Municipal Ground-Water Development and Withdrawals in the Central Lower Peninsula of Michigan, 1870-1987

By M.A. Baltusis, M.F. Quigley, and R.J. Mandle

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For additional information
write to:

District Chief
U.S. Geological Survey
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CONVERSION FACTORS

Multiply	By	To obtain
foot (ft)	0.3048	meter
square mile (mi^2)	2.590	square kilometer
gallon (gal)	0.003785	cubic meter
million gallons (Mgal)	3,785	cubic meter
million gallons per day (Mgal/d)	0.04381	cubic meter per second

MUNICIPAL GROUND-WATER DEVELOPMENT AND WITHDRAWALS IN THE CENTRAL LOWER PENINSULA OF MICHIGAN, 1870-1987

By M.A. Baltusis, M.F. Quigley, and R.J. Mandle

ABSTRACT

Municipal water-supply systems in the central Lower Peninsula of Michigan were categorized into four regions on the basis of source of water for 1987. These categories included water systems that obtained water from aquifers in glacial drift, bedrock, or both, as well as those that obtained water from surface-water sources. Data on ground-water development were collected for 182 municipal water-supply systems for the period 1870-1987. Of the 182 systems, 135 used ground water for supply. Wells in glacial-drift aquifers supplied water for 60 municipalities; wells in bedrock aquifers supplied 58 municipalities. Combinations of wells in bedrock and glacial-drift aquifers supplied 17 municipalities. Surface-water sources supplied 45 municipalities; two municipalities used surface water and ground water. Of the 182 municipal systems, withdrawal data were available for only 145. Withdrawal data were collected for the period 1903-1985. Analysis of annual ground-water withdrawal data for the 145 municipal water-supply systems indicates that average annual per capita municipal ground-water withdrawal ranged from 60 gallons per day per person in 1915 to 166 gallons per day per person in 1973. The maximum reported ground-water withdrawal for the area was 103 million gallons per day in 1979. Records from most municipalities include long periods for which no ground-water withdrawal data are available. The average annual per capita data among the municipalities varies over the period of record because of incomplete reporting of pumping rates, unusually high pumping rates, short-term economic changes, and other changes not associated with local population changes.

INTRODUCTION

During the mid-1800's, municipal water-supply systems[1] in the central Lower Peninsula of Michigan primarily used surface water. Water was pumped directly from rivers, creeks, or lakes, mainly for firefighting. Potable water for household use was obtained from cisterns, springs, or from dug, bored, or driven wells. The quality of water delivered by municipal water systems and privately owned sources was similar until 1900, when municipal water supplies improved (LaNier, 1976, p. 174).

[1] Referred to as "municipal water supplies" in this report.

Since 1920, population increase, industrial growth, and demand for improved water quality have required the expansion of municipal systems. Municipalities in the central Lower Peninsula obtained water from nearby inland lakes and streams, Lake Michigan, Lake Huron, or aquifers. The source of water was determined by availability and costs of pumping, distribution, and treatment. As the demand for water increased, some municipalities switched from ground-water to surface-water because of unacceptable concentrations of chloride or iron, hard water, insufficient well production, or ground-water contamination.

Purpose and Scope

This report summarizes the history of ground-water development by municipal water supplies from 1870 through 1987 and annual reported ground-water withdrawals of municipal water supplies, excluding water supplied by townships, from 1903 through 1985 in the central Lower Peninsula of Michigan. Knowledge of how ground-water withdrawal rates varied with time is needed to help assess the effects of withdrawals on the area's aquifers.

Description of Study Area

The study area is in the central part of Michigan's Lower Peninsula (fig. 1). This area covers approximately 29,000 mi^2 and contains 182 municipal water supplies. The area is defined by the subcrop of the contact between the Coldwater Shale and the overlying Marshall Sandstone. Principal aquifers include the Marshall, Parma-Bayport, Grand River-Saginaw, and glacial-drift aquifers. The hydrostratigraphic relations of geologic formations and regional aquifers is shown on figure 2. Over most of the area, the Marshall aquifer consists of sandstones whose total thickness ranges from 200 to 300 ft; the Parma-Bayport aquifer consists of sandstones that range from 100 to 150 ft in thickness; and the Grand River-Saginaw aquifer consists of lenticular sandstones whose composite thickness ranges from 50 to 350 ft (Grannemann, N.G. and Long, D.T., U.S. Geological Survey, written commun., 1991). The glacial-drift aquifers consist of discontinuous coarse-grained deposits.

In addition to ground water, surface-water resources within the area are abundant. Two of the five Great Lakes—Michigan and Huron—border the Lower Peninsula on the west and east, respectively, and are used for municipal water supply.

Previous Studies

Numerous water-resources investigations in Michigan by various government agencies and private organizations have been done. The U.S. Geological Survey (USGS), in cooperation with State and local government agencies, has studied statewide, regional, and municipal water-resources.

Statewide water-use studies were done by Kedzie (1876a, 1876b), Lane (1899), Russell (1906), Ferris and Ash (1951), Deutsch and Vanlier (1961), Michigan Department of Conservation, Water Resources Commission (1969), and Sweat and Van Til (1988, 1989). Municipal-water supplies were described by Leverett (1906), Leverett and others (1906, 1907), Rich (1918), Olin (1925), Guy

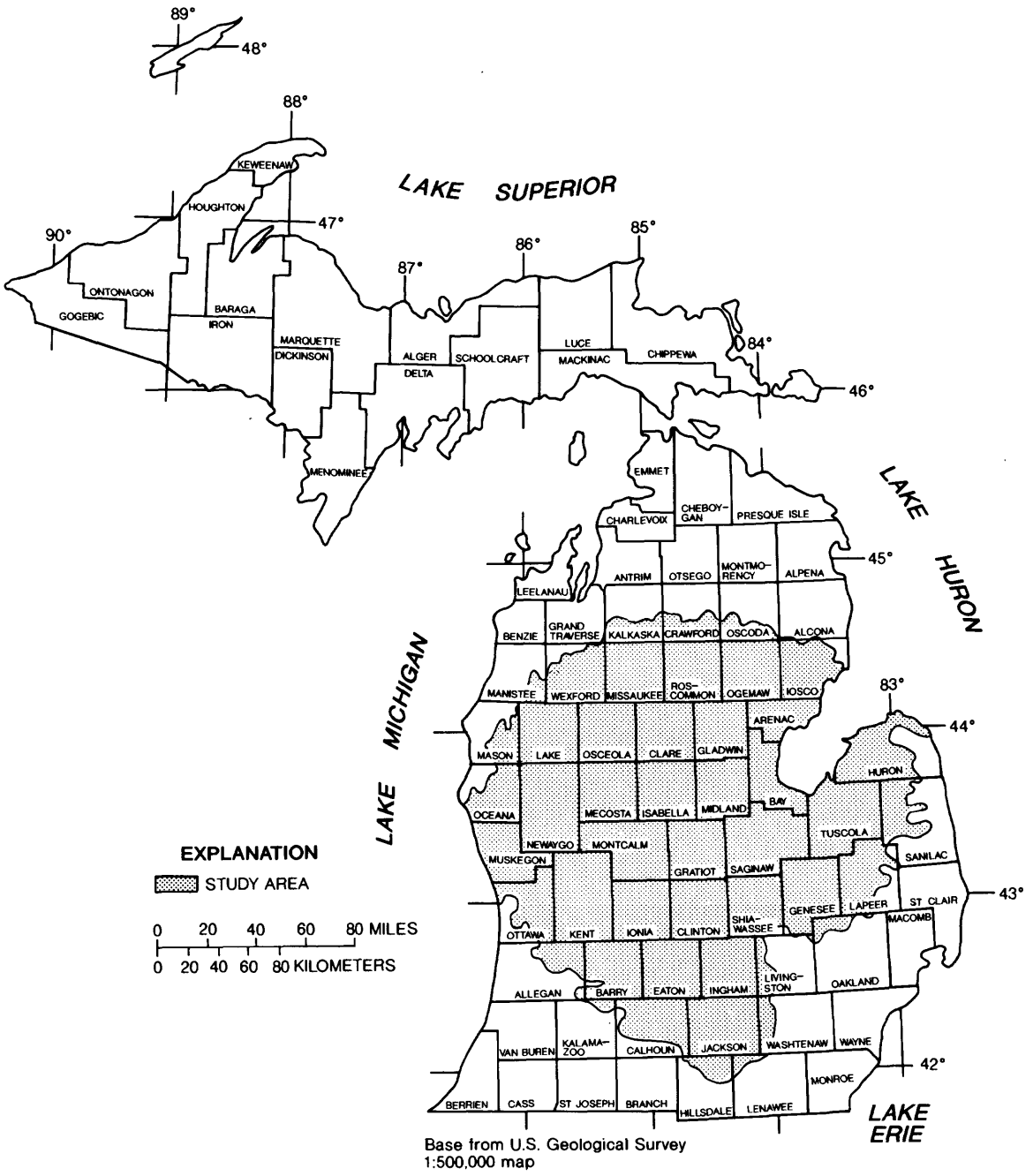


Figure 1.--Location of study area in the central Lower Peninsula of Michigan.

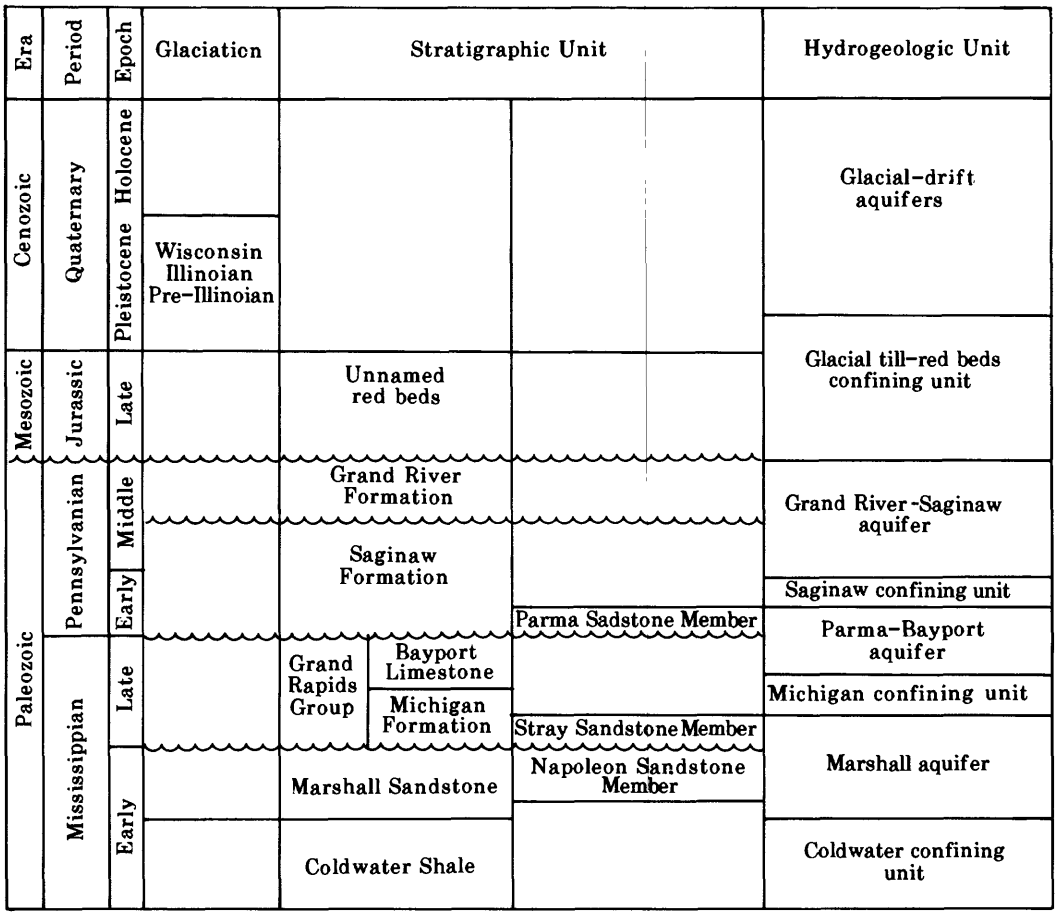


Figure 2.--Stratigraphic column and hydrogeologic units in the study area. (Modified from Mandle and Westjohn, 1989; stratigraphic column modified from Michigan Department of Conservation, 1964, chart 1).

(1928), Michigan Department of Health (1921, 1933, 1934, 1937, 1948, 1960, 1966), Michigan Municipal League (1968), and Bedell (1982). Michigan's water industry was described by Vander Velde (1966).

Municipal ground-water withdrawals were reported by Giroux (1957, 1958, 1960, 1962), Giroux and Thompson (1959, 1961), Giroux and Huffman (1963-70), Huffman and Thompson (1971, 1973), and Huffman (1973-1977, 1979a, 1979b, 1980-1985, 1988).

Ferris and others (1954), Mozola (1954), and Twenter and Knutilla (1972) investigated the water resources of Oakland County, Michigan. Water resources of Van Buren County were investigated by Giroux and others (1964) and by Cummings and others (1984). Deutsch and others (1960), Allen and others (1972), and Rheaume (1990) studied the ground-water hydrology and glacial geology of Kalamazoo County. Branch County's water resources were examined by Giroux and others (1966). Ayres and others (1966) reported on the water supply and sanitary sewerage systems of Washtenaw County. Hydrogeologic studies in Washtenaw County, Michigan were done by Twenter and others (1976) and Fleck (1980). Swanson (1970) studied the ground water in Ionia County. Water-supply studies of Clinton, Eaton, and Ingham counties were done by Vanlier and others (1973).

Several municipal water-resources studies have been done. Stuart and Stallman (1945) investigated the ground-water resources of Benton Harbor. Ground-water investigations of the Lansing area were reported by Stuart (1945) and Vanlier and Wheeler (1968). Water resources of the Detroit area were investigated by Wisler and others (1952). An investigation of the water resources of Grand Rapids was done by Stramel and others (1954). In the Holland area, ground-water resources were studied by Deutsch and others (1958). A summary of ground-water conditions near Elsie was compiled by Vanlier (1962). A study of the ground-water resources of Alma also was done by Vanlier (1963). Water resources of Flint were investigated by Wiitala and others (1963). The ground-water resources of Battle Creek were reported by Vanlier (1966) and Grannemann and Twenter (1985).

Water-supply studies were prepared for several river basins in the Lower Peninsula including the Paw Paw, Flint, Huron, Tittabawassee, upper Grand, Maumee, and lower Grand Rivers (Michigan Department of Conservation, Water Resources Commission, 1955, 1956, 1957, 1960, 1961, 1964, 1968a). A similar study of the lower Lake Michigan drainage basin was also prepared (Michigan Department of Conservation, Water Resources Commission, 1968b). The geology and ground-water resources of Grand River Basin were examined by Vanlier (1968).

Methods of Investigation

Histories of municipal water supplies and annual ground-water withdrawal data were obtained from the files of the USGS, the Michigan Department of Public Health, and various departments of public works. Municipal-withdrawal data have been compiled by the USGS since 1956. Some withdrawal data are available for most municipalities from 1956 through 1985. Withdrawal data collected before 1956 were available for some municipalities. Additional withdrawal data were obtained from Leverett (1906), Leverett and others (1906, 1907), and Bedell (1982).

Histories of municipal water supplies and some withdrawal data were available from the Division of Water Supply, Michigan Department of Public Health. This information included all correspondence between personnel of the municipal water authority and the Michigan Department of Public Health. If information was missing, municipalities were contacted, and information was requested about the history of the water supply and data on annual ground-water withdrawals.

To relate ground-water withdrawals and municipal population, the population of each municipality was tabulated for each census year from 1900 through 1980 (U.S. Department of Commerce, 1981; Legislative Manual and Official Directory of the State of Michigan, 1901, 1917, 1921, 1935, 1945, 1956, 1966, 1980). For some rural municipalities, reported populations before 1920 are questionable because of changes in county and township names and boundaries which were primarily caused by townships that became incorporated municipalities. The average annual per capita municipal ground-water withdrawal was calculated by dividing annual municipal ground-water withdrawal for a given year by the municipality's population for that year.

Acknowledgments

Acknowledgment is made to the Michigan Department of Public Health for allowing access to files and for other assistance. Special acknowledgment is made to Karen Kalinowski, Anne Elliott, and Joe Lovato of the Michigan Department of Public Health for their assistance. Acknowledgments are also made to the following: Archives Section of the Michigan Bureau of History, Library of Michigan, Michigan State University Library, and the municipalities that willingly provided information.

HISTORY OF MUNICIPAL GROUND-WATER DEVELOPMENT

Increased urbanization during the late 1800's required development of municipal water supplies to supplement private wells. Obtaining adequate quantities of water, mainly for fire protection, took precedence over concerns about water quality.

Ground-water sources were supplemented by surface-water sources when the capacities of ground-water-supplied systems were exceeded. "Although surface water was generally softer than ground water, it was often unpleasant in taste and susceptible to contamination" (Russell, 1906, p. 134). Until about 1910, some of the municipal water supplies provided nonpotable water. In these areas, domestic wells were maintained for drinking water. Municipalities that supplied water for purposes other than drinking began chlorinating all water after 1910 when the chlorination process was developed. Chlorination allowed these municipalities to provide potable water without the expense of installing new water-distribution systems.

The locations of sources of potable water for municipal water supplies from 1880 through 1980 are shown, by decade, in figures 3 through 8. During this time, the number of municipal water supplies increased substantially. In 1880, potable water was provided by eight municipal water supplies (fig. 3). The city of Jackson used ground water; the Grand River-Saginaw and Marshall aquifers were the source. Bay City, Big Rapids, Grand Rapids, Hesperia, Holly, Muskegon, and Saginaw

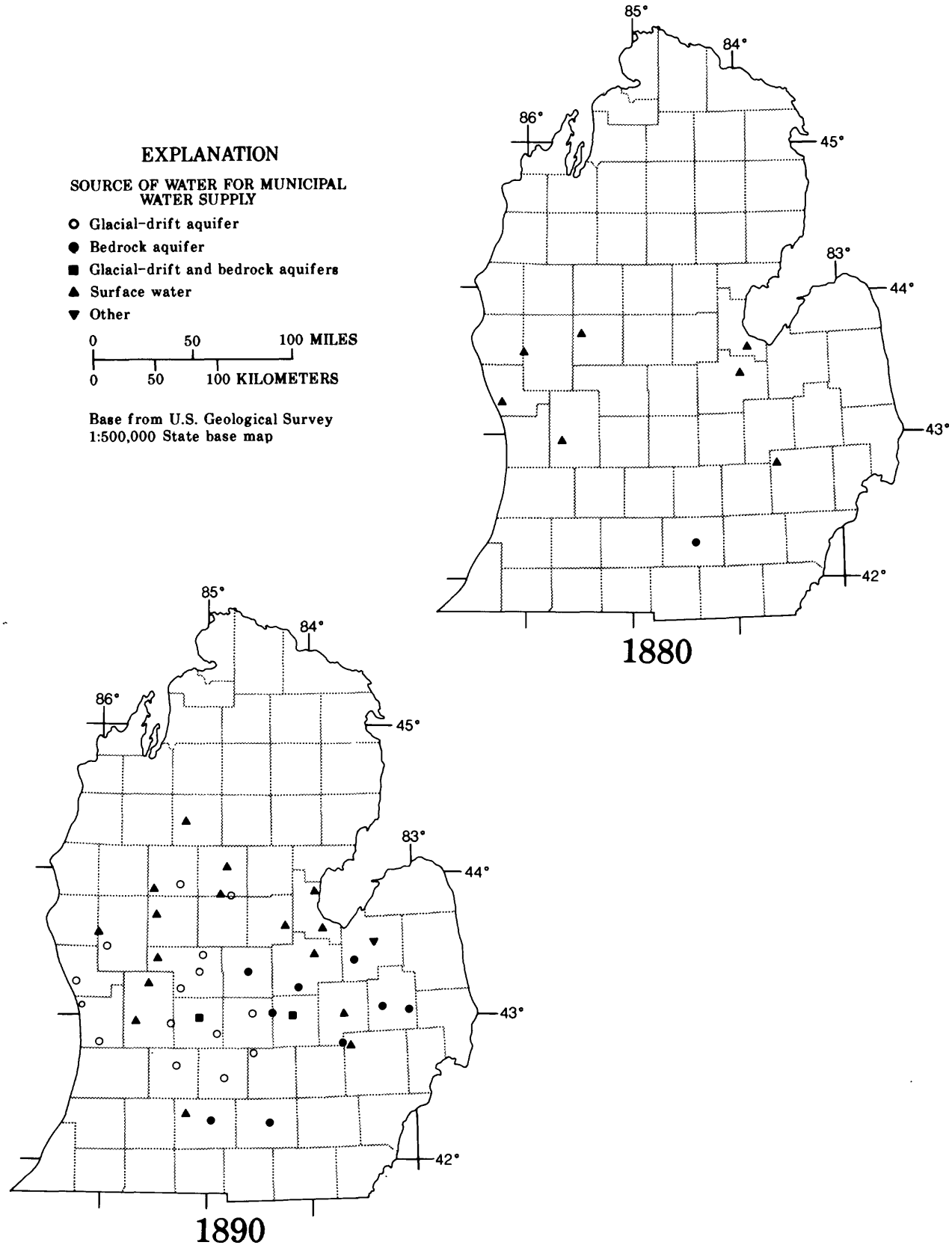


Figure 3.--Location of municipal water supplies in the central Lower Peninsula of Michigan, 1880 and 1890.

