WATER SUPPLY REPORT NUMBER FIVE

STATE OF MICHIGAN

DEPARTMENT OF CONSERVATION
Gerald E. Eddy, Director

GEOLOGICAL SURVEY DIVISION
William L. Daoust, State Geologist

SUMMARY OF GROUND-WATER CONDITIONS IN MICHIGAN

1960

By

P. R. Giroux and Ted Thompson
U. S. Geological Survey

Prepared in cooperation with the
United States Department of the Interior
Geological Survey

1961

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INTRODUCTION

This report is the fifth of a series covering ground-water levels and related hydrologic data in the State of Michigan . It summarizes and interprets, in part, the results of the program of measurement of ground-water levels and the collection of other pertinent hydrologic information by the U. S. Geological Survey. The program is a part of the overall water-resources investigation carried out in cooperation with the Michigan Geological Survey, and during 1960, with the following cities, townships, and villages:

Cooperator	Cooperating Official
City of Alma	J. D. McNaughton, City Manager
City of Battle Creek, Water and Sewer Div., Dept. of Public Works	K. E. Garvey, Superintendent
City of Grand Ledge, Water Dept.	Harrison Millard, Superintendent
City of Hastings, Public Services	K. P. Laberteaux, Director
City of Jackson, Water Dept.	J. M. Rogeven, Superintendent
City of Kalamazoo, Utilities Dept.	Albert Sabo, Manager
City of Lansing, Board of Water and Light	O. E. Eckert, General Manager
Village of Ontonagon	Warren Millard, Village Supt.
City of Pontiac, Water Dept.	H. G. Parker, Superintendent

Township of Waterford	J. E. Seeterlin, Township Clerk
City of St. Louis	R. M. Henneberger, Jr., City Mgr.
City of Wyoming	P. T. Spelman, City Engineer
City of Ypsilanti, Water Purification Plant	John Max, Superintendent
Township of Ypsilanti, Water and Sewer Dept.	Robert Norris, Manager

Cooperative ground-water investigations by the U. S. Geological Survey in Michigan are directed jointly by O. M. Hackett, Chief of the Ground Water Branch, U. S. Geological Survey, Washington, D. C., and W. L. Daoust, State Geologist, Michigan Geological Survey, Lansing, and are supervised by Morris Deutsch, District Geologist.

Records and interpretations of water levels and artesian pressures from 1935 through 1955 have been published in the annual series of U. S. Geological Survey Water-Supply Papers entitled "Water Levels and Artesian Pressures in the United States". The following tabulation lists the papers containing water-level data for Michigan:

Year	No.	Year	No.	Year	No.
1935	777	1942	944	1949	1156
1936	817	1943	986	1950	1165
1937	840	1944	1016	1951	1191
1938	845	1945	1023	1952	1221
1939	886	1946	1071	1953	1265
1940	906	1947	1096	1954	1321
1941	936	1948	1126	1955	1404

Beginning in 1956, the U. S. Geological Survey discontinued publication of its series of annual reports and is now publishing, at 5-year intervals, a reduced number of water-level records without interpretive text or illustrations. The first of these series for the

Northeastern States, which includes Michigan, has been published for the 2-year period 1956-57 as Water-Supply Paper No. 1537. The needs of the State, however, require more detailed and current ground-water information. As a result, publication of annual Water Supply Reports entitled "Summary of ground-water conditions in Michigan" by the Michigan Geological Survey was started in 1956.

The first four reports of this series published, cover ground-water conditions in Michigan for the calendar years 1956 through 1959 as follows:

Water Supply Report	Year
1	1956
2	1957
3	1958
4	1959

The Water Supply Reports are designed to supplement data contained in the Federal reports and also provide interpretive text and illustrations. By means of these ground-water summaries, basic information concerning ground-water conditions in Michigan are made readily available to the public.

Objectives of the Observation Well Program

The observation-well program in Michigan is a part of a nation-wide program, the purpose of which was summarized by Sayre (Water-Supply Paper 1404, p. 1, 1957) as follows:

"The objectives of the observation-well program are to provide a day-to-day evaluation of available ground-water supplies, to facilitate the prediction of trends in ground-water levels that will indicate the probable status of important ground-water supplies in the

future, to delineate present or potential areas of detrimentally high or low ground-water levels, to aid in the prediction of the base flow of streams, to determine the several forces that act on a ground-water body, and to demonstrate the interplay of those forces in the ground-water regimen, to furnish information for use in basic research, and to provide long-term continuous records of fluctuations of water levels in representative wells. These selected records serve as a framework to which many short-term records collected during an intensive investigation may be related."

Scope of this Report

This report was based on periodic measurements of water levels made during 1960 in 209 wells, of which 57 were equipped with continuous recording gages. The report summarizes water-level changes observed throughout the State, and analyzes these changes in selected areas. During 1960 the program was expanded to include cooperation with the major users of ground water listed above. The main purpose of the expansion was to observe and analyze the effects of pumping on water levels in important areas of ground-water withdrawals. During the year, 24 recording gages were installed in wells tapping several different aquifers in 14 municipalities. The distribution of all wells in which water levels were observed in 1960 is shown in figure 1.

Figure 2 is a geologic section through the Michigan basin illustrating the geometry and extent of the bedrock formations that include important fresh-water aquifers in varying parts of the State. Surficial deposits of glacial drift--although present over most of the State--are not shown.


ISLE ROYALE
TO KEWEENAW COUNTY
EXPLANATION
Observation well
Two or more observation wells
N
0 10 20 30 Miles
R.30W.
T. 49 N.
Diagram of geographical township
KEWEENAW
HOUGHTON
KEWEENAW BAY
LAKE SUPERIOR
ONTONAGON
BARAGA
GOGEBIC
MARQUETTE
ALGER
LUCE
WHITEFISH BAY
CHIPPEWA
MACKINAC
SCHOOLCRAFT
IRON
DICKINSON
DELTA
WISCONSIN
Menominee River
MENOMINEE
GREEN BAY
LAKE MICHIGAN
LAKE HURON
TO MACKINAC COUNTY

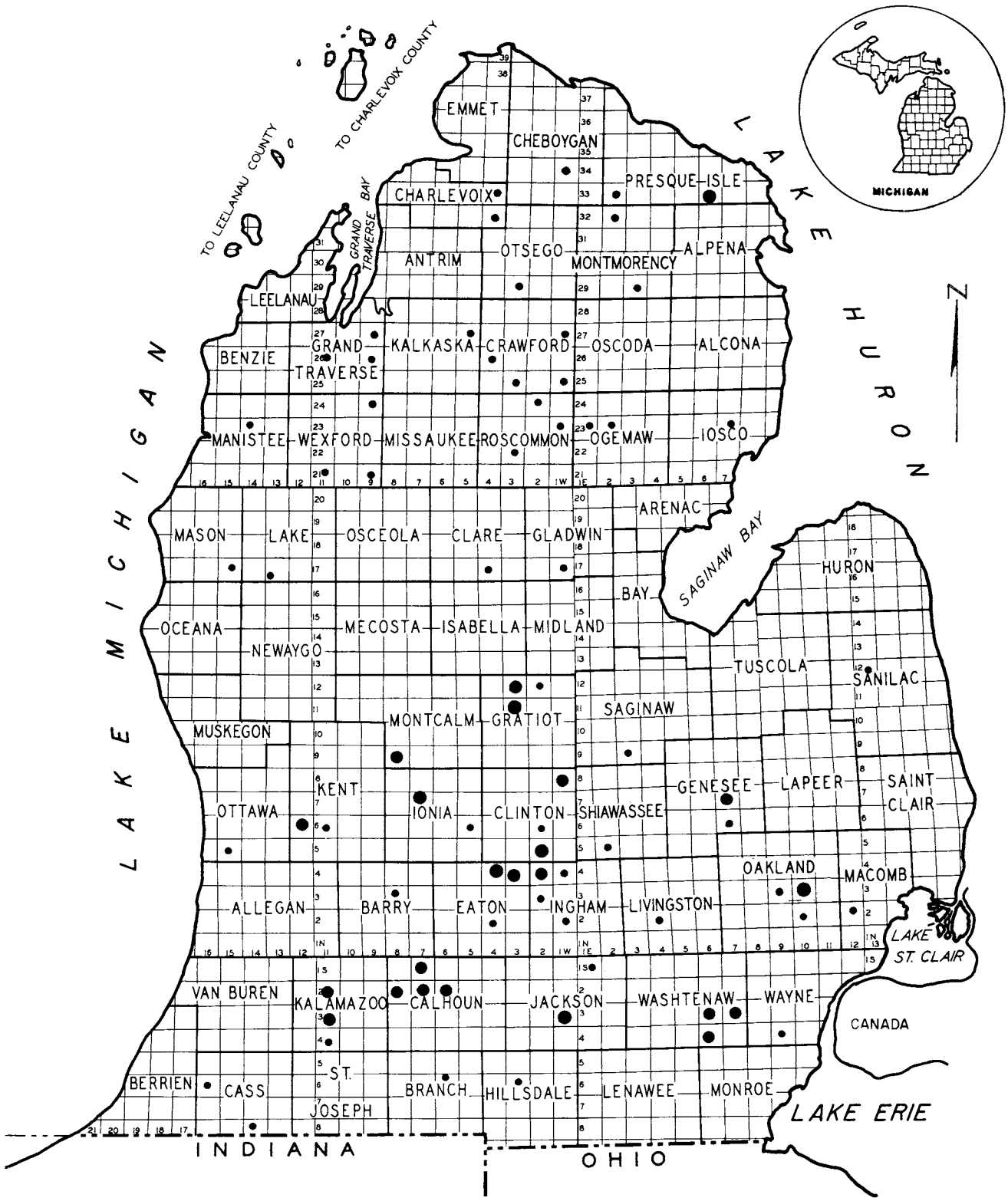


Figure 1. Location of observation wells in Michigan, 1960

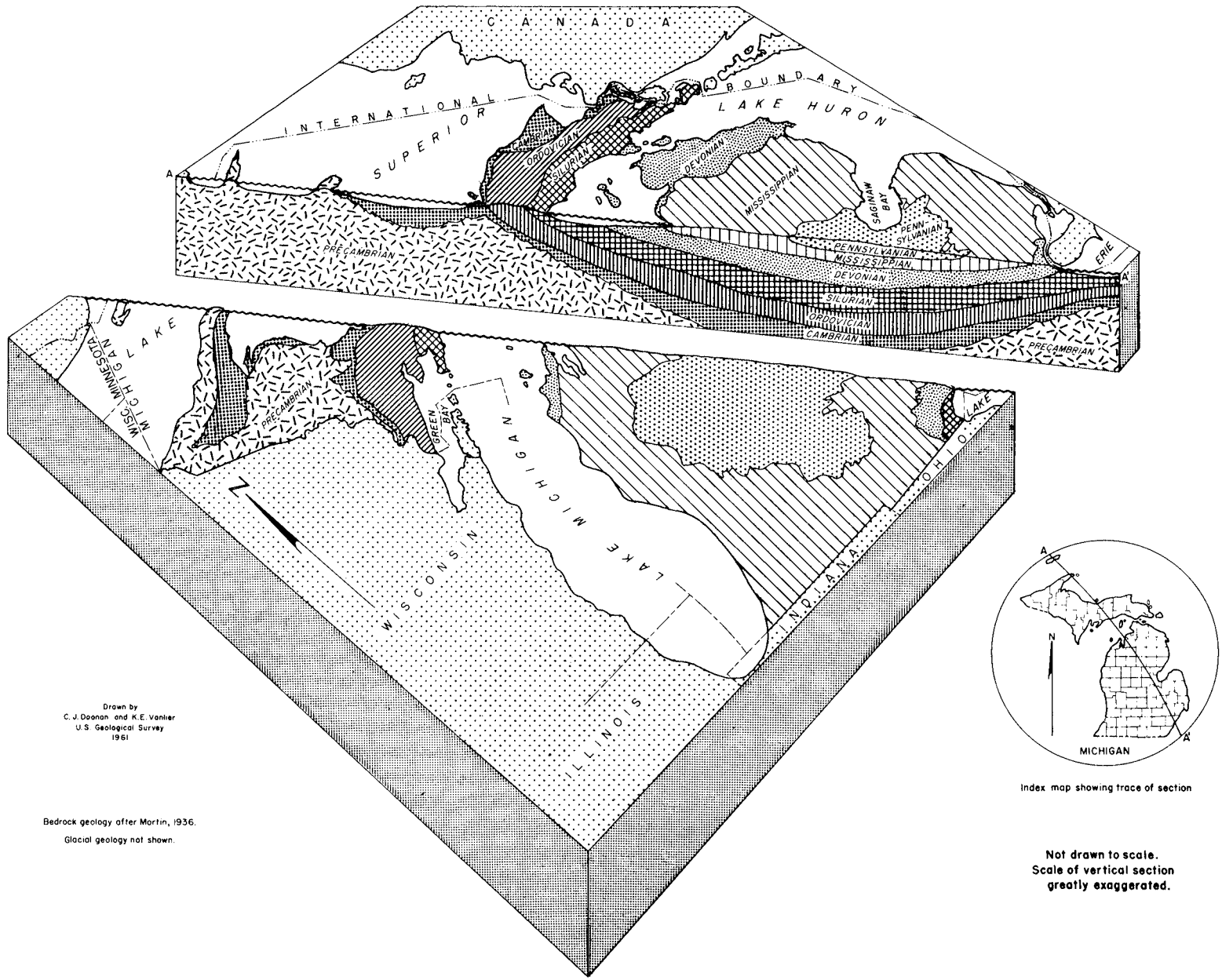


Figure 2.--Block diagram showing schematic geological cross-section through the Michigan basin.

Table 1 lists the basic information for each observation well, and the extremes of water-level fluctuations in 1960 and for the previous period of record. Fluctuations of water levels in representative wells are also shown by numerous hydrographs, and in many cases graphic interpretations of the changes in water level are made by including pertinent climatic and (or) pumpage data.

Several illustrations in this report include graphs showing the cumulative departures of annual precipitation from the long-term mean. These graphs were constructed by using the "zero" or "average" line to denote the average precipitation for the period of record preceding the period of the graph. Starting at this line the excess or deficiency of precipitation for each month or year is added algebraically to prepare the cumulative departure graph. Thus, for each time unit, a line sloping downward always indicates below-average precipitation and a line sloping upward, above-average precipitation. In cumulative graphs such as these, the slope of the line is the important part--that is, even where the graph is far below the zero line, if the slope is upward the period is one of above-average precipitation. The end point of the graph thus also gives the total rainfall above or below the average for the entire period of the graph.

Table 2 lists the reported monthly and annual ground-water pumpage for many municipalities, institutions, and some of the industries in the State.

A discussion of principles of occurrence and movement of ground water and causes of water-level fluctuations was included in previous reports of this series.

Open-File and Published Records

Complete tabulations of water-level measurements and hydrographs for each observation well, records of chemical quality of ground water, water-temperature measurements, well records including logs, aquifer tests, records of pumping for public supply and industrial use, and published and unpublished water-resource reports are on file for public inspection. They may be examined at the office of the Water Resources Section of the Michigan Geological Survey, 4th Floor, Mason Building, Lansing or at the Michigan district office of the U. S. Geological Survey, Ground Water Branch, 407 Capitol Savings and Loan Building, Lansing. Records for the Northern Peninsula are kept on file also in the offices of the State or Federal Geological Surveys, 203 State Office Building, Escanaba.

U. S. Geological Survey Water-Supply Papers are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., or can be consulted at the offices listed above and in major university or municipal libraries. The Federal Survey also issues a monthly publication entitled "Water Resources Review" which briefly summarizes ground-water levels and streamflow throughout the United States. The monthly issues plus spring and annual summaries can be obtained free of charge by application to the Director, U. S. Geological Survey, Washington 25, D. C. Publications of the Michigan Geological Survey can be purchased from the Michigan Department of Conservation, Publications Room, Mason Building, Lansing 26, Michigan.

Reports of cooperative ground-water investigations covering specific areas of the State are published from time to time by the

Michigan Geological Survey or the U. S. Geological Survey. These reports are also available for inspection at the offices listed above.

Well-Numbering System

The well-numbering system used by the State and Federal Surveys in Michigan indicates the location of wells within the rectangular subdivision of the public lands with reference to the Michigan meridian and base line (fig. 1). The first two segments of a well number designate township and range; the third segment designates both the section and the well within the section. Thus, well number 32N 6E 16-1 is well number 1 in section 16, Township 32 North, Range 6 East. In the several small areas of the State where the rectangular subdivisions have not been made, wells are numbered as above by projection of the rectangular subdivisions to those areas.

Acknowledgments

Acknowledgment is made to personnel of Federal and State agencies, industrial concerns, municipalities, and public utilities whose cooperation has contributed to the accumulation of the basic data presented in this report.

Appreciation is also extended to Messrs. J. G. Rulison and A. E. Slaughter of the Michigan Geological Survey, for their assistance in the editing of this report series.

PRECIPITATION AND TEMPERATURE

Precipitation and temperature are the major climatic factors affecting the ground-water regimen in any area. Recharge to aquifers is supplied directly or indirectly by precipitation. Ground-water levels are affected by the quantity, the season of occurrence, the intensity, and the nature of the precipitation.

As evidenced by hydrographs of natural fluctuations of water in wells (figs. 3 and 7), spring and fall are the periods when most of the ground-water recharge occurs. In the spring before the growing season starts, snowmelt and rain normally results in large additions to the ground-water reservoirs. Layers of ice, or frost in the ground can impede infiltration when thaws occur. As a result water from snowmelt and early spring precipitation may be mostly lost to the aquifers by quick surface runoff. In the fall after the growing season ends and evapotranspiration demands are reduced by colder weather, substantial rises in water level from rains usually occur.

According to the U. S. Weather Bureau, precipitation during 1960 was well above average in the Northern Peninsula and northwestern part of the Southern Peninsula, and slightly above average in the northeastern part of the Southern Peninsula. In most of the remainder of the State it was considerably below average. For the year precipitation varied from an excess of 13 inches at Grand Marais to a deficiency of 11 inches at Pontiac.

Considerable amounts of ground-water recharge occurred in the spring of 1960, when high-water content snow melted in a few days and

heavy precipitation fell. For example, from 7 to 10 inches of rain fell between April 23 - May 10 in the western part of the Northern Peninsula. However, the amount of water available for recharge in the spring far exceeded the infiltration capacity of the land and resulted in abnormal runoff to streams and serious flooding. In the fall of 1960, precipitation was generally deficient, precluding the usual rises and most water levels continued to decline to the end of the year.

Temperatures have a strong effect on recharge rates of water into the aquifers. Accumulations of winter ice and snow cannot be recharged to the ground until it is released by thaws. In addition, the time of occurrence of spring and fall frosts or freezing weather controls the length of the growing season and hence, the amount of water transpired by vegetation. Generally, very little recharge to ground-water aquifers occurs during the growing season. However, cool weather during the warm seasons of the year reduces evapotranspiration demands.

Average temperatures during 1960 were slightly below normal. March was the coldest month of record in most of the State, with below zero readings common at most stations. However, at the end of March and early April, warm temperatures caused sudden thawing. June and July temperatures were cooler than usual thus reducing evapotranspiration. December was very cold averaging between 3 and 5 degrees F below the average and the frozen ground impeded recharge to the aquifers.

