87	09/17/90	583.71	11/26/90	584.70
	03/18/91	585.31	07/09/91	583.88	10/15/91	584.34	01/13/92	584.43	03/30/92	584.95
	06/23/92	583.62	09/08/92	583.99						
E-7	06/22/87	584.70	07/15/87	584.92	08/04/87	583.86	10/13/87	584.24	11/04/87	584.51
	03/31/88	585.33	07/05/88	583.06	10/11/88	584.16	01/25/89	584.67	04/17/89	584.45
	08/02/89	584.31	02/26/90	585.36	05/29/90	584.94	09/17/90	583.79	11/26/90	584.73
	03/18/91	585.44	07/09/91	583.96	10/15/91	584.48	01/13/92	584.57	03/30/92	585.13
	05/13/92	584.15	06/23/92	583.60	09/08/92	584.02				
E-10	10/17/85	582.02	10/30/85	581.10	11/05/85	581.31	11/11/85	581.81	12.18.85	582.48
	01/06/86	581.92	02/06/86	581.99	02/20/86	581.92	02/26/86	582.16	03/08/86	582.13
	03/22/86	582.59	04/03/86	582.42	05/16/86	581.91	08/14/86	581.38	11/24/86	582.46
	12/15/86	582.72	01/14/87	582.25	02/23/87	582.05	06/26/87	582.31	07/16/87	581.93
	08/04/87	581.48	03/31/88	582.82	07/06/88	580.99	10/12/88	580.42	01/25/89	582.12
	04/17/89	582.26	08/02/89	581.54	02/26/90	582.46	05/29/90	583.04	09/17/90	581.81
	11/26/90	582.20	03/21/91	583.24	07/09/91	581.74	10/18/91	580.85	01/15/92	582.15
	04/03/92	582.48	06/23/92	581.23						
E-15	10/17/85	582.04	10/30/85	581.14	11/05/85	581.42	11/11/85	581.89	12/19/85	582.20
	01/06/86	581.72	02/06/86	581.84	02/20/86	581.79	03/08/86	581.83	03/22/86	582.15
	04/03/86	582.16	05/16/86	581.71	08/14/86	581.29	11/24/86	582.18	02/23/87	581.85
	08/04/87	581.24	03/31/88	582.48	07/06/88	580.84	01/25/89	581.83	08/02/89	581.14
	02/26/90	582.11	05/29/90	582.45	09/17/90	581.46	11/26/90	581.80	03/21/91	582.48
	07/09/91	581.33	10/18/91	580.62	01/15/92	581.68	03/30/92	581.92	06/23/92	580.93
	09/11/92	580.68								
E-17	10/25/85	581.31	11/27/85	581.89	01/06/86	581.51	02/20/86	581.67	03/08/86	581.42
	03/22/86	581.45	04/03/86	581.52	05/09/86	581.61	06/10/86	581.71	08/04/86	581.67
	08/19/86	581.52	09/26/86	581.97	12/31/86	581.60	02/25/87	581.34	08/04/87	580.93
	03/31/88	581.23								

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
E-20	08/28/85	587.34	10/25/85	587.44	12/06/85	588.67	01/08/86	587.67	02/04/86	587.80
	02/20/86	588.10	03/08/86	588.03	03/22/86	588.41	04/03/86	588.13	05/09/86	587.66
	06/10/86	588.10	08/04/86	587.26	08/20/86	586.79	09/26/86	587.37	12/31/86	588.03
	02/25/87	587.84	02/26/87	587.84	07/15/87	587.72	08/04/87	587.16	03/31/88	588.94
	07/06/88	586.98	10/11/88	586.79	01/25/89	588.26	04/17/89	588.56	08/02/89	587.79
	02/26/90	589.11	05/29/90	588.85	09/19/90	587.96	11/26/90	588.42	03/21/91	589.34
	07/09/91	587.71	10/18/91	587.67	01/15/92	588.50	04/03/92	588.96	06/24/92	587.44
	09/08/92	588.34								
HWT2-9	12/10/85	582.21	02/06/86	581.93	02/18/86	581.64	03/17/86	581.77	03/31/86	581.80
	05/09/86	581.91	06/09/86	582.35	07/24/86	582.44	09/22/86	582.26	11/25/86	581.89
	02/26/87	581.60	06/25/87	581.68	03/31/88	580.28	07/06/88	580.26	10/13/88	579.90
	01/25/89	579.69	04/19/89	579.55	08/03/89	580.28	02/27/90	579.74	05/30/90	580.21
	09/18/90	580.30	11/27/90	579.67	03/19/91	580.04	07/10/91	580.53	10/16/91	580.15