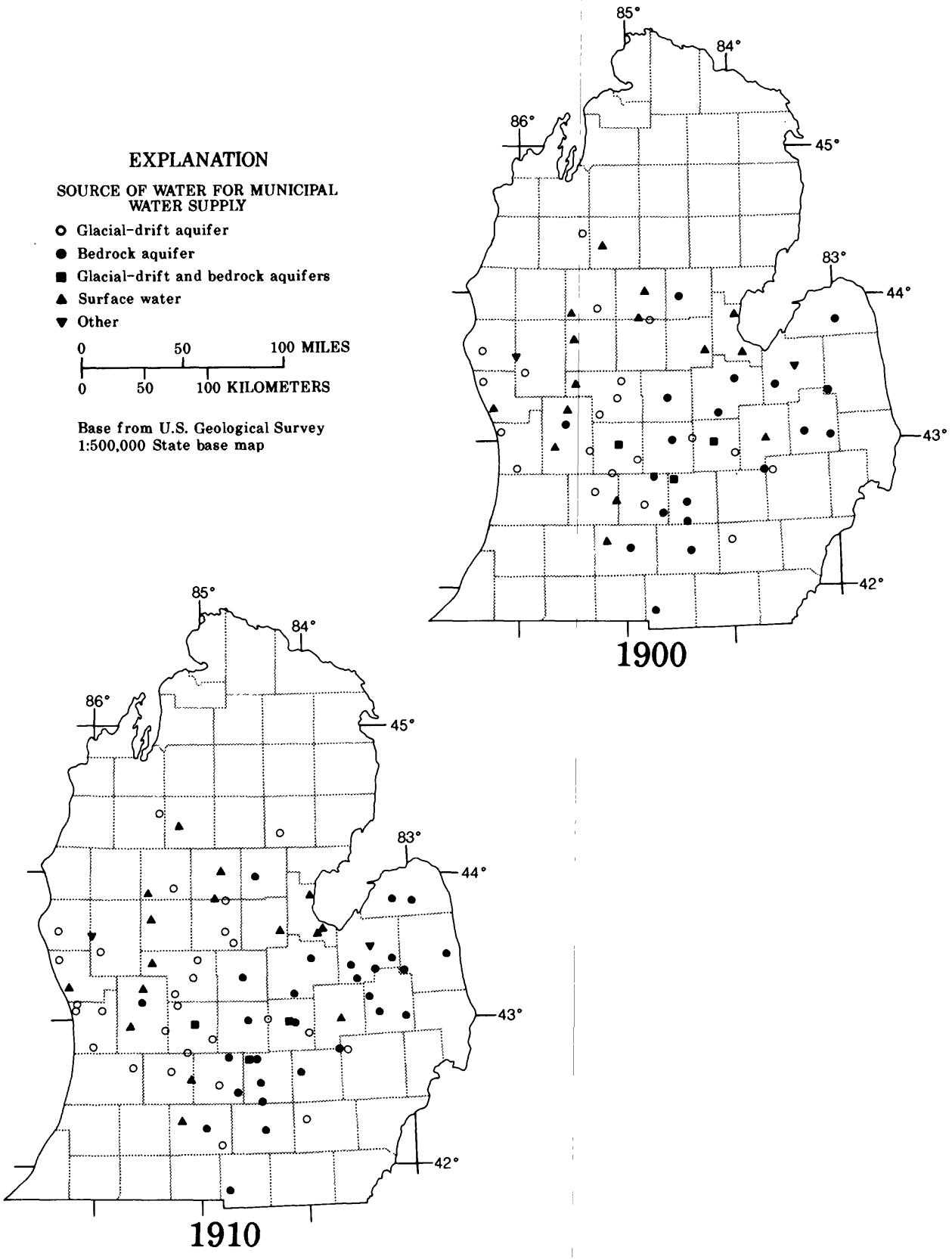


Figure 4.--Location of municipal water supplies in the central Lower Peninsula of Michigan, 1900 and 1910.

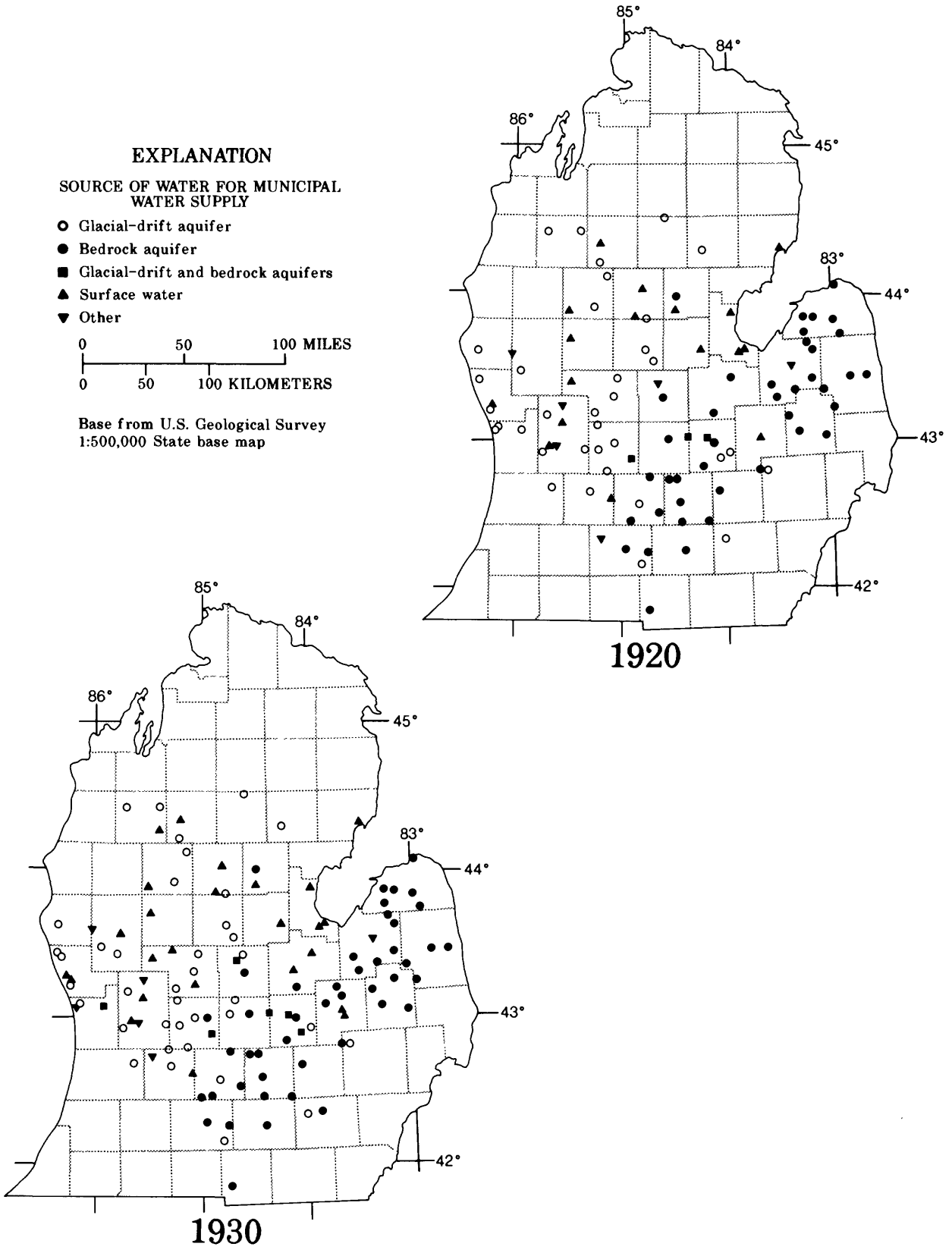


Figure 5.--Location of municipal water supplies in the central Lower Peninsula of Michigan, 1920 and 1930.

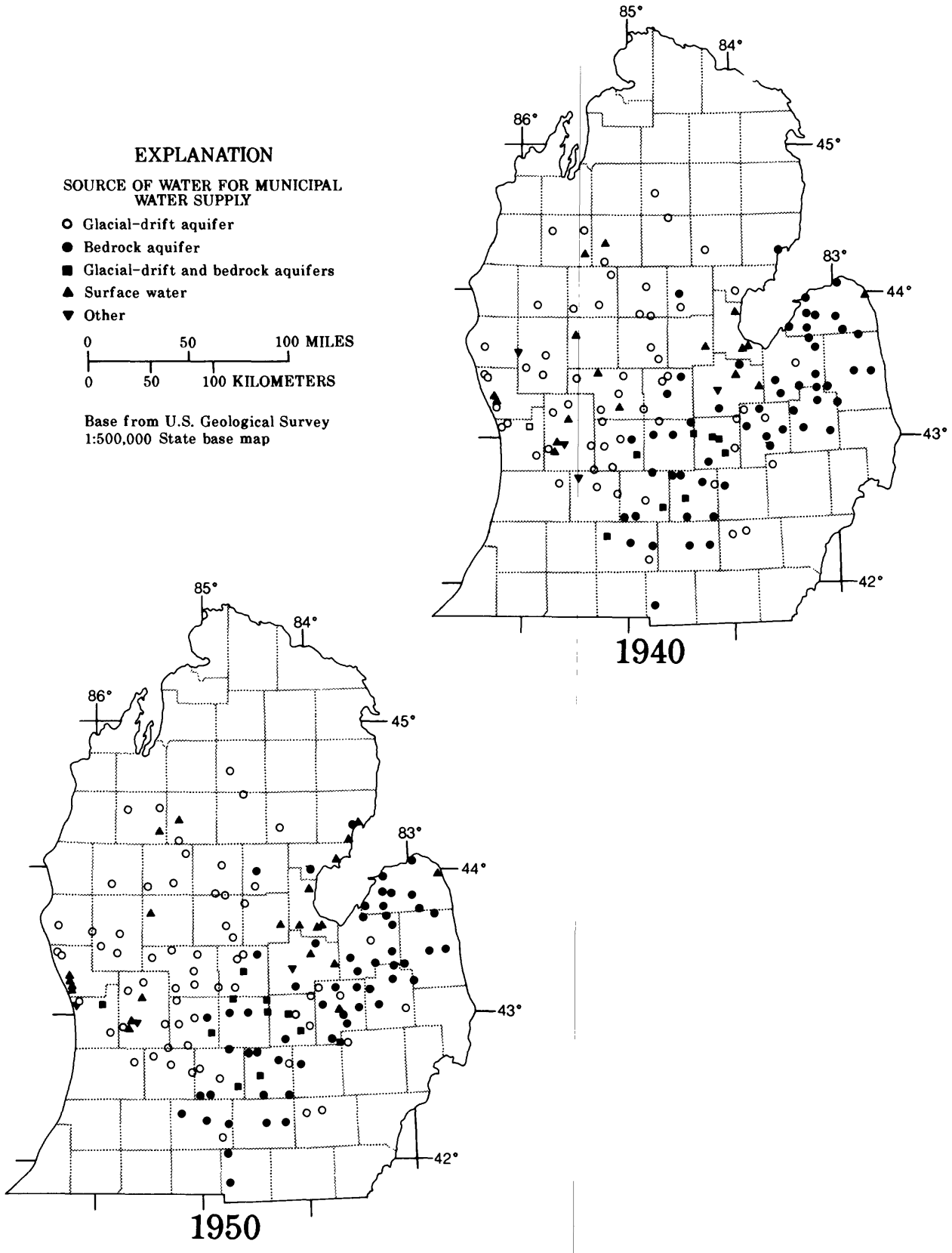


Figure 6.--Location of municipal water supplies in the central Lower Peninsula of Michigan, 1940 and 1950.

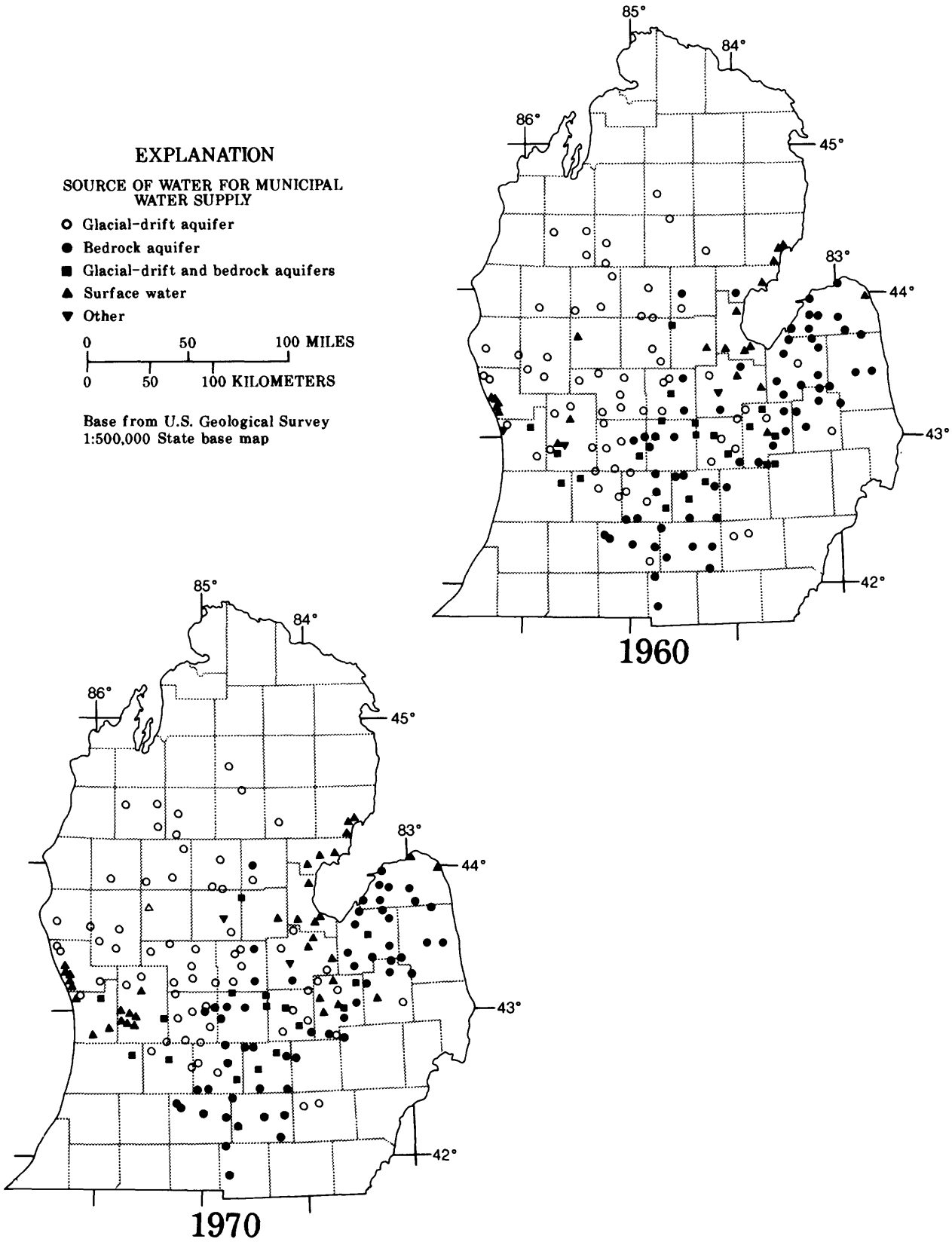


Figure 7.--Location of municipal water supplies in the central Lower Peninsula of Michigan, 1960 and 1970.

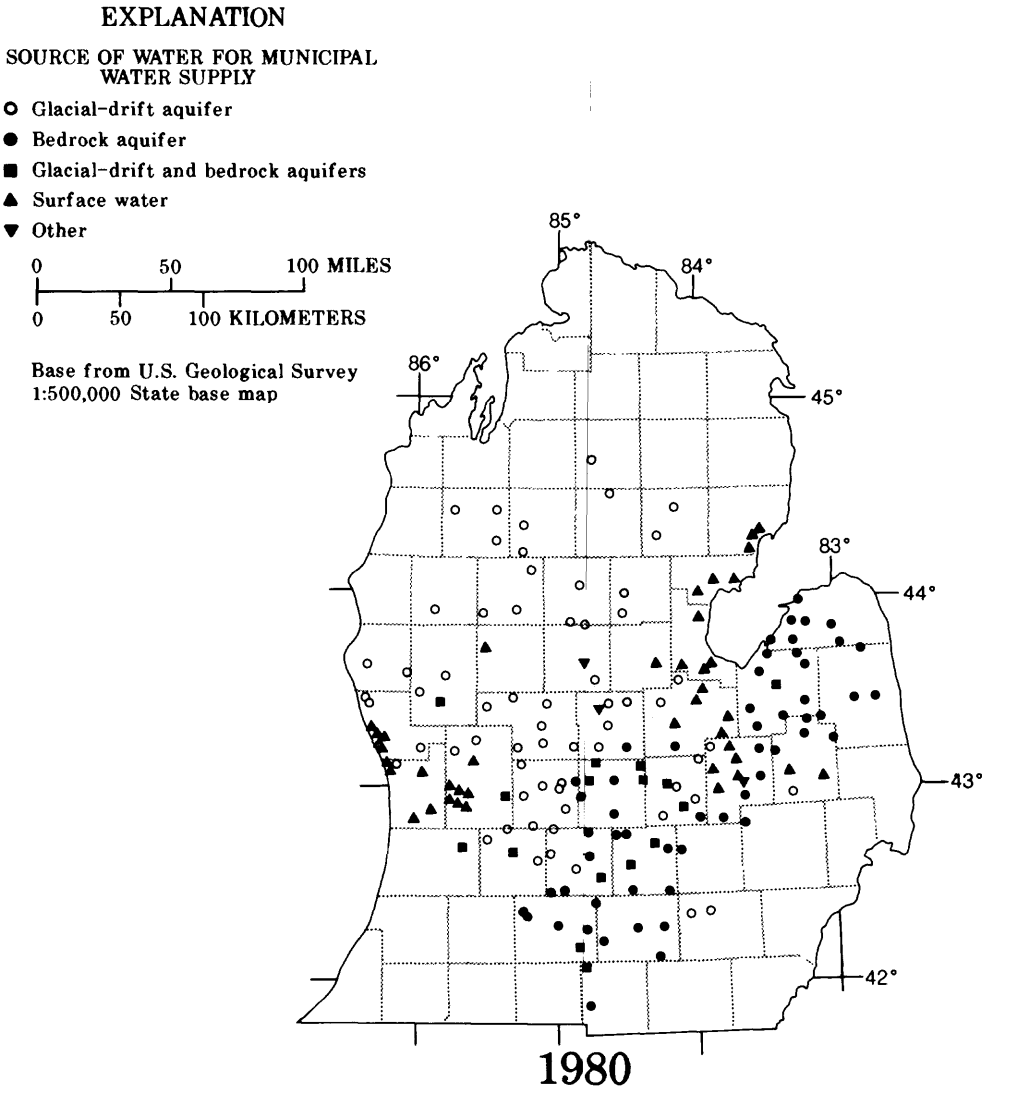


Figure 8.--Location of municipal water supplies in the central Lower Peninsula of Michigan, 1980.

pumped water from rivers and (or) lakes. From 1880 through 1960, the number of ground-water-supplied systems increased steadily (figs. 3-7), particularly in the southern part of the study area. The number of municipal water supplies using surface water peaked between 1920 and 1930 (fig. 5), mainly because of municipalities providing chlorinated water. After 1930, some municipalities began using ground water because it was less susceptible to contamination. After 1960, surface-water use, mainly from Lake Huron or Lake Michigan, increased again because adequate supplies of ground water of acceptable quality could not be obtained by several municipalities. Most of these municipalities were near large cities that already used surface water as their primary source. In 1987, there were 182 municipal water supplies within the study area (fig. 9). A summary of information about these systems, which includes the year the water supply was installed, initial water source, the year additional water sources were added, additional or new sources of water, and the reason for changing sources of water, is listed in table 1 (at back of report).

Of the 182 systems, 135 used ground water for supply. Wells in glacial-drift aquifers supplied water for 60 municipalities; wells in bedrock aquifers supplied 58 municipalities. Combinations of wells in bedrock and glacial-drift aquifers supplied 17 municipalities. Surface-water sources supplied 45 municipalities; two municipalities used surface water and ground water.

Most municipalities that have switched from ground-water to surface-water sources withdraw water from either Lake Huron or Lake Michigan. Figures 10 and 11 show the year lake-water intakes were installed and when other water supplies were connected. In 1987, six municipalities withdrew water from Lake Michigan; nine pumped water from Lake Huron. Of these, 10 systems supplied water to 30 municipalities. Four municipalities (Pinconning, Alabaster, Port Hope, and Port Austin) had individual intakes and supplied water to meet local demand. Four municipalities (Zeeland, Flint, Imlay City, and Lapeer) purchased water from sources outside the study area.

The study area was divided into four regions (fig. 9) on the basis of predominant source of water in 1987. Region 1 includes municipalities that primarily used ground water from glacial-drift aquifers. Municipalities in region 2 generally obtained water from bedrock aquifers. In this region, seven municipalities, located outside the study area, pumped water from possible outliers of the Marshall aquifer. Municipalities in region 3 pumped water from glacial-drift or bedrock aquifers or both. Within region 4, most systems used Lake Huron or Lake Michigan to satisfy demands. In this region, one municipality, located outside the study area, pumped water from possible outliers of the Marshall aquifer.

Region 1

Region 1 contains the municipalities in the west-central and northwestern part of the study area (fig. 12). Information about water supplies for the municipalities shown on figure 12 is included in table 1.

Surficial deposits in the northern part of region 1 are mostly glaciofluvial deposits. Till and glaciofluvial deposits are common in the central part, and till is the principal surficial deposit in the southern part (Farrand, 1982). Glacial deposits, which are absent at some locations, increase in thickness northward to as much as 1,000 ft (Western Michigan University, 1981, pl. 15). Muskegon River and

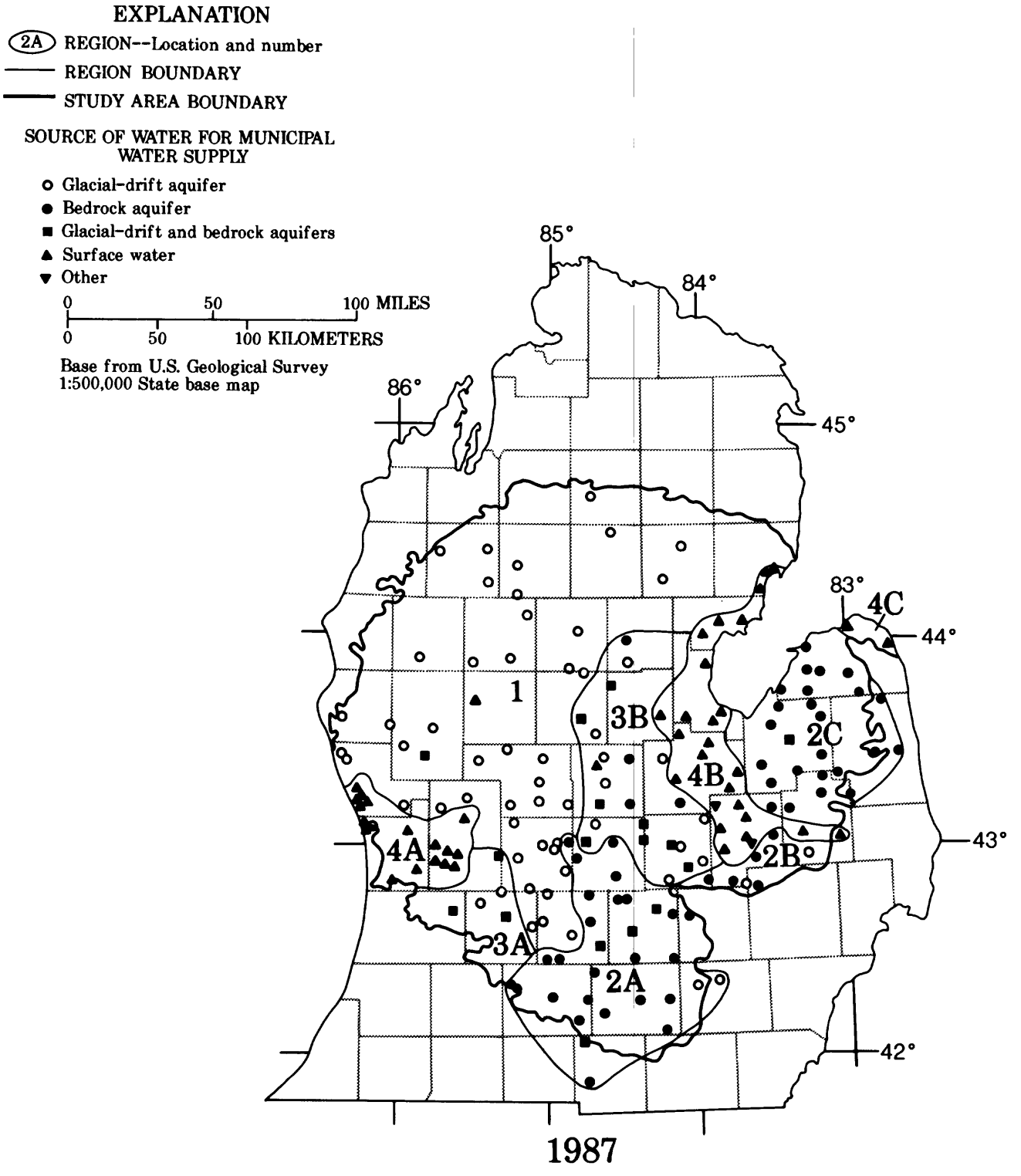
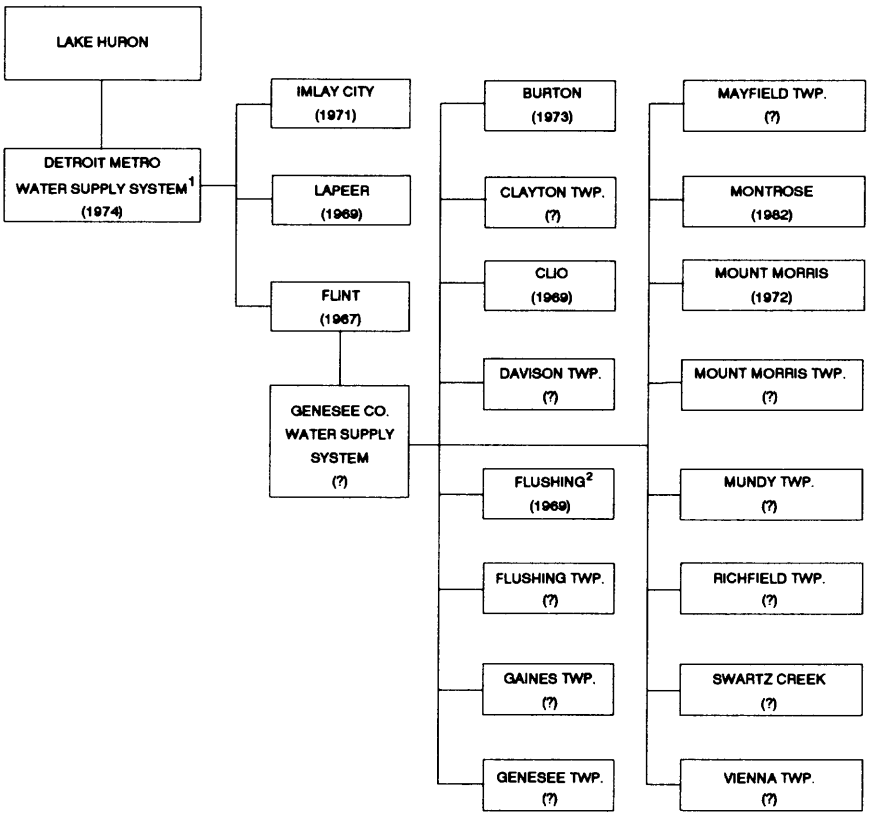


Figure 9.--Location of municipal water supplies in 1987 and region boundaries.