SUMMARIES OF GROUND-WATER CONDITIONS

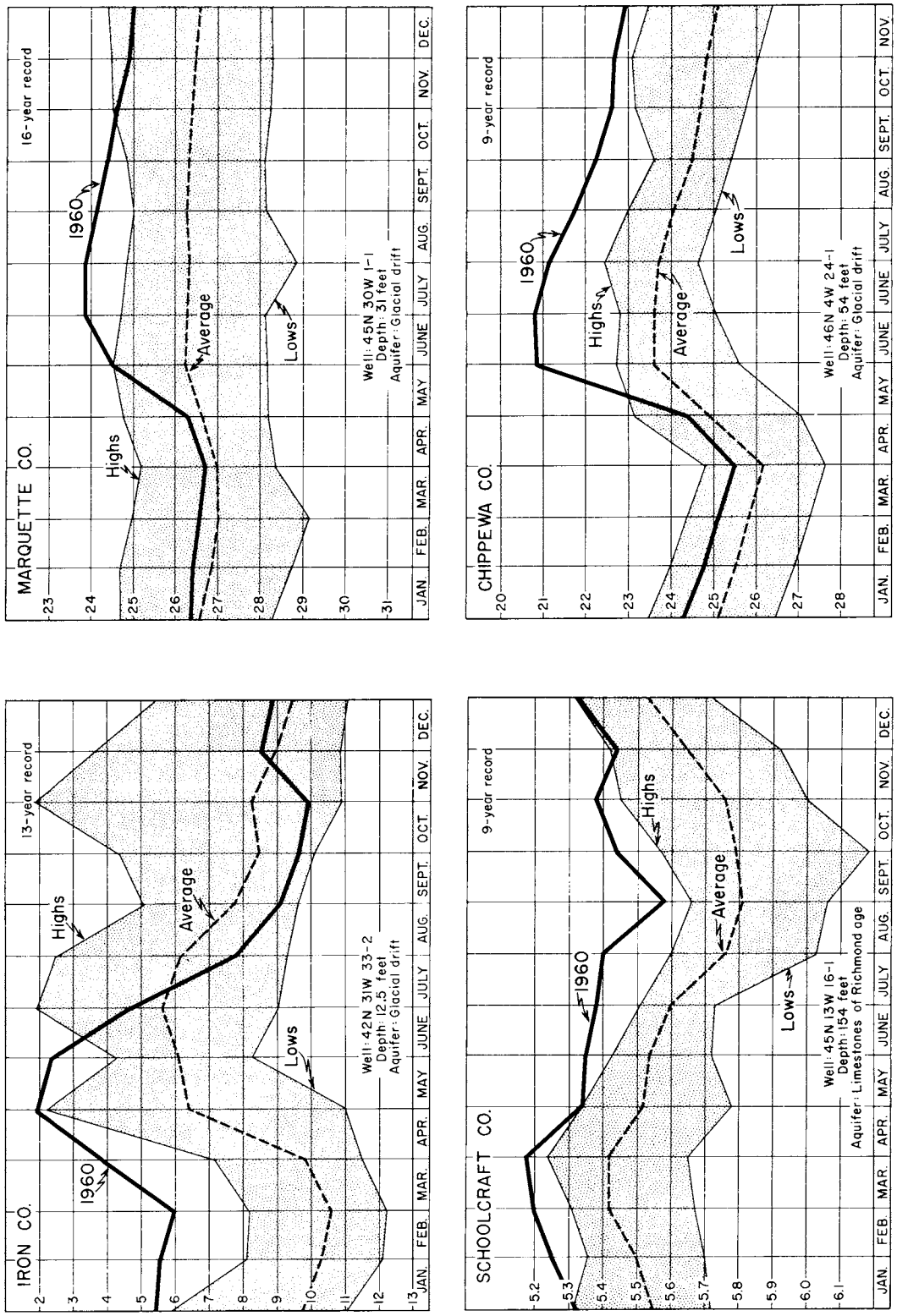
Statewide Changes in Storage from Natural Influences

Generally, in the State, ground-water levels were high at the beginning of the year owing to a carryover of high ground-water levels from the fall of 1959. Many record and near-record highs (figs. 3 and 7) occurred in the spring as the result of recharge from heavy precipitation and snowmelt. Stages continued to be well above the average for the remainder of the year in the Northern Peninsula, but in some areas of the Southern Peninsula stages fell to below-average levels owing to dryness during the fall months.

Northern Peninsula

Figure 3 shows the hydrographs of 1960 month-end levels in four key wells and compares these levels with the extremes and the average for the periods of record. New highs were recorded in all four wells for significant periods during the year. The high water levels resulted from the large amounts of recharge in the fall of 1959 and again in the spring of 1960.

Figure 4 superimposes hydrographs for three years of record for each of three observation wells. The response of water levels to infiltration from snowmelt and precipitation at different seasons of the year is apparent. Water levels in the shallow Baraga County well quickly respond to recharge while in the deeper Schoolcraft County and Chippewa County wells the recharge effects lag and thus the hydrographs reflect only general seasonal fluctuations.



High, average, and low readings are for the period of record through 1959

Figure 3. Month-end water levels in key observation wells in the Northern Peninsula, 1960.

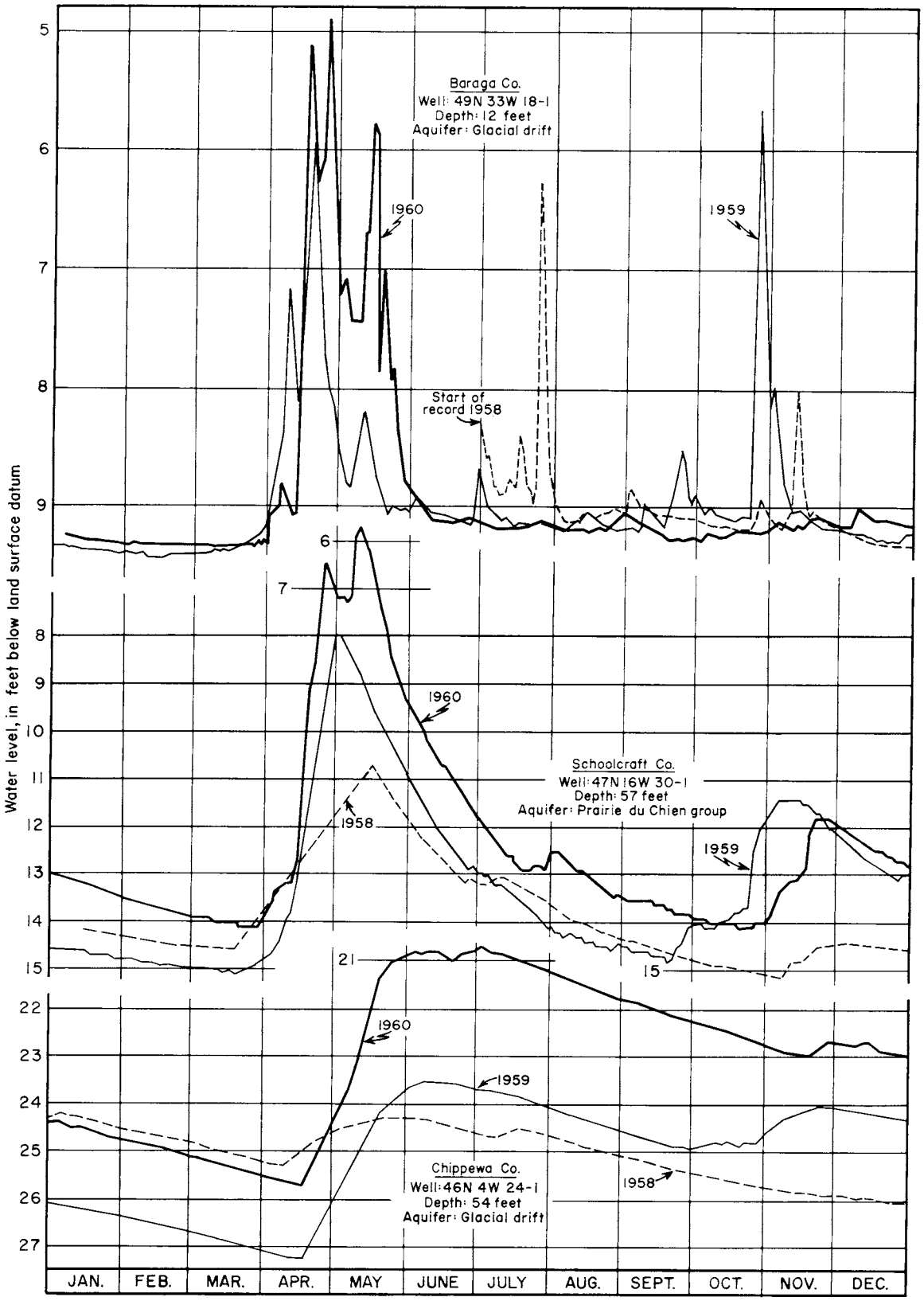


Figure 4. Hydrographs of selected wells in Baraga, Chippewa, and Schoolcraft Counties, 1958-60.

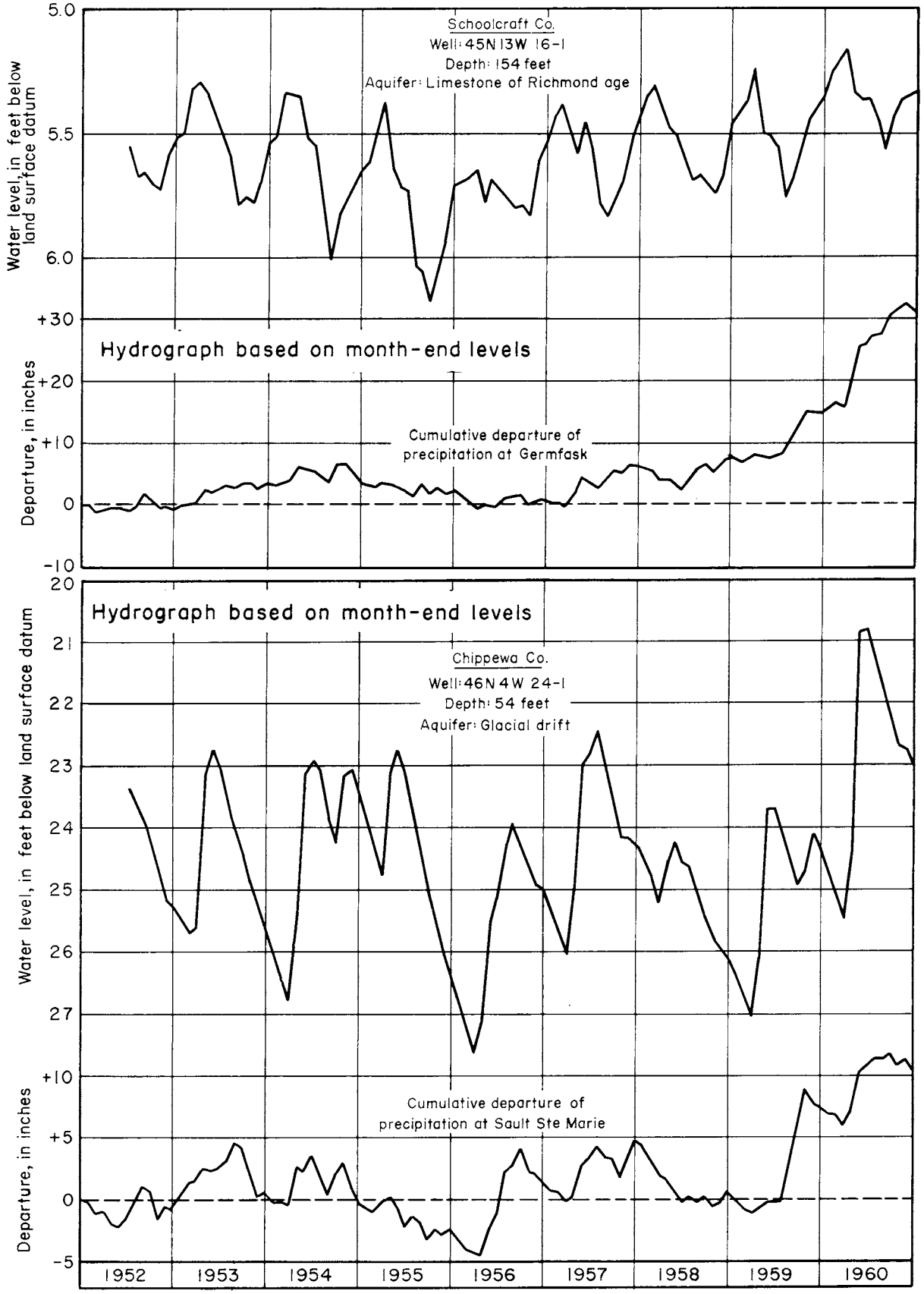


Figure 5. Hydrographs of selected wells in Chippewa and Schoolcraft Counties, and precipitation departures, 1952-60.

In figure 5 the seasonal changes in water level in 2 wells are plotted along with trends in precipitation. In general, the water levels correlate closely with precipitation departures but the pattern of seasonal fluctuations is sometimes changed by periods of intense or continuous precipitation. For instance, in the Chippewa County well the usual long seasonal decline from the spring high in one year to the next spring may be interrupted by heavy fall rains as in 1954 and 1959.

Figure 6 shows the difference in the 1960 hydrographs of three wells finished at similar depths but in different aquifers. The levels in the Ontonagon and Mackinac County wells fluctuate similarly to the Schoolcraft County well in figure 4. However, the graph of the Iron County well lacks the seasonal effects shown in the other hydrographs.

Elsewhere in the Northern Peninsula ground-water levels followed much the same general pattern--levels were high in the spring (table 1) and then generally remained above average during the remainder of the year.

Many of the observation wells presently observed in the western half of the Northern Peninsula (table 1) are those maintained by the Wisconsin-Michigan Power Co. to evaluate ground-water storage and to aid in the prediction of streamflows in the Menominee River Basin. These wells are finished at shallow depth in glacial-drift deposits and reflect changes in natural storage in the shallow aquifers of that area.

The Company issues monthly summaries of hydrologic conditions and also an annual report (Kurtyka, 1960) containing valuable hydrologic information such as weather, evapotranspiration and ground-water storage data. The report (p. 155) states "Groundwater conditions remained above normal for the Menominee River Basin during 1960***"

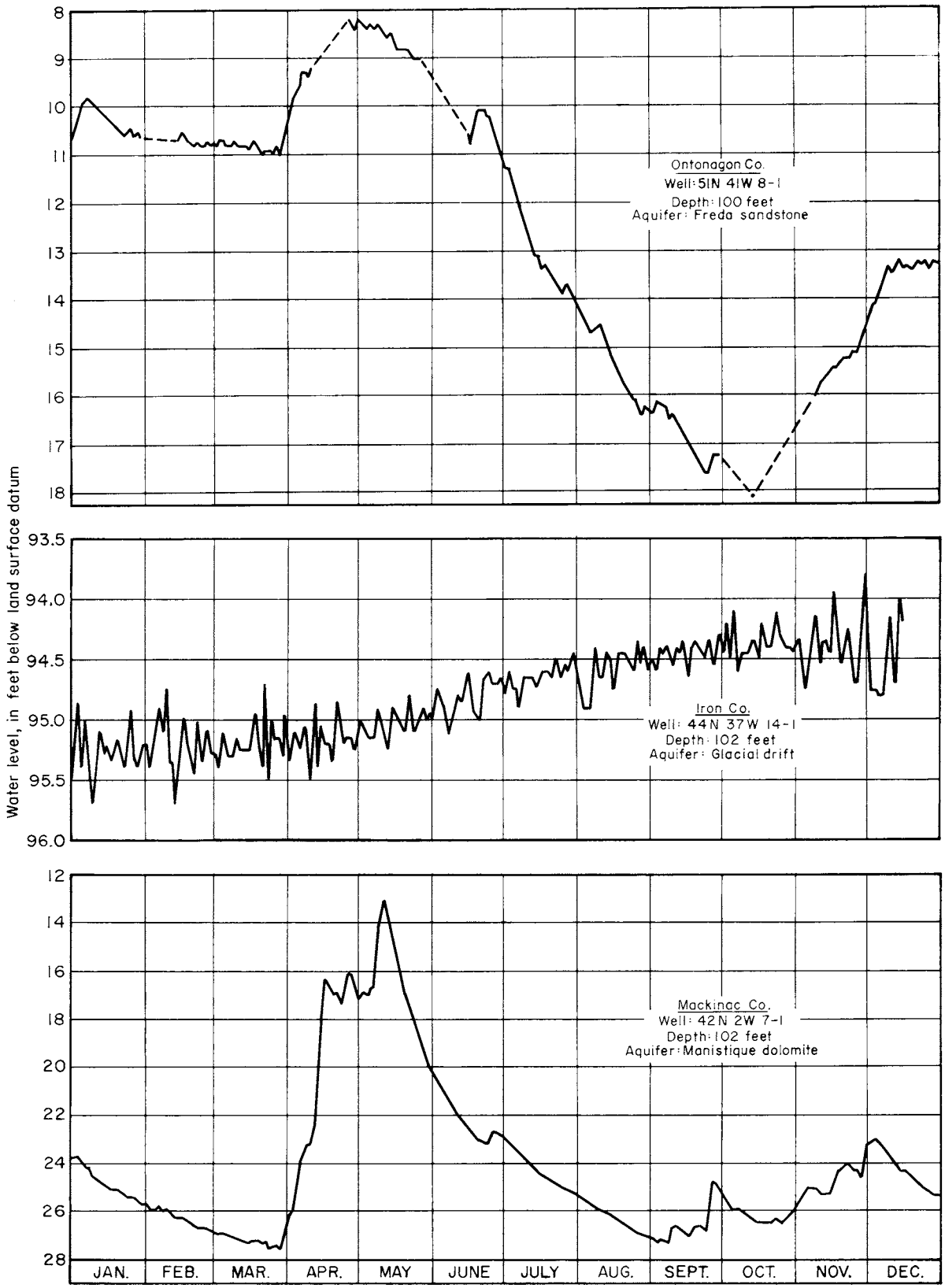


Figure 6. Hydrographs of selected wells in Iron, Mackinac, and Ontonagon Counties, 1960.

"As a result of snow cover releases and excessive precipitation during April, a new record end of the month average well elevation of 5.38 feet was established for the Menominee River Basin. This is about 1.8 feet above the normal April average well elevation."