	01/14/92	580.05	03/31/92	579.97	06/23/92	580.07	09/09/92	579.89		
HWT2-10	12/10/85	588.66	02/06/86	588.08	02/18/86	585.55	03/17/86	588.27	03/31/86	587.91
	05/09/86	587.30	06/09/86	588.15	07/24/86	587.73	09/22/86	586.79	11/25/86	587.94
	02/26/87	587.50	08/04/87	587.12	03/31/88	588.57	07/06/88	586.36	10/13/88	586.16
	01/25/89	587.83	04/19/89	588.01	08/03/89	587.56	02/27/90	588.18	05/30/90	588.88
	09/18/90	588.15	11/27/90	589.16	03/19/91	588.90	07/10/91	587.47	10/16/91	587.33
	01/14/92	588.18	03/31/92	588.22	06/24/92	586.61	09/09/92	586.31		
HWT2-12S	(REPLACES P-7)		06/23/92	584.95						
HWT14-5	12/10/85	584.84	02/06/86	584.55	02/18/86	584.56	03/17/86	584.61	03/31/86	584.57
	05/09/86	584.09	06/09/86	584.71	07/24/86	584.61	09/22/86	583.08	11/25/86	584.53
	02/26/87	585.44	08/04/87	584.39	03/31/88	585.17	07/06/88	584.07	10/13/88	583.94
	01/25/89	584.57	04/19/89	584.59	08/03/89	584.59	02/27/90	586.26	06/01/90	584.80
	09/18/90	584.72	11/27/90	584.10	03/19/91	585.45	07/10/91	584.39	10/16/91	584.43
	01/14/92	584.89	03/31/92	585.23	06/24/92	584.33	09/09/92	584.39		
P-4	12/10/85	583.86	02/06/86	583.93	02/18/86	584.25	03/17/86	583.86	03/31/86	583.80
	05/09/86	583.23	06/09/86	584.12	07/24/86	583.96	09/22/86	583.56	11/25/86	583.28
	02/26/87	584.01	08/04/87	582.96	03/31/88	583.38	07/06/88	582.32	10/13/88	581.97
	01/25/89	582.75	04/19/89	582.47	08/03/89	583.06	02/27/90	583.19	05/30/90	583.48
	09/18/90	583.02	11/27/90	582.79	03/19/91	583.37	07/10/91	583.18	10/16/91	583.04
	01/14/92	582.31	03/31/92	582.78	06/23/92	582.24	09/09/92	582.36		

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
P-7	12/10/85	585.71	02/06/86	584.74	02/18/86	584.71	03/17/86	584.83	03/31/86	584.88
	05/09/86	584.84	06/09/86	585.04	07/24/86	585.36	09/22/86	584.70	11/25/86	584.94
	02/26/87	585.99	08/04/87	584.57	03/31/88	584.14	07/06/88	584.27	10/13/88	584.31
	01/25/89	584.28	04/19/89	584.23	08/03/89	584.63	06/23/92	584.95		
P-11	12/10/85	586.89	02/06/86	585.51	02/18/86	585.44	03/17/86	585.71	03/31/86	585.49
	05/09/86	585.28	06/09/86	585.84	07/24/86	586.10	09/22/86	585.06	11/25/86	585.57
	02/26/87	585.87	08/04/87	585.38	03/31/88	585.41	07/06/88	584.81	10/13/88	584.96
	01/25/89	585.36	04/19/89	585.34	08/03/89	585.63	02/27/90	585.88	05/30/90	588.21
	09/18/90	586.48	11/27/90	586.25	03/19/91	586.13	07/10/91	585.77	10/16/91	586.13
	01/14/92	585.67	03/31/92	585.44	06/23/92	585.13	09/09/92	585.08		
S-1	03/04/86	583.01	03/21/86	582.93	04/03/86	582.96	05/09/86	583.18	06/03/86	583.22
	06/10/86	583.31	07/24/86	583.28	08/04/86	583.23	08/19/86	583.15	09/25/86	583.27
	12/30/86	583.21	02/25/87	583.19	06/22/87	583.12	08/04/87	583.03	10/13/87	583.00
	11/04/87	583.14	03/31/88	583.51	07/05/88	582.82	10/11/88	583.11	01/25/89	583.23
	04/17/89	583.06	08/02/89	583.08	02/26/90	583.43	05/29/90	583.81	09/17/90	583.78
	11/26/90	583.87	03/18/91	584.18	07/09/91	583.73	10/15/91	583.85	01/13/92	583.87
	03/30/92	583.87	06/23/92	583.04	09/08/92	582.91				
S-2	05/09/86	582.32	06/03/86	582.64	06/10/86	582.81	08/04/86	582.79	08/19/86	582.62