[1]Detroit obtained water from the Detroit River until 1974, when it then began obtaining water from Lake Huron.

[2]Started purchasing water from Flint in 1964; in 1969, it began purchasing water from Genesee Co. Water Supply System.

Figure 10a.--Water supplies using water from Lake Huron. Date in parentheses indicates year of connection to the system. (Modified from K. Kalinowski, Michigan Department of Public Health, written commun., 1987; R.S. Sacks, Michigan Department of Public Health, written commun., 1991)

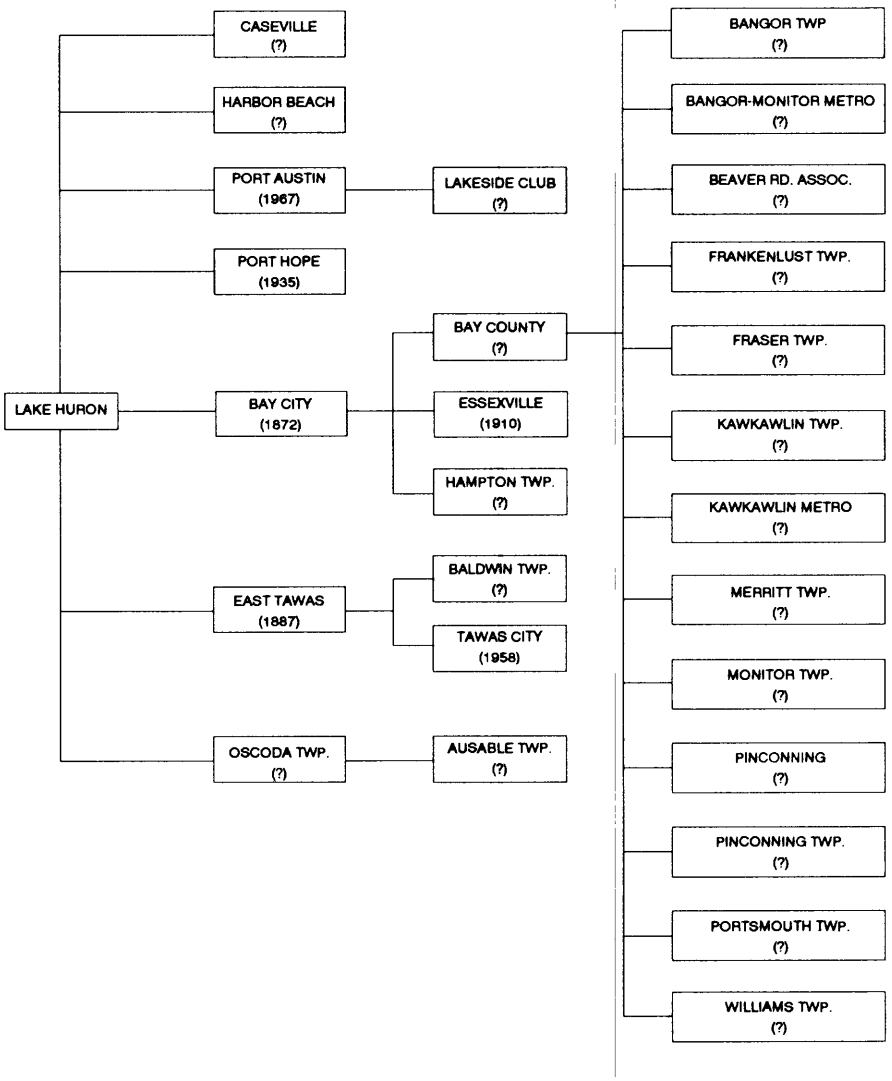
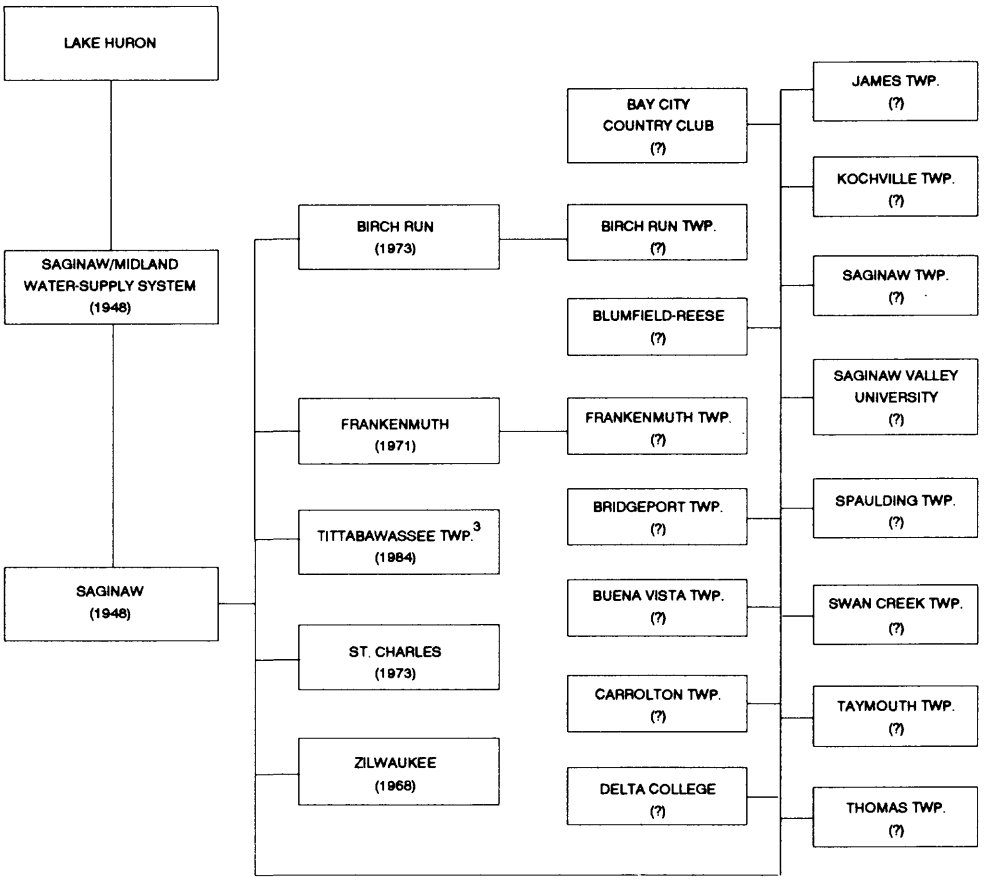


Figure 10b.--Water supplies using water from Lake Huron. Date in parentheses indicates year of connection to the system. (Modified from K. Kalinowski, Michigan Department of Public Health, written commun., 1987; R.S. Sacks, Michigan Department of Public Health, written commun., 1991)



[3]Includes the municipality of Freeland.

Figure 10c.--Water supplies using water from Lake Huron. Date in parentheses indicates year of connection to the system. (Modified from K. Kalinowski, Michigan Department of Public Health, written commun., 1987; R.S. Sacks, Michigan Department of Public Health, written commun., 1991)

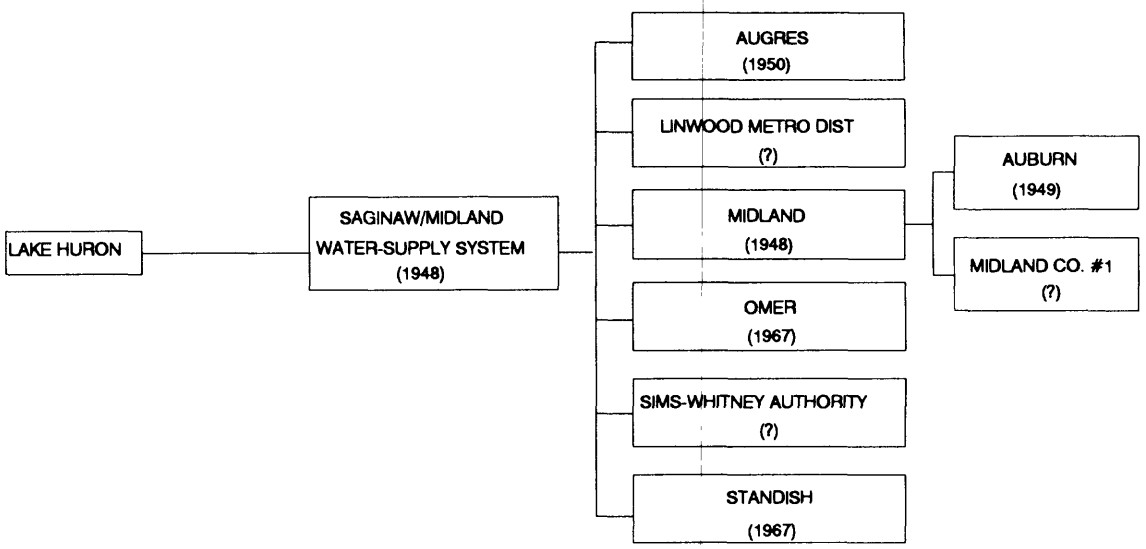
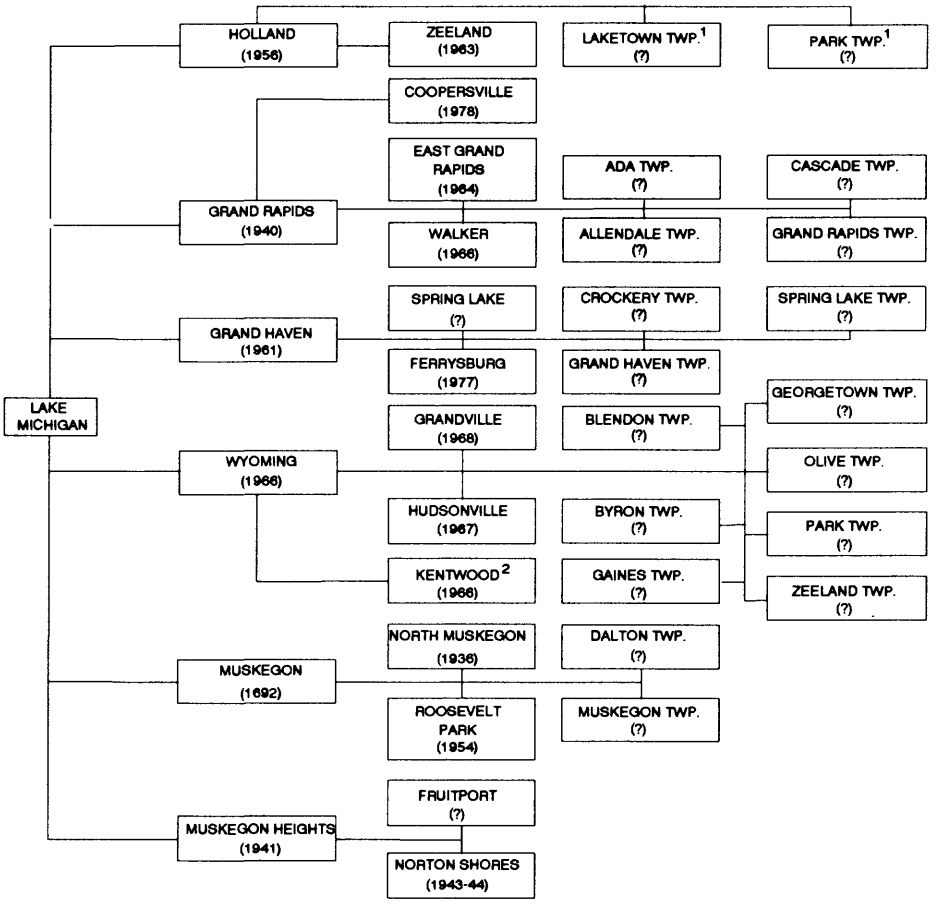


Figure 10d.--Water supplies using water from Lake Huron. Date in parentheses indicates year of connection to the system. (Modified from K. Kalinowski, Michigan Department of Public Health, written commun., 1987; R.S. Sacks, Michigan Department of Public Health, written commun., 1991)



[1]A portion of the township is receiving service.

[2]A portion of the city is receiving service from Grand Rapids.

Figure 11.--Water supplies using water from Lake Michigan. Date in parentheses indicates year of connection to the system. (Modified from K. Kalinowski, Michigan Department of Public Health, written commun., 1987; R.S. Sacks, Michigan Department of Public Health, written commun., 1991)

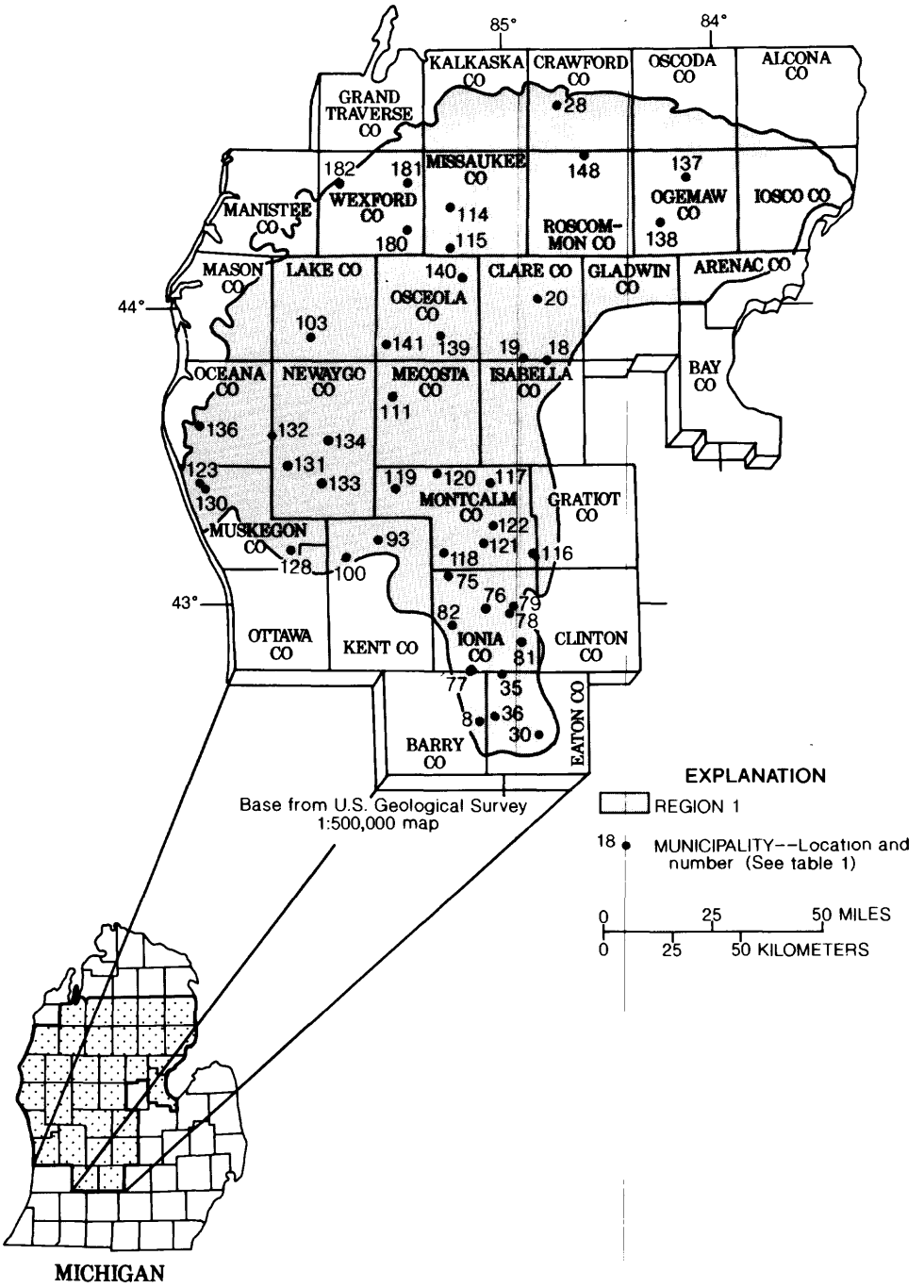


Figure 12.--Location of municipalities within region 1.

its tributaries drain most of the region. Other rivers include Flat, Au Sable, Manistee, Little Manistee, Pine, and Pere Marquette Rivers.

Most municipalities within region 1 obtain water from glacial-drift aquifers. Of the 45 municipalities in the region, 24 obtained water from glacial-drift aquifers exclusively. Many municipalities initially used nearby lakes as a water supply. The city of Cadillac used Little Clam Lake for supply from 1906 through 1960. Budd Lake supplied water to the city of Harrison from 1889 through 1940. Lake City used water from Lake Missaukee from 1888 through 1955. The village of Lakeview obtained water from Tamarack Lake from 1923 through 1948. Sheridan used water from Pearl Lake from 1890 through 1948. These communities constructed wells in glacial-drift aquifers because of objectionable taste or local contamination of surface water.

Several municipalities obtained water from nearby streams for drinking and other uses before switching to glacial-drift aquifers. The village of Baldwin withdrew water from Baldwin Creek from 1937 (or earlier) through 1939. The city of Big Rapids started using water from the Muskegon River in 1871. Cedar Creek provided water to the city of Cedar Springs from 1890 through 1931. The village of Farwell used Little Field Creek as its source of water from 1887 through 1938. The village of Hesperia withdrew water from White River from 1880 through 1944. Water from Tamarack Creek was used by Howard City from 1890 through 1939. The village of Nashville used water from Thornapple River from 1891 through 1936. Reed City withdrew water from the "millpond" from 1882 until sometime between 1904 and 1913, and then from the Hersey River until 1936. Montague used water from Mill Creek from 1903 through 1927. The town of Lyons withdrew water from Grand River from 1890 through 1925. White River supplied water to White Cloud from 1880 through 1938. The village of Roscommon used water from Robinson Creek from 1883 through 1916. Manton used Cedar Creek to meet some of its water demand (excluding drinking water) from 1894 through 1931. Each of these municipalities, except for Big Rapids, switched to ground water from the glacial-drift aquifers because of local contamination problems.

Some municipalities added wells that produced from bedrock. In 1974, Newaygo added a well tapping the Marshall aquifer. In 1918, Portland added a well tapping the Grand River-Saginaw aquifer; this well was abandoned between 1957 and 1961.

Region 2

Region 2, shown in figure 13, is divided into 2A, 2B, and 2C. Municipalities shown on figure 13 are included in table 1. Municipalities outside the study area that pumped water from possible outliers of the Marshall aquifer are indicated by numbers 57, 58, and 179 on figure 13.

Mississippian sedimentary rocks underlie the southeastern parts of regions 2A and 2B. Pennsylvanian sedimentary rocks underlie the northwestern parts of these regions. Eskers, which trend north and south, are present in the northern parts of both regions. Moraines, till plains, and outwash lie between the eskers (Farrand, 1982). In region 2A, glacial deposits range in thickness from 0 to 250 ft; in region 2B, they range from 100 to 250 ft (Western Michigan University, 1981, pl. 15). Regions 2A and 2B are drained by Shiawassee and Flint Rivers and their tributaries and by the upper Grand and upper Kalamazoo Rivers and their tributaries, respectively.