Southern Peninsula

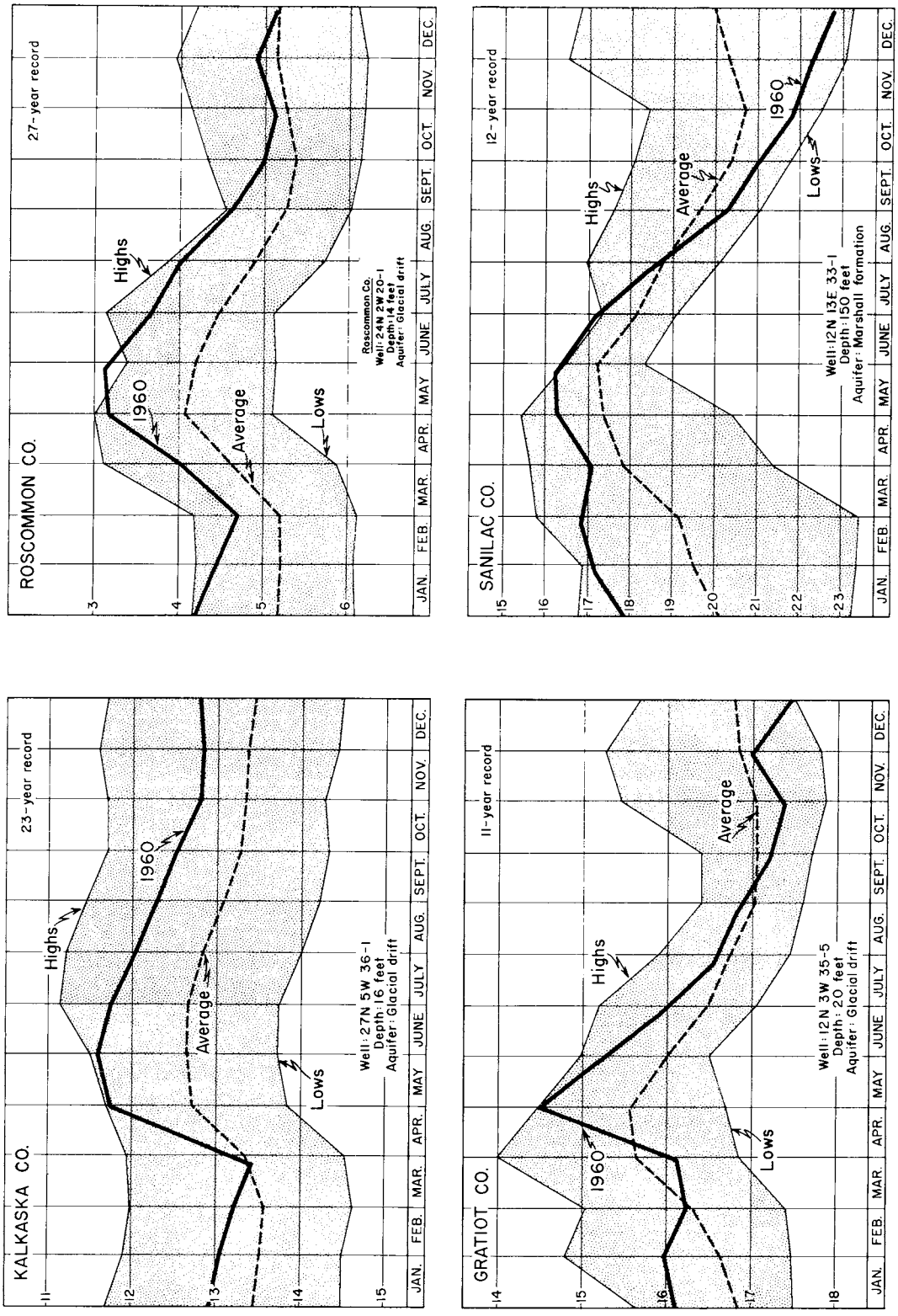
Figure 7 gives the 1960 month-end levels as compared to the extremes and average of record for eight key wells affected primarily by natural climatic conditions.

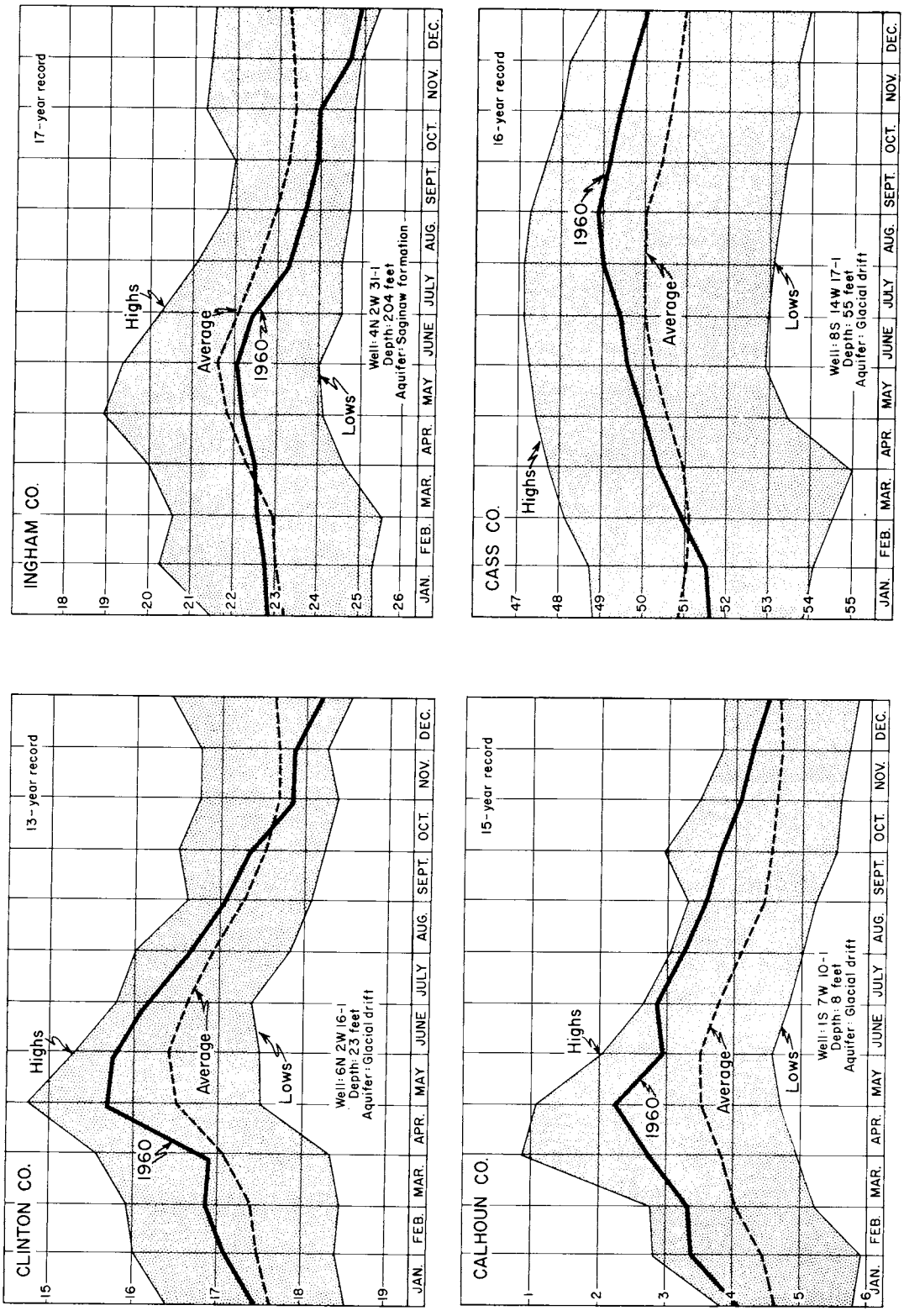
In the northern half of the Southern Peninsula the key wells in Roscommon and Kalkaska Counties remained at high stages throughout most of the year. In the spring, levels were at or near record highs.

This was typical of mahy other observation wells in the area and many new highs of record were observed (table 1). The higher levels were the result of a carryover of high stages from late 1959 and the additional recharge from heavy snowmelt and precipitation in the spring of 1960.

In the southern half of the Southern Peninsula, levels in key wells were also higher during the spring than a year ago. However, owing to dryness little or no recovery of water levels occurred in the fall and stages generally fell to below-average by the end of 1960.

In the Thumb area water levels in the key observation well in Sanilac County were at record high stages late in the spring. However, stages fell sharply to below-average levels by late summer. The usual fall recovery did not occur owing to precipitation deficiencies, and end-of-the-year levels were near record low in sharp contrast to the high spring levels.


KALKASKA CO.
23-year record
Highs
1960
Average
Lows
Well: 27N 5W 36-1
Depth: 16 feet
Aquifer: Glacial drift
ROSCOMMON CO.
27-year record
Highs
1960
Average
Lows
Roscommon Co.
Well: 24N 2W 20-1
Depth: 14 feet
Aquifer: Glacial drift
GRATIOT CO.
11-year record
Highs
1960
Average
Lows
Well: 12N 3W 35-5
Depth: 20 feet
Aquifer: Glacial drift
SANILAC CO.
12-year record
Highs
Average
1960
Lows
Well: 12N 13E 33-1
Depth: 150 feet
Aquifer: Marshall formation
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
Water level, in feet below land-surface datum



High, average, and low readings are for the period of record through 1959

Figure 7. Month-end water levels in key observation wells in the Southern Peninsula, 1960.

In Gratiot County the levels in the key well reacted very similarly to the Sanilac County well except that stages fell to below average levels by the end of March.

Levels in the key well in Clinton County were also high in the spring and low at the end of the year but they remained closer to the average stage than levels in the Sanilac and Gratiot County wells.

The levels in the Ingham County well were above average at the beginning of the year but fell to a near-record low stage by the end of the year as a result of about a 6-inch deficiency of precipitation and increased pumping from the Saginaw formation in the immediate area. Here, the effects of climate are being gradually masked by the influence of pumping in the growing metropolitan area of Lansing.

The key well in Calhoun County is finished to a depth of 8 feet in glacial drift. In this well levels remained high throughout the year, although precipitation deficiencies in the fall resulted in a continuation of the summer rate of decline.

In Cass County the key well is finished to a depth of 55 feet and is typical of wells in that area. Here, precipitation was about 35 inches for the year and levels were above average from February through December. End-of-the-year levels were about 1 1/2 feet higher than at the end of 1959.

Elsewhere in the southern half of the Southern Peninsula water levels in observation wells at locations remote from pumping effects were also generally high. Several new record-highs were recorded (table 1).

Statewide Changes in Storage from Pumping Influences

In areas where ground water is used for municipal or industrial supplies, water levels are observed to determine if the discharge from wells exceeds the total natural recharge to the aquifers. Long-term declines, in contrast to seasonal and natural climatic variations, would thus indicate a gradual depletion of the aquifers. A most effective method of determining the amount of water available from an aquifer is the analysis of long-term records of water levels and pumpage.

A recording station provides for the continuous collection of basic hydrologic data, which serves to indicate the day-to-day effects of pumping within the source aquifer. The information obtained may be especially valuable to municipalities, industries, and institutions and their ground-water consultants in estimating the capacity of aquifers to meet present and future demands for water, the desirable separation between wells, and whether expansion of ground-water systems is feasible.

Northern Peninsula

Ontonagon County

Village of Ontonagon.--The village of Ontonagon obtains its municipal supply from a reservoir (52N 39W 30-1) fed by a tile gallery constructed in beach sand along the shore of Lake Superior (Francis, 1950). Lake water is recharged through the sand into the gallery. The water levels in the reservoir reflect the water level in the beach sands along the tile.

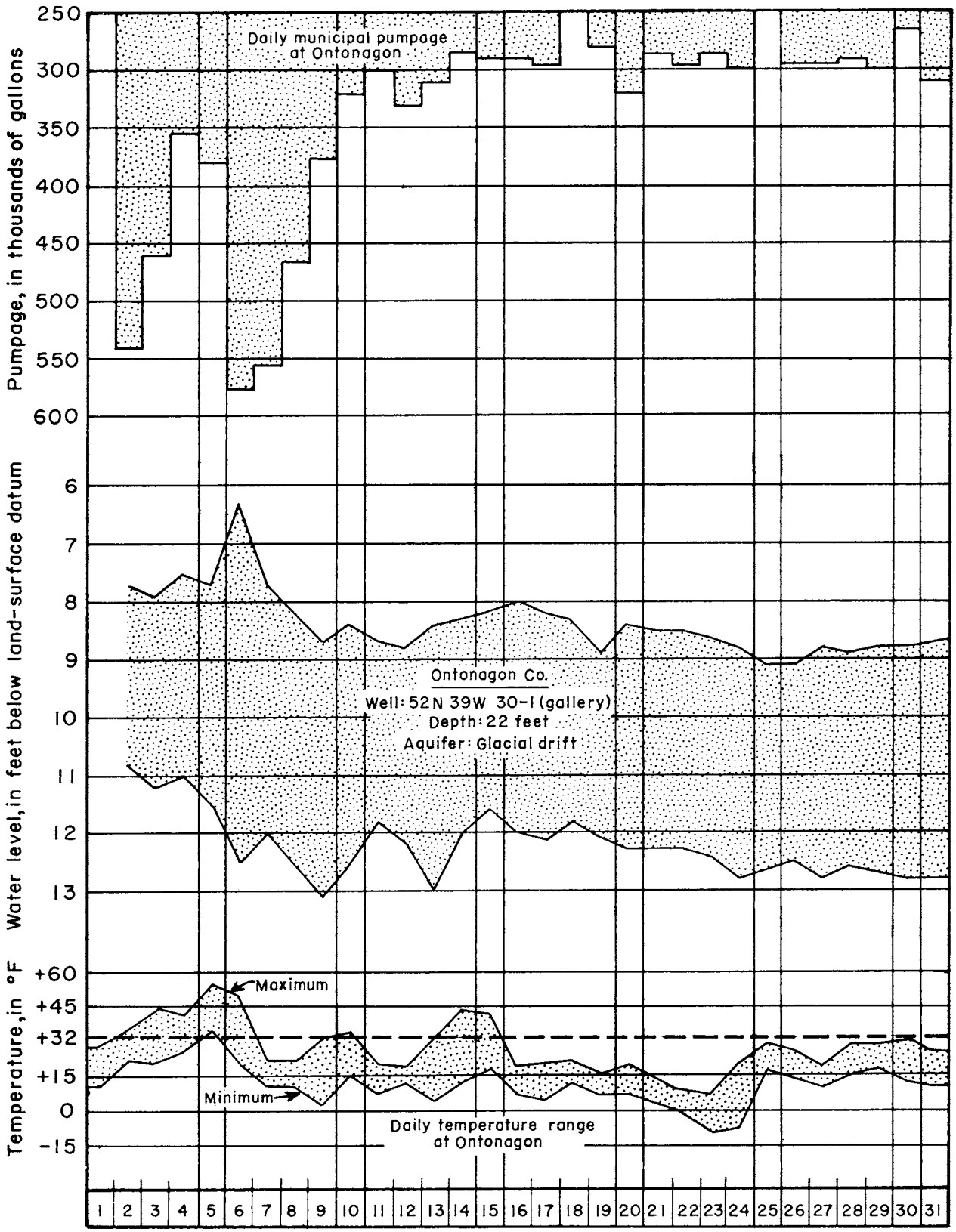


Figure 8. Range of water level and air temperature, and municipal pumpage at Ontonagon, December 1960.

During prolonged periods of freezing weather ice forms on the shore above the gallery and continues to build out over the lake. This reduces the area of recharge in the immediate vicinity of the gallery, slowing the rate of infiltration and resulting in greater drawdown in the aquifer. A continuous recording gage was installed on the gallery December 2, in cooperation with the Village. The water level in the sand is controlled by regulating the rate of pumping. The daily range of water levels and air temperature, and pumpage for December 1960 is shown graphically in figure 8. In early December, maximum daily temperatures were above freezing, no ice formed and water levels remained fairly high during a period when pumpage averaged at least 450,000 gallons daily. Although daily pumpage was reduced to about 300,000 gallons after the 10th of the month, water levels fell steadily indicating the reduction in recharge caused by the buildup of ice.

Municipal withdrawal of ground water was reported as 142 million gallons for 1960 as compared to the 92 mg reported for 1959.

Southern Peninsula

Barry County

City of Hastings.--The city obtains its water supply from wells finished in glacial drift. Observation well 3N 8W 18-1 is also finished in the glacial drift and reflects the withdrawal of ground water by municipal and industrial wells.

A continuous recording gage was installed on the observation well at the Fair Grounds on July 28, in cooperation with the city of Hastings. Figure 9 shows the daily range in water levels at this station, precipitation, and pumpage by the city. The nearest municipal

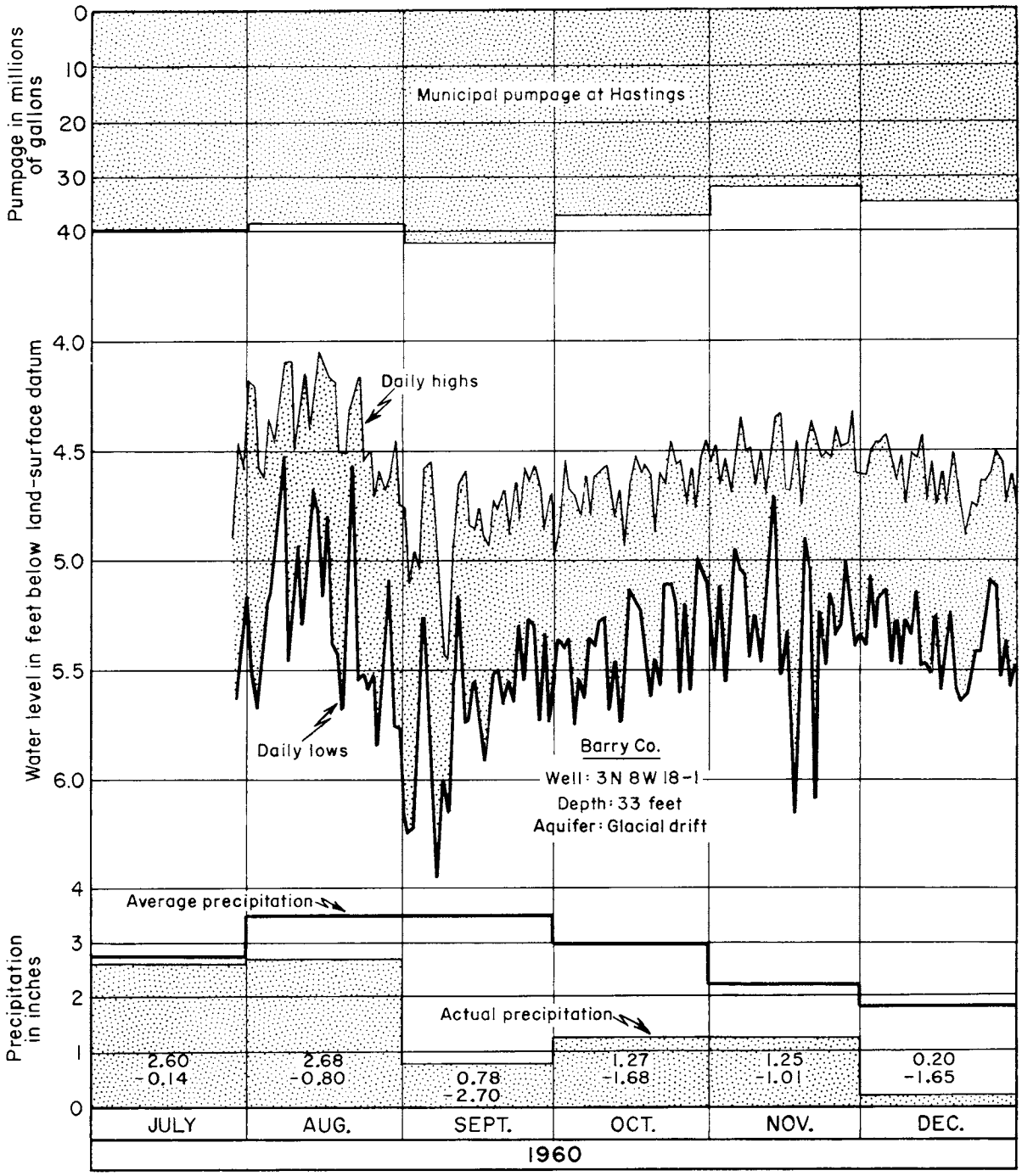


Figure 9. Hydrograph of daily range for well at Hastings, municipal pumpage, and precipitation, July - December 1960.

well is about a quarter of a mile away, but the water level in the observation well responds quickly to the effects of pumping. The immediate effects of precipitation are masked by pumping from area wells. The deficiency of precipitation during the last half of the year prevented the usual fall rise in water levels.