	09/25/86	582.69	12/30/86	582.50	02/25/87	582.15	08/04/87	581.74	08/06/87	581.68
	10/13/87	582.06	11/04/87	582.08	03/31/88	582.41	07/05/88	581.20	10/11/88	581.12
	01/25/89	582.33	04/17/89	582.93	08/02/89	582.47	02/26/90	582.93	05/29/90	582.58
	09/17/90	582.17	11/26/90	582.40	03/18/91	582.50	07/09/91	581.72	10/15/91	581.26
	01/13/92	582.02	03/30/92	582.04	06/23/92	581.27				
S-3	06/04/86	582.66	08/04/87	581.99	10/13/87	582.00	03/31/88	582.37	07/05/88	582.02
	10/11/88	581.95	01/25/89	582.08						
S-4	06/04/86	582.65	08/05/87	581.99	10/13/87	582.00	11/04/87	582.04	03/31/88	582.32
	07/05/88	582.02	10/11/88	581.94	01/25/89	582.07				
S-7	12/06/85	582.75	01/07/86	582.18	02/03/86	582.28	02/17/86	582.33	03/04/86	582.10
	03/22/86	581.38	04/01/86	582.20	05/09/86	582.85	06/09/86	583.07	08/05/86	582.77
	08/19/86	583.11	09/26/86	583.23	12/31/86	582.06				
S-8	01/14/86	579.62	02/03/86	579.75	02/17/86	579.12	03/06/86	579.31	03/20/86	579.43
	05/09/86	579.41	06/09/86	579.39	09/25/86	579.31	12/30/86	579.57	08/05/87	579.80
	03/31/88	580.12	07/06/88	579.89	10/12/88	579.99	04/18/89	580.03	08/01/89	579.89
	03/01/90	580.07	05/29/90	580.12	09/20/90	579.96	11/28/90	579.92	03/21/91	580.17
	07/11/91	579.88	10/15/91	579.91	04/02/92	580.07	06/23/92	579.91	09/10/92	579.85

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
S-9	08/04/87	585.79	03/31/88	586.03	07/07/88	585.01	10/11/88	584.05	01/24/89	585.13
	04/18/89	585.85	08/01/89	585.72	02/28/90	585.93	05/31/90	586.10	09/19/90	585.77
	11/28/90	586.18	03/20/91	586.58	07/11/91	586.04	10/17/91	585.40	04/02/92	586.33
	06/23/92	585.59	09/10/92	585.27						
S-10	11/11/85	582.08	11/27/85	581.96	12/04/85	582.75	01/03/86	582.84	02/04/86	582.92
	02/17/86	582.62	03/06/86	582.68	03/20/86	582.96	03/31/86	582.51	05/09/86	583.13
	06/09/86	583.09	07/24/86	583.13	08/04/86	583.04	08/19/86	583.17	09/25/86	583.10
	12/30/86	582.74	08/04/87	582.49	04/01/88	581.63	07/05/88	581.46	10/11/88	581.45
	01/26/89	581.90	04/20/89	581.54	08/01/89	582.17	02/27/90	581.81	05/31/90	581.76
	09/20/90	582.16	11/28/90	582.83	03/20/91	581.97	07/10/91	583.08	10/17/91	581.53
	01/15/92	581.23	04/01/92	581.22	06/24/92	582.08	09/09/92	582.09		
S-11	08/05/87	589.97	04/01/88	590.19	07/07/88	589.83	10/12/88	589.99	01/24/89	590.24
	04/19/89	590.24	08/04/89	590.07	03/01/90	590.19	05/31/90	590.15	11/29/90	590.52
	03/21/91	590.34	07/11/91	590.07	10/17/91	590.10	04/01/92	590.37	06/24/92	589.28
	09/08/92	589.56								
S-12	08/28/85	582.20	11/11/85	583.47	11/27/85	583.21	12/04/85	582.89	12/12/85	581.69
	01/03/86	582.96	02/03/86	582.53	02/17/86	582.87	03/06/86	582.67	03/20/86	583.04
	03/31/86	582.65	05/09/86	583.16	06/09/86	583.17	07/24/86	583.36	08/04/86	583.11
	08/19/86	583.09	09/25/86	583.10	12/30/86	582.71	02/26/87	582.28	08/04/87	582.89
	04/01/88	582.44	07/05/88	582.39	10/12/88	581.91	01/26/89	581.74	04/20/89	581.79
	08/01/89	582.94	02/27/90	581.59	05/30/90	582.41	09/20/90	583.08	11/28/90	583.56
	07/10/91	583.80	10/17/91	582.20	01/15/92	581.56	04/01/92	581.76	06/24/92	583.40