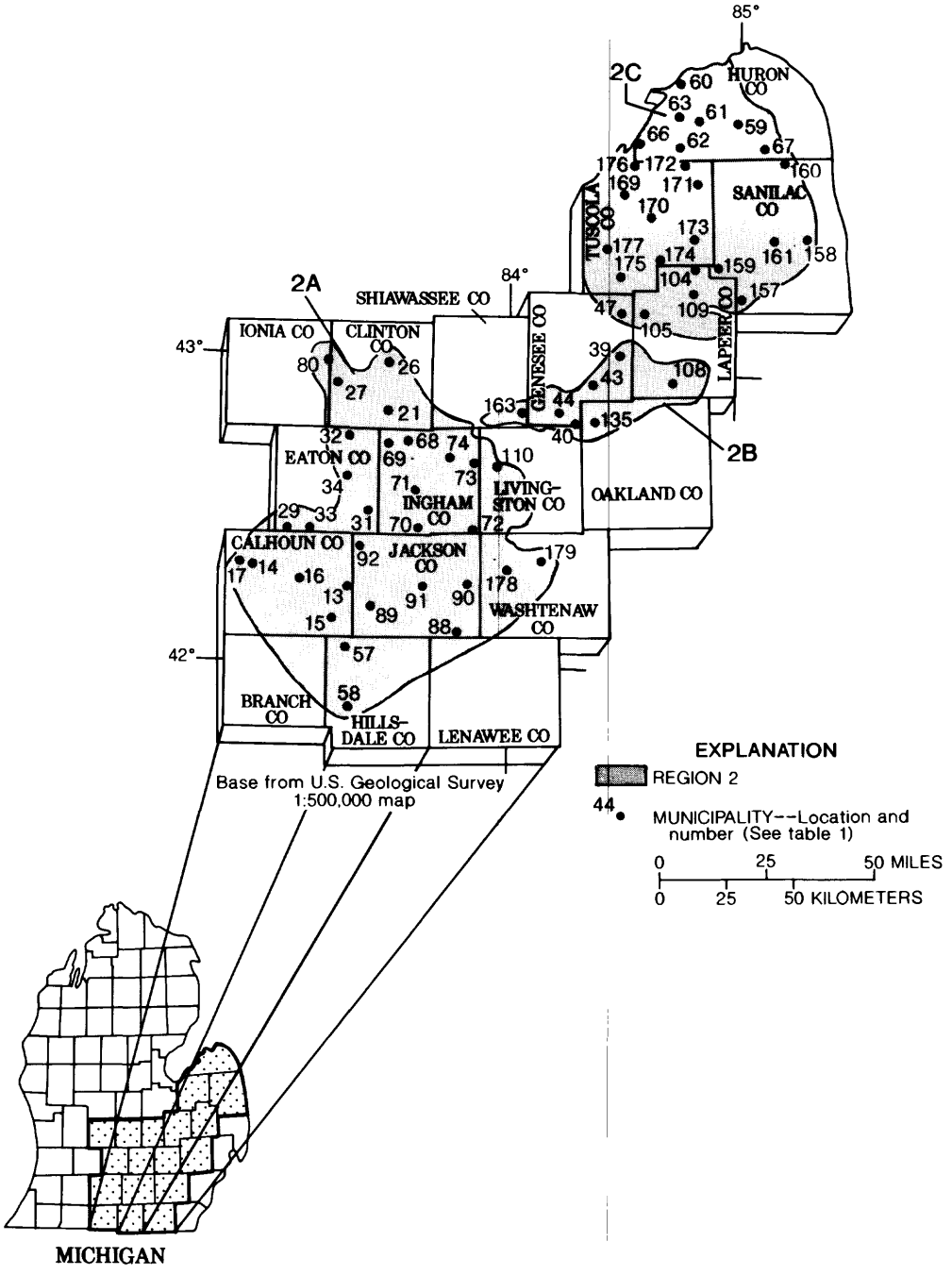


Figure 13.--Location of municipalities within region 2.

Region 2C is underlain by Mississippian sedimentary rock, mainly the Marshall Sandstone. Lacustrine clay deposits are found near Lake Huron; however, most of the area is mantled by stratified till and outwash deposits (Farrand, 1982). Glacial deposits range in thickness from 0 to 250 ft (Western Michigan University, 1981, pl. 15). Elk, Cass, and upper Flint Rivers drain region 2C.

Most municipalities within region 2 pumped water from bedrock aquifers. These aquifers are shallow, relatively thick, and provide a higher yield than do glacial-drift aquifers. Of the 63 municipalities, 46 used bedrock aquifers exclusively. Of those 46 municipalities, 30 pumped water from the Marshall aquifer, 14 pumped water from the Grand River-Saginaw aquifer, and 2 pumped water from both the Marshall and Grand River-Saginaw aquifers. The other 17 municipalities had pumped water from a combination of different sources since their water system was initially installed.

Several municipalities first used water from local lakes or streams or glacial-drift aquifers before switching to bedrock aquifers. The village of Caro obtained water from infiltration galleries along the Cass River from 1889 through 1925; wells constructed in glacial-drift aquifers were used from 1938 through 1964, at which time wells were drilled into the Marshall aquifer. The city of Battle Creek used water from Goguac Lake from 1887 through 1929; wells were first used from the Marshall aquifer in 1915. The village of Holly used pond water from 1879 through 1900; wells completed in glacial deposits were used from 1900 through 1960, and Marshall aquifer has been used since 1960. Lansing obtained water from wells developed in glacial-drift aquifers from 1885 through 1915; wells drilled into the Grand River-Saginaw aquifer were added in 1895. Other smaller municipalities, such as Gagetown, Webberville, and Homer, switched from glacial-drift aquifers to bedrock aquifers in 1918, 1956, and 1970, respectively. Eaton Rapids, Otisville, Litchfield, Mason, Williamston, Fenton, and Dexter used combinations of wells completed in glacial-drift and in bedrock aquifers.

Region 3

Region 3 is divided into 3A and 3B. The municipalities within the region are shown on figure 14 and included in table 1. Mississippian sedimentary rocks underlie all of region 3A. Glacial deposits include a complex sequence of till and glaciofluvial deposits (Farrand, 1982). Glacial deposits range in thickness from 10 to 600 ft (Western Michigan University, 1981, pl. 15). The region is drained predominately by Thornapple River and its tributaries.

Region 3B is underlain by Pennsylvanian sedimentary rocks. It is covered on the east by shallow lacustrine sand and clay deposits and by a complex sequence of till and outwash deposits in the remainder of the region (Farrand, 1982). Tittabawassee, Tobacco, Salt, Little Salt, Pine, Maple, Bad, and Shiawassee Rivers drain the area. Glacial deposits range in thickness from 10 to 600 ft (Western Michigan University, 1981, pl. 15).

Municipalities in region 3 obtained water from glacial-drift aquifers, bedrock aquifers, or both. Glacial-drift aquifers were used if they yielded adequate quantities of potable ground water. Bedrock aquifers were used if yields from glacial-drift aquifers were low or if shallow ground water was contaminated. Of 28 municipalities within region 3, 5 pumped water from only glacial-drift aquifers and 3 pumped water from the Grand River-Saginaw aquifer exclusively. Five municipalities

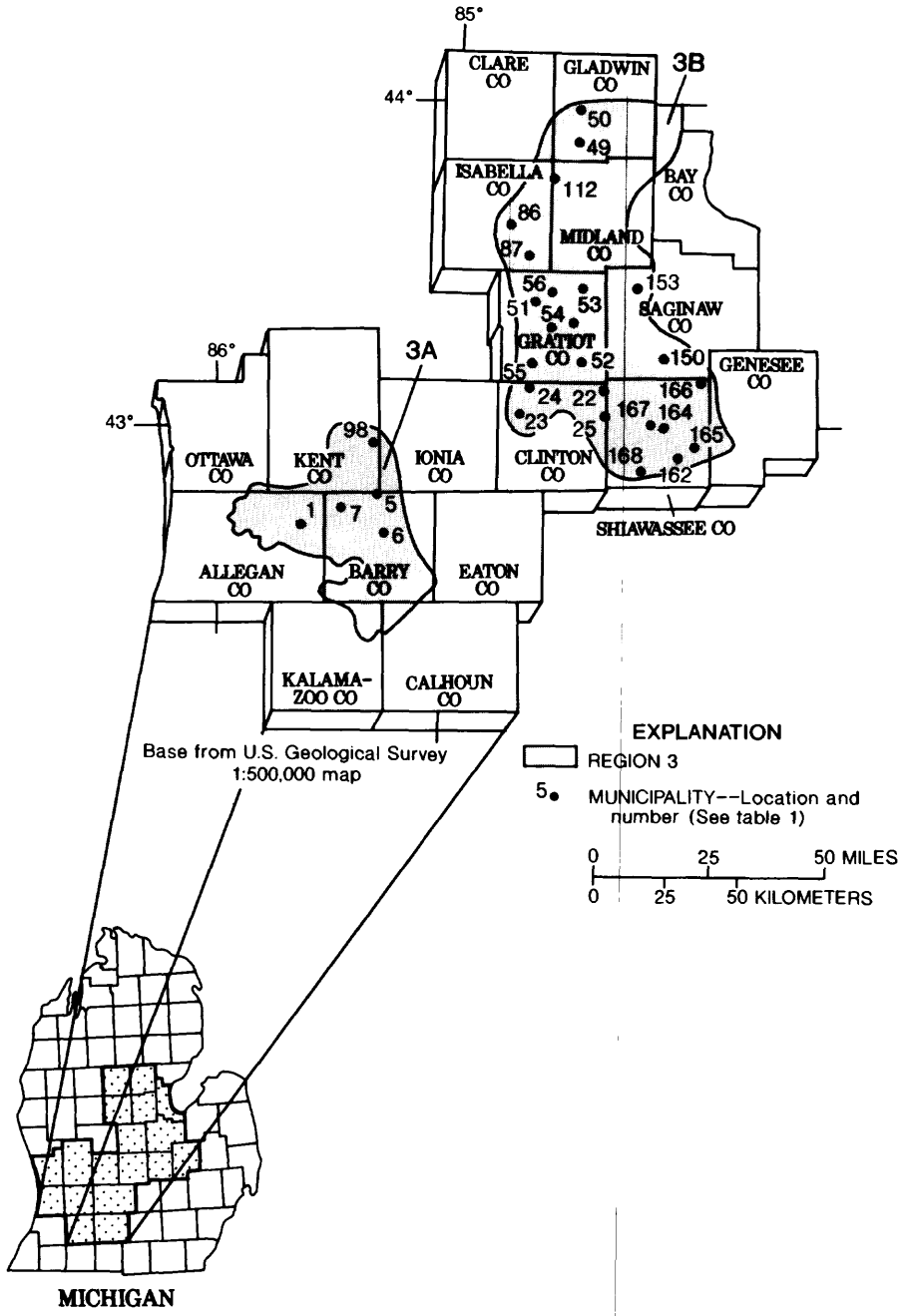


Figure 14.--Location of municipalities within region 3.

used a combination of glacial-drift aquifers and the Marshall aquifer; 10 produced water from glacial-drift aquifers and the Grand River-Saginaw aquifer. The other seven municipalities used a combination of different sources since their water system was initially installed.

Three municipalities used or continue to use surface water. The city of Alma has been using Pine River since 1882. Beaverton obtained water from the Tobacco River from before 1914 through approximately 1940. Shiawassee River was used as a backup supply for the city of Chesaning from 1888 through 1929. Middleville, Alma, Ithaca, Corunna, and Perry have abandoned wells in bedrock aquifers because of objectionable concentrations of iron, chloride, or hardness; they now use surface-water sources.

In general, within region 3, glacial-drift aquifers are the predominant sources of water in the north and northwest. Bedrock and surface water are the most used sources in the southwest, south and east.

Region 4

Region 4 is divided into 4A, 4B, and 4C. The municipalities shown in figure 15 are included in table 1. Region 4A is underlain by Mississippian sedimentary rocks. Lacustrine sand deposits overlie the western half of the area and grade to till plains, moraines, and outwash sediment to the east (Farrand, 1982). Glacial deposits, which are absent at some locations, increase in thickness to as much as 250 ft (Western Michigan University, 1981, pl. 15). The region is drained by Rabbit, Black, and Grand Rivers.

Lacustrine deposits, end moraines, and some dune sand (Farrand, 1982), overlie Pennsylvanian sandstones and shale throughout most of region 4B. Glacial deposits, which are absent at some locations, increase in thickness to as much as 300 ft (Western Michigan University, 1981, pl. 15). Saginaw and Flint Rivers drain most of the region.

Lacustrine deposits (Farrand, 1982) overlie Mississippian sedimentary rocks, primarily the Marshall Sandstone, in region 4C. Glacial deposits, which are absent at some locations, increase in thickness to as much as 100 ft (Western Michigan University, 1981, pl. 15). The region is drained by New River and Willow Creek.

Most municipalities within region 4A used surface water or wells in glacial-drift aquifers as their initial sources. All of the municipalities within this area, except Grand Haven, obtained water from Lake Michigan. Other surface-water sources were abandoned because of local contamination or irregular supply. Wells completed in the glacial-drift aquifers were abandoned because of inadequate supply.

The city of Grand Rapids withdrew water from Grand River from 1873 through 1940. In 1940, Grand Rapids began withdrawing water from Lake Michigan. East Grand Rapids, Coopersville, and Walker each purchased water from the city of Grand Rapids. East Grand Rapids and Coopersville had individual water supplies before this. East Grand Rapids withdrew water from Reed Lake and wells in glacial-drift aquifers from 1914 through 1964, when the city began purchasing water from Grand Rapids. The city of Coopersville used water from glacial-drift aquifers from 1904 through 1921 and from the Marshall aquifer from 1921 through 1978. Walker began purchasing water from Grand Rapids in 1966.

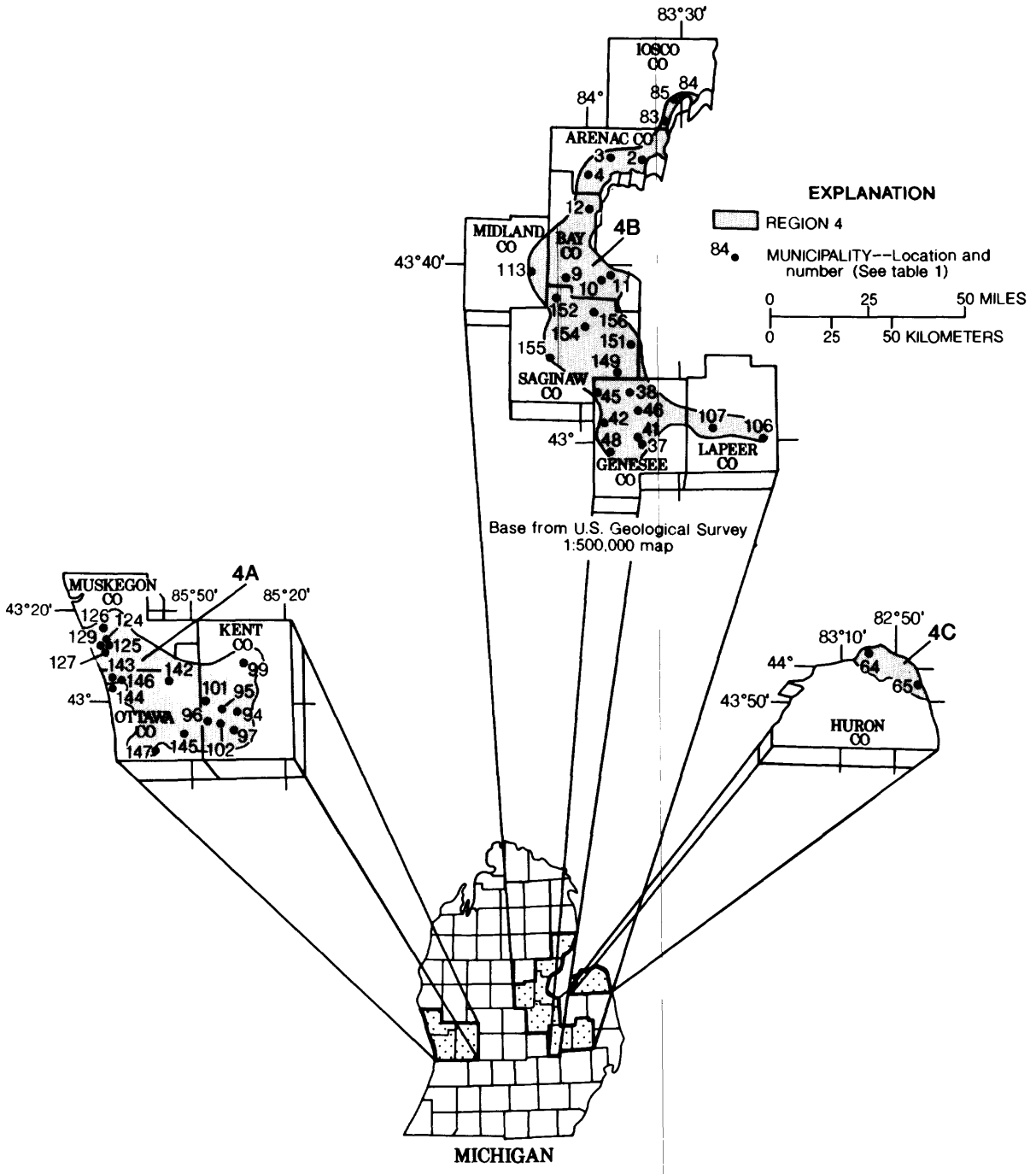


Figure 15.--Location of municipalities within region 4.

The city of Wyoming purchased water from Grand Rapids from 1931 through 1949. Water from wells in glacial-drift aquifers and the Marshall aquifer was used from 1947 until 1966, when Wyoming installed its own intake to Lake Michigan. The municipalities of Grandville and Hudsonville each pumped water from glacial-drift aquifers prior to purchasing water from the city of Wyoming. Grandville used ground water from 1914 through 1968, and Hudsonville used ground water from 1939 through 1967. The city of Kentwood had no municipal water supply prior to purchasing water from Wyoming in 1968.

The city of Muskegon used water from a spring-fed pond from 1874 through 1887. Wells in glacial-drift aquifers were used from 1887 through 1892, at which time Muskegon began withdrawing water from Lake Michigan. North Muskegon and Roosevelt Park purchased their water from Muskegon, beginning in 1936 for North Muskegon and 1964 for Roosevelt Park. Prior to this, North Muskegon obtained water from Bear Lake from 1923 through 1936 and supplemented by water from glacial-drift aquifers from 1927 through 1930.

Muskegon Heights used water from glacial-drift aquifers from before 1918 until 1941. At this time, the city began withdrawing water from Lake Michigan. Norton Shores began purchasing water from Muskegon Heights about 1943 and 1944.

The city of Grand Haven pumped water from wells in glacial-drift aquifers from 1888 through 1928. Water from Grand River was used from 1928 through 1939. Wells and infiltration galleries in shallow glacial-drift aquifers were used from 1939 through 1961. In 1961, Grand Haven began withdrawing water from Lake Michigan. The city of Ferrysburg began purchasing water from Grand Haven in 1977.

Zeeland began pumping water from glacial-drift aquifers in 1890. In 1916, wells were drilled into the Marshall aquifer, providing water to Zeeland until 1963, at which time Zeeland began purchasing water from the city of Holland.

As of 1987, Rockford and Spring Lake were the only municipalities in region 4A that continued to use ground water. Spring Lake had pumped ground water from glacial-drift aquifers from 1906 through 1987. Rockford had pumped ground water from the Marshall aquifer from 1897 through 1987, having used the Rouge River from 1892 through 1897.

Most municipal water supplies within region 4B and 4C used water from Lake Huron. The municipalities replaced local surface-water or ground-water sources because of contamination of local sources of surface water (the Saginaw and Tittabawassee Rivers), the presence of saline water in bedrock aquifers, low yields from glacial-drift aquifers, and increased demand caused by population and industrial growth.

Several municipalities in region 4B established regional water supplies. Saginaw, Midland, Standish, AuGres, Omer, Birch Run, Frankenmuth, Auburn, Freeland, St. Charles, and Zilwaukee constitute the Saginaw-Midland Water-Supply System, which was formed in 1948. These municipalities, except for AuGres, Omer, and Auburn, each had a water supply prior to the formation of Saginaw-Midland Water-Supply System. Saginaw used Saginaw River from 1872 through approximately 1880 and from 1929 through 1948. From 1880 through 1929, wells drilled into the Grand River-Saginaw aquifer were used until chloride concentration became too high. Midland obtained water from Chippewa River from 1882 until 1968. Ground water was used from 1912

through 1915, but the wells were abandoned because of unacceptable water quality, especially chloride concentration. The city of Standish withdrew water from Pine River from 1914 through 1936. Glacial-drift aquifers and the Marshall aquifer were used from 1936 through 1950 and from 1950 through 1967, respectively. The village of Birch Run pumped water from glacial-drift aquifers from 1962 through 1973. Frankenmuth withdrew water from the Cass River from 1939 through 1971. The city of Freeland pumped water from glacial-drift aquifers from 1962 through 1984. St. Charles withdrew water from Bad River from 1911 through 1937. From 1937 through 1973, water was pumped from the Grand River-Saginaw aquifer, but pumping was discontinued because of unacceptable chloride concentration. The city of Zilwaukee used water from the Grand River-Saginaw aquifer to meet demand from 1940 through 1968.

Flint, Burton Township, Clio, Flushing, Montrose, Mt. Morris, and Swartz Creek are part of the Flint and Genesee County Water-Supply System, which obtained water from the Detroit Metropolitan Water System as of 1987. Each municipality, except for Swartz Creek, had a water supply prior to the formation of the Flint and Genesee County Water-Supply System. The city of Flint withdrew water from Flint River from 1883 through 1967. Burton Township and Flushing used Flint River before switching to ground water. Burton Township used Flint River from 1928 until 1938, when the township drilled wells into the Grand River-Saginaw aquifer; wells in glacial-drift aquifers were added in 1954. The city of Flushing withdrew water from Flint River from 1895 through 1923; water from the Grand River-Saginaw aquifer was pumped from 1923 through 1955, and from glacial-drift aquifers from 1955 through 1964. The village of Montrose pumped water full time from glacial-drift aquifers from 1938 through 1982, and part time since 1982, when the village began purchasing water from the Genesee County Water-Supply System. The city of Clio began using water from the Grand River-Saginaw aquifer in 1929 and added water from wells drilled into glacial-drift aquifers in 1958; however, all wells were abandoned in 1967 because of local contamination. Mount Morris pumped water from the Grand River-Saginaw aquifer from 1922 through 1935, and from glacial-drift aquifers from 1935 through 1972.

Several municipalities in regions 4B and 4C near Saginaw Bay or Lake Huron developed their own water supply. Alabaster, East Tawas, and Port Hope have used Lake Huron water since 1940, 1887, and 1935, respectively. Bay City has used Saginaw Bay water since 1872 but also had wells completed in glacial-drift aquifers for backup until 1981. The city of Pinconning has used water from Saginaw Bay since 1887; in 1962, wells were drilled into the Grand River-Saginaw aquifer to be used as backup supply. Port Austin initially pumped ground water from the Marshall aquifer beginning in 1913; this source was abandoned in 1967 because of unacceptable hardness and chloride concentration. Port Austin has withdrawn water from Lake Huron since 1967. Tawas City pumped water from the Marshall aquifer from 1937 until 1958, at which time Tawas City began purchasing water from East Tawas. The city of Essexville, which did not have a municipal water supply, built a system and purchased water from Bay City in 1910.

Both the city of Lapeer and Imlay City had wells in the Marshall aquifer. Lapeer pumped ground water from 1888 through 1969, and Imlay City used ground water from 1890 through 1971. Both municipalities abandoned their wells because of unacceptable water quality, especially chloride concentration. Lapeer and Imlay City began purchasing water from the Detroit Metropolitan Water System in 1969 and 1971, respectively.

MUNICIPAL GROUND-WATER WITHDRAWALS

From 1870 through 1985, 145 municipal water-supply systems used ground water as their principal source of water for an average of 65 years (56 percent of the period). Municipal ground-water-withdrawal data were obtained for 28 percent of the total period of time that the 145 systems pumped ground water. The most complete period of reporting was from 1960 through 1980 (fig. 16). Prior to 1960, ground-water-withdrawal data are sparse.