Municipal withdrawals of ground water by the city of Hastings were reported to be 398 million gallons for the year as compared to 315 mg in 1959. This was an increase of about 25 percent. Average daily use of water was highest in September when 1.37 mgd was pumped.

Branch County

City of Coldwater.--Observation well 6S 6W 22-1 is finished in glacial drift and located at the municipal well field. The water levels are affected by withdrawals of ground water by municipal wells that also tap the glacial drift.

During the winter and spring the water levels in the well were the highest recorded since 1952. However, year-end levels were lower than at the end of 1959 as the result of reduced recharge resulting from dry weather in the fall.

Reported municipal pumpage of 599 million gallons was a record high and 7 mg more than in 1959.

Calhoun County

Battle Creek Metropolitan area.--Most municipal and industrial wells in the area obtain water from the Marshall formation. Some domestic wells are finished in the overlying glacial drift. The city of Battle Creek cooperates in maintaining the observation well network in the area.

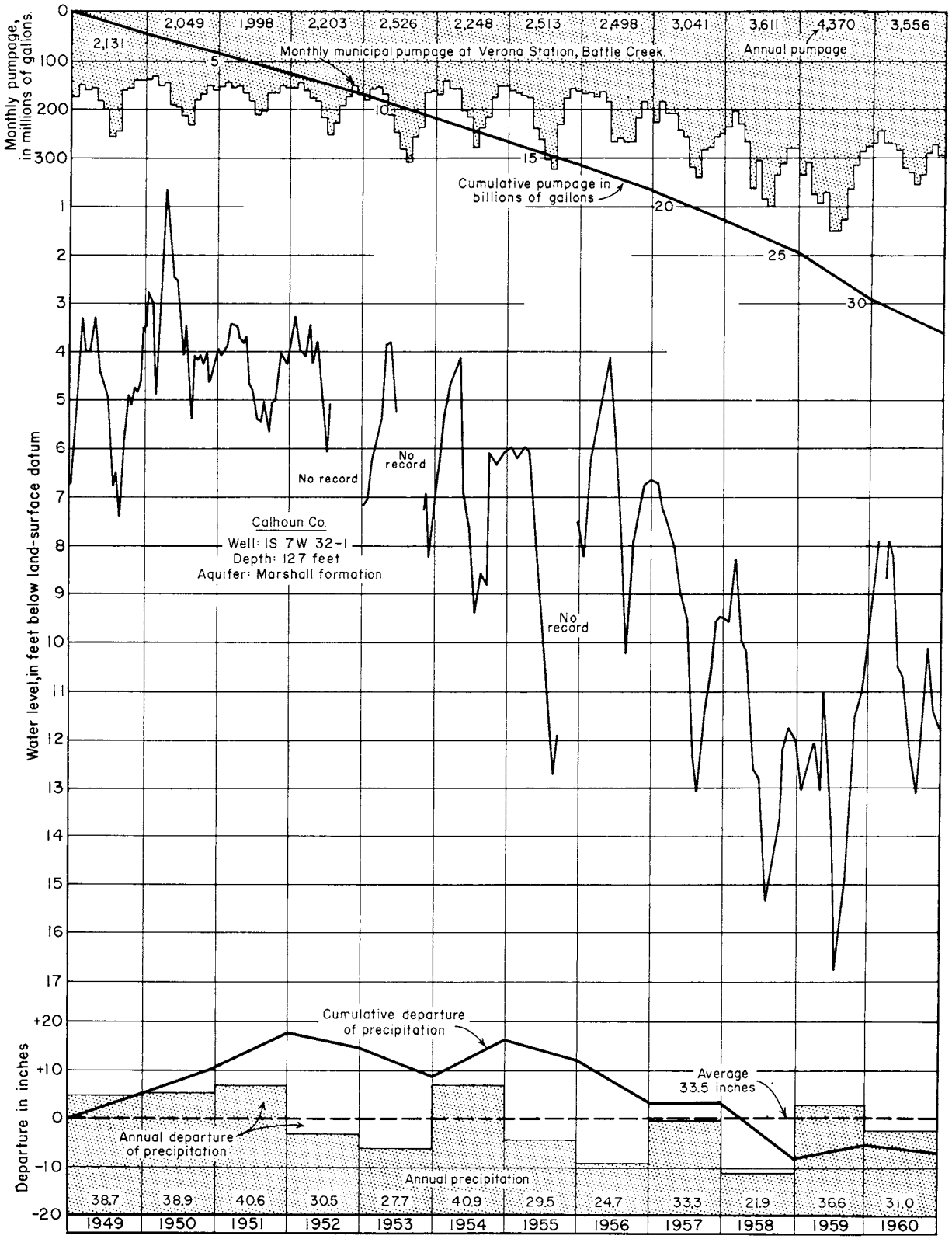


Figure 10. Hydrograph of well at Verona Station, municipal pumpage, and precipitation departures at Battle Creek, 1949-60.

As a result of a carryover of higher ground-water levels from the abundant precipitation and favorable recharge conditions of the fall of 1959, early 1960 levels in observation wells were the highest observed for the last few years. However, precipitation deficiencies in the latter part of the year reduced the usual fall recharge. Year-end levels were 0.3 to 1.5 feet lower than at the end of 1959. No extremes of water levels were recorded in 1960 (table 1).

Figure 10 shows the late 1959 and early 1960 recovery of water levels in the observation well at Battle Creek's Verona well field mostly owing to decreased pumpage and also to large amounts of recharge from precipitation. Water levels in late fall of 1960 declined as a result of dry weather.

Total municipal pumpage was reported to be 3.6 billion gallons. This was in marked contrast to the record 4.4 bg reported for 1959. Water use decreased in 1960 (fig. 10), reversing the rising trend since 1956.

City of Marshall.--The three observation wells in the city (table 1) tap the Marshall formation and reflect municipal and industrial withdrawals of ground water from that aquifer in the Marshall area.

In the spring, levels were among the highest observed for the past 10 years. By year-end, however, levels had fallen to about the same as at the end of 1959.

Total municipal pumpage was reported as 358 million gallons for the year, which was 66 mg less than in 1959.

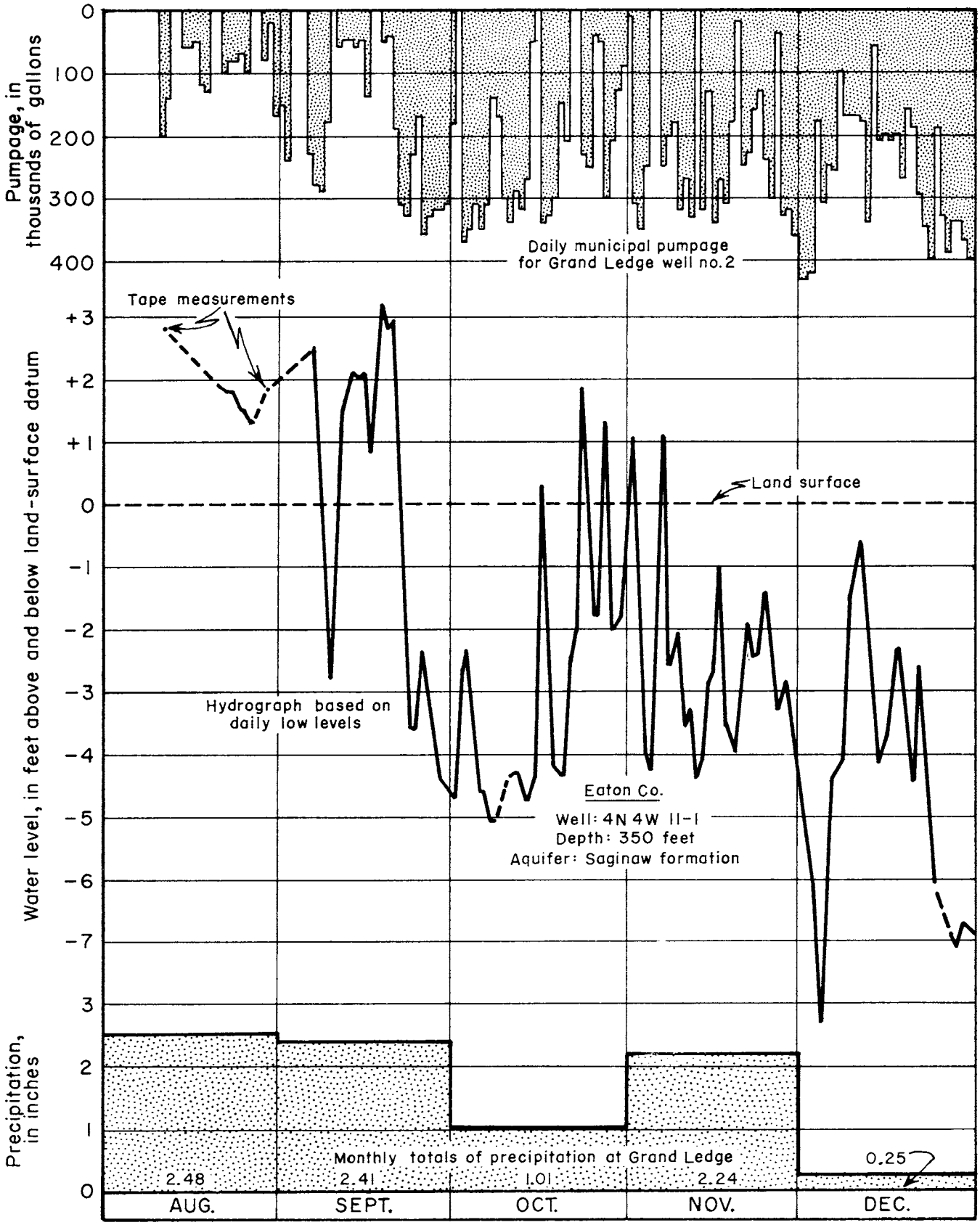


Figure 11. Hydrograph of well, pumpage, and precipitation at Grand Ledge, August-December 1960.

Eaton County

City of Charlotte.--Observation well 2N 4W 19-1 and municipal supply wells at the Municipal Park in Charlotte are finished in glacial drift. Stages in the observation well are affected by municipal pumping. Based on quarterly measurements, levels in the observation well were the highest since 1952.

Reported municipal withdrawals of ground water were 389 million gallons (table 2), which was slightly lower than the record high of 391 mg pumped in 1959.

City of Grand Ledge.--The two observation wells and the municipal wells in Grand Ledge are finished in the Saginaw formation.

A recording gage was installed August 11 on well 4N 4W 11-1 and is being maintained in cooperation with the city of Grand Ledge.

In figure 11 the marked effects of pumping during the August-December period by city well no. 2 are reflected in the water levels in the observation well. Pumpage effects and lack of recharge owing to relatively dry weather in the fall caused stages to decline. Although Grand Ledge well no. 2 is located about a half-mile southeast of the observation well, the influence of its pumping is quickly felt in the observation well. Changes in stage of the Grand River adjacent to the well field also affect the water levels in the observation well.

By early summer of 1960 stages in the other observation well at Grand Ledge (table 1, well 4N 4W 2-1) rose from the low of record in September of 1959 to the highest observed stage since 1956. Despite a subsequent sharp decline as a result of pumpage and deficient precipitation, year-end levels were still about half a foot higher than at the end of 1959.

Total municipal pumpage was reported as 150 million gallons (table 2), which was about 20 percent less than in 1959.

Genesee County

Flint Metropolitan area.--The city of Flint obtains its municipal water supply from the Flint River. However, Burton Township to the south, Beecher Metropolitan Water District to the north, and many industries in the area obtain water from the Saginaw formation or from the overlying glacial drift.

Observation wells in the area reflect changes in water levels owing to pumping from the drift and bedrock. However, water levels in a few shallow wells finished in the glacial drift (table 1) respond principally to natural climatic conditions. Observed spring levels in these shallow drift deposits were among the highest of the past several years, but by the end of the year were much lower than at the end of 1959.

In the deeper drift deposits (table 1, well 7N 7E 20-2) water levels during the spring were the highest observed since 1952, but by the end of the year fell to about 2 feet below the level observed at the end of 1959. In well 7N 7E 32-1 the effects of nearby pumping from the drift aquifer influences water levels and stages in this well have been falling for several years. However, in 1960, a small net gain for the year was observed.

In the Saginaw formation the highest levels since 1953 were observed in the spring. However, year-end levels were only slightly higher than at the close of 1959.

Water levels in well 6N 7E 9-1 (fig. 12) tapping the Saginaw formation at the Grand Blanc Fisher Body Plant dropped to the lowest stage of record by late summer owing to the increased pumpage at the plant. The net decline of about 2 feet for the year resulted from a combination of pumpage and precipitation deficiencies. Reported pumpage by the plant was 79.8 million gallons for the year, or about 10 percent more than in 1959.

Gratiot County

City of Alma.--Municipal and industrial wells obtain water from the buried outwash. One deep municipal well taps the underlying Saginaw formation but is seldom used because the water is of poor chemical quality. Observation wells in the Alma area are finished in shallow drift and in deeply buried sand and gravel outwash. Water levels in the shallow drift primarily reflect climatic conditions, whereas artesian pressures in the buried outwash are affected mainly by municipal and industrial pumping.

In May 1960 a recording gage was installed on well 11N 3W 4-1 (TW 6) in cooperation with the city of Alma to observe changes in artesian pressure resulting from withdrawals of ground water in the area. The daily low water levels from this recording gage and monthly water-level measurements in four other observation wells in Alma are plotted to a common mean sea level datum so that comparison can readily be made (fig. 13). The Reed Excavating Co. well is finished in the shallow drift, whereas the other four observation wells tap the buried outwash. Precipitation deficiencies prevented normal amounts of water from recharging to the aquifer and thus recovery of water levels from the summer lows

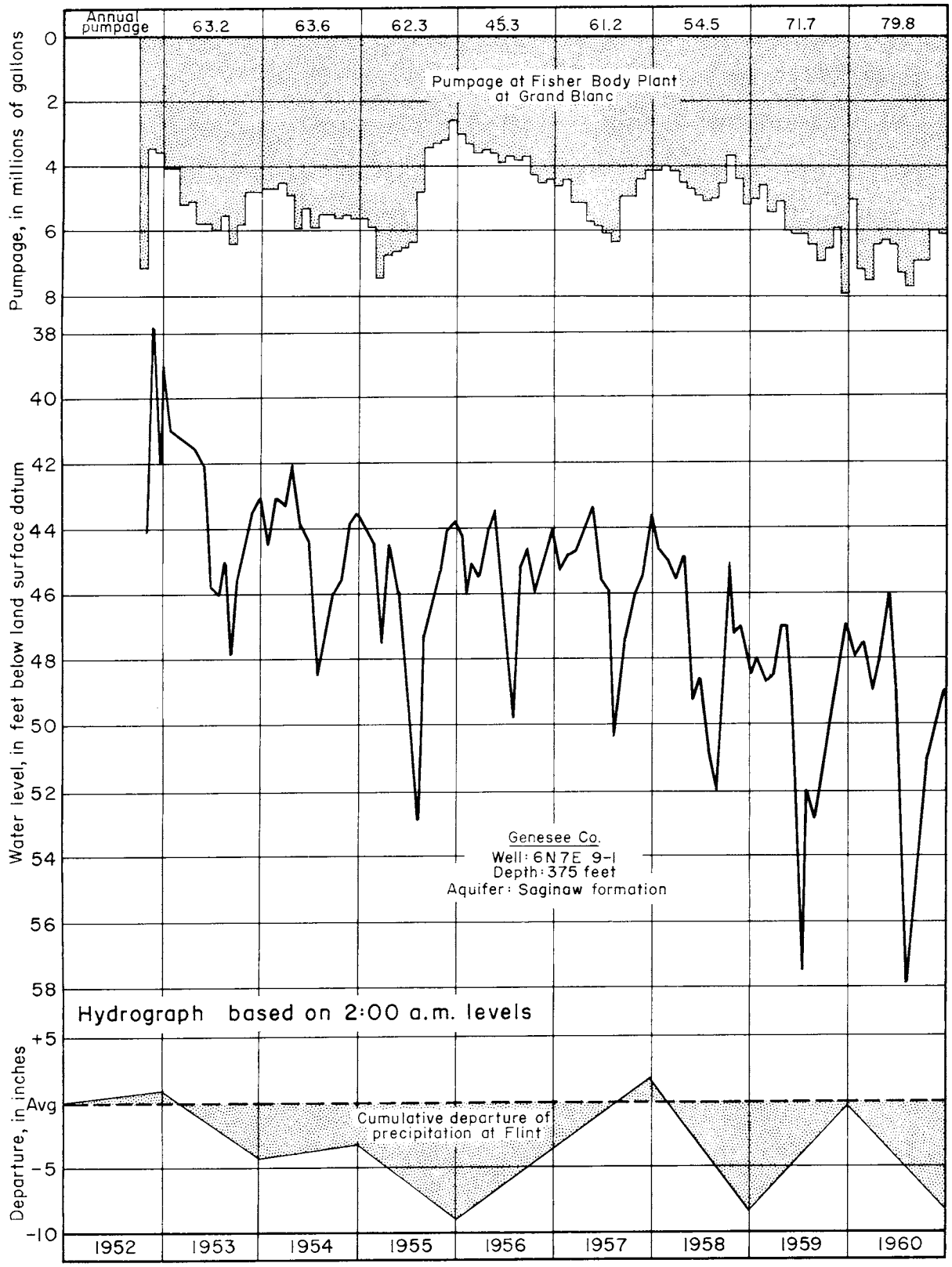


Figure 12. Hydrograph of well at Fisher Body Plant near Grand Blanc, pumpage, and precipitation departures, 1952-60.