	09/09/92	582.57								
S-13	10/12/88	582.74	01/24/89	582.62	04/20/89	582.60	08/03/89	583.38	02/27/90	582.47
	05/30/90	583.01	09/18/90	583.56	11/27/90	583.69	03/20/91	583.22	07/10/91	584.20
	10/16/91	583.05	01/15/92	582.39	04/01/92	582.58	06/24/92	583.70	09/08/92	583.18
S-14	09/10/85	581.85	05/16/86	582.56	06/09/86	582.81	07/24/86	582.64	02/26/87	581.87
	08/04/87	581.86	08/06/87	581.45	03/31/88	580.96	07/06/88	580.33	10/13/88	580.39
	01/25/89	579.71	04/19/89	579.47	08/03/89	579.37	02/27/90	579.06	09/18/90	579.58
	11/27/90	579.63	03/19/91	579.01	07/10/91	580.28	01/14/92	580.27	03/31/92	579.36
	06/23/92	580.10	09/09/92	579.85						
S-15	08/06/87	586.90	09/15/87	587.20	03/31/88	587.20	07/06/88	587.00	10/13/88	586.90
	01/25/89	587.10	04/19/89	587.00	08/03/89	586.80	02/27/90	587.00	05/30/90	587.20
	09/18/90	587.00	11/27/90	587.20	03/20/91	587.60	07/10/91	587.30	01/14/92	587.17
	03/31/92	587.06	06/23/92	586.96	09/09/92	586.94	12/08/92	587.19		

Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
S-16	08/07/87	589.24	07/07/88	588.76						
S-17	12/05/85	582.22	01/08/86	581.81	02/04/86	582.50	02/20/86	582.19	03/07/86	582.41
	03/21/86	582.02	04/01/86	582.30	05/10/86	582.82	06/10/86	582.76	08/05/86	582.77
	08/20/86	582.84	09/26/86	582.94	12/31/86	582.00				
S-18	06/04/86	583.01	08/04/87	582.51	10/13/87	582.58	11/04/87	582.61	03/31/88	583.16
	07/05/88	582.37	10/11/88	582.54	01/25/89	582.62				
S-19	06/04/86	583.00	06/22/87	583.01	08/04/87	582.68	10/13/87	582.74	11/04/87	582.72
	03/31/88	583.09	07/05/88	582.30	10/11/88	582.73	01/25/89	582.74		
S-20	06/04/86	582.99	08/04/87	582.40	10/13/87	582.23	11/04/87	582.17	03/31/88	583.14
	07/05/88	581.24	10/11/88	582.18	01/25/89	582.44				
S-21	06/04/86	582.97	08/04/87	582.71	10/13/87	582.48	11/04/87	582.46		
S-22	06/04/86	583.27	08/04/87	582.03	11/04/87	582.06	03/31/88	582.37	07/05/88	582.06
	10/11/88	582.08	01/25/89	582.14						
S-23	06/15/85	582.35	07/15/85	582.18	08/15/85	582.05	09/15/85	582.15	10/17/85	581.79
	10/24/85	581.92	11/11/85	582.51	11/27/85	582.48	12/04/85	582.09	12/17/85	581.86
	01/03/86	582.38	02/03/86	582.02	02/17/86	581.99	03/06/86	582.25	03/20/86	582.22
	03/31/86	581.99	04/15/86	582.51	05/09/86	582.54	06/09/86	582.58	07/24/86	582.61
	08/04/86	582.71	08/19/86	582.91	09/25/86	582.91	10/15/86	583.10	11/15/86	582.12
	12/30/86	582.41	01/15/87	582.25	02/26/87	581.86	03/15/87	582.12	04/15/87	582.05
	05/15/87	581.72	06/15/87	581.82	07/05/87	581.79	08/04/87	581.72	08/06/87	581.46
	09/15/87	581.07	10/15/87	580.64	11/15/87	580.61	12/15/87	581.17	01/15/88	579.56
	02/14/88	579.89	03/15/88	580.25	03/31/88	580.31	04/15/88	580.31	05/15/88	580.51
	06/15/88	580.31	07/05/88	580.31	08/15/88	579.79	09/15/88	579.79	10/13/88	579.40
	11/15/88	579.63	12/15/88	579.69	01/25/89	579.79	02/14/89	579.26	03/15/89	579.43
	04/20/89	579.49	05/15/89	579.66	06/15/89	580.38	07/15/89	580.22	08/03/89	579.76
	09/15/89	579.89	10/15/89	579.33	11/15/89	579.72	12/15/89	579.10	01/15/90	578.64
	02/27/90	578.58	03/15/90	578.74	04/15/90	578.97	05/30/90	579.66	06/15/90	579.69