Average annual per capita municipal ground-water withdrawal is shown in figure 17. Per capita withdrawal varied greatly from 60 gal/d in 1915 to 166 gal/d in 1973, but generally increased with time. The fluctuations in pumping are much more apparent prior to 1930, before accurate records were kept. One reason for the fluctuations was that only a few municipalities, often with unusually high per capita municipal withdrawals, would not consistently report withdrawal data. Because these apparent changes in reported per capita municipal ground-water withdrawal rates probably did not reflect long-term trends for the study area, the long-term trends are obscured. These differences might be attributed to undocumented partial conversion from surface water to ground water or from ground water to surface water, to short-term economic influences such as plant openings or closings (American Water Works Association Committee on Water Use, 1973, p. 292) (which would cause abrupt changes in industrial ground-water withdrawal), or to any other abrupt changes in municipal ground-water withdrawal not related to local population changes (Durfor and Becker, 1962, p. 6), (Larson and Hudson, Jr., 1951, p. 604), and (American Water Works Association Committee on Water Use, 1973, p. 287). However, increasing per capita municipal ground-water withdrawal probably reflects increased industrialization (Kollar and Brewer, 1977, p. 469), water losses that increase with time as distribution systems age (Larson and Hudson, Jr., 1951, p. 604), and increasing domestic use of water (Durfor and Becker, 1962, p. 6), (American Water Works Association Committee on Water Use, 1973, p. 295).

The reported ground-water withdrawals for all municipalities is included in table 2. The total reported municipal ground-water withdrawals, the total municipal population corresponding to the ground-water withdrawals, and the total municipal population dependent upon ground water are shown on figure 18.

SUMMARY AND CONCLUSIONS

Information describing the history of municipal water supplies was collected for 182 municipalities within the central Lower Peninsula of Michigan. These municipal water supplies were categorized into four geographic regions. Region 1 consists of municipalities that used ground water from the glacial-drift aquifers in the northern and northeastern part of the study area. Municipalities that generally used ground water from either the Grand River-Saginaw or Marshall aquifers are located in region 2, in the southern and southeastern part of the area. Region 3, in the center of the area, consists of municipalities that generally used ground water from glacial-drift aquifers and

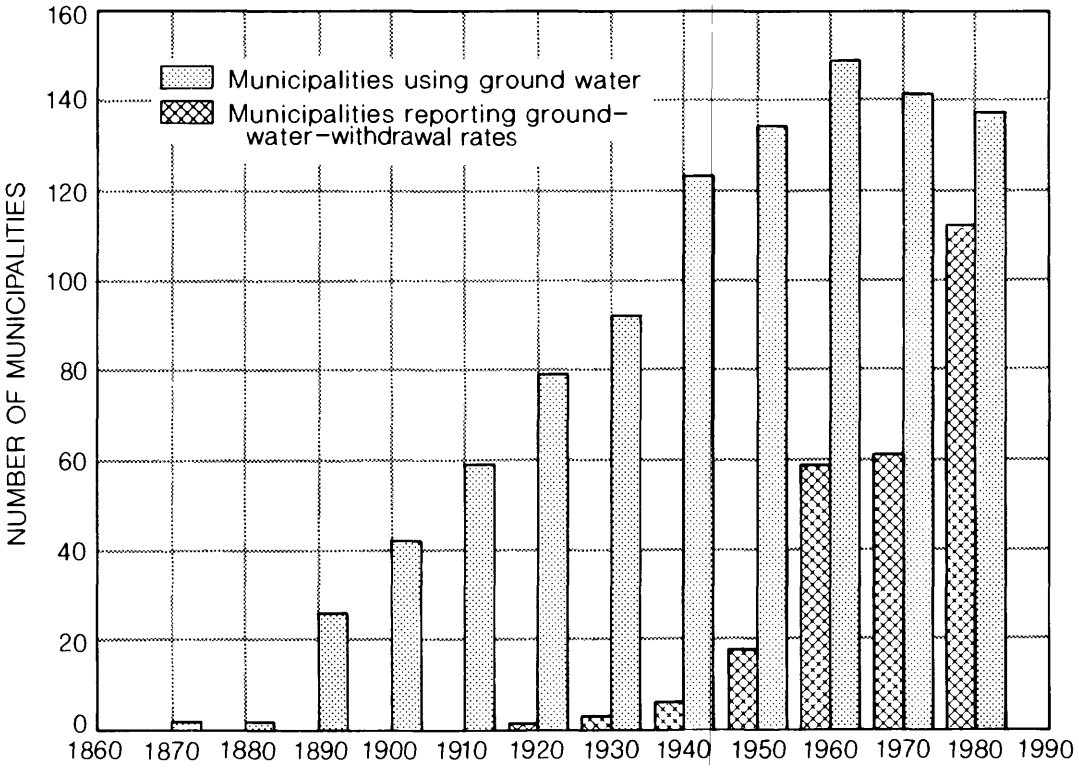


Figure 16.--Number of municipalities that used ground water and number of municipalities for which ground-water-withdrawal data were available, 1870-1980.

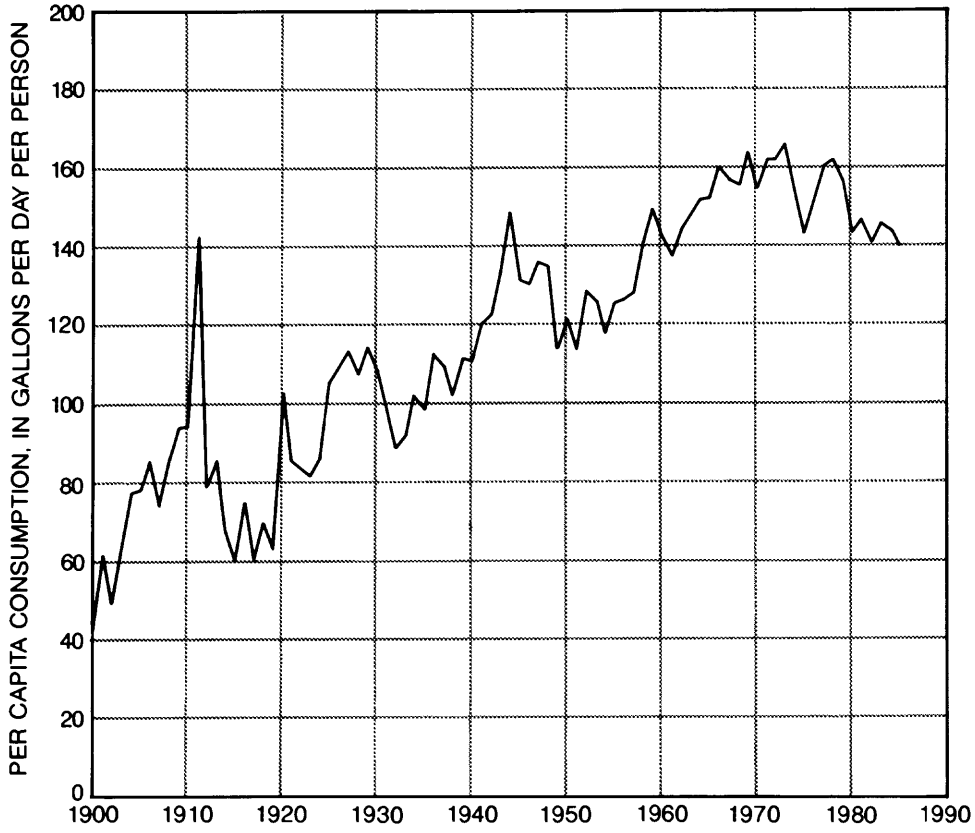


Figure 17.--Average annual per capita municipal ground-water withdrawals, 1870-1985.

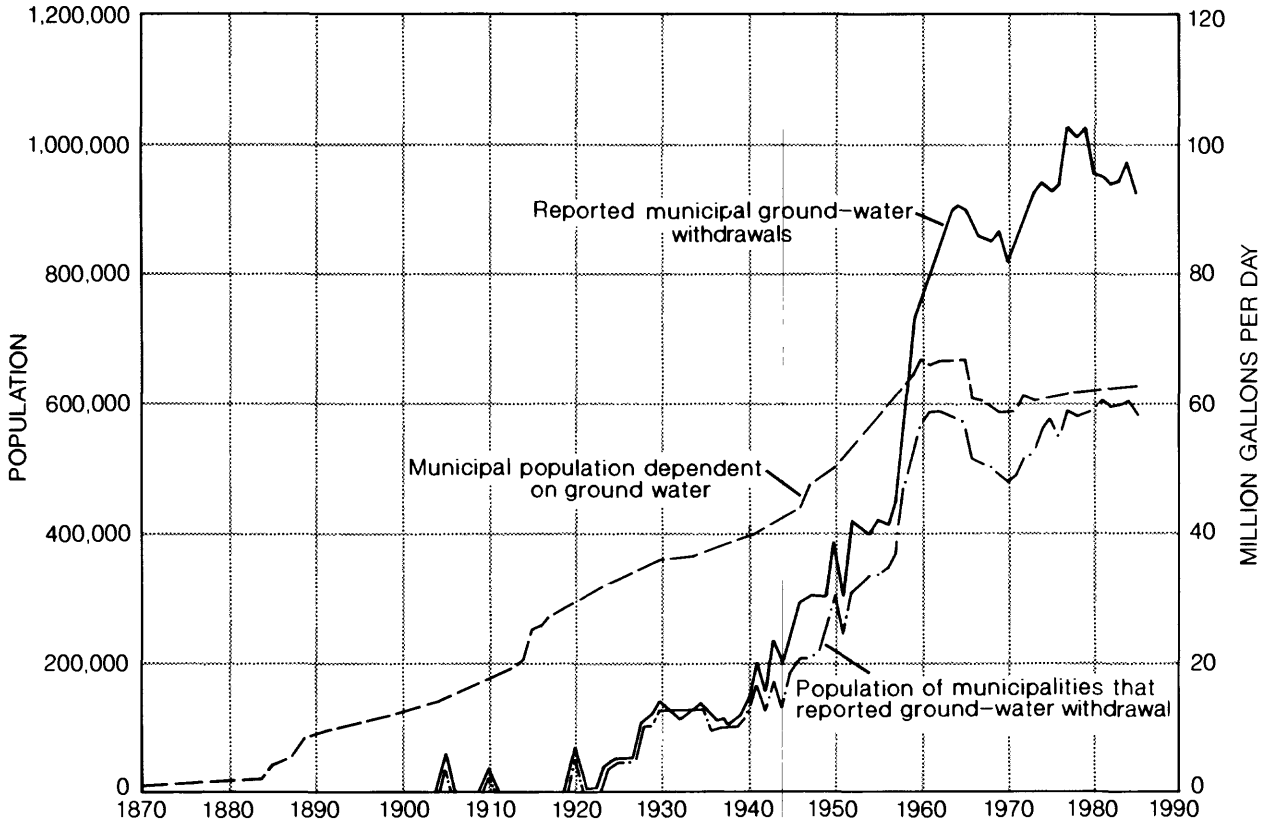


Figure 18.--Municipal population dependent on ground water, population of municipalities that reported ground-water withdrawals, and annual municipal ground-water withdrawal, 1870-1985.

underlying bedrock aquifers. Municipalities in region 4 are in the east-central and western part of the area; within this region, 43 municipalities used water from the Great Lakes.

Municipal ground-water-withdrawal data were collected from 145 municipalities; reported data ranged from 1 to 63 years of continuous record. Data are sparse before 1960; the best coverage is from 1960 through 1980. The maximum recorded ground-water withdrawal for the area was 103 million gallons per day in 1979. The average annual per capita municipal ground-water withdrawal for the reporting municipalities varies over the period of record. Although the data indicate an increase in per capita municipal ground-water withdrawal with time, these fluctuations could result from incomplete reporting of source changes, short-term economic changes, and other changes not associated with local population changes.

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TABLES OF DATA

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*

[Water source: Q, glacial-drift aquifer; P, Grand River-Saginaw aquifer; M, Marshall aquifer; WSS, water-supply system]

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
1	Wayland	Allegan	1907	Q	1957	M	--	Q and M
2	AuGres	Arenac	1950	Saginaw-Midland WSS	--	--	--	Saginaw-Midland WSS
3	Omer	Arenac	1967	Saginaw-Midland WSS	--	--	--	Saginaw-Midland WSS
4	Standish	Arenac	1914	Pine River[1]	1936	Q[2]	--	--
					1950	M[3]	--	--
					1967	Saginaw-Midland WSS	--	Saginaw-Midland WSS
5	Freeport	Barry	1918-25	Q	--	--	--	Q
6	Hastings	Barry	1884	Q	1961	M	--	Q and M
7	Middleville	Barry	1921	Springs[4]	1927	Q	Infiltration[5] lines	--
					1942	Q	--	--
					1953	M[6]	--	--
					1960	Q	--	Q

[1] Used mainly for fire protection. Abandoned between 1934 and 1937.

[2] Abandoned between 1940 and 1960.

[3] Abandoned in 1967.

[4] Abandoned between 1937 and 1940.

[5] Discontinued between 1948 and 1960.

[6] Abandoned between 1955 and 1960.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source: Year added to system	Additional water source: Water source	Remarks	(1987) Present water source
8	Nashville	Barry	1891	Thornapple River	1936	Q	Thornapple River abandoned	Q
9	Auburn	Bay	1949	Saginaw-Midland WSS	--	--	--	Saginaw-Midland WSS
10	Bay City	Bay	1872	Lake Huron[7]	--	--	--	Lake Huron
11	Essexville	Bay	1910	Bay City	--	--	--	Bay City
12	Pinconning	Bay	1887	Lake Huron	1962	P[8]	--	Lake Huron
13	Albion	Calhoun	1915-17	M	--	--	--	M
14	Battle Creek	Calhoun	1887	Goguac Lake	1915	M	--	--
					1929	Q[9]	Goguac Lake abandoned	M
15	Homer	Calhoun	1910	Q	1946	Q	Second Q well installed	--
					1970	M	First Q well abandoned	M with Q as a stand-by
16	Marshall	Calhoun	1889	M	--	--	--	M
17	Springfield	Calhoun	1948-60	Battle Creek Township[10]	--	--	--	Battle Creek Township

[7] Pitcher pumps in glacial material also were used. Pumps abandoned in 1981.

[8] Backup well only to be used when lake levels were lowered beyond the intake structure.

[9] Discontinued in August 1950.

[10] Battle Creek Township uses wells in the Marshall aquifer.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
18	Clare	Clare	1886	Q	--	--	--	Q
19	Farwell	Clare	1887	Little Field Creek[11]	1938	Q	--	Q
20	Harrison	Clare	1889	Budd Lake	1935	Q	Budd Lake used for emergency and fire	--
					1940	Q	Budd Lake abandoned	Q
21	DeWitt	Clinton	1976	P	--	--	--	P
22	Elsie	Clinton	1937	P?	1948?	Q	--	P and Q
23	Fowler	Clinton	1918-25	Q[12]	1928-33	P	--	--
					1979	Q	--	Q and P
24	Maple Rapids	Clinton	1927	Q	1950	P[13]	--	Q
25	Ovid	Clinton	1888	Q	1888-1914	P	--	Q and P
26	St. Johns	Clinton	1888-89	P	--	--	--	P
27	Westphalia	Clinton	1953	P	--	--	--	P
28	Grayling	Crawford	1889?	AuSable[14] River	1935	Q	AuSable River abandoned	Q

[11] Abandoned between 1937 and 1940.

[12] Abandoned between 1925 and 1933.

[13] Abandoned between 1966 and 1982.

[14] Water from this system not intended for drinking.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
29	Bellevue	Eaton	1928	M	--	--	--	M
30	Charlotte	Eaton	1886	Q	--	--	--	Q
31	Eaton Rapids	Eaton	1898	P	1931	Q	--	Q and P
32	Grand Ledge	Eaton	1896	P	--	--	--	P
33	Olivet	Eaton	1913	P? and M	--	--	--	P? and M
34	Potterville	Eaton	1953	P	--	--	--	P
35	Sunfield	Eaton	1959	Q	--	--	--	Q
36	Vermontville	Eaton	1947	Q	--	--	--	Q
37	Burton	Genesee	1928	Flint River	1938	P	Flint River abandoned	--
					1954	Q	--	--
					1973	Genesee County WSS	50 percent of the city is on line	Q, P and Genesee County WSS
38	Clio	Genesee	1929	P	1958	Q	--	--
					1969	Flint[15]	--	Flint
39	Davison	Genesee	1938	M	--	--	--	M
40	Fenton	Genesee	1889	M[16]	1925-33	Q	--	Q

[15] Switched to surface water because of unacceptable chloride and iron concentrations and a water shortage caused by contamination of well field with oil.

[16] Discontinued in the 1960's.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
41	Flint	Genesee	1883	Flint River	1967	Detroit	From Detroit River	--
					1974	Detroit	From Lake Huron	Detroit
42	Flushing	Genesee	1895	Flint River[17]	1923	P[18]	--	--
					1933	Q	Used only during summer	--
					1955	Q[19]	Used full time	--
					1964	Flint	--	--
					1969	Genesee County WSS	--	Genesee County WSS
43	Grand Blanc	Genesee	1937	P	--	--	--	P
44	Linden	Genesee	1948	M	--	--	--	M
45	Montrose	Genesee	1938	Q	1982	Genesee County WSS	--	Q and Genesee County WSS
46	Mount Morris	Genesee	1922	P	1935	Q	P wells abandoned	--
					1972	Genesee County WSS	--	Genesee County WSS

[17] Used mainly for fire protection. Abandoned between 1918 and 1925.

[18] Abandoned in 1963.

[19] Abandoned in 1965.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
47	Otisville	Genesee	1946	P	1970	Q[20]	--	P
48	Swartz Creek	Genesee	1970	Flint	--	--	--	Flint
49	Beaverton	Gladwin	Pre-1918	Tobacco River	1938	Q	Tobacco River abandoned	Q
50	Gladwin	Gladwin	1900	P	--	--	--	P
51	Alma	Gratiot	1882	Pine River[21]	1917	Q	--	--
					1921	P	--	Pine River and Q, P for standby
52	Ashley	Gratiot	1955	P	--	--	--	P
53	Breckenridge	Gratiot	1934	P	--	--	--	P
54	Ithaca	Gratiot	1890?	P[22]	1942	Q	--	Q
55	Perrinton	Gratiot	1949	Q	1984	P	--	Q and P
56	St. Louis	Gratiot	[23]1922	Q	--	--	--	Q
57	Litchfield	Hillsdale	1941	M	1973	Q	--	M and Q
58	Reading	Hillsdale	1900	M	--	--	--	M
59	Bad Axe	Huron	1894	M	--	--	--	M

[20] Abandoned in 1978.

[21] Used mainly for fire protection.

[22] Abandoned between 1948 and 1960.

[23] First water system, installed before 1906, used water from flowing wells at the level of a mill pond, but later switched to using the mill pond. Used mainly for fire protection.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source: Year added to system	Additional water source: Water source	Remarks	(1987) Present water source
60	Caseville	Huron	1940	M	--	--	--	M[24]
61	Elkton	Huron	1908	M	--	--	--	M
62	Owendale	Huron	1916	M	--	--	--	M
63	Pigeon	Huron	1911	M	--	--	--	M
64	Port Austin	Huron	1913	M	1967	Lake Huron[25]	--	Lake Huron
65	Port Hope	Huron	1935	Lake Huron	--	--	--	Lake Huron
66	Sebewaing	Huron	1939	M	--	--	--	M
67	Ubly	Huron	1911	M	--	--	--	M
68	East Lansing	Ingham	1909	P	--	--	--	P
69	Lansing	Ingham	1885	Q[26]	1895	P	--	P
70	Leslie	Ingham	1899	P	--	--	--	P
71	Mason	Ingham	1891	P	1931	Q	--	P and Q
72	Stockbridge	Ingham	1912	P	--	--	--	P
73	Webberville	Ingham	1930's	Q	1956	P	Q wells abandoned	P
74	Williamston	Ingham	1918	Red Cedar[27] River	1937	P	--	--
					1957	Q	--	P and Q

[24] Presently constructing a pipeline to bring water from Lake Huron because of unacceptable chloride concentration of water from municipal ground-water supply.

[25] Abandoned wells in the Marshall aquifer and started to use lake water because municipal wells produced water that was very hard and contained unacceptable chloride and iron concentrations.

[26] Abandoned in 1915?

[27] Used mainly for fire protection. Abandoned between 1934 and 1940.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source: Year added to system	Additional water source: Water source	Remarks	(1987) Present water source
75	Belding	Ionia	1906?	Q	--	--	--	Q
76	Ionia	Ionia	1885	P and Q	1918	--	P wells abandoned	Q
77	Lake Odessa	Ionia	1899	Q	--	--	--	Q
78	Lyons	Ionia	1890	Grand River[28]	1925	P[29]	--	--
					[30]1972	Muir	--	Muir
79	Muir	Ionia	1953	Q	--	--	--	Q[31]
80	Pewamo	Ionia	1956	P	--	--	--	P
81	Portland	Ionia	[32]1889	Q	1918	P[33]	--	Q
82	Saranac	Ionia	1915	Q	--	--	--	Q
83	Alabaster	Iosco	1940	Lake Huron	--	--	--	Lake Huron
84	East Tawas	Iosco	1887	Lake Huron	--	--	--	Lake Huron
85	Tawas City	Iosco	1937	M	1958	East Tawas	M wells abandoned?	East Tawas

[28] Used mainly for fire protection. Abandoned between 1940 and 1982.

[29] Privately owned water system.

[30] Lyons installed a municipal-water system for drinking and began purchasing water from Muir.

[31] In 1972, sold water to Lyons.

[32] Unknown 300-foot-deep well in the Grand River-Saginaw aquifer discovered in 1984; was estimated to date from the late 1890's.

[33] Abandoned between 1957 and 1961.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source: Year added to system	Additional water source: Water source	Remarks	(1987) Present water source
86	Mount Pleasant	Isabella	1907	Q	1961	Q[34]	Infiltration well	--
					1972	P	--	Q and P
87	Shepherd	Isabella	1909	Q	--	--	--	Q
88	Brooklyn	Jackson	1952	M	--	--	--	M
89	Concord	Jackson	1951	M	--	--	--	M
90	Grass Lake	Jackson	1938	M	--	--	--	M
91	Jackson	Jackson	1870	P and M	--	--	--	P and M
92	Springport	Jackson	1953	P	--	--	--	P
93	Cedar Springs	Kent	1890?	Cedar Creek[35]	1914	Springs[36]	--	--
					1929	Q	--	Q
94	East Grand Rapids	Kent	1914?	Reed's Lake and Q	1964	Grand Rapids[37]	--	Grand Rapids
95	Grand Rapids	Kent	1873	Grand River	1940	Lake Michigan	--	Lake Michigan and Grand River
96	Grandville	Kent	1914	Q	1968	Wyoming	Q wells abandoned	Wyoming
97	Kentwood	Kent	1968	Wyoming	--	--	--	Wyoming

[34] Abandoned approximately 1984.

[35] Abandoned in 1931.

[36] Abandoned between 1918 and 1925.