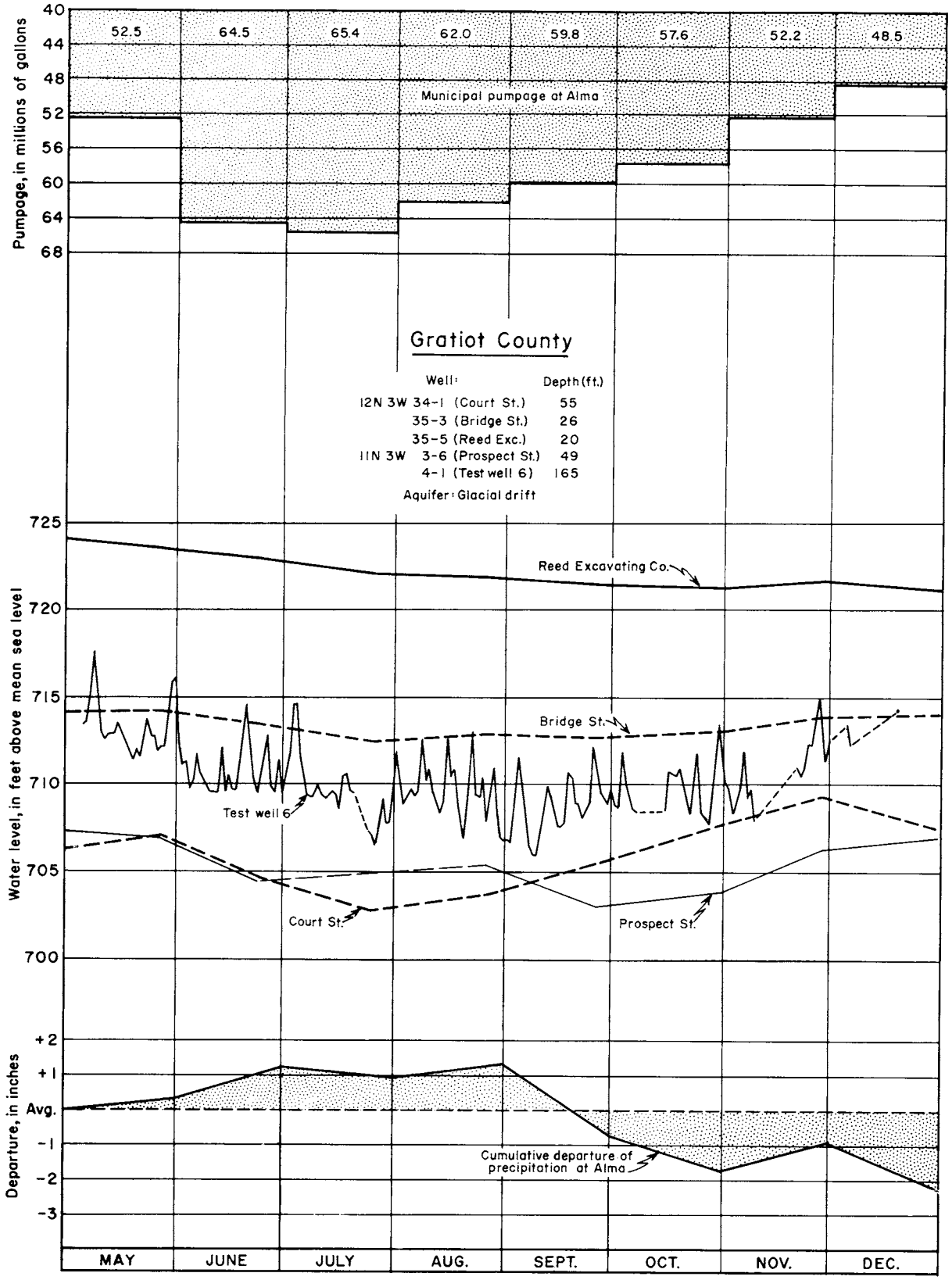


Figure 13. Hydrographs of wells, municipal pumpage, and precipitation at Alma, May-December 1960.

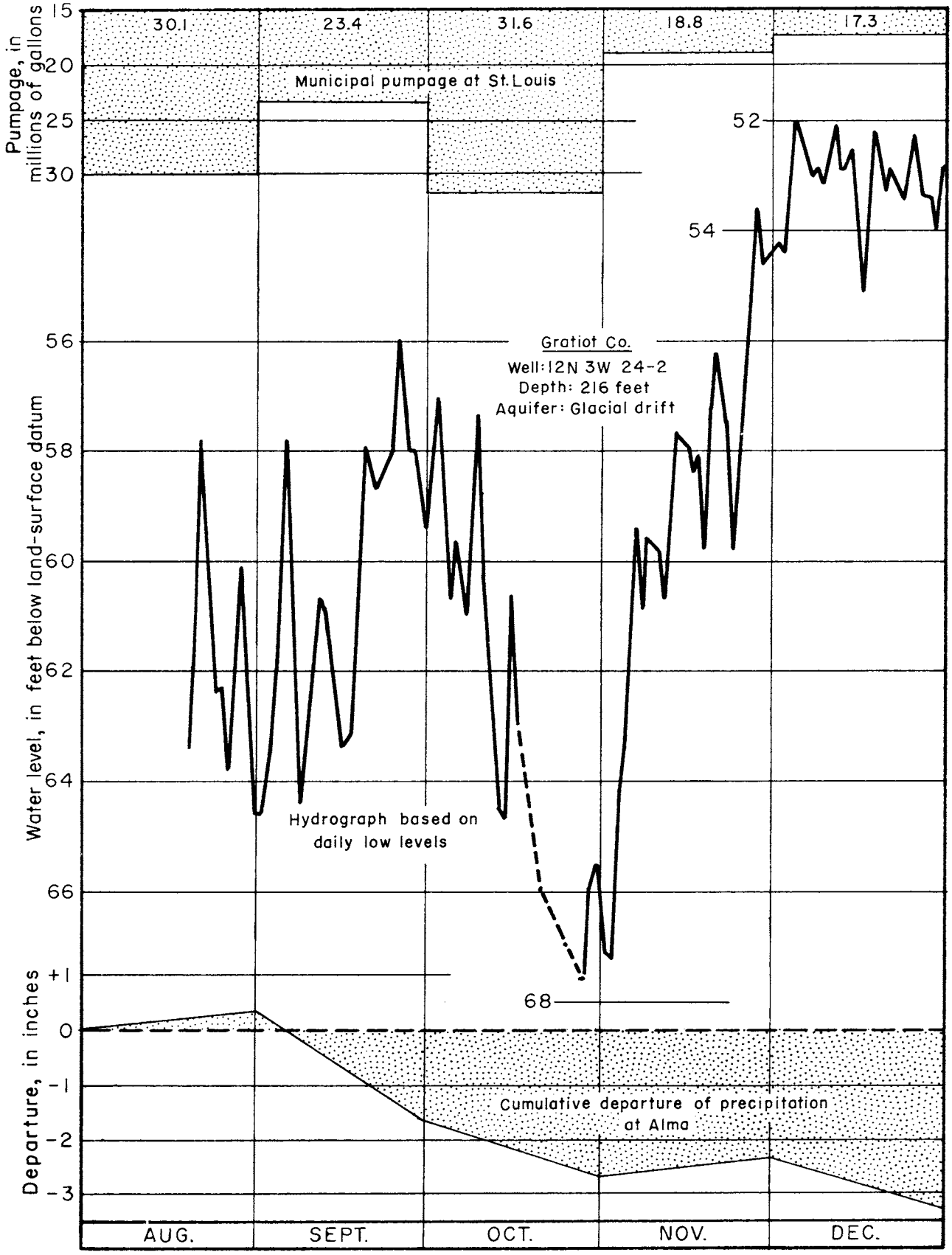


Figure 14. Hydrograph of St Louis well no. 3, pumpage, and precipitation departures, August – December, 1960.

was principally due to the decreased pumpage. The water levels in TW 6 are affected principally by the pumping of municipal well 7. Observed stages in the buried outwash were lowest for the area in the Court and Prospect wells where the effect of pumping by city wells 2 and 4 is reflected.

Total municipal withdrawals of 645 million gallons of ground water for the year was reported by the city of Alma. This was about the same as in 1959. Pumpage averaged slightly more than 2 mgd during the period June-August.

City of St. Louis.--Municipal and industrial water supplies in the city are obtained from wells tapping deeply buried sand and gravel outwash deposits. In August 1960, a continuous recording gage was installed on St. Louis well 3 (12N 3W 24-2) to observe fluctuations of water levels in response to pumpage and climatic conditions (fig. 14). From the short-term record it is apparent that the water levels are affected primarily by pumping. Pumping in September was about 7 million gallons less than in August, and a net rise in stage of about 6 feet was recorded. Increased pumping in October then resulted in a sharp decline to the lowest stage for the short period of record. However, in November and December levels rose nearly 15 feet when pumping decreased sharply.

Although water levels in this observation well respond primarily to the nearby pumping, some relation with precipitation departures is evident during the months October-December. During this period monthly deficiencies or excesses in precipitation correlated with changes in stage shown on the hydrograph.

Reported municipal withdrawal of 262 million gallons (table 2) by the city of St. Louis was somewhat higher than in 1959 but considerably below the 315 mg pumped in 1958.

Ingham County

Lansing Metropolitan area.--The Saginaw formation is the principal source of water for municipal, industrial, and domestic wells in the area, although a few wells obtain water from the overlying glacial drift.

All but one of the area observation wells are finished in the Saginaw formation. The water levels in the rock wells reflect changes in distribution and rate of pumping from the formation. A few on the perimeter of the area (fig. 7 and table 1, Ingham County) primarily reflect climatic conditions.

Ground-water levels in most of the observation wells were generally higher than in 1959 when many record low stages were recorded. The higher stages resulted from recharge due to favorable conditions in the spring and also from a small reported area decrease in total pumpage withdrawals, although Michigan State University pumped 100 million gallons more than in 1959, mostly owing to increased use for golf course irrigation and additional married housing.

In mid-1960, five recording gages were installed in this area and are being maintained in cooperation with the Lansing Board of Water and Light. The hydrographs constructed from daily low water levels in these wells are shown by figure 15A. The Holt and Airport wells are at some distance from centers of heavy pumping and in these wells the continuation of the summer decline to the end of the year reflected reduced

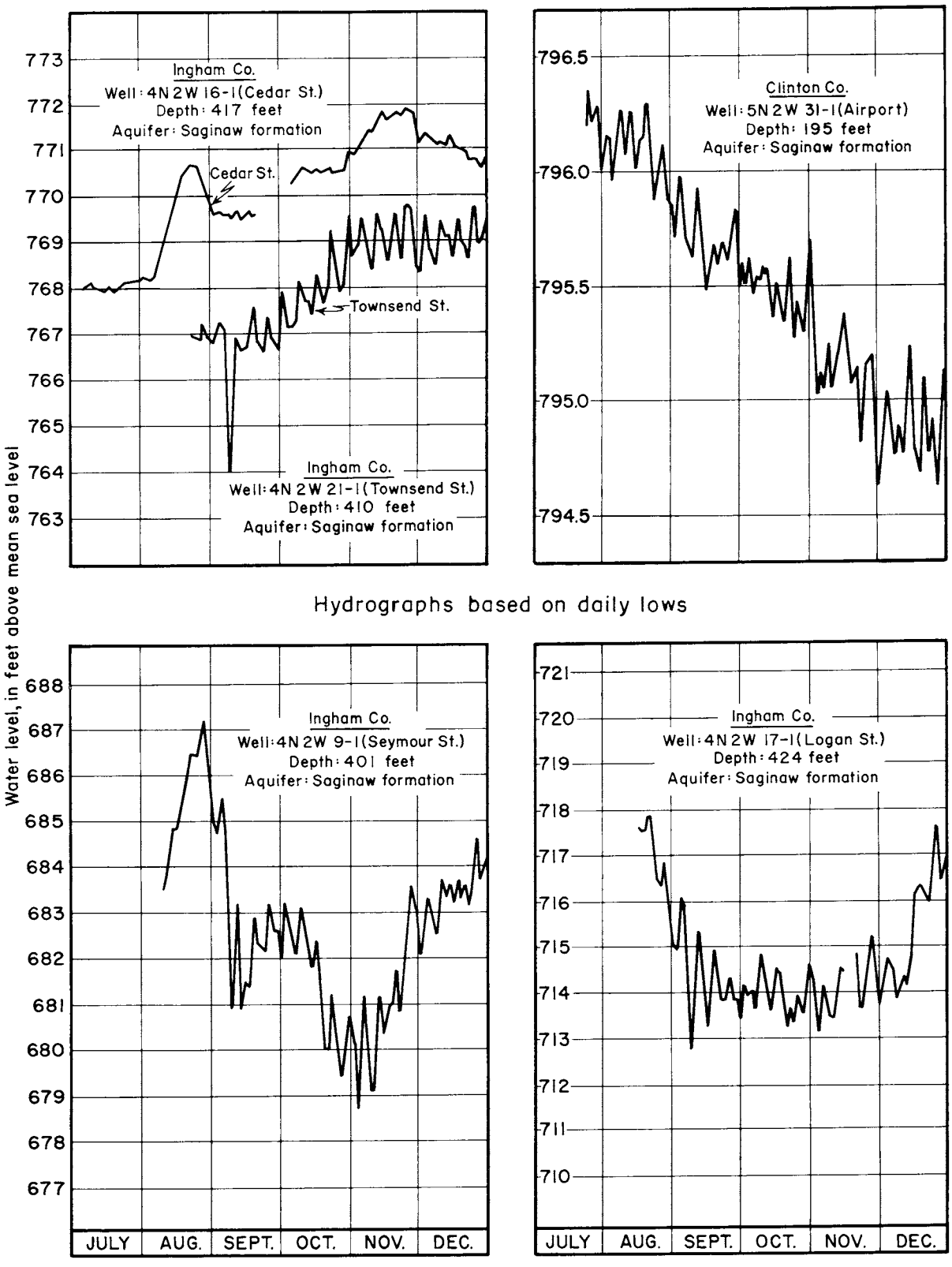
recharge from precipitation in the fall. All the hydrographs in figure 15 were plotted in mean-sea level datum to illustrate the difference in altitude of observed ground-water levels in the metropolitan area. The levels in the Holt well are nearly 200 feet higher than at the Seymour well. The water level on the east side of the area (Michigan State University well), on the west (Wheeler well), and the northwest (airport well) are each at about the same elevation and about 85 feet lower than the levels in the Holt well.

Generally, ground-water levels for the year, as compared to 1959, were about 10 feet lower in the northwestern part, and 2-3 feet lower in the southwestern part of the area. Gains of as much as 9 feet, however, were recorded in the central and eastern part. These wide differences were principally the result of changes in the rate and distribution of pumping by municipal, industrial, and institutional wells. In a few of the wells stages in the spring were the highest observed in recent years. However, precipitation deficiencies late in the year (fig. 15B) resulted in less-than-usual recharge and levels in many wells showed a net decline for the year.

Total reported withdrawals of ground water for municipal and institutional use in the Lansing Metropolitan area (table 2) averaged about 22.9 million gallons per day in 1960. The total in 1960 was 8.4 billion gallons as compared to 8.2 in 1959. This represented about 15 percent of the total ground-water pumpage listed in table 2, indicating the importance of ground-water resources to the Lansing area.

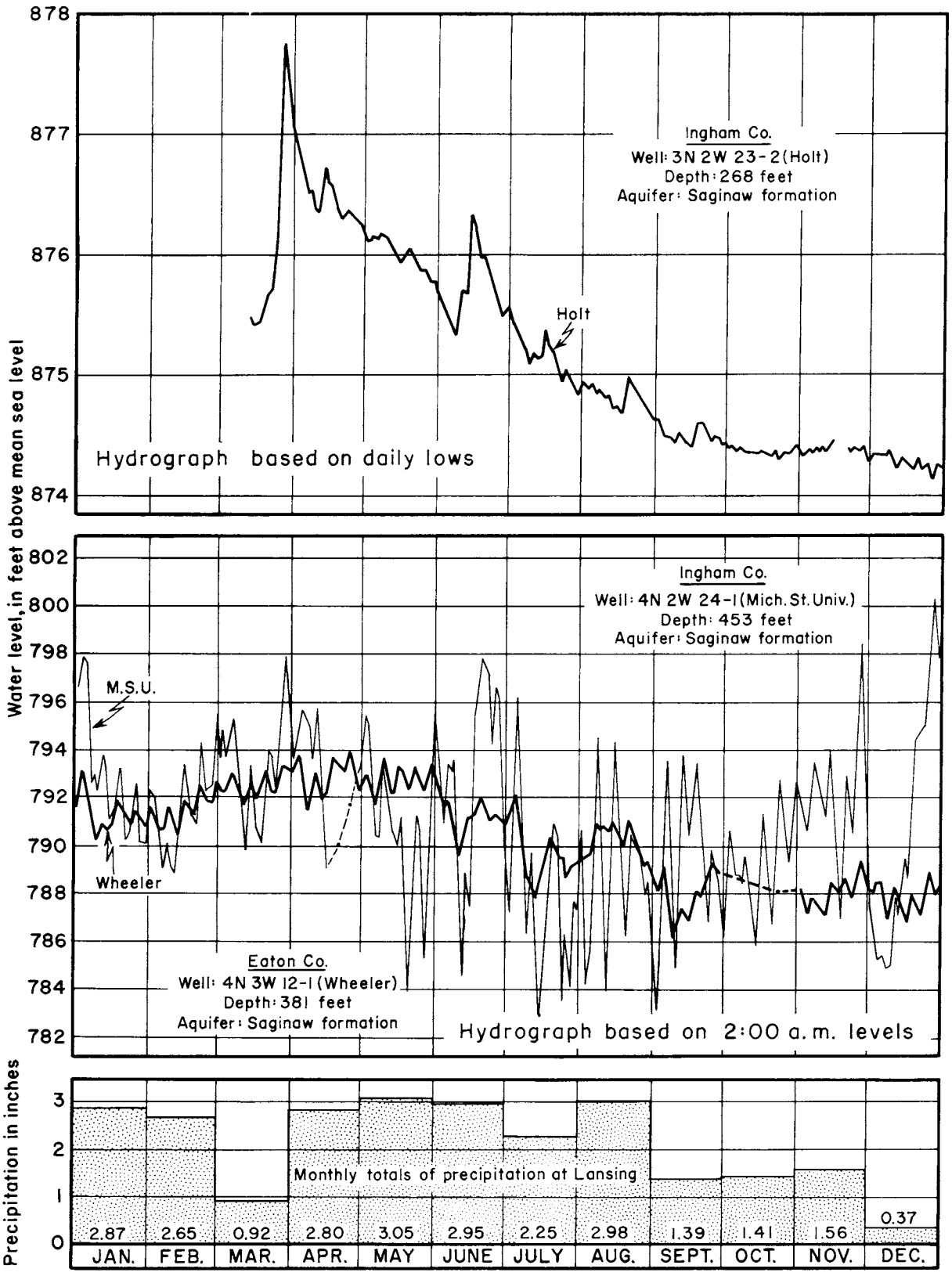
Jackson County

City of Jackson.--Most municipal, industrial, and institutional wells in and near Jackson obtain water from sandstone strata in



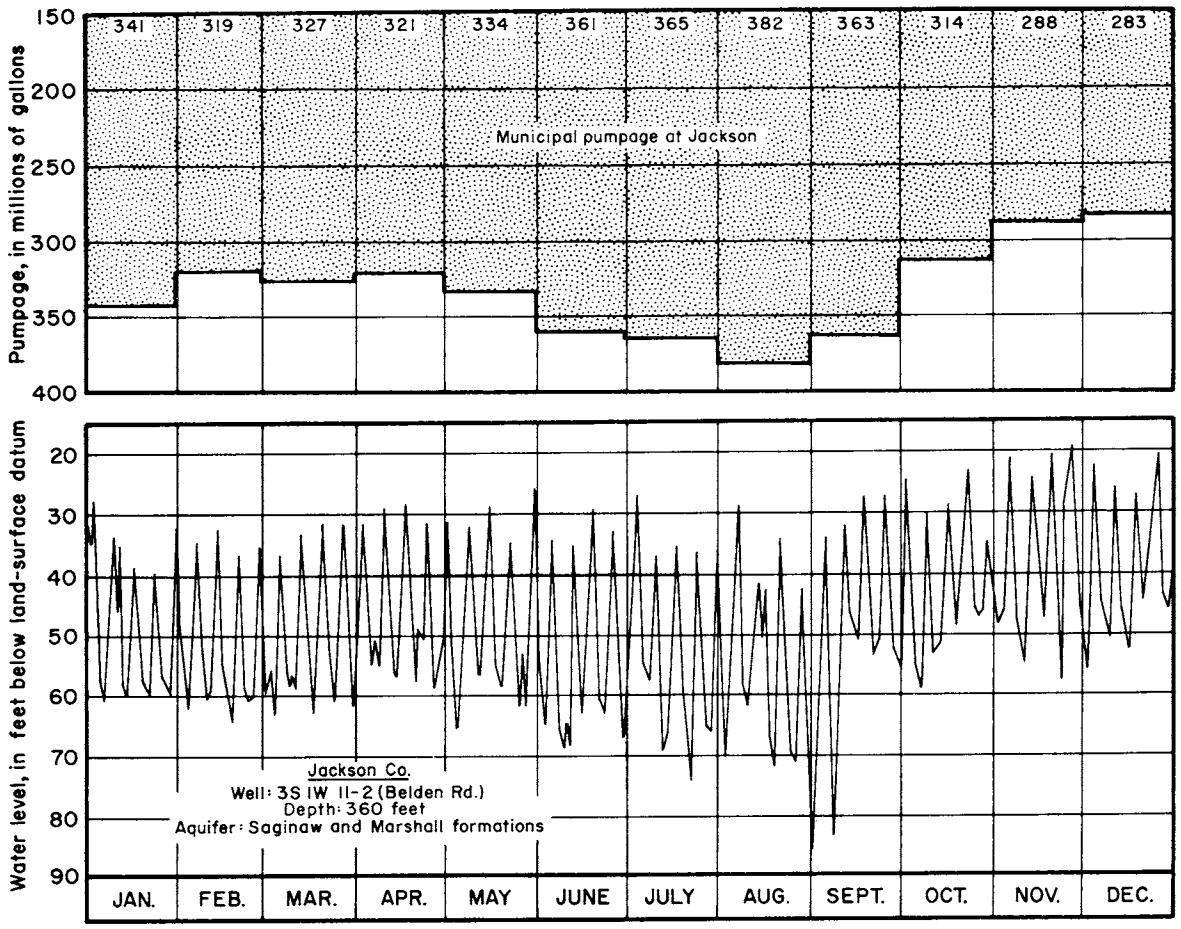
Hydrographs based on daily lows

15 A. July - December 1960



15B. 1960

Figure 15. Hydrographs of selected wells in the greater Lansing area, and precipitation, 1960.