	07/15/90	579.99	08/15/90	579.66	09/18/90	579.63	10/15/90	579.43	11/27/90	579.53
	12/15/90	579.49	01/15/91	579.49	02/14/91	579.79	03/19/91	579.13	04/15/91	580.12
	05/15/91	580.22	06/15/91	580.35	07/10/91	580.38	08/15/91	580.05	09/15/91	579.69
	10/16/91	579.00	11/15/91	579.53	12/15/91	579.23	01/14/92	580.05	02/14/92	579.40
	03/31/92	579.56	04/15/92	579.85	05/15/92	580.05	06/24/92	580.12	07/15/92	580.22
	08/15/92	580.25	09/09/92	579.59	09/30/92	579.92				

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Table 5. Water levels in selected wells in the Calumet aquifer and surface-water sites in northern Lake County, Indiana, August 1985 through October 1992—Continued

Site name	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level	Date measured (month/day/year)	Water level
A-11S	12/17/85	585.66	02/06/86	585.60	02/18/86	585.58	03/17/86	585.58	03/31/86	585.62
	05/16/86	585.62	09/22/86	585.82	11/25/86	585.53	02/26/87	585.50	06/26/87	586.27
	08/04/87	586.39	03/31/88	585.57	07/06/88	586.51	10/13/88	585.65	01/25/89	585.45
	04/19/89	585.57	08/03/89	586.25	02/27/90	585.47	05/30/90	585.73	09/18/90	585.68
	11/27/90	585.69	03/19/91	585.67	07/10/91	586.08	10/16/91	585.72	01/14/92	585.60
	03/31/92	585.51	06/23/92	586.17	09/09/92	585.73				
C-16S	12/18/85	582.47	01/08/86	582.24	02/04/86	582.89	02/20/86	582.51	03/07/86	582.69
	03/21/86	582.35	04/01/86	582.55	05/15/86	582.87	08/13/86	583.42	12/17/86	582.47
	02/24/87	582.33	08/05/87	582.36	09/18/87	582.32	12/17/87	582.28	03/30/88	582.25
	07/06/88	580.97	10/13/88	581.22	01/25/89	581.83	04/19/89	581.91	08/04/89	581.61
	03/01/90	581.90	05/31/90	581.96	09/20/90	581.87	11/28/90	582.03	03/21/91	581.98
	07/11/91	582.06	10/17/91	581.71	01/17/92	581.92	04/01/92	582.02	06/24/92	582.00
	09/10/92	582.08								
D-36S	01/23/86	582.03	03/08/86	581.63	03/22/86	581.59	03/31/86	582.61	05/15/86	583.05
	08/13/86	582.80	11/24/86	582.23	11/25/86	582.44	02/26/87	582.23	03/26/87	581.66
	08/04/87	581.94	10/13/87	580.94	07/05/88	580.86	10/11/88	579.90	01/24/89	580.38
	04/18/89	579.64	08/02/89	580.66	02/28/90	578.91	05/31/90	579.80	09/19/90	580.27
	11/28/90	578.92	03/20/91	579.22	07/11/91	580.44	10/17/91	578.99	01/15/92	580.27
	04/02/92	579.80	06/23/92	580.52	09/10/92	579.55				
D-54S	12/12/85	582.47	02/05/86	582.57	03/07/86	582.27	04/03/86	582.27	05/15/86	582.49
	08/14/86	582.83	11/25/86	582.47	12/16/86	582.46	10/12/88	580.20	01/24/89	580.05
	04/19/89	580.16	02/28/90	579.12	09/10/92	580.02				
E-16S	12/19/85	581.04	01/06/86	581.16	02/06/86	581.59	02/20/86	581.41	03/08/86	580.93
	03/22/86	580.83	04/03/86	581.58	05/16/86	581.60	08/14/86	581.21	11/24/86	581.42
	02/23/87	581.30	03/26/87	581.02	08/04/87	581.00	03/31/88	580.99	07/06/88	580.50
	10/11/88	579.41	01/25/89	580.32	04/17/89	580.28	08/02/89	579.99	02/26/90	580.25
	05/29/90	580.45	09/17/90	579.89	11/26/90	580.27	03/21/91	580.20	07/09/91	579.85
	10/18/91	579.56	01/15/92	579.98	04/03/92	580.02	06/23/92	579.74	09/11/92	580.24

* Air/oil interface.

** Oil/water interface.