[37] Reed's Lake abandoned because of unacceptable water quality and lowering of the lake level. Use of wells in the glacial drift aquifer was discontinued at this time.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source: Year added to system	Additional water source: Water source	Remarks	(1987) Present water source
98	Lowell	Kent	1887	Q	1964	M	--	Q and M
99	Rockford	Kent	1892	Rogue River	1897	M	Rogue River for emergency	--
					1916	Rogue River	M wells abandoned[38]	Rogue River
100	Sparta	Kent	Pre-1918	Q	--	--	--	Q
101	Walker	Kent	1966	Grand Rapids	--	--	--	Grand Rapids
102	Wyoming	Kent	1931	Grand Rapids[39]	1947	Q and M	--	--
					1966	Lake Michigan	Wells abandoned	Lake Michigan
103	Baldwin	Lake	1937	Baldwin Creek	1939	Q	Baldwin Creek abandoned	Q
104	Clifford	Lapeer	1936	M	--	--	--	M
105	Columbiaville	Lapeer	1910	M	--	--	--	M
106	Imlay City	Lapeer	1890	M	1942	Q	M wells abandoned	--
					1971	Detroit[40]	--	Detroit
107	Lapeer	Lapeer	1888	M[41]	1969	Detroit	--	Detroit

[38] Bacterial contamination of well supply.

[39] In November 1949, discontinued purchase of Grand Rapids water.

[40] Abandoned wells in the glacial drift aquifer because of unacceptable water quality and dwindling supply. Some wells on standby.

[41] Abandoned in 1971.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
108	Metamora	Lapeer	1975	Q	--	--	--	Q
109	North Branch	Lapeer	1923	M	--	--	--	M
110	Fowlerville	Livingston	1908	M	--	--	--	M
111	Big Rapids	Mecosta	1871	Muskegon River	--	--	--	Muskegon River
112	Coleman	Midland	1950?	Q?	1955	P	--	Q and P
113	Midland	Midland	1882	Chippewa River	1915	Q	--	--
					1916?	Chippewa[42] River	--	--
					[43]1948	Saginaw-Midland WSS	Chippewa River abandoned	Saginaw-Midland WSS
114	Lake City	Missaukee	1888	Lake Missaukee[44]	1955	Q	--	Q
115	McBain	Missaukee	1915	Q	--	--	--	Q
116	Carson City	Montcalm	1888	Fish Creek[45]	1938	Q	--	Q
117	Edmore	Montcalm	1889	Q	--	--	--	Q
118	Greenville	Montcalm	1888	Q	--	--	--	Q

[42] Wells abandoned because of unacceptable water quality and insufficient yield.

[43] The Saginaw-Midland-Water-Supply System put into operation a Lake Huron intake.

[44] Abandoned between 1948 and 1960.

[45] Used mainly for fire protection. Abandoned between 1937 and 1940.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source: Year added to system	Additional water source: Water source	Remarks	(1987) Present water source
119	Howard City	Moncalm	1890	Tamarack[46] Creek	1939	Q	--	Q
120	Lakeview	Montcalm	1923	Tamarack Lake	1948	Q	Tamarack Lake abandoned	Q
121	Sheridan	Montcalm	1890	Pearl Lake[47]	1948	Q	Pearl Lake abandoned	Q
122	Stanton	Montcalm	1888	Q	--	--	--	Q
123	Montague	Muskegon	1903	Mill Creek[48]	1927	Q	--	Q
124	Muskegon	Muskegon	1875	Pond	1887	Q?	Pollution of pond	--
					1892	Lake Michigan	Inadequate well supply	Lake Michigan
125	Muskegon Heights	Muskegon	Pre-1918	Q[49]	1936	Q	--	--
					1941	Lake Michigan	Q wells abandoned	Lake Michigan

[46] Abandoned between 1937 and 1940.

[47] Used mainly for fire protection.

[48] Used mainly for fire protection. Abandoned between 1925 and 1928.

[49] Infiltration gallery along Black Creek. Abandoned in 1941.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
126	North Muskegon	Muskegon	1883	Bear Lake[50]	1923	Q	Infiltration line along Bear Lake	--
					1927	Q[51]	--	--
					1936	Muskegon[52]	--	Muskegon
127	Norton Shores	Muskegon	1943-44	Muskegon Heights	--	--	--	Muskegon Heights
128	Ravenna	Muskegon	1964	Q	--	--	--	Q
129	Roosevelt Park	Muskegon	1954	Muskgeon	--	--	--	Muskegon
130	Whitehall	Muskegon	1892	Q	--	--	--	Q
131	Fremont	Newaygo	1883	Q	--	--	--	Q
132	Hesperia	Newaygo	1880	White River[53]	1898?	Q[54]	--	--
					1944	Q[55]	--	Q
133	Newaygo	Newaygo	1929	Q	1974	M	--	Q and M
134	White Cloud	Newaygo	1880	White River[56]	1938	Q	--	Q

[50] Used for domestic purposes other than drinking.

[51] The well in the glacial-drift aquifer was abandoned in 1930.

[52] Discontinued use of infiltration lines and lake supply because of the lack of adequate supply and contamination of Bear Lake, respectively.

[53] Abandoned between 1937 and 1940.

[54] Private water supplier. Supplied approximately 40 homes.

[55] Complete water system installed.

[56] Used mainly for fire protection. Abandoned between 1937 and 1940.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
135	Holly	Oakland	1879	Pond	1900?	Q[57]	--	--
					1960	M	--	M
136	Shelby	Oceana	1895	Q	--	--	--	Q
137	Rose City	Ogemaw	1978	Q	--	--	--	Q
138	West Branch	Ogemaw	1908	Q	--	--	--	Q
139	Evart	Osceola	1889	Q	--	--	--	Q
140	Marion	Osceola	1913	Q	--	--	--	Q
141	Reed City	Osceola	1882	Mill pond	1913?	Hersey River	--	--
					1936	Q	Hersey River abandoned	Q
142	Coopersville	Ottawa	1903	Deer Creek[58]	1904	Q	Deer Creek abandoned	--
					1921	M	--	--
					1978	Grand Rapids	Wells discontinued	Grand Rapids
143	Ferrysburg	Ottawa	1977	Grand Haven	--	--	--	Grand Haven

[57] Abandoned in 1965.

[58] Used mainly for fire protection.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
144	Grand Haven	Ottawa	1888	Q	1928	Grand River	--	--
					1932	Q[59]	Grand River abandoned	--
					1950	Radial collector wells	--	--
					1961	Lake Michigan	--	Lake Michigan
145	Hudsonville	Ottawa	1939	Q	1967	Wyoming	Wells abandoned	Wyoming
146	Spring Lake	Ottawa	1906	Q	--	--	--	Q
147	Zeeland	Ottawa	1890	Q	1916?	M	--	--
					1963	Holland[60]	--	Holland
148	Roscommon	Roscommon	1883	Robinson[61] Creek	1916	Q	Robinson Creek abandoned	Q
149	Birch Run	Saginaw	1963	Q[62]	1973	Saginaw-Midland WSS	--	Saginaw-Midland WSS
150	Chesaning	Saginaw	1888	P[63]	1929?	--	Shiawassee River abandoned	P

[59] Wells along Lake Michigan installed.

[60] Wells taken out of service in 1964.

[61] Used mainly for fire protection.

[62] Aquifer abandoned in 1976.

[63] Shiawassee River was used for backup.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
151	Frankenmuth	Saginaw	1939	Cass River	1971	Saginaw-Midland WSS	--	Saginaw-Midland WSS
152	Freeland	Saginaw	1962	Q	1984	Saginaw-Midland WSS[64]	--	Saginaw-Midland WSS
153	Hemlock	Saginaw	1953	Q	--	--	--	Q
154	Saginaw	Saginaw	1872-73	Saginaw River	Pre-1899	P	--	--
					1929	Saginaw River	Wells became saline	--
					1948	Lake Huron	--	Lake Huron
155	St. Charles	Saginaw	1911	Bad River[65]	1937	P?	--	--
					1940	Q[66]	Infiltration line	--
					1948-59	P[67]	--	--
					1973	Saginaw-Midland WSS	--	Saginaw-Midland WSS
156	Zilwaukee	Saginaw	1940	P[68]	1968	Saginaw-Midland WSS	--	Saginaw-Midland WSS

[64] Switched to surface water because of loss of head from wells.

[65] Used mainly for fire protection. Abandoned between 1937 and 1940.

[66] Infiltration line abandoned approximately 1987.

[67] Most of the wells in the Grand River-Saginaw aquifer were abandoned in 1973; one well remained on standby.

[68] Abandoned shortly after connecting to the Saginaw-Midland WSS.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
157	Brown City	Sanilac	1903	M[69]	1912	M	For drinking	M
158	Carsonville	Sanilac	1909	M	--	--	--	M
159	Marlette	Sanilac	1896	M	--	--	--	M
160	Minden City	Sanilac	1935	M	--	--	--	M
161	Sandusky	Sanilac	1911	M	--	--	--	M
162	Bancroft	Shiawassee	1915	Q	1925	M	--	Q and M
163	Byron	Shiawassee	1956	M	--	--	--	M
164	Corunna	Shiawassee	1904	P[70]	1936	Q	--	Q
165	Durand	Shiawassee	1899	Q	--	--	--	Q
166	New Lothrop	Shiawassee	1931?	Q	--	--	--	Q
167	Owosso	Shiawassee	1885	Q and P	--	--	--	Q and P
168	Perry	Shiawassee	1914	M	1956	Q	M well abandoned	Q
169	Akron	Tuscola	1956	P	--	--	--	P
170	Caro	Tuscola	1889	Q[71]	1938	Q	--	--
					1964?	M	--	Q and M
171	Cass City	Tuscola	1914	M	--	--	--	M

[69] Used mainly for fire protection.

[70] Abandoned in 1949.

[71] Infiltration line along the Cass River. Discontinued use approximately 1938 because of growth of the municipality.

Table 1.--*History of municipal water supplies in the central Lower Peninsula of Michigan, by county, 1870-1987*--Continued

Location number	Municipality	County	Year water system installed	Initial water source	Additional water source		Remarks	(1987) Present water source
					Year added to system	Water source		
172	Gagetown	Tuscola	1911	Q[72]	1918	M	--	M
173	Kingston	Tuscola	1902	M	--	--	--	M
174	Mayville	Tuscola	1905	M	--	--	--	M
175	Millington	Tuscola	1901-04	P	--	--	--	P
176	Unionville	Tuscola	1949	P	--	--	--	P
177	Vassar	Tuscola	1888	P	--	--	--	P
178	Chelsea	Washtenaw	1896	Q	--	--	--	Q
179	Dexter	Washtenaw	1926	M	1937	Q	M well abandoned	Q
180	Cadillac	Wexford	Pre-1906	Little Clam Lake[73]	1916?	Lake Cadillac[74]	--	--
					1960	Q	--	Q
181	Manton	Wexford	1894	Q[75]	1931	Q	Cedar Creek abandoned	Q
182	Mesick	Wexford	1914	Q	--	--	--	Q

[72] Abandoned between 1911 and 1918.

[73] Used mainly for fire protection.

[74] Abandoned between 1954 and 1960.

[75] Cedar Creek water was used with well water in case of fire.

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*
[--, no data]

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Allegan	Wayland	1973	0.300
		1974	--
		1975	.216
		1976	.202
		1977	.253
		1978	.237
		1979	.219
		1980	--
		1981	.251
		1982	.230
		1983	.225
		1984	.218
		1985	.245
Barry	Freeport	1983	.023
		1984	--
		1985	.021
	Hastings	1937	.410
		1938	.409
		1939	.399
		1940	.480
		1941	.549
		1942	.518
		1943	.601
		1944	.651
		1945	.610
		1946	.693
		1947	.755
		1948	.816
		1949	.725
		1950	.756
		1951	.788
		1952	.785
		1953	.760
		1954	.768
		1955	.874
		1956	.840
		1957	.687
		1958	.719
		1959	.862
		1960	1.092
		1961	.953
		1962	1.085
		1963	1.251
		1964	1.274
		1965	1.281
		1966	1.414
		1967	1.297
		1968	1.256
		1969	1.308
		1970	1.273
		1971	1.324
		1972	1.164
		1973	1.186
		1974	1.005
		1975	1.002
		1976	.955
Barry	Hastings	1977	0.919
		1978	.830
		1979	.777
		1980	.819
		1981	.919
		1982	.802
		1983	.834
		1984	.785
		1985	.926
	Middleville	1961	.572
		1962	.577
		1963	.419
		1964	.299
		1965	.373
		1966	.514
		1967	.614
		1968	.471
		1969	.461
		1970	.427
		1971	.501
		1972	.425
		1973	.437
		1974	.420
		1975	.444
		1976	.465
		1977	.474
		1978	.463
		1979	.438
		1980	.442
		1981	.429
		1982	.302
		1983	.302
		1984	.245
		1985	.318
	Nashville	1960	.100
		1961	--
		1962	--
		1963	--
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	.121
		1975	.116
		1976	.114
		1977	.137
		1978	.117
		1979	.121
		1980	.109
		1981	.111

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Barry	Nashville	1982	0.123
		1983	.103
		1984	.138
		1985	.119
Bay	Pinconning	1962	.008
		1963	.019
		1964	.009
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	--
		1975	--
		1976	--
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	--
		1983	--
		1984	.004
Calhoun	Albion	1946	1.488
		1947	1.564
		1948	1.762
		1949	1.523
		1950	1.682
		1951	2.200
		1952	2.299
		1953	2.723
		1954	2.756
		1955	3.315
		1956	3.299
		1957	3.343
		1958	3.214
		1959	3.989
		1960	3.868
		1961	3.737
		1962	4.315
		1963	4.994
		1964	5.649
		1965	5.485
		1966	5.907
		1967	6.395
		1968	6.099
		1969	5.203
		1970	4.693
		1971	4.377
		1972	4.351
		1973	4.896
		1974	5.064
		1975	3.823
Calhoun	Albion	1976	3.383
		1977	3.429
		1978	3.451
		1979	3.262
		1980	2.646
		1981	2.612
		1982	2.761
		1983	2.688
		1984	2.864
		1985	2.641
	Battle Creek	1924	3.540
		1925	4.480
		1926	4.770
		1927	5.129
		1928	5.071
		1929	5.170
		1930	4.918
		1931	4.589
		1932	4.450
		1933	4.649
		1934	4.819
		1935	4.189
		1936	--
		1937	--
		1938	--
		1939	--
		1940	--
		1941	4.833
		1942	--
		1943	5.101
		1944	--
		1945	5.671
		1946	6.263
		1947	6.704
		1948	6.786
		1949	6.060
		1950	5.693
		1951	--
		1952	--
		1953	6.921
		1954	6.153
		1955	6.614
		1956	6.844
		1957	8.329
		1958	9.893
		1959	11.970
		1960	9.742
		1961	10.252
		1962	9.630
		1963	9.989
		1964	10.745
		1965	10.343
		1966	10.789
		1967	10.137
		1968	9.955
		1969	8.980
		1970	7.669
		1971	7.031

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Calhoun	Battle Creek	1972	7.532
		1973	7.355
		1974	5.939
		1975	6.093
		1976	6.457
		1977	6.693
		1978	7.285
		1979	7.877
		1980	7.770
		1981	7.512
		1982	9.837
		1983	9.576
		1984	8.447
		1985	8.082
	Homer	1974	.171
		1975	.148
		1976	.189
		1977	.194
		1978	.189
		1979	.210
		1980	.156
		1981	.152
		1982	.152
		1983	.165
		1984	.182
		1985	.188
	Marshall	1949	.831
		1950	.867
		1951	.807
		1952	.896
		1953	.885
		1954	.859
		1955	1.019
		1956	.952
		1957	1.045
		1958	1.048
		1959	1.163
		1960	.982
		1961	1.033
		1962	1.096
		1963	1.225
		1964	1.126
		1965	1.109
		1966	1.490
		1967	1.770
		1968	1.689
		1969	1.396
		1970	1.338
		1971	1.430
		1972	1.433
		1973	1.473
		1974	1.481
		1975	1.188
		1976	1.242
		1977	1.231
		1978	1.282
Calhoun	Marshall	1979	1.196
		1980	1.116
		1981	1.143
		1982	1.373
		1983	.975
		1984	1.201
		1985	1.411
Clare	Clare	1959	.605
		1960	.698
		1961	.693
		1962	.651
		1963	.739
		1964	.707
		1965	.750
		1966	.850
		1967	.800
		1968	.915
		1969	.748
		1970	.893
		1971	1.009
		1972	.781
		1973	.754
		1974	.780
		1975	.750
		1976	.847
		1977	.950
		1978	.935
		1979	.964
		1980	.765
		1981	.712
		1982	.648
		1983	.565
		1984	.615
		1985	.640
	Farwell	1974	.108
		1975	.113
		1976	.141
		1977	.164
		1978	.192
		1979	.205
		1980	.173
		1981	.151
		1982	.130
		1983	.121
		1984	.112
		1985	.130
	Harrison	1961	.120
		1962	.103
		1963	.109
		1964	.091
		1965	.102
		1966	.101
		1967	.103
		1968	.113
		1969	.123

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Clare	Harrison	1970	0.154
		1971	.161
		1972	.165
		1973	.167
		1974	.192
		1975	.215
		1976	.249
		1977	.306
		1978	.329
		1979	.281
		1980	.203
		1981	.203
		1982	.205
		1983	.195
		1984	.216
		1985	.205
Clinton	Dewitt	1981	.039
		1982	--
		1983	--
		1984	--
		1985	.010
	Elsie	1951	.479
		1952	.525
		1953	.489
		1954	--
		1955	--
		1956	--
		1957	--
		1958	.405
		1959	--
		1960	--
		1961	--
		1962	.053
		1963	--
		1964	.099
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	--
		1975	--
		1976	--
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	--
		1983	--
		1984	.180
		1985	.147

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Clinton	Fowler	1974	0.078
		1975	.070
		1976	--
		1977	.084
		1978	.077
		1979	.082
		1980	.069
		1981	.070
		1982	.070
		1983	.071
		1984	.065
		1985	.062
	Maple Rapids	1974	.049
		1975	.052
		1976	.057
		1977	.062
		1978	.094
		1979	.067
		1980	.063
		1981	.062
		1982	.059
		1983	.064
		1984	.065
		1985	.077
	Ovid	1912	.001
		1913	--
		1914	--
		1915	--
		1916	--
		1917	--
		1918	--
		1919	--
		1920	--
		1921	--
		1922	--
		1923	--
		1924	--
		1925	--
		1926	--
		1927	--
		1928	--
		1929	--
		1930	--
		1931	--
		1932	--
		1933	--
		1934	--
		1935	--
		1936	--
		1937	--
		1938	--
		1939	--
		1940	--
		1941	--
		1942	--
		1943	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Clinton	Ovid	1944	--
		1945	--
		1946	--
		1947	--
		1948	--
		1949	--
		1950	--
		1951	--
		1952	--
		1953	--
		1954	--
		1955	--
		1956	--
		1957	--
		1958	--
		1959	--
		1960	--
		1961	0.082
		1962	.078
		1963	.085
		1964	.074
		1965	.074
		1966	.099
		1967	.081
		1968	.089
		1969	.121
		1970	.133
		1971	.118
		1972	.123
		1973	.134
		1974	.135
		1975	.126
		1976	.182
		1977	.190
		1978	.218
		1979	.208
		1980	.165
		1981	.161
		1982	.205
		1983	.167
		1984	.181
		1985	.193
	St. Johns	1905	.275
		1906	--
		1907	--
		1908	--
		1909	--
		1910	--
		1911	--
		1912	--
		1913	--
		1914	--
		1915	--
		1916	--
		1917	--
		1918	--
		1919	--
Clinton	St. Johns	1920	--
		1921	--
		1922	--
		1923	--
		1924	--
		1925	--
		1926	--
		1927	--
		1928	--
		1929	--
		1930	--
		1931	--
		1932	--
		1933	--
		1934	--
		1935	--
		1936	--
		1937	--
		1938	--
		1939	--
		1940	--
		1941	--
		1942	--
		1943	--
		1944	--
		1945	0.251
		1946	.281
		1947	.322
		1948	.339
		1949	.382
		1950	.340
		1951	.358
		1952	.424
		1953	.455
		1954	.491
		1955	.615
		1956	.618
		1957	.668
		1958	.704
		1959	.751
		1960	.822
		1961	.924
		1962	.888
		1963	.965
		1964	1.120
		1965	1.221
		1966	1.203
		1967	1.296
		1968	1.207
		1969	1.464
		1970	1.425
		1971	1.465
		1972	1.332
		1973	1.598
		1974	1.579
		1975	1.532
		1976	1.540
		1977	1.664
		1978	1.450

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Clinton	St. Johns	1979	1.401
		1980	1.160
		1981	1.164
		1982	1.133
		1983	1.130
		1984	1.288
		1985	1.157
	Westphalia	1974	.050
		1975	.054
		1976	--
		1977	.061
		1978	.059
		1979	.059
		1980	.057
		1981	.057
		1982	.055
		1983	.053
		1984	.055
		1985	.053
Crawford	Grayling	1958	.293
		1959	--
		1960	.353
		1961	--
		1962	--
		1963	.315
		1964	.245
		1965	.309
		1966	.221
		1967	.226
		1968	.235
		1969	.271
		1970	--
		1971	.411
		1972	.473
		1973	.427
		1974	.436
		1975	.474
		1976	.481
		1977	.641
		1978	.608
		1979	.545
		1980	.567
		1981	.539
		1982	.552
		1983	.567
		1984	.627
		1985	.653
Eaton	Bellevue	1960	.066
		1961	.066
		1962	.070
		1963	.108
		1964	.069
		1965	.089
		1966	.121
		1967	.151
Eaton	Bellvue	1968	--
		1969	0.142
		1970	.125
		1971	.121
		1972	.169
		1973	.158
		1974	.139
		1975	.152
		1976	.126
		1977	.149
		1978	.129
		1979	.151
		1980	.144
		1981	.156
		1982	.138
		1983	.133
		1984	.131
		1985	.126
	Charlotte	1952	.602
		1953	.660
		1954	.748
		1955	--
		1956	--
		1957	--
		1958	.940
		1959	1.071
		1960	1.066
		1961	1.111
		1962	1.121
		1963	1.170
		1964	1.284
		1965	1.420
		1966	1.545
		1967	1.491
		1968	1.482
		1969	1.673
		1970	1.733
		1971	1.764
		1972	1.799
		1973	1.717
		1974	1.640
		1975	1.312
		1976	1.326
		1977	1.294
		1978	1.342
		1979	1.195
		1980	1.131
		1981	1.119
		1982	1.036
		1983	1.091
		1984	1.161
		1985	1.093
	Eaton Rapids	1961	1.047
		1962	.953
		1963	--
		1964	.822
		1965	.739