Hydrograph based on daily measurements

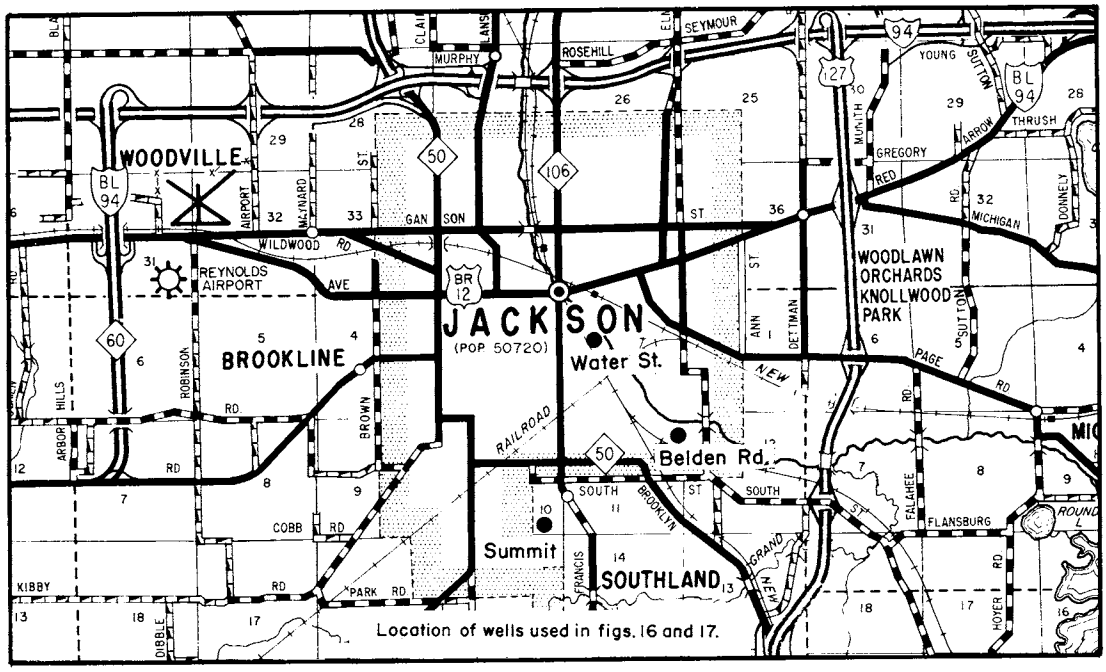


Figure 16. Hydrograph of well at Belden Road Station and municipal pumpage, 1960.

the Saginaw, Parma, and Marshall formations.

An observation well at the Belden Road municipal well field (3S 1W 11-2) is finished in these sandstone formations and reflects withdrawals of ground water by the city of Jackson. Figure 16 shows the large fluctuations of water level in this observation well from the nearby pumping and the monthly totals of precipitation and pumpage. The hydrograph was constructed from daily water-level measurements made by city personnel. Although the nearby pumping causes large declines in the water levels, these levels recover quickly when the pumping is reduced. Year-end stages in this well were higher than at the end of 1959.

In September 1960, recording gages were installed in cooperation with the city of Jackson, on two unused wells, one on Water Street and one in Summit Township, about 1.1 and 1.7 miles from the city well field, respectively (see map, fig. 16). Facsimiles of monthly recorder charts from these two wells are shown on figure 17. The fluctuations of water levels on these charts demonstrate that the effects of pumping at the Belden Road Station extend quickly over a large area. The Water Street well is closer to the pumping at the Belden Road Station, and the fluctuations in this well are about 50 percent greater than in the Summit well. The marked recoveries of water level are due to decreased pumpage during weekends. The annual range in water-level fluctuation is about 10 feet in the Summit well, 19 feet in the Water Street well, and more than 65 feet in the Belden Road observation well.

Reported municipal withdrawals of ground water by the city of Jackson totaled 4.0 billion gallons in 1960 as compared to 4.5 in 1959. An additional 0.5 bg was pumped by the State Prison at Jackson (table 2).

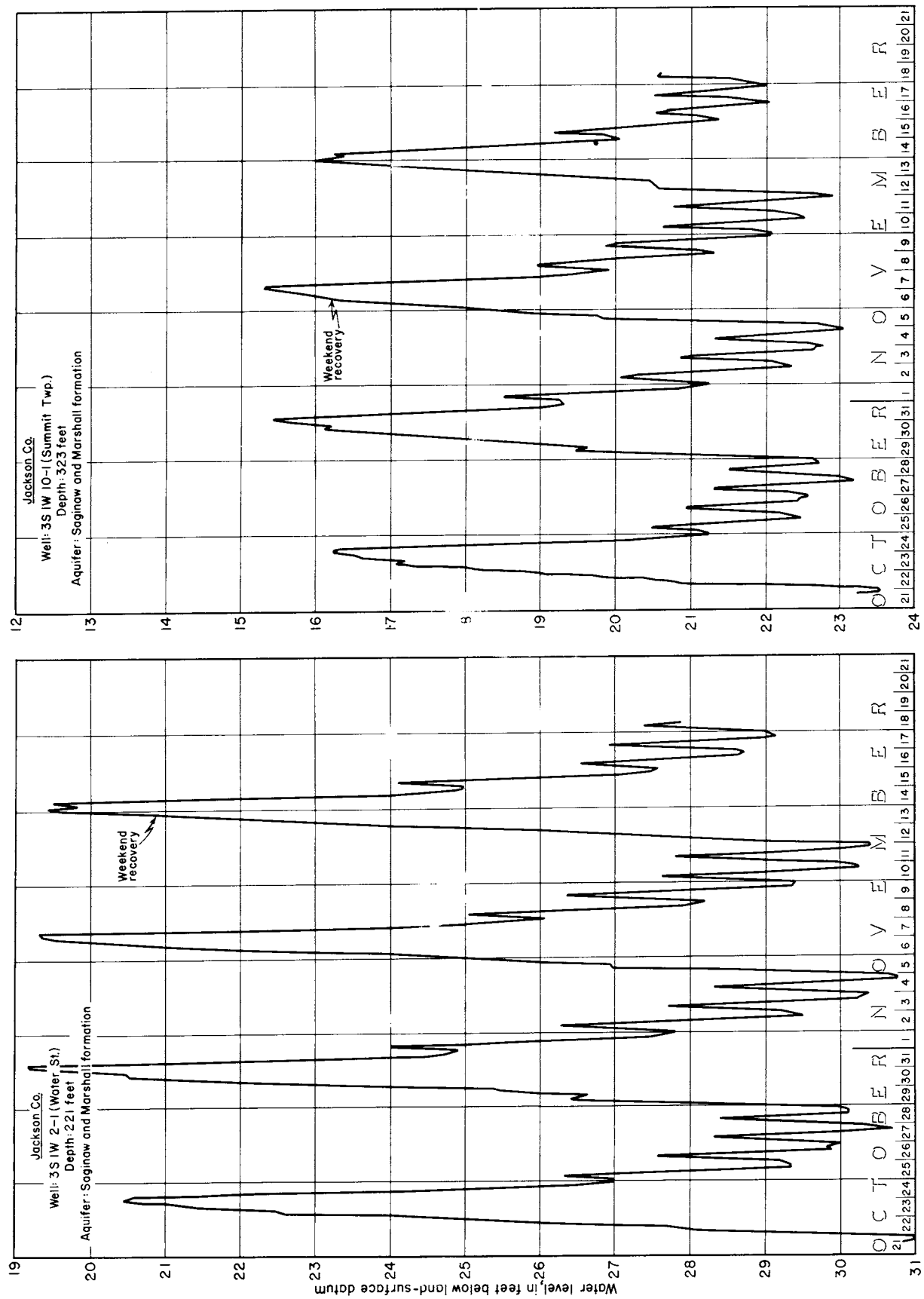


Figure 17. Monthly recorder charts from 2 wells in the Jackson area, October 21–November 18, 1960.

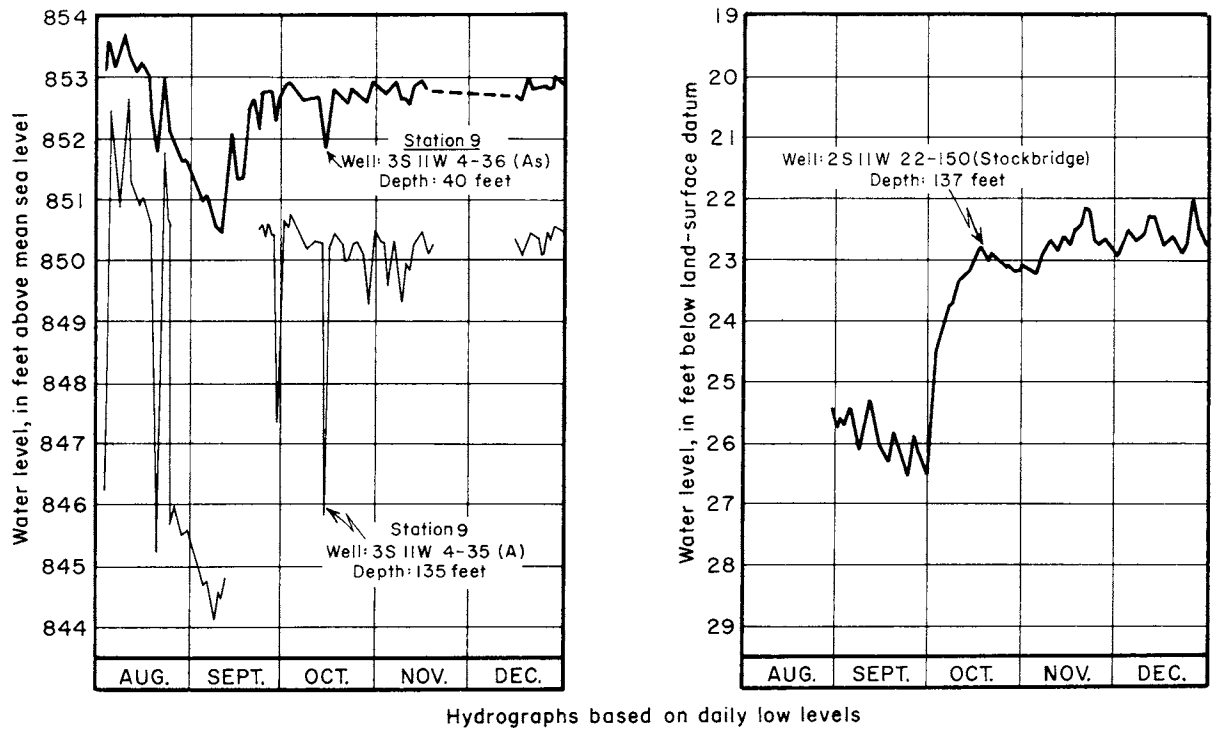
Kalamazoo County

City of Kalamazoo.--All wells in the greater Kalamazoo area obtain water from glacial-drift aquifers.

In the spring, levels in a few observation wells in the Kalamazoo area after having fallen to record and near record lows for 3 consecutive years, responded to above-average precipitation and rose to the highest stages recorded since 1952. The gain in storage was later offset by a deficiency of 7 inches of precipitation in the August-December period. Since 1952 this area has experienced a total deficiency of precipitation of about 30 inches, or nearly a year's normal rainfall.

Figure 18 shows the effect of area pumping and climatological conditions on water levels in selected Kalamazoo observation wells. Following the summer decline, levels normally rise as pumping decreases, evapotranspiration ends, and fall rains occur. However, in 1960, the hydrographs for the late fall period are rather flat indicating reduced recharge owing to the dryness. The figure also shows the effect of pumping from the lower aquifer at Station 9 on the water levels in two observation wells, A and As. Although there is about 40 feet of sandy clay between the upper and lower aquifers, the pumping of the municipal wells tapping the lower aquifer at this station also affects water levels in the upper aquifer. This illustrates the effect of infiltration or leakage from the recharge channel at the field. A detailed study of the hydraulic characteristics of this field was made by the U. S. Geological Survey in cooperation with the city of Kalamazoo (Deutsch, 1962).

The Stockbridge well was drilled by the city of Kalamazoo to replace the Burdick well, which is to be abandoned. Hydrographs from both these wells reflect pumping in the Axtell Creek area, which is the



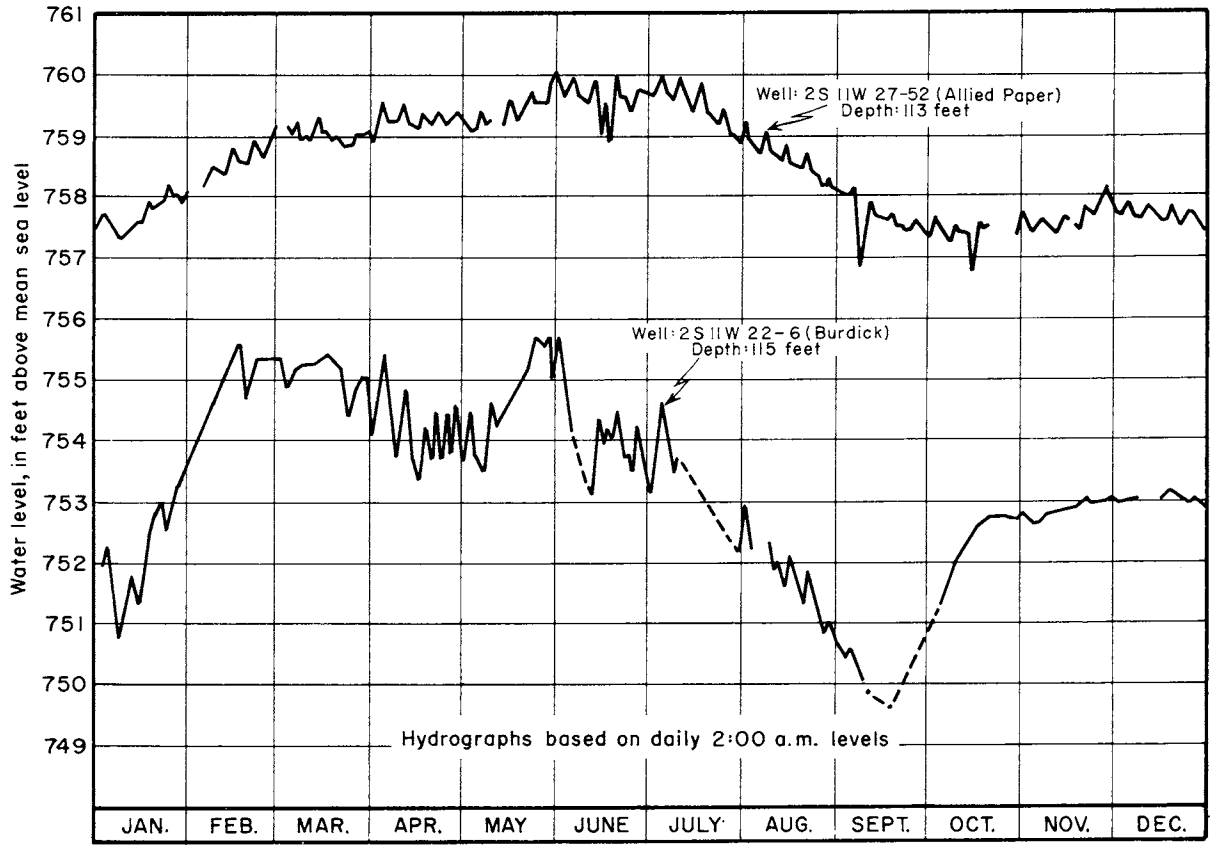


Figure 18. Hydrographs of selected wells finished in glacial drift at Kalamazoo, 1960.

main area of municipal withdrawals of ground water. The Allied Paper well is further from the influence of heavy pumping and water-level fluctuations in the well are smaller. The water levels at Station 9 (wells A and As) are about 100 feet higher than at the Axtell Creek area wells.

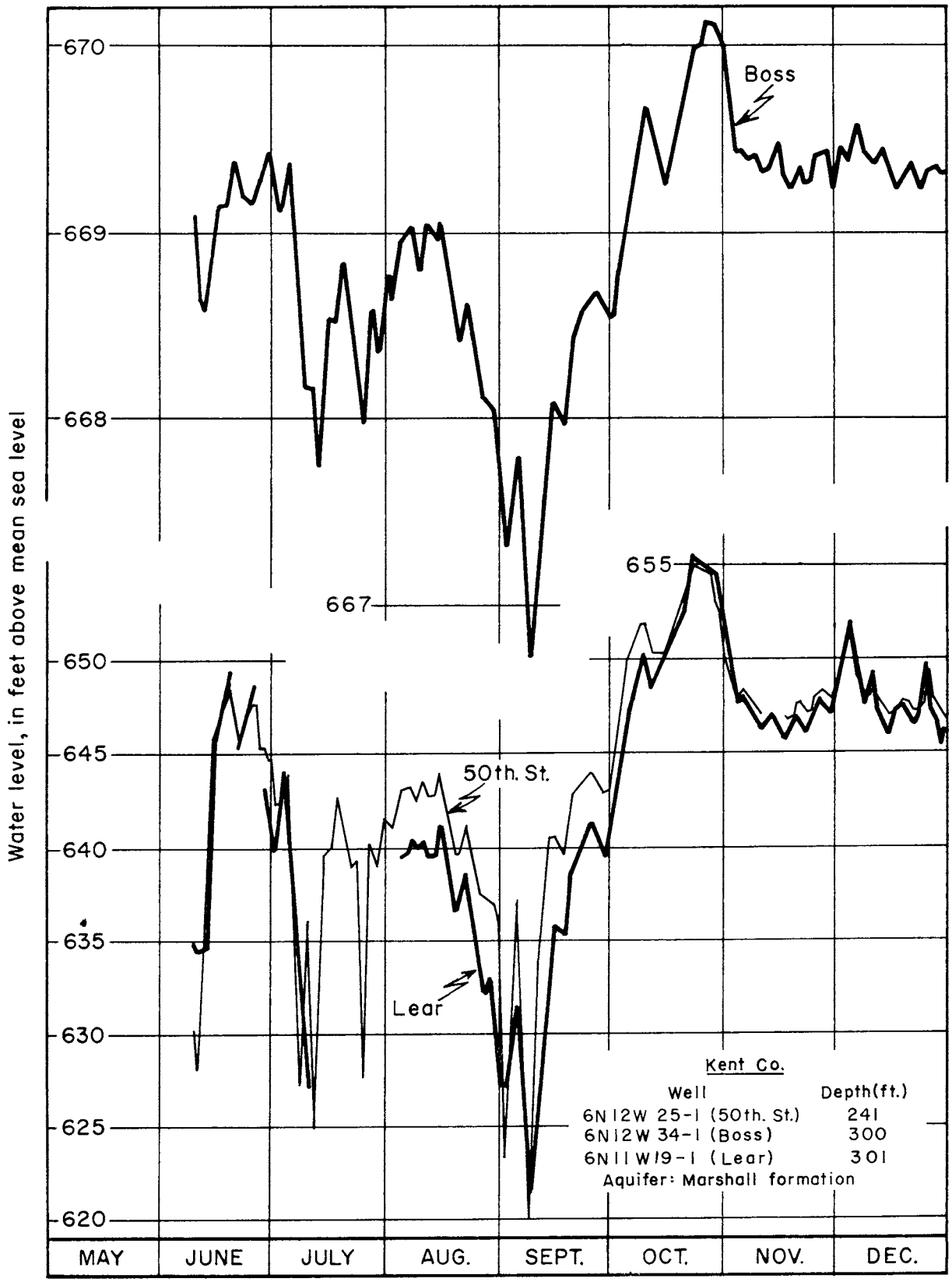
The two observation wells at Station 9 and the Stockbridge observation well were equipped with recording gages in August 1960, and are being maintained in cooperation with the city of Kalamazoo.

Reported municipal withdrawal of ground water by the city was 5,086 million gallons (table 2), or slightly less than the record pumpage of 5,116 mg in 1959.

Kent County

City of Wyoming.--Municipal water supplies are obtained from wells finished in the Marshall formation and from some wells tapping the overlying glacial drift. In June 1960, 3 observation wells tapping the Marshall formation were equipped with recording gages and are being maintained in cooperation with the city. The water levels in these wells reflect withdrawals of ground water from the Marshall formation by the city and other public and industrial users.

Figure 19 shows the fluctuations for the period of record. The fluctuations of water levels in the 50th Street and Lear wells correlate very closely. Similar but smaller fluctuations were observed in the Boss well, which is further from areas of heavy pumping. The low stages for the period of record in all three wells were recorded in early September following heavy pumping during the summer (table 2). In the 50th Street and Lear wells the net summer declines were about



Hydrographs based on daily lows

Figure 19. Hydrographs of 3 wells in the Wyoming area, June–December 1960

20 feet. By mid-October, water levels in both wells recovered to stages higher than those observed at the beginning of the summer. However, despite decreased pumping, a 5-inch deficiency of precipitation for the period September-December precluded further rises in stage for the remainder of the year.

Observations of changes in water level in the drift aquifer were not made in 1960.

Reported municipal pumpage by the city of Wyoming totaled 1,530 million gallons for the year (table 2), which was less than the 1,685 mg reported for 1959.

Oakland County

City of Pontiac.--Municipal and industrial supplies of water in the city are obtained from wells tapping glacial-drift aquifers. The two observation wells in Pontiac reflect withdrawals of water from the drift and also climatic conditions.

Figure 20 is a generalized long-term hydrograph for well 3N 10E 32-1 at the city's Walnut Street Station. In this well the long-term decline in ground-water levels was reversed in 1956 when the distribution of pumping by municipal wells was changed to stop the lowering of the piezometric surface. By regulation of pumping, the water levels in the Walnut Street area have been generally stabilized. However, in 1960 a total precipitation deficiency of nearly 11 inches for the year resulted in lower levels. Nearly 6 inches of this deficiency occurred during the fall months when conditions are usually favorable for ground-water recharge. This reduced recharge impeded the usual fall recovery of ground-water levels.

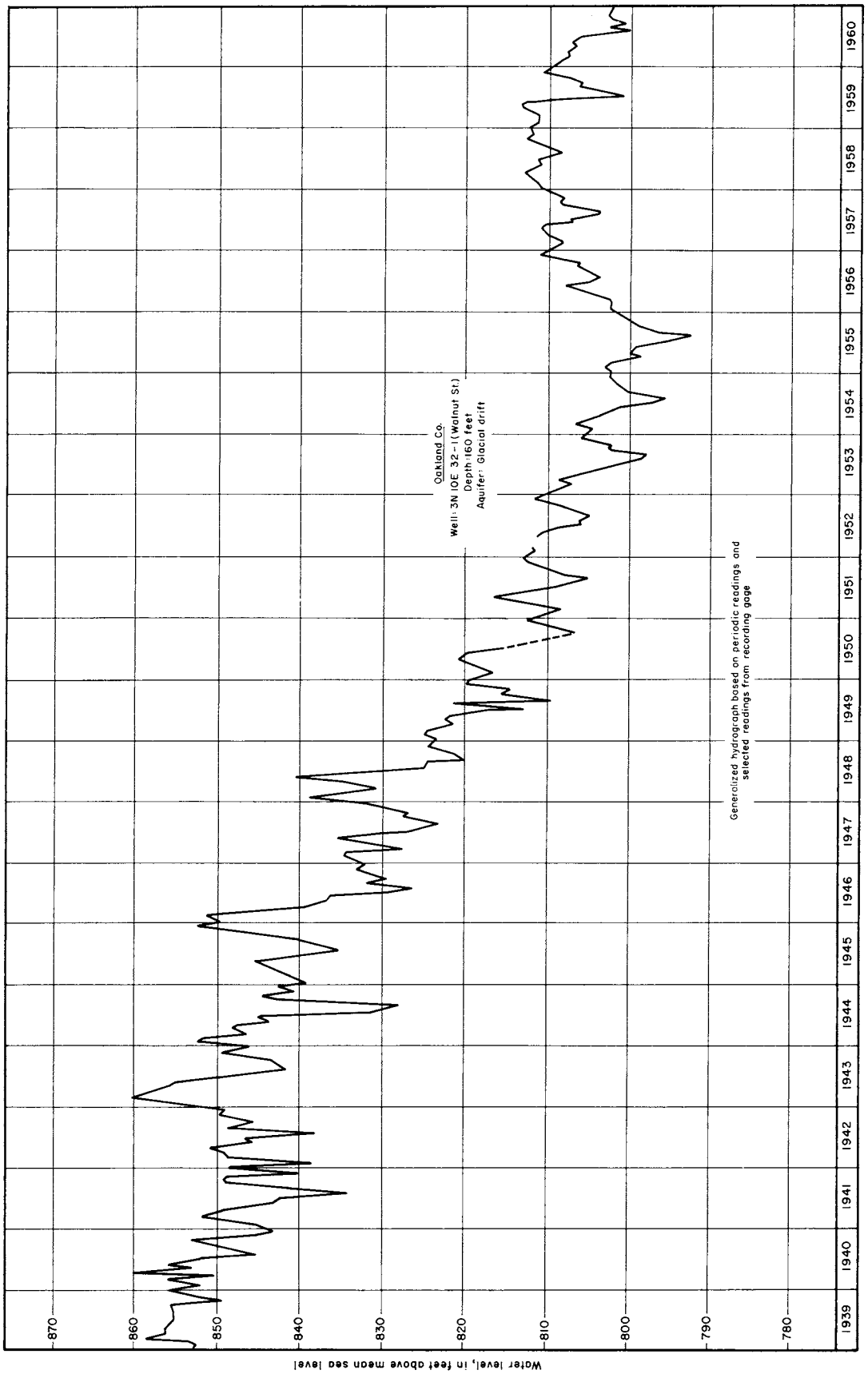


Figure 20. Hydrograph of well in Pontiac, for period 1939-60.

Recording gages in Pontiac are maintained in cooperation with the city on two wells (Walnut Street and Orchard Lake). Figure 21 shows the hydrographs for these wells along with total municipal pumpage and precipitation departures for 1960. Water levels at the Walnut Street well were about 3 feet lower than at the Orchard Lake well.

Reported municipal pumpage at Pontiac totaled 3,798 million gallons in 1960 as compared to 3,925 mg reported for 1959.

Waterford Township.--The township obtains its water for public supply from wells tapping the glacial-drift aquifers. In July 1960, a continuous recording gage was installed on an unused public-supply well at Josephine Street Street (well 3N 9E 36-1) in cooperation with the township in order to observe changes in ground-water levels in response to pumpage and climatic conditions. Figure 22 shows the hydrograph for the period July-December 1960 along with pumpage by the township and precipitation departures. The fall seasonal recovery generally observed in wells in this area failed to materialize despite decreased withdrawals. As shown by the precipitation departure graph, this was largely the result of a deficiency of more than 6 inches of rainfall from average for the period.

Reported township pumpage for the year was about 284 million gallons (table 2).

Washtenaw County

City of Ypsilanti.--The city obtains its municipal water supply from wells finished in glacial drift. In June 1960 a continuous recording gage was installed on a well at Gilbert Park and is being maintained in cooperation with the city of Ypsilanti. In addition, a

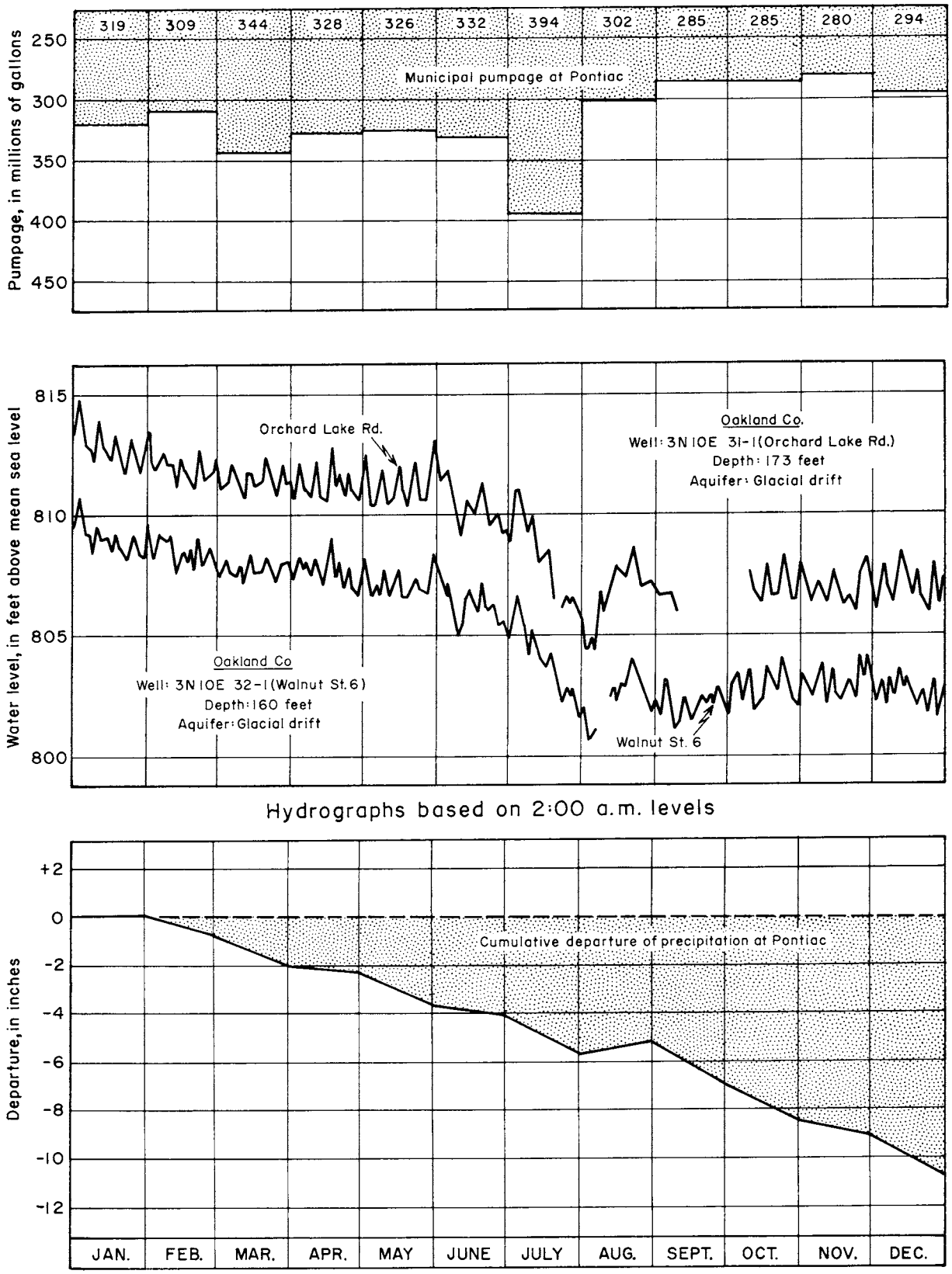


Figure 21. Hydrographs of 2 wells, pumpage, and precipitation departures at Pontiac, 1960.

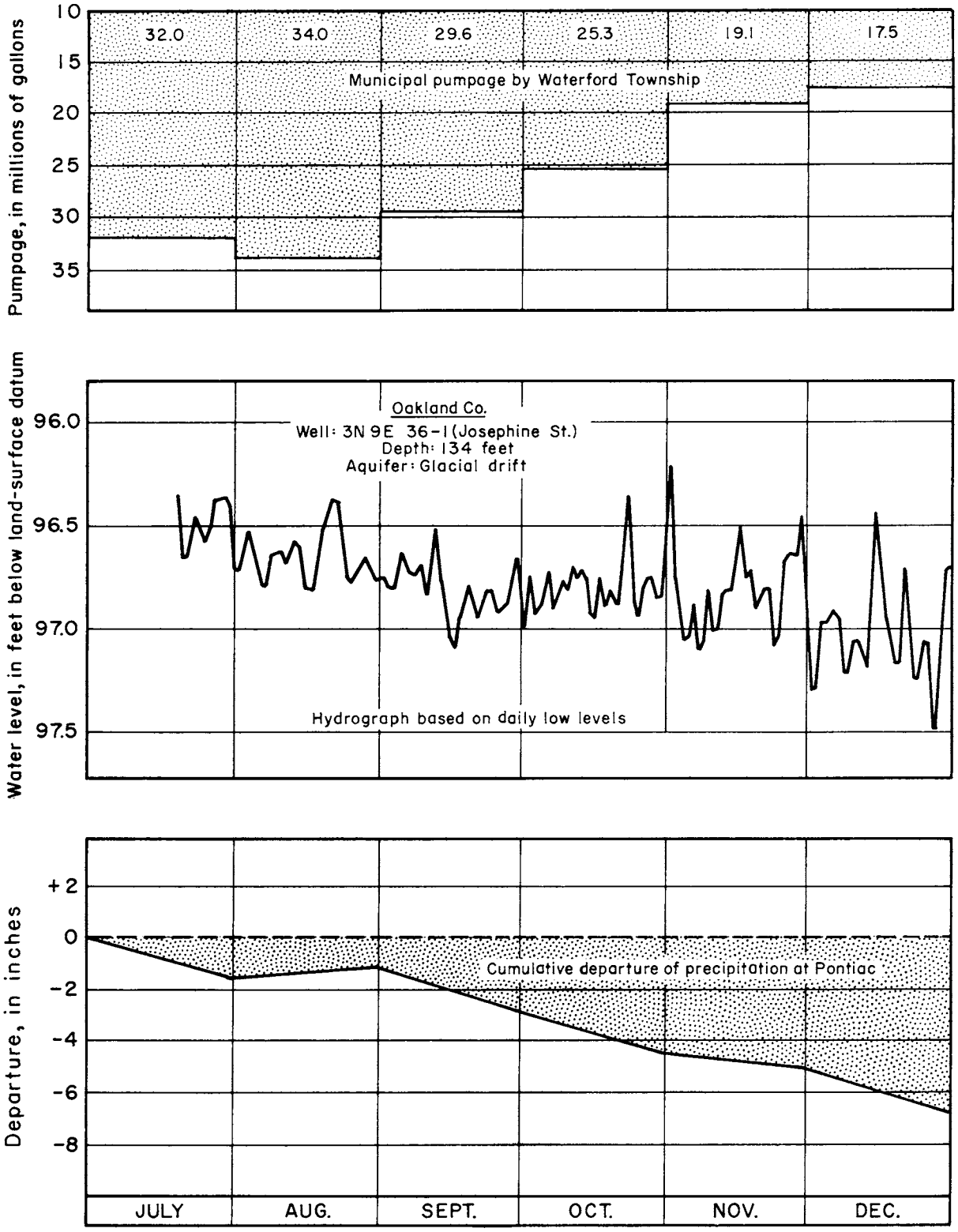


Figure 22. Hydrograph of well in Waterford Township, pumpage, and precipitation departures, July-December 1960.

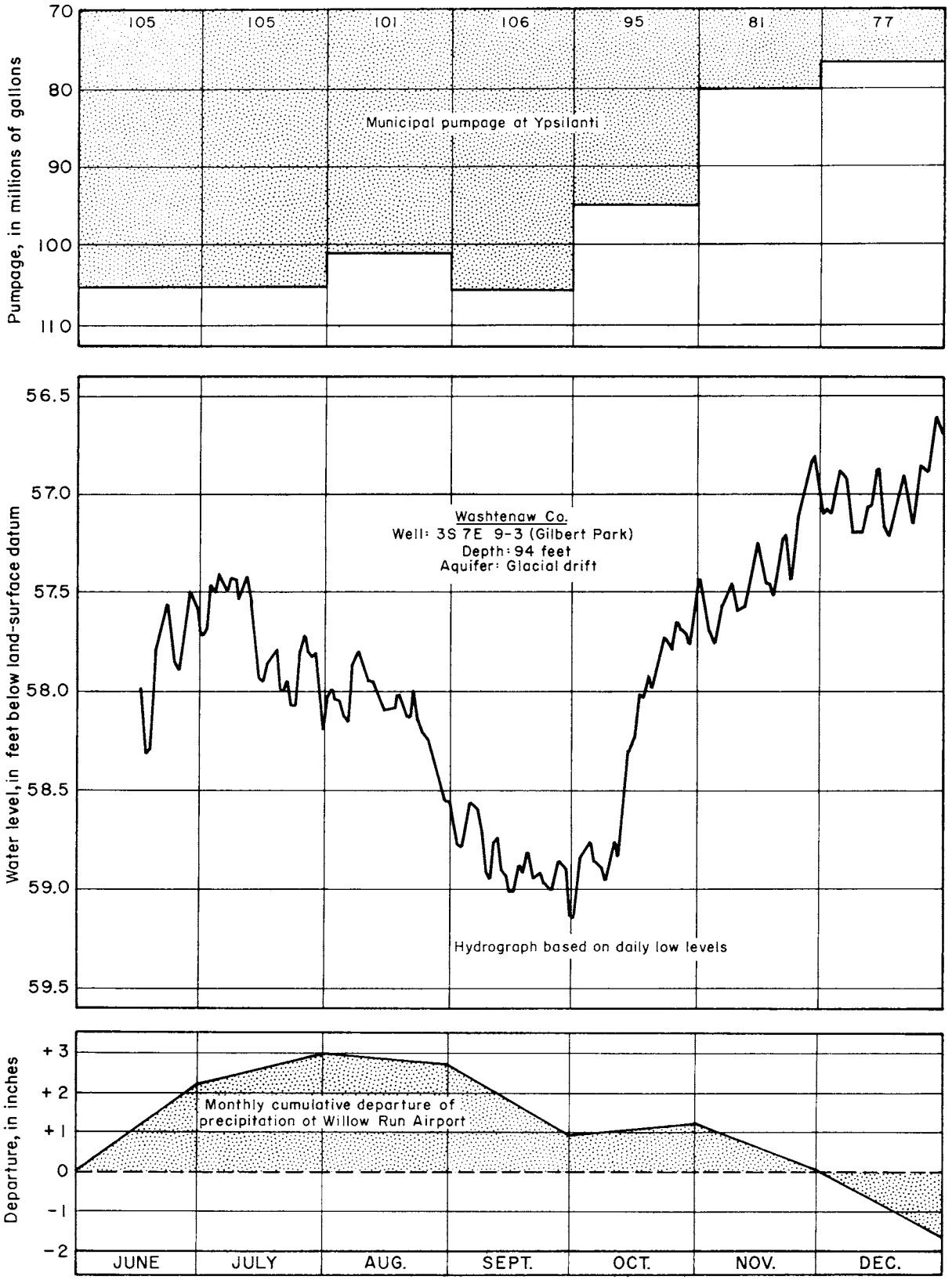


Figure 23. Hydrograph of well in Ypsilanti, pumpage, and precipitation departures, June-December 1960.

few miscellaneous measurements of water level were taken in two other wells in the city (table 1).