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Eaton	Eaton Rapids	1966	0.714
		1967	.828
		1968	.955
		1969	.750
		1970	.877
		1971	.951
		1972	.914
		1973	.842
		1974	.934
		1975	.917
		1976	--
		1977	.864
		1978	1.080
		1979	1.032
		1980	.957
		1981	1.004
		1982	.861
		1983	.778
		1984	.749
		1985	.759
	Grand Ledge	1949	.417
		1950	.402
		1951	.562
		1952	.639
		1953	.511
		1954	.398
		1955	.454
		1956	.428
		1957	.472
		1958	.474
		1959	.510
		1960	.379
		1961	.427
		1962	.420
		1963	.519
		1964	.441
		1965	.486
		1966	.473
		1967	.513
		1968	.480
		1969	.521
		1970	.513
		1971	.543
		1972	.539
		1973	.578
		1974	.577
		1975	.591
		1976	.602
		1977	.612
		1978	.608
		1979	.615
		1980	.628
		1981	.618
		1982	.645
		1983	.609
		1984	.680
		1985	.617
Eaton	Olivet	1960	0.049
		1961	.049
		1962	.058
		1963	.106
		1964	.092
		1965	.110
		1966	.134
		1967	.142
		1968	.132
		1969	.137
		1970	.137
		1971	.185
		1972	.125
		1973	.122
		1974	.153
		1975	.107
		1976	--
		1977	.139
		1978	--
		1979	--
		1980	--
		1981	.083
		1982	--
		1983	--
		1984	--
		1985	.098
	Potterville	1980	.123
		1981	.123
		1982	.118
		1983	.122
		1984	.131
		1985	.130
	Sunfield	1974	.060
		1975	.057
		1976	--
		1977	.078
		1978	.081
		1979	--
		1980	.081
		1981	.083
		1982	.089
		1983	.086
		1984	.081
		1985	.074
	Vermontville	1980	.051
		1981	.063
		1982	.051
		1983	.053
		1984	.062
		1985	.075
Genesee	Burton	1972	.956

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Genesee	Clio	1962	0.147
		1963	.100
		1964	.140
		1965	.138
		1966	.140
		1967	.151
		1968	.164
	Davison	1949	.089
		1950	--
		1951	--
		1952	.152
		1953	.150
		1954	.163
		1955	.211
		1956	.230
		1957	.270
		1958	.293
		1959	.305
		1960	.280
		1961	.317
		1962	.321
		1963	.358
		1964	.381
		1965	.433
		1966	.502
		1967	.511
		1968	.556
		1969	.619
		1970	.538
		1971	.652
		1972	.657
		1973	.813
		1974	.732
		1975	.673
		1976	.858
		1977	--
		1978	.779
		1979	.707
		1980	.753
		1981	.608
		1982	.817
		1983	.661
		1984	.634
		1985	.627
	Fenton	1959	.567
		1960	.526
		1961	.548
		1962	.586
		1963	.650
		1964	.616
		1965	.644
		1966	.621
		1967	.612
		1968	.652
		1969	.779
		1970	.792

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Genesee	Fenton	1971	0.853
		1972	.852
		1973	.873
		1974	.867
		1975	.795
		1976	.860
		1977	.976
		1978	.971
		1979	.917
		1980	.876
		1981	.859
		1982	--
		1983	.790
		1984	.777
		1985	.776
	Flushing	1946	.121
		1947	.111
		1948	.130
		1949	.129
		1950	.119
		1951	.126
		1952	.136
		1953	.132
		1954	--
		1955	.214
		1956	--
		1957	.193
		1958	.236
		1959	.250
		1960	.249
		1961	.241
		1962	.250
		1963	.227
	Grand Blanc	1951	.596
		1952	.596
		1953	.601
		1954	.614
		1955	.618
		1956	.627
		1957	.627
		1958	.640
		1959	.642
		1960	.667
		1961	.705
		1962	.690
		1963	.679
		1964	.703
		1965	.722
		1966	.740
		1967	.778
		1968	.804
		1969	.900
		1970	1.331
		1971	1.158
		1972	.999
		1973	1.062
		1974	.922

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Genesee	Grand Blanc	1975	1.007
		1976	1.183
		1977	1.177
		1978	1.250
		1979	1.161
		1980	1.116
		1981	1.121
		1982	1.045
		1983	1.091
		1984	1.122
		1985	1.146
	Linden	1961	.052
		1962	--
		1963	.124
		1964	.148
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	.065
		1971	.087
		1972	.090
		1973	.095
		1974	.130
		1975	.151
		1976	.142
		1977	.142
		1978	.142
		1979	.162
		1980	.167
		1981	.172
		1982	.164
		1983	.169
		1984	.180
		1985	.181
	Montrose	1961	.072
		1962	.075
		1963	.098
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	.128
		1975	.139
		1976	.151
		1977	.181
		1978	.178
		1979	.200
		1980	.203
Genesee	Montrose	1981	0.190
		1982	.138
Genesee	Mt. Morris	1953	.245
		1954	.260
		1955	.249
		1956	.208
		1957	.197
		1958	.199
		1959	.209
		1960	.205
		1961	.211
		1962	.215
		1963	.235
		1964	.219
		1965	.230
		1966	.242
		1967	.241
		1968	.257
		1969	.250
		1970	.227
		1971	.258
	Otisville	1958	.031
		1959	.032
		1960	.030
		1961	.037
		1962	.041
		1963	.040
		1964	.038
		1965	.037
		1966	.040
		1967	.038
		1968	.041
		1969	.040
		1970	.040
		1971	.044
		1972	.039
		1973	.038
		1974	.036
		1975	.040
		1976	.040
		1977	.043
		1978	--
		1979	.041
		1980	.042
		1981	.053
		1982	.047
		1983	.051
		1984	.056
		1985	.057
Gladwin	Beaverton	1958	.082
		1959	.065
		1960	.056
		1961	.096
		1962	.081
		1963	.090

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Gladwin	Beaverton	1964	0.081
		1965	.086
		1966	--
		1967	.081
		1968	.090
		1969	.092
		1970	.097
		1971	.103
		1972	.127
		1973	.128
		1974	.118
		1975	.101
		1976	.107
		1977	.128
		1978	.117
		1979	.126
		1980	.100
		1981	.128
		1982	.121
		1983	.152
		1984	.187
		1985	.131
Gratiot	Alma	1919	.311
		1920	.810
		1921	.701
		1922	.643
		1923	.590
		1924	.608
		1925	.637
		1926	.710
		1927	.597
		1928	.544
		1929	.596
		1930	.668
		1931	.649
		1932	.604
		1933	.723
		1934	.775
		1935	.877
		1936	1.041
		1937	1.105
		1938	1.227
		1939	1.251
		1940	1.227
		1941	1.167
		1942	1.314
		1943	1.816
		1944	1.936
		1945	2.250
		1946	2.673
		1947	2.087
		1948	1.315
		1949	1.142
		1950	1.206
		1951	1.413
		1952	1.431
		1953	1.352
		1954	1.435
		1955	1.801
		1956	1.807
		1957	1.517
		1958	1.784
		1959	1.764
		1960	1.768
		1961	1.654
		1962	1.660
		1963	1.628
		1964	1.799
		1965	1.046
		1966	.284
		1967	.254
		1968	.548
		1969	.495
		1970	.469
		1971	.438
		1972	.708
		1973	.428
		1974	--
		1975	.067
		1976	.097
		1977	.194
		1978	--
		1979	--
		1980	.009
		1981	.056
		1982	.118
		1983	.026
		1984	--
		1985	.001
	Ashley	1974	.067
		1975	.067
		1976	.090
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	.053
		1983	.055
		1984	.059
		1985	.050
	Breckenridge	1961	.097
		1962	.093
		1963	.100
		1964	.095
		1965	.110
		1966	.099
		1967	.095
		1968	.098
		1969	.098
		1970	.112
		1971	.103
		1972	.101

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Gratiot	Breckenridge	1973	0.106
		1974	.108
		1975	.130
		1976	.116
		1977	.108
		1978	.118
		1979	.100
		1980	.095
		1981	.100
		1982	.107
		1983	.112
		1984	.114
		1985	.125
	Ithaca	1951	.057
		1952	--
		1953	--
		1954	--
		1955	--
		1956	--
		1957	--
		1958	.159
		1959	--
		1960	.186
		1961	.157
		1962	.176
		1963	.188
		1964	.173
		1965	.204
		1966	.181
		1967	.152
		1968	.206
		1969	.202
		1970	.188
		1971	.211
		1972	.202
		1973	.228
		1974	.355
		1975	.299
		1976	.316
		1977	.252
		1978	.256
		1979	.309
		1980	.290
		1981	.288
		1982	.322
		1983	.364
		1984	.316
		1985	.335
	Perrinton	1975	.050
		1976	--
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	.046
		1983	.044
Gratiot	Perrinton	1984	0.051
		1985	.047
	St. Louis	1950	.661
		1951	.799
		1952	.775
		1953	.661
		1954	.651
		1955	.662
		1956	.844
		1957	.968
		1958	.863
		1959	.698
		1960	.719
		1961	.595
		1962	.636
		1963	.698
		1964	.702
		1965	.903
		1966	1.056
		1967	1.285
		1968	1.088
		1969	1.156
		1970	1.563
		1971	1.438
		1972	1.562
		1973	1.499
		1974	1.451
		1975	1.369
		1976	1.486
		1977	1.460
		1978	1.140
		1979	.454
		1980	.371
		1981	.364
		1982	.381
		1983	.448
		1984	.501
		1985	.736
Hillsdale	Litchfield	1974	.106
		1975	.127
		1976	.127
		1977	.136
		1978	.142
		1979	.122
		1980	.129
		1981	.144
		1982	.146
		1983	.149
		1984	.133
		1985	.133
	Reading	1960	.022
		1961	.004
		1962	--
		1963	--
		1964	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Hillsdale	Reading	1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	0.128
		1973	--
		1974	--
		1975	.130
		1976	--
		1977	.260
		1978	--
		1979	--
		1980	--
		1981	--
		1982	--
		1983	--
		1984	.119
		1985	.143
Huron	Bad Axe	1982	.515
		1983	.517
		1984	.466
		1985	.518
	Caseville	1976	.060
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	--
		1983	--
		1984	--
		1985	.061
	Elkton	1962	.010
		1963	.053
		1964	.085
		1965	.070
		1966	.075
		1967	.113
		1968	.217
		1969	.182
		1970	.118
		1971	.130
		1972	.069
		1973	.062
		1974	.073
		1975	.082
		1976	.072
		1977	.082
		1978	.066
		1979	.047
		1980	.069
		1981	.072

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Huron	Elkton	1982	0.074
		1983	.072
		1984	.076
		1985	.075
	Owendale	1976	.401
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	--
		1983	--
		1984	--
		1985	.033
	Pigeon	1961	.137
		1962	.110
		1963	.140
		1964	.148
		1965	.152
		1966	.168
		1967	.175
		1968	.195
		1969	.207
		1970	.209
		1971	.185
		1972	.090
		1973	.099
		1974	.094
		1975	.087
		1976	.086
		1977	.081
		1978	.094
		1979	.096
		1980	.124
		1981	.135
		1982	.146
		1983	.162
		1984	.141
		1985	.120
	Sebewaing	1952	.159
		1953	.165
		1954	.187
		1955	.213
		1956	.213
		1957	.207
		1958	.276
		1959	.270
		1960	.291
		1961	.299
		1962	.359
		1963	.397
		1964	.338
		1965	.298
		1966	.245
		1967	.261
		1968	.288

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Huron	Sebewaing	1969	0.365
		1970	.292
		1971	.313
		1972	.292
		1973	.313
		1974	.315
		1975	.254
		1976	.300
		1977	.386
		1978	.383
		1979	.384
		1980	.339
		1981	.310
		1982	.358
		1983	.393
		1984	.492
		1985	.287
	Ubly	1976	.600
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	--
		1983	.190
		1984	.204
		1985	.225
Ingham	East Lansing	1936	.441
		1937	.405
		1938	.493
		1939	.562
		1940	.600
		1941	.762
		1942	.666
		1943	.723
		1944	.838
		1945	.756
		1946	.858
		1947	.923
		1948	.937
		1949	.923
		1950	.980
		1951	.981
		1952	1.040
		1953	1.152
		1954	1.258
		1955	1.181
		1956	1.065
		1957	1.084
		1958	1.140
		1959	1.262
		1960	1.253
		1961	1.232
		1962	1.590
		1963	2.052
		1964	2.139
		1965	2.490
Ingham	East Lansing	1966	2.575
		1967	2.941
		1968	3.350
		1969	3.424
		1970	3.522
		1971	3.407
		1972	5.173
		1973	6.465
		1974	6.214
		1975	6.571
		1976	6.736
		1977	6.990
		1978	7.222
		1979	7.558
		1980	7.439
		1981	8.213
		1982	7.762
		1983	8.575
		1984	9.619
		1985	9.152
	Lansing	1905	1.367
		1906	--
		1907	--
		1908	--
		1909	--
		1910	2.900
		1911	--
		1912	--
		1913	--
		1914	--
		1915	--
		1916	--
		1917	--
		1918	--
		1919	--
		1920	6.197
		1921	--
		1922	--
		1923	--
		1924	--
		1925	--
		1926	--
		1927	--
		1928	--
		1929	--
		1930	8.422
		1931	7.378
		1932	6.394
		1933	6.693
		1934	7.748
		1935	7.909
		1936	9.189
		1937	9.099
		1938	8.137
		1939	8.923
		1940	9.381
		1941	10.792
		1942	11.112

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Ingham	Lansing	1943	12.901
		1944	14.153
		1945	13.471
		1946	13.375
		1947	15.011
		1948	15.408
		1949	14.477
		1950	14.833
		1951	15.444
		1952	16.014
		1953	17.224
		1954	16.151
		1955	17.139
		1956	17.267
		1957	16.992
		1958	16.576
		1959	17.601
		1960	17.644
		1961	16.712
		1962	18.468
		1963	19.539
		1964	19.855
		1965	21.341
		1966	21.939
		1967	21.373
		1968	19.742
		1969	22.916
		1970	21.771
		1971	23.024
		1972	23.449
		1973	24.247
		1974	22.066
		1975	22.190
		1976	24.594
		1977	25.213
		1978	25.499
		1979	26.231
		1980	23.541
		1981	23.582
		1982	22.417
		1983	22.207
		1984	22.601
		1985	21.767
	Leslie	1959	.182
		1960	.180
		1961	.199
		1962	.170
		1963	.195
		1964	.185
		1965	.185
		1966	.184
		1967	.190
		1968	.185
		1969	.185
		1970	--
		1971	--
		1972	--
		1973	.198
Ingham	Leslie	1974	0.242
		1975	--
		1976	.269
		1977	.255
		1978	.277
		1979	.287
		1980	.258
		1981	.248
		1982	.258
		1983	.255
		1984	.302
		1985	.264
	Mason	1903	.103
		1904	--
		1905	--
		1906	--
		1907	--
		1908	--
		1909	--
		1910	--
		1911	--
		1912	--
		1913	--
		1914	--
		1915	--
		1916	--
		1917	--
		1918	--
		1919	--
		1920	--
		1921	--
		1922	--
		1923	--
		1924	--
		1925	--
		1926	--
		1927	--
		1928	--
		1929	--
		1930	--
		1931	--
		1932	--
		1933	--
		1934	--
		1935	--
		1936	--
		1937	--
		1938	--
		1939	--
		1940	--
		1941	--
		1942	--
		1943	--
		1944	--
		1945	--
		1946	--
		1947	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Ingham	Mason	1948	--
		1949	--
		1950	--
		1951	--
		1952	--
		1953	--
		1954	--
		1955	--
		1956	--
		1957	--
		1958	0.367
		1959	.379
		1960	.386
		1961	.485
		1962	.403
		1963	.469
		1964	.464
		1965	.475
		1966	.506
		1967	.514
		1968	.515
		1969	.554
		1970	.508
		1971	.565
		1972	.527
		1973	.492
		1974	.610
		1975	.578
		1976	.599
		1977	.565
		1978	.524
		1979	.630
		1980	.596
		1981	.638
		1982	.624
		1983	.635
		1984	.658
		1985	.658
	Stockbridge	1961	.064
		1962	.071
		1963	.072
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	.110
		1975	.104
		1976	.127
		1977	.123
		1978	.136
		1979	.137
		1980	.119
Ingham	Stockbridge	1981	0.121
		1982	.129
		1983	.111
		1984	.149
		1985	.144
	Webberville	1975	.101
		1976	.113
		1977	.137
		1978	.153
		1979	.138
		1980	.123
		1981	.137
		1982	.135
		1983	.165
		1984	.187
		1985	.150
	Williamston	1967	.140
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	--
		1975	.404
		1976	--
		1977	.270
		1978	.255
		1979	.260
		1980	.249
		1981	.309
		1982	.289
		1983	.264
		1984	--
		1985	.249
Ionia	Belding	1950	.432
		1951	.486
		1952	.467
		1953	.569
		1954	.625
		1955	.858
		1956	.797
		1957	.799
		1958	.892
		1959	1.084
		1960	1.369
		1961	1.527
		1962	1.824
		1963	1.606
		1964	1.855
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Ionia	Belding	1970	--
		1971	--
		1972	--
		1973	--
		1974	1.702
		1975	2.054
		1976	--
		1977	1.496
		1978	1.819
		1979	1.899
		1980	1.554
		1981	1.605
		1982	1.396
		1983	1.355
		1984	1.625
		1985	1.785
	Ionia	1936	.475
		1937	.467
		1938	.416
		1939	.441
		1940	.440
		1941	.466
		1942	.591
		1943	.695
		1944	.715
		1945	.724
		1946	.703
		1947	.805
		1948	.843
		1949	.770
		1950	.776
		1951	.766
		1952	.817
		1953	.928
		1954	.989
		1955	1.085
		1956	.908
		1957	1.067
		1958	.984
		1959	.935
		1960	.978
		1961	1.114
		1962	1.047
		1963	.971
		1964	1.023
		1965	.926
		1966	1.039
		1967	.969
		1968	1.043
		1969	1.062
		1970	--
		1971	1.059
		1972	1.139
		1973	1.242
		1974	--
		1975	--
		1976	--
		1977	0.973
		1978	.979
		1979	.977
		1980	.837
		1981	.870
		1982	.884
		1983	.911
		1984	.910
		1985	.803
	Lake Odessa	1973	.290
		1974	--
		1975	--
		1976	--
		1977	--
		1978	--
		1979	.291
		1980	.264
		1981	.283
		1982	.297
		1983	.261
		1984	.272
		1985	.305
	Muir	1974	.081
		1975	.066
		1976	.103
		1977	--
		1978	.088
		1979	.138
		1980	.122
		1981	.128
		1982	.135
		1983	.134
		1984	.131
		1985	.136
	Pewamo	1974	.042
		1975	.043
		1976	.049
		1977	.055
		1978	.054
		1979	.051
		1980	.046
		1981	.049
		1982	.051
		1983	.053
		1984	.056
		1985	.055
	Portland	1958	.307
		1959	.325
		1960	.323
		1961	.351
		1962	.343
		1963	.396
		1964	.370
		1965	.395

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Ionia	Portland	1966	0.410
		1967	.426
		1968	.419
		1969	.443
		1970	.438
		1971	.468
		1972	.487
		1973	.512
		1974	.556
		1975	.464
		1976	.446
		1977	.448
		1978	.433
		1979	.441
		1980	.402
		1981	.434
		1982	.388
		1983	--
		1984	.415
		1985	.453
	Saranac	1958	.171
		1959	.237
		1960	.280
		1961	.279
		1962	.312
		1963	.375
		1964	.259
		1965	.285
		1966	.266
		1967	.267
		1968	.353
		1969	.318
		1970	.318
		1971	.276
		1972	.313
		1973	.326
		1974	.353
		1975	.276
		1976	.337
		1977	.402
		1978	.397
		1979	.363
		1980	.297
		1981	.349
		1982	.301
		1983	.510
		1984	.531
		1985	.287
Isabella	Mt. Pleasant	1959	1.969
		1960	1.850
		1961	1.638
		1962	1.611
		1963	1.813
		1964	1.768
		1965	1.916
		1966	2.007
		1967	2.001
Isabella	Mt. Pleasant	1968	2.029
		1969	2.161
		1970	2.262
		1971	2.222
		1972	2.121
		1973	2.282
		1974	2.179
		1975	2.189
		1976	2.370
		1977	2.541
		1978	2.241
		1979	2.158
		1980	2.485
		1981	2.457
		1982	2.230
		1983	2.412
		1984	2.535
		1985	2.351
	Shepherd	1963	.065
		1964	.073
		1965	--
		1966	.072
		1967	.080
		1968	.077
		1969	.075
		1970	.083
		1971	.095
		1972	.104
		1973	--
		1974	--
		1975	--
		1976	--
		1977	.143
		1978	.132
		1979	.144
		1980	.131
		1981	.153
		1982	.127
		1983	--
		1984	--
		1985	.090
Jackson	Concord	1961	.063
		1962	.058
		1963	.076
		1964	.070
		1965	.079
		1966	.076
		1967	.081
		1968	.075
		1969	.083
		1970	.085
		1971	.113
		1972	.085
		1973	.102
		1974	.103
		1975	.132

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Jackson	Concord	1976	0.147
		1977	.164
		1978	.127
		1979	.125
		1980	.120
		1981	.116
		1982	.114
		1983	.136
		1984	.182
		1985	.205
	Grass Lake	1961	.043
		1962	.037
		1963	.070
		1964	.070
		1965	.059
		1966	.083
		1967	.064
		1968	.065
		1969	.072
		1970	.073
		1971	.090
		1972	.083
		1973	.067
		1974	.066
		1975	.063
		1976	--
		1977	.072
		1978	.059
		1979	.064
		1980	.061
		1981	.065
		1982	.622
		1983	.636
		1984	.690
		1985	.068
	Jackson	1905	2.000
		1906	--
		1907	--
		1908	--
		1909	--
		1910	--
		1911	--
		1912	--
		1913	--
		1914	--
		1915	--
		1916	--
		1917	--
		1918	--
		1919	--
		1920	--
		1921	--
		1922	--
		1923	--
		1924	--
		1925	--
		1926	--
		1927	--
		1928	5.676
		1929	6.380
		1930	--
		1931	--
		1932	--
		1933	--
		1934	--
		1935	--
		1936	--
		1937	--
		1938	--
		1939	--
		1940	--
		1941	--
		1942	--
		1943	--
		1944	--
		1945	--
		1946	--
		1947	--
		1948	--
		1949	--
		1950	8.570
		1951	--
		1952	10.016
		1953	--
		1954	--
		1955	--
		1956	--
		1957	--
		1958	10.655
		1959	12.427
		1960	10.950
		1961	11.197
		1962	11.606
		1963	11.551
		1964	12.348
		1965	12.811
		1966	14.000
		1967	12.702
		1968	12.625
		1969	12.708
		1970	11.881
		1971	12.293
		1972	13.476
		1973	13.327
		1974	12.696
		1975	11.171
		1976	11.243
		1977	11.863
		1978	11.576
		1979	10.940
		1980	10.231
		1981	9.620
		1982	9.079
		1983	8.458
		1984	8.315
		1985	8.389

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Jackson	Springport	1974	0.128
		1975	.125
		1976	.124
		1977	.123
		1978	.102
		1979	.069
		1980	.071
		1981	.099
		1982	.089
		1983	.103
		1984	.135
		1985	.102
Kent	Cedar Springs	1961	.249
		1962	--
		1963	--
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	.281
		1975	.292
		1976	.308
		1977	.373
		1978	.405
		1979	.357
		1980	.319
		1981	.335
		1982	.330
		1983	.365
		1984	.363
		1985	.404
	Grandville	1959	.481
		1960	.524
		1961	.679
		1962	.737
		1963	.724
		1964	.784
		1965	.795
		1966	.953
		1967	.916
	Kentwood	1965	1.557
	Lowell	1934	.184
		1935	--
		1936	--
		1937	--
		1938	--
		1939	--
		1940	--
		1941	--
		1942	--
		1943	--
		1944	--
		1945	--
		1946	--
		1947	--
		1948	--
		1949	--
		1950	--
		1951	--
		1952	--
		1953	--
		1954	--
		1955	--
		1956	--
		1957	--
		1958	0.254
		1959	.315
		1960	.426
		1961	.391
		1962	.471
		1963	.458
		1964	.550
		1965	.623
		1966	.494
		1967	.556
		1968	.551
		1969	.510
		1970	.508
		1971	.545
		1972	.520
		1973	.595
		1974	.534
		1975	--
		1976	--
		1977	.657
		1978	.642
		1979	.675
		1980	.667
		1981	.717
		1982	.651
		1983	.672
		1984	.663
		1985	.710
	Sparta	1958	.364
		1959	.438
		1960	.484
		1961	.456
		1962	.438
		1963	.438
		1964	.407
		1965	.440
		1966	.504
		1967	.427
		1968	.309
		1969	.339
		1970	.337

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Kent	Sparta	1971	0.419
		1972	.417
		1973	.391
		1974	.368
		1975	.321
		1976	--
		1977	.376
		1978	.345
		1979	.350
		1980	.418
		1981	.425
		1982	.398
		1983	.425
		1984	.464
		1985	.515
	Wyoming	1949	.824
		1950	.958
		1951	.641
		1952	.871
		1953	1.084
		1954	1.151
		1955	1.454
		1956	1.391
		1957	1.500
		1958	1.871
		1959	2.045
		1960	1.829
		1961	4.962
		1962	5.839
		1963	6.247
		1964	6.458
		1965	6.126
Lake	Baldwin	1974	.063
		1975	.040
		1976	--
		1977	.126
		1978	.149
		1979	.139
		1980	.139
		1981	.140
		1982	.178
		1983	.182
		1984	.225
		1985	.197
Lapeer	Clifford	1983	.053
		1984	.047
		1985	.052
	Columbiaville	1974	.130
		1975	--
		1976	.119
		1977	.137
		1978	.139
		1979	.138
		1980	.104
Lapeer	Columbiaville	1981	0.102
		1982	.100
		1983	.105
		1984	.087
		1985	.085
	Imlay City	1961	.248
		1962	.312
		1963	.317
		1964	.310
		1965	.305
		1966	.286
		1967	.310
		1968	.278
		1969	.343
		1970	.318
	Lapeer	1959	.486
		1960	.487
		1961	.495
		1962	.565
		1963	.559
		1964	.504
		1965	.559
		1966	.597
		1967	.590
		1968	.579
	North Branch	1974	.082
		1975	.095
		1976	.094
		1977	.097
		1978	.096
		1979	.103
		1980	.078
		1981	.085
		1982	.075
		1983	.090
		1984	--
		1985	.076
Livingston	Fowlerville	1959	.132
		1960	--
		1961	--
		1962	--
		1963	--
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	--
		1975	.233
		1976	.257

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Livingston	Fowlerville	1977	0.296
		1978	.409
		1979	.637
		1980	.370
		1981	.376
		1982	.294
		1983	.312
		1984	.327
		1985	.336
Midland	Coleman	1974	.093
		1975	.096
		1976	--
		1977	.112
		1978	.124
		1979	.138
		1980	.115
		1981	.120
		1982	.132
		1983	.142
		1984	--
		1985	.161
Missaukee	Lake City	1975	.152
		1976	.186
		1977	.195
		1978	.167
		1979	.171
		1980	.159
		1981	.169
		1982	.147
		1983	.137
		1984	.141
		1985	.160
	McBain	1977	.085
		1978	.063
		1979	.071
		1980	.069
		1981	.081
		1982	.080
		1983	.078
		1984	.079
		1985	.108
Montcalm	Carson City	1960	.294
		1961	.317
		1962	.277
		1963	.305
		1964	.339
		1965	.314
		1966	.311
		1967	.305
		1968	.323
		1969	.309
		1970	.294
		1971	.197
		1972	.224
Montcalm	Carson City	1973	0.196
		1974	.233
		1975	.229
		1976	.225
		1977	.208
		1978	.199
		1979	.200
		1980	.169
		1981	.159
		1982	.164
		1983	.157
		1984	.161
		1985	.169
	Edmore	1975	.230
		1976	.241
		1977	.228
		1978	.185
		1979	.178
		1980	.155
		1981	.159
		1982	.154
		1983	.186
		1984	.172
		1985	.169
	Greenville	1951	.719
		1952	--
		1953	--
		1954	1.016
		1955	--
		1956	--
		1957	1.207
		1958	1.449
		1959	1.152
		1960	.995
		1961	.847
		1962	.868
		1963	1.365
		1964	1.317
		1965	1.309
		1966	1.392
		1967	1.303
		1968	1.408
		1969	1.718
		1970	1.835
		1971	1.984
		1972	1.765
		1973	1.838
		1974	1.962
		1975	1.656
		1976	2.026
		1977	2.138
		1978	2.397
		1979	2.525
		1980	2.530
		1981	2.615
		1982	2.019

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Montcalm	Greenville	1983	2.295
		1984	2.607
		1985	2.600
	Howard City	1961	.032
		1962	.043
		1963	.056
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	.067
		1975	--
		1976	.075
		1977	.076
		1978	.069
		1979	.072
		1980	.092
		1981	.094
		1982	.100
		1983	.072
		1984	.071
		1985	.100
	Lakeview	1961	.054
		1962	.055
		1963	.094
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	--
		1975	--
		1976	--
		1977	--
		1978	--
		1979	--
		1980	--
		1981	--
		1982	--
		1983	--
		1984	.099
		1985	.088
	Sheridan	1960	.048
		1961	.050
		1962	.064
Montcalm	Sheridan	1963	0.078
		1964	.068
		1965	.070
		1966	.069
		1967	.067
		1968	.067
		1969	.067
		1970	.070
		1971	.092
		1972	.080
		1973	.090
		1974	.088
		1975	.081
		1976	.101
		1977	.099
		1978	.087
		1979	.086
		1980	.075
		1981	.077
		1982	.077
		1983	.088
		1984	.091
		1985	.094
	Stanton	1964	.055
		1965	.054
		1966	.061
		1967	.063
		1968	.079
		1969	.061
		1970	.070
		1971	.083
		1972	.088
		1973	.099
		1974	.100
		1975	.105
		1976	.105
		1977	.137
		1978	.161
		1979	.186
		1980	.188
		1981	.240
		1982	.251
		1983	.264
		1984	.332
		1985	.136
Muskegon	Montague	1947	.077
		1948	.093
		1949	--
		1950	--
		1951	--
		1952	--
		1953	--
		1954	--
		1955	--
		1956	--
		1957	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Muskegon	Montague	1958	--
		1959	--
		1960	0.204
		1961	.206
		1962	.210
		1963	.205
		1964	.210
		1965	.168
		1966	.173
		1967	.162
		1968	.194
		1969	.254
		1970	.216
		1971	.240
		1972	.208
		1973	.197
		1974	.215
		1975	.223
		1976	.216
		1977	.215
		1978	.265
		1979	.262
		1980	.236
		1981	.239
		1982	.224
		1983	.251
		1984	.253
		1985	.239
	Ravenna	1971	.062
		1972	--
		1973	--
		1974	.070
		1975	.067
		1976	.079
		1977	.073
		1978	.077
		1979	.080
		1980	--
		1981	.096
		1982	.077
		1983	--
		1984	--
		1985	.056
	Whitehall	1960	.389
		1961	.402
		1962	.423
		1963	.463
		1964	.487
		1965	.455
		1966	.642
		1967	.782
		1968	1.014
		1969	1.043
		1970	1.068
		1971	1.324
		1972	1.241
		1973	1.193
Muskegon	Whitehall	1974	1.162
		1975	1.256
		1976	1.302
		1977	1.241
		1978	1.272
		1979	1.451
		1980	1.346
		1981	1.334
		1982	1.346
		1983	1.399
		1984	1.345
		1985	1.317
Newaygo	Fremont	1940	.205
		1941	.210
		1942	.224
		1943	.202
		1944	.211
		1945	.194
		1946	--
		1947	--
		1948	.198
		1949	--
		1950	.376
		1951	.551
		1952	.605
		1953	.629
		1954	.532
		1955	.491
		1956	.438
		1957	.484
		1958	.580
		1959	.587
		1960	.565
		1961	.676
		1962	.697
		1963	.564
		1964	.569
		1965	.646
		1966	.638
		1967	.651
		1968	.810
		1969	.873
		1970	--
		1971	.809
		1972	.688
		1973	.672
		1974	.740
		1975	.705
		1976	.929
		1977	.765
		1978	.826
		1979	.783
		1980	.955
		1981	.904
		1982	.988
		1983	1.133
		1984	1.240

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Newaygo	Fremont	1985	1.048
	Hesperia	1974	.061
		1975	.059
		1976	.061
		1977	.062
		1978	.062
		1979	.077
		1980	.044
		1981	.053
		1982	.051
		1983	.056
		1984	.056
		1985	.063
	Newaygo	1974	.194
		1975	.202
		1976	.189
		1977	.254
		1978	.214
		1979	.183
		1980	.169
		1981	.148
		1982	.125
		1983	.212
		1984	.178
		1985	.164
	White Cloud	1974	.233
		1975	.262
		1976	.330
		1977	.273
		1978	.285
		1979	.373
		1980	.327
		1981	.399
		1982	.294
		1983	.224
		1984	.281
		1985	.232
Oakland	Holly	1960	.285
		1961	.340
		1962	.410
		1963	.400
		1964	.391
		1965	.399
		1966	--
		1967	--
		1968	.483
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	--
		1975	.380
Oakland	Holly	1976	--
		1977	0.471
		1978	.501
		1979	.473
		1980	.474
		1981	.428
		1982	.422
		1983	.423
		1984	.446
		1985	.458
Oceana	Shelby	1974	.525
		1975	.428
		1976	--
		1977	.130
		1978	.055
		1979	.382
		1980	.050
		1981	.052
		1982	.045
		1983	.039
		1984	.048
		1985	.372
Ogemaw	Rose City	1979	.006
		1980	.013
		1981	.011
		1982	.012
		1983	.013
		1984	.008
		1985	.015
	West Branch	1960	.226
		1961	.231
		1962	.236
		1963	.244
		1964	.233
		1965	.236
		1966	.225
		1967	.204
		1968	.216
		1969	.246
		1970	.270
		1971	.298
		1972	.308
		1973	.332
		1974	.318
		1975	.292
		1976	.327
		1977	.350
		1978	.341
		1979	.358
		1980	.319
		1981	.315
		1982	.322
		1983	.288
		1984	.299
		1985	.288

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Osceola	Evart	1960	1.233
		1961	.953
		1962	1.216
		1963	1.578
		1964	1.438
		1965	1.057
		1966	1.153
		1967	1.326
		1968	1.401
		1969	1.616
		1970	1.730
		1971	1.549
		1972	1.600
		1973	1.688
		1974	1.678
		1975	2.167
		1976	1.951
		1977	2.227
		1978	2.290
		1979	2.157
		1980	1.773
		1981	1.714
		1982	1.823
		1983	2.134
		1984	2.181
		1985	2.036
	Marion	1974	.127
		1975	--
		1976	--
		1977	.120
		1978	.145
		1979	.179
		1980	.164
		1981	.167
		1982	.119
		1983	--
		1984	.111
		1985	.125
	Reed City	1974	.342
		1975	.323
		1976	.406
		1977	.487
		1978	.507
		1979	.466
		1980	.394
		1981	.365
		1982	.375
		1983	.389
		1984	.354
		1985	.333
Ottawa	Coopersville	1960	.109
		1961	--
		1962	.126
		1963	.154
		1964	.148
		1965	0.146
		1966	.135
		1967	.153
		1968	.161
		1969	.176
		1970	.163
		1971	.190
		1972	.157
		1973	.161
		1974	.142
		1975	.146
		1976	--
		1977	.167
	Grand Haven	1905	1.125
		1906	--
		1907	--
		1908	--
		1909	--
		1910	--
		1911	--
		1912	--
		1913	--
		1914	--
		1915	--
		1916	--
		1917	--
		1918	--
		1919	--
		1920	--
		1921	--
		1922	--
		1923	--
		1924	--
		1925	--
		1926	--
		1927	--
		1928	--
		1929	--
		1930	--
		1931	--
		1932	--
		1933	--
		1934	--
		1935	--
		1936	--
		1937	--
		1938	--
		1939	--
		1940	--
		1941	--
		1942	--
		1943	--
		1944	--
		1945	--
		1946	1.000
		1947	--
		1948	--
		1949	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Ottawa	Grand Haven	1950	--
		1951	--
		1952	--
		1953	--
		1954	--
		1955	--
		1956	--
		1957	--
		1958	--
		1959	--
		1960	3.008
	Hudsonville	1951	.090
		1952	.097
		1953	.104
		1954	.122
		1955	.155
		1956	.158
		1957	.152
		1958	.164
		1959	.180
		1960	.162
		1961	.191
		1962	.205
		1963	.200
		1964	.209
		1965	.201
		1966	.176
	Spring Lake	1958	.368
		1959	.425
		1960	.416
		1961	.404
		1962	.397
		1963	.373
		1964	.354
		1965	.348
		1966	.374
		1967	.371
		1968	.402
		1969	.445
		1970	.484
		1971	.499
		1972	.442
		1973	.447
		1974	.408
		1975	.407
		1976	.436
		1977	.481
		1978	.468
		1979	.456
		1980	.373
		1981	.387
		1982	.368
		1983	--
		1984	.407
		1985	.501
Ottawa	Zeeland	1960	0.783
		1961	.898
		1962	.899
Roscommon	Roscommon	1962	.132
		1963	.132
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	.142
		1975	.147
		1976	.175
		1977	.217
		1978	.151
		1979	.182
		1980	.176
		1981	--
		1982	--
		1983	.201
		1984	.215
		1985	.203
Saginaw	Birch Run	1972	.157
	Chesaning	1974	.278
		1975	.272
		1976	.301
		1977	.352
		1978	.307
		1979	.336
		1980	.312
		1981	.292
		1982	.275
		1983	.283
		1984	--
		1985	.313
	Freeland	1974	.111
		1975	.121
		1976	.155
		1977	.175
		1978	.163
		1979	.192
		1980	.209
		1981	.212
		1982	.238
		1983	.236
	Hemlock	1977	.125
		1978	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Saginaw	Hemlock	1979	0.118
		1980	--
		1981	.122
		1982	.109
		1983	.103
		1984	.099
		1985	.163
	St. Charles	1961	.117
		1962	.145
		1963	.149
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	.175
Sanilac	Brown City	1974	.199
		1975	.174
		1976	.167
		1977	.176
		1978	.164
		1979	.137
		1980	--
		1981	--
		1982	--
		1983	--
		1984	--
		1985	.168
	Marlette	1974	.295
		1975	.278
		1976	.288
		1977	.330
		1978	.312
		1979	.342
		1980	.294
		1981	.279
		1982	.249
		1983	.254
		1984	.275
		1985	.274
	Sandusky	1960	.469
		1961	.448
		1962	.349
		1963	.462
		1964	.426
		1965	.499
		1966	.478
		1967	.440
		1968	.530
		1969	.524
Sanilac	Sandusky	1970	0.523
		1971	.556
		1972	.579
		1973	.627
		1974	.523
		1975	.563
		1976	--
		1977	.588
		1978	.579
		1979	.549
		1980	.570
		1981	--
		1982	.568
		1983	.633
		1984	.596
		1985	.449
Shiawasee	New Lathrop	1971	.036
		1972	.044
		1973	.046
		1974	.047
		1975	.046
		1976	.049
		1977	.053
		1978	.049
		1979	.051
		1980	.055
		1981	.068
		1982	.058
		1983	.060
		1984	.063
		1985	.070
	Bancroft	1974	.056
		1975	.045
		1976	--
		1977	.063
		1978	.058
		1979	.050
		1980	.056
		1981	.045
		1982	.048
		1983	.049
		1984	.061
		1985	.056
	Byron	1974	.040
		1975	.054
		1976	.039
		1977	.045
		1978	.063
		1979	.070
		1980	.063
		1981	.062
		1982	.060
		1983	.061
		1984	.062
		1985	.061

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Shiawassee	Corunna	1957	0.190
		1958	.180
		1959	.181
		1960	.193
		1961	.196
		1962	.185
		1963	.193
		1964	.171
		1965	.170
		1966	.169
		1967	.166
		1968	.164
		1969	--
		1970	.188
		1971	--
		1972	--
		1973	.222
		1974	.224
		1975	.221
		1976	.240
		1977	.252
		1978	.289
		1979	--
		1980	--
		1981	.224
		1982	--
		1983	--
		1984	.241
		1985	.268
	Durand	1947	.171
		1948	.196
		1949	.181
		1950	.207
		1951	.248
		1952	.236
		1953	.265
		1954	.316
		1955	.366
		1956	.339
		1957	.329
		1958	.329
		1959	.333
		1960	.334
		1961	.356
		1962	.325
		1963	.346
		1964	.376
		1965	.393
		1966	.375
		1967	.376
		1968	.380
		1969	.430
		1970	.430
		1971	.505
		1972	.551
		1973	.476
		1974	.467
		1975	.450
		1976	0.519
		1977	.505
		1978	.364
		1979	.359
		1980	.370
		1981	.373
		1982	.375
		1983	.387
		1984	.370
		1985	.343
	Owosso	1940	1.158
		1941	1.313
		1942	1.315
		1943	1.636
		1944	1.743
		1945	1.573
		1946	1.816
		1947	1.834
		1948	1.956
		1949	1.870
		1950	--
		1951	1.889
		1952	2.022
		1953	2.104
		1954	1.931
		1955	2.101
		1956	2.104
		1957	2.153
		1958	2.370
		1959	2.528
		1960	2.427
		1961	2.491
		1962	2.758
		1963	2.442
		1964	2.494
		1965	2.643
		1966	2.596
		1967	2.433
		1968	2.448
		1969	2.596
		1970	2.667
		1971	2.892
		1972	2.682
		1973	2.740
		1974	2.698
		1975	2.534
		1976	2.531
		1977	2.570
		1978	2.626
		1979	2.533
		1980	2.392
		1981	2.195
		1982	2.239
		1983	2.131
		1984	2.340
		1985	2.177

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Shiawassee	Perry	1958	0.053
		1959	.054
		1960	.060
		1961	.062
		1962	.066
		1963	.078
		1964	.070
		1965	.072
		1966	.074
		1967	.081
		1968	.076
		1969	.081
		1970	.105
		1971	.144
		1972	.112
		1973	.118
		1974	.127
		1975	.132
		1976	.147
		1977	.160
		1978	.180
		1979	.170
		1980	.156
		1981	.169
		1982	.161
		1983	.164
		1984	.175
		1985	.167
Tuscola	Akron	1974	.770
		1975	.922
		1976	.929
		1977	.919
		1978	.307
		1979	.304
		1980	.316
		1981	.045
		1982	.009
		1983	.005
		1984	.004
		1985	.411
	Caro	1974	.540
		1975	.548
		1976	.582
		1977	.653
		1978	.626
		1979	.589
		1980	.602
		1981	.592
		1982	.593
		1983	.589
		1984	.627
		1985	.519
	Cass City	1959	.308
		1960	.301
		1961	.223
Tuscola	Cass City	1962	0.204
		1963	.196
		1964	.183
		1965	.202
		1966	--
		1967	.213
		1968	.223
		1969	.263
		1970	.237
		1971	.281
		1972	.302
		1973	.320
		1974	.301
		1975	.296
		1976	.329
		1977	.378
		1978	.339
		1979	.315
		1980	.285
		1981	.273
		1982	.245
		1983	.275
		1984	.312
		1985	.303
	Kingston	1974	.044
		1975	.050
		1976	.048
		1977	.044
		1978	.050
		1979	.047
		1980	.043
		1981	.034
		1982	.036
		1983	.041
		1984	.041
		1985	.036
	Mayville	1974	.048
		1975	.140
		1976	--
		1977	.134
		1978	.013
		1979	.120
		1980	.135
		1981	.132
		1982	.081
		1983	.108
		1984	.079
		1985	.090
	Millington	1970	.152
		1971	--
		1972	--
		1973	--
		1974	--
		1975	--
		1976	--

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Tuscola	Millington	1977	--
		1978	0.146
		1979	.134
		1980	.130
		1981	.130
		1982	.125
		1983	.126
		1984	.125
		1985	.139
	Unionville	1979	.041
		1980	.041
		1981	.041
		1982	.042
		1983	.041
		1984	.039
		1985	.039
	Vassar	1960	.457
		1961	.451
		1962	--
		1963	--
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	--
		1975	.566
		1976	.627
		1977	.683
		1978	.516
		1979	.648
		1980	.605
		1981	.650
		1982	.597
		1983	.532
		1984	.564
		1985	.561
Washtenaw	Chelsea	1951	.345
		1952	.384
		1953	.415
		1954	.387
		1955	.413
		1956	.405
		1957	--
		1958	.391
		1959	.423
		1960	.404
		1961	--
		1962	--
		1963	--
Washtenaw	Chelsea	1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	0.589
		1973	.570
		1974	.567
		1975	.568
		1976	.608
		1977	.604
		1978	.605
		1979	.555
		1980	.524
		1981	.528
		1982	.495
		1983	.546
		1984	.539
		1985	.517
	Dexter	1961	.143
		1962	.148
		1963	.151
		1964	.164
		1965	.176
		1966	.188
		1967	.213
		1968	.219
		1969	--
		1970	.217
		1971	.243
		1972	.243
		1973	.222
		1974	.256
		1975	.220
		1976	.259
		1977	.284
		1978	--
		1979	.207
		1980	.218
		1981	.190
		1982	.216
		1983	.207
		1984	.198
		1985	.213
Wexford	Cadillac	1961	.834
		1962	1.447
		1963	1.825
		1964	1.556
		1965	1.560
		1966	2.053
		1967	1.776
		1968	1.900
		1969	2.115
		1970	1.999

Table 2.--*Reported ground-water withdrawals for municipal water supplies in the central Lower Peninsula of Michigan, by county*--Continued

County	Municipal water supply	Year	Withdrawal (million gallons per day)
Wexford	Cadillac	1971	1.924
		1972	1.784
		1973	2.031
		1974	2.162
		1975	2.189
		1976	2.288
		1977	2.377
		1978	2.330
		1979	2.188
		1980	2.023
		1981	1.901
		1982	1.736
		1983	1.852
		1984	2.023
		1985	2.111
	Manton	1960	.052
		1961	.043
		1962	--
		1963	--
		1964	--
		1965	--
		1966	--
		1967	--
		1968	--
		1969	--
		1970	--
		1971	--
		1972	--
		1973	--
		1974	.086
		1975	.088
		1976	.092
		1977	.174
		1978	.196
		1979	.225
		1980	.167
		1981	.144
		1982	.132
		1983	.142
		1984	.160
		1985	.143