The water levels in the well at Gilbert Park were measured periodically in some of the past years (table 1). On the basis of the entire record, the stage in early September 1960 (fig. 23) was the lowest observed. The rise of water levels in the fall resulting from decreased municipal pumping was small, as a precipitation deficiency of nearly three inches was recorded during November and December.

Reported withdrawals of ground water by the city of Ypsilanti totaled 1,186 million gallons for the year, slightly less than the 1,205 mg reported for 1959.

Ypsilanti State Hospital.--Institutional water supplies are obtained from wells tapping the glacial drift. Water levels in the two observation wells at the hospital reflect pumping by the institution and climatic conditions. Stages were generally higher during the year than in the past several years and pumpage was about the same as in 1959. Favorable periods of precipitation during the early part of the year contributed recharge to the aquifer, although in the fall, recharge was less than usual.

Total reported institutional withdrawal of ground water in 1960 was 227 million gallons (table 2).

Ypsilanti Township.--Public supply wells and the observation wells at the township well field are finished in glacial drift. In July 1960 a continuous recording gage was installed on observation well 3S 7E 24-6 in cooperation with the township. The daily low stages from this well, township pumpage, and monthly totals of precipitation are

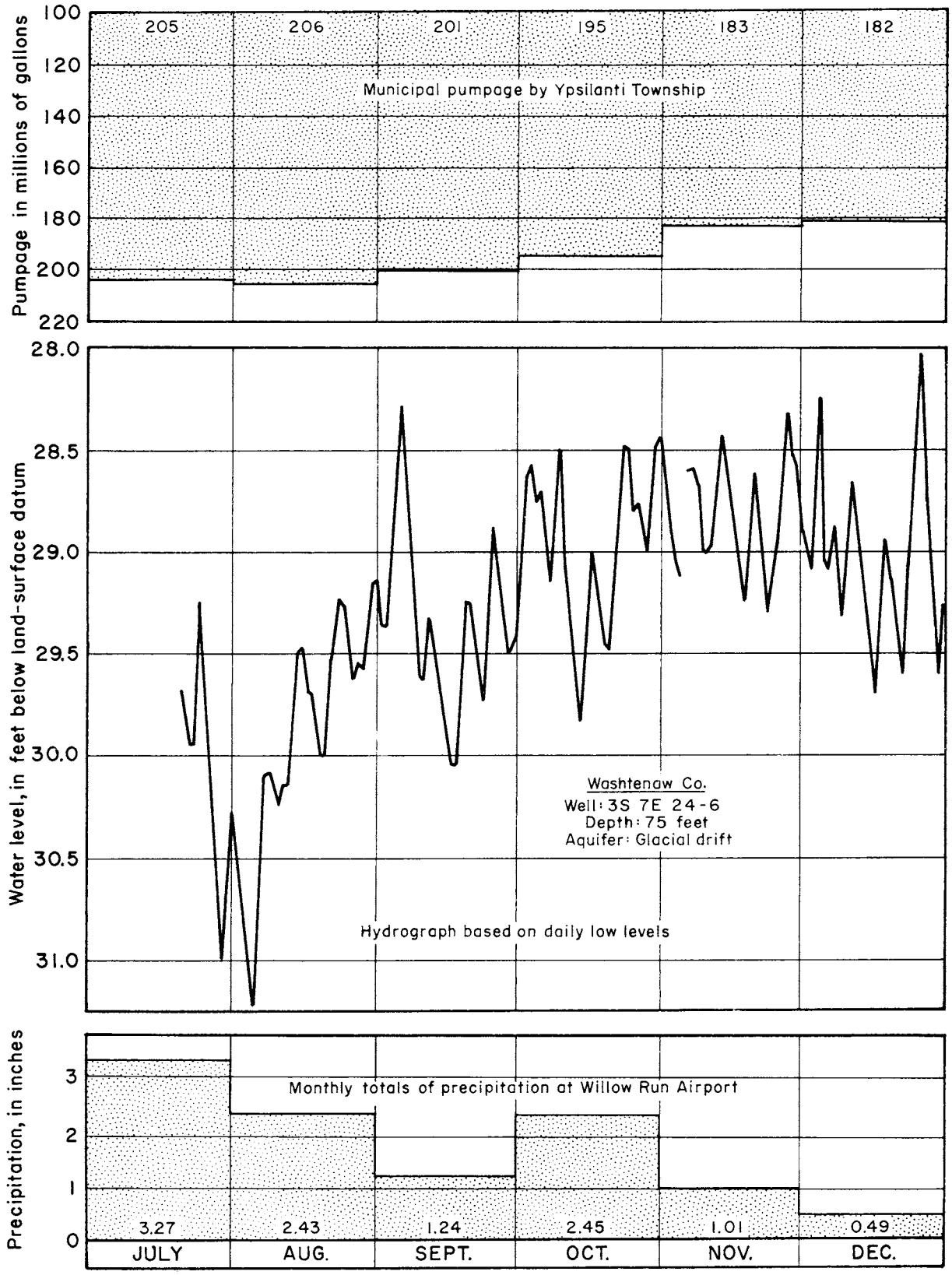


Figure 24. Hydrograph of well at Ypsilanti Township well field, pumpage and precipitation, July-December 1960.

shown by figure 24. Levels fell to their lowest of record in early August, as the result of heavy withdrawals of ground water plus a 4-inch deficiency of rainfall for the year. Four of the six observation wells measured at the well field also fell to new lows of record (table 1).

Reported municipal pumpage of 2,191 million gallons was the highest of record and was 187 mg more than was pumped in 1959.

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Francis, G. W., 1950, Infiltration gallery at Ontonagon: Jour. Am. Waterworks Assoc., v. 42, no. 2, p. 186-188.

Kurtyka, J. C., and others, 1961, in 1960 Report of the Committee on Hydrology, Wisconsin-Michigan Power Co. Ann. Rept., 223 p., 89 figs.

Table 1.--Records of Michigan observation wells and extremes in water levels observed in 1960 and for the period of record.

Owner: MDC - Mich. Dept. of Conservation; WMP - Wisconsin-Michigan Power Co.; MSHD - Mich. State Highway Dept.; USFS - U. S. Forest Service.

Chief Aquifer:

Qgd - Glacial drift deposits of Pleistocene (Quaternary) age
Ps - Saginaw Formation of Pennsylvanian age
Mb - Bayport Limestone of Mississippian age
Mm - Marshall Formation of Mississippian age
Dt - Traverse Formation of Middle and Late Devonian age
Dtb - Thunder Bay Limestone of Middle and Late(?) Devonian age
Ds - Sylvania Sandstone of Middle Devonian age
Ss - Salina Formation of Late Silurian age
Sm - Manistique Dolomite of Middle Silurian age
Or - Limestones of Richmond age (Late Ordovician)
Otb - Black River and Trenton Limestones of Ordovician age
Op - Prairie du Chien Group of Early Ordovician age (previously designated as Au Train Formation)
Cm - Munising Sandstone of Cambrian age
pC - Rocks of Precambrian age (undifferentiated)
pCf - Freda Sandstone of Keweenawan age (Precambrian)

Altitude: Land-surface datum in feet above mean-sea level.

F - 60: Frequency of measurement in 1960. R - Continuous recorder; D - Daily; W - Weekly; M - Monthly; Q - Quarterly; S - Semiannual; A - Annual.

Observed water-level extremes: 1960 measurements underscored are new extremes for entire period of record (in feet below or above (+) land-surface).

Remarks: P - water level affected by pumping. Water-level measurements are made by the U. S. Geological Survey unless otherwise noted.

Well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F 60	Observed water level extremes								Remarks
									Through 1959				In 1960				
									Highest	Date	Lowest	Date	Highest	Date	Lowest	Date	
Alger County																	
45N 19W 25-1	SW NE	USFS	66	6	Qgd	-	1959-60	M	11.84	11-27-59	12.66	8-26-59	6.35	6-29	12.42	3-31	Record started 6-10-59.
Baraga County																	
49N 33W 18-1	NE SW	Mich. College of Mining and Tech.	12	16	Qgd	-	1958-60	R	5.65	10-26-59	9.40	2- 9-59	e4.90	4-25	9.33	3-7	Meas. by owner.
48N 32W 12-1	SE SE	MSHD (WMP 14)	10	1¼	Qgd	-	1948-60	M	4.19	5- 3-51	6.72	3-15-49	4.52	11-1	4.96	12-30	Meas. by WMP.
Barry County																	
3N 8W 18-1	SE NE	City of Hastings (Fairgrounds)	33	6	Qgd	-	1958-60	M,R	2.32	4- 5-59	6.71	7-16-59	4.00	7-11	6.45	9-7	P, Recorder replaced 7-28-60
Branch County																	
6S 6W 22-1	NE SW	City of Coldwater(3)	130	6	Qgd	-	1949-60	W	10.08	4- 8-50	16.67	1-15-54	11.65	2-12	15.77	11-8	P, Meas. by owner.
Calhoun County																	
1S 7W 10-1	NW NW	K. N. Sabin	8	15	Qgd	907.99	1946-60	W	0.89	3-28-50	5.98	2-11-59	2.23	4-27	4.48	12-28	
32-1	NE SE	City of Battle Creek (Verona 22)	127	8	Mm	830.79	1939-60	D	0.7	4-26-50	16.75	7-16-59	7.90	2-14	13.10	9-8	P, Meas. by owner.
32-2	NE NW	Mrs. Harriett Rice	43	2	Mm	842.88	1946-60	Q	8.98	4-25-50	18.93	9-23-59	14.37	6-29	16.73	10-7	P
2S 8W 1-1	SW SE	Sherman Mfg. Co.	22	2	Qgd	825.19	1946-60	Q	10.49	4-11-47	18.82	9-23-59	16.29	4-12	18.15	12-22	
2-1	NW SE	Oliver Elec. Mfg. Co.	92	10	Mm	819.99	1946-60	R	4.75	4- 9-47	14.95	9-11-59	11.52	6-21	14.43	12-30	P
3-1	SE SE	Dominic Conto	12	2	Qgd	862.02	1946-60	Q	1.75	4-28-50	9.89	9-23-59	4.77	6-29	7.53	10-7	
3-2	SE NE	Eaton Mfg. Co.	80	10	Mm	833.39	1946-60	Q	13.43	4-25-50	25.41	9-23-59	20.12	6-29	23.22	10-7	P
14-1	NE SE	City of Battle Creek (TW 3)	62	2	Qgd	916.05	1939-60	Q	9.10	5-31-52	32.76	3-26-41	10.42	6-29	11.68	4-12	

2S	8W	14-2	SE SE	City of Battle Creek (TW 1)	89	26	Qgd	914.97	1945-60	Q	6.22	5-29-50	12.86	10-18-46	7.24	6-29	8.78	2-26	
2S	7W	7-1	SW NE	Oliver Farm Implement Co.	74	6	Mm	834.30	1946-60	Q	15.00	4-11-47	24.68	9-23-59	18.37	6-29	22.94	10-7	P
		17-1	NW SW	City of Battle Creek	87	2	Mm	841.78	1945-60	Q	6.57	4-25-50	11.38	9-23-59	8.52	4-12	10.36	10-7	P
		18-1	SW SW	do.	87	2	Mm	832.49	1945-60	Q	+0.50	4-25-50	3.24	9-21-49	0.41	4-12	2.30	10-7	P
2S	6W	25-1	NE NE	City of Marshall (Ferguson)	59	6	Mm	904.85	1950-60	M	5.46	5- 9-50	9.59	10- 6-58	7.23	5-2	8.40	12-22	P, Meas. by owner
		25-2	SE NW	City of Marshall (Egeler)	67	6	Mm	901.15	1950-51, 56-60	Q	6.50	9-14-50	9.00	8-14-57	7.54	4-12	8.04	12-22	P
		25-3	SW SE	City of Marshall (Filkin)	82	4	Mm	914.15	1950-60	Q	19.71	5- 3-50	26.32	12-19-56	22.33	4-12	24.40	12-22	P
									Cass County										
6S	16W	1-1	SW NE	City of Dowagiac	159	10	Qgd	750.19	1949-60	W	+4.60	12-25-59	-5.97	7-24-53	+5.20	2-20	-0.75	1-29	P, Meas. by owner
8S	14W	17-1	NE NW	Ted Little	55	28	Qgd	-	1945-60	W	46.20	7-16-50	55.03	3-10-47	48.83	8-21	51.77	1-3	
									Charlevoix County										
33N	4W	2-1	SW NE	MDC	94	6	Qgd	-	1948-60	Q	70.48	7- 9-59	75.85	4-16-56	69.49	7-14	73.21	4-25	
32N	4W	10-1	NE SE	MDC (33)	17	2	Qgd	-	1934-41, 48-60	M	1.19	3-30-58	7.42	2-12-59	2.43	5-11	6.34	3-9	
									Cheboygan County										
34N	1W	1-1	NW SW	MDC (7)	11	2	Qgd	-	1938-41, 48-52, 55-60	Q	2.75	3-28-38	5.55	10-13-55	3.44	4-13	4.40	9-13	
									Chippewa County										
46N	4W	24-1	NE SE	USFS	54	6	Qgd	-	1952-60	R	e22.45	7-25-57	27.77	4-12-56	20.70	7-3	25.70	4-15	
45N	1W	28-3	SW SW	MDC	28	1¼	Qgd	-	1958-60	M	24.80	12-29-59	26.37	3-30-59	23.34	6-30	25.02	2-26	
									Clare County										
17N	4W	33-1	NW NW	Watervliet Paper Co.	15	1½	Qgd	-	1958-60	M	8.60	5- 4-59	10.56	2-27-59	8.52	5-2	10.23	10-31	Meas. started 8-1-58.
									Clinton County										
8N	1W	13-1	SW NW	Village of Elsie	298	12	Ps	699.68	1947-60	M	+3.78	6- 3-50	37.55	10-15-57	+0.14	8-26	12.37	9-26	P
		13-3	SW NW	do. (3)	45	12	Qgd	706.17	1947-60	M	7.33	12-28-59	26.4	10-11-49	6.40	4-29	8.54	7-22	P
6N	2W	16-1	SE SE	MSHD	23	14	Qgd	803.32	1948-60	M	14.59	4-19-52	18.53	12-29-53	15.69	4-28	18.17	12-30	
5N	2W	31-1	NW SW	Mich. Dept. of Aeronautics	195	6	Ps	e850.	1949, 55, 60	R	45.0	3-21-49	53.00	9- 2-55	53.47	7-30	55.38	12-27	P, Recorder installed 7-22-60
		32-1	SW SE	Mich. Health Dept.	135	4	Ps	849.21	1944-60	M	42.02	9-14-44	79.06	6-29-59	72.43	3-31	82.94	12-1	P
									Crawford County										
27N	1W	20-1	SW SW	MDC (22)	15	2	Qgd	-	1934-57, 60	Q	1.55	7-11-43	5.92	10-12-55	1.87	4-27	4.07	12-21	
26N	4W	11-1	NW SW	MDC	12	15	Qgd	1147.59	1942-60	R	4.03	6- 1-43	9.85	9- 3-58	4.99	5-23	9.05	10-21	
25N	3W	28-1	SW SW	MDC (8)	13	1¼	Qgd	1175.14	1934-37, 39-60	Q	8.70	6-15-43	11.28	10-22-58	8.60	7-28	10.21	12-21	
25N	1W	15-1	SE SE	USFS	56	6	Qgd	-	1948-60	R	29.44	8- 4-53	35.97	4- 4-51	29.36	7-27	32.14	1-4	
									Delta County										
43N	19W	24-3	NW NW	Harry Clarage	405	4	Otb	-	1958-60	M	79.27	10-10-58	80.06	4- 9-59	77.02	7-29	79.66	3-31	
42N	19W	20-3	NE NE	USFS	134	6	Or	-	1958-60	M	25.42	7-23-58	25.86	3-31-59	23.76	6-27	25.32	3-31	
42N	18W	17-2	SW NE	USFS	60	6	Qgd	-	1958-60	M	23.77	7-22-58	24.97	3-31-59	21.20	5-25	24.66	3-31	

Table 1.--Records of Michigan observation wells and extremes in water levels observed in 1960 and for the period of record.--Continued

Well number	Location in section (¼ ¼)	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F 60	Observed water level extremes								
									Through 1959				In 1960				
									Highest	Date	Lowest	Date	Highest	Date	Lowest	Date	
Delta County (Continued)																	
41N 19W 17-1	NE SW	USFS	58	6	Or	635±	1958-60	M	0.89	10-28-59	3.82	8-26-59	0.50	4-29	2.87	10-24	
41N 18W 31-2	SE SW	Charles Thompson	250	4	Or	-	1958-60	R	3.84	10-25-59	5.91	8- 3-59	3.77	5-7	5.39	7-20	
40N 22W 4-2	NE NW	USFS	40	5	Qgd	-	1958-60	M	22.84	12-31-59	23.50	4-28-59	20.28	10-13	22.77	1-29	
4-4	NE NW	USFS	34	5	Qgd	-	1959-60	M	-	-	-	-	14.87	7-29	17.10	4-29	Record started 11-27-59.
39N 23W 28-3	SW NE	Marshall and Sherman Blake	530	5	Cm	680±	1958-60	R	1.99	10-24-59	3.86	9-28-58	1.52	5-6	2.69	8-27	
38N 22W 24-1	NW SE	USFS (3)	36	6	Or	585±	1958-60	M	1.12	4-28-59	5.53	10-27-58	1.10	4-29	4.74	10-26	
Dickinson County																	
43N 29W 32-1	NW NE	Dickinson Co.(WMP 11)	12	1¼	Qgd	-	1948-60	M	5.12	4-18-51	dry	10-12-48	6.25	5-3	10.20	9-1	Meas. by WMP.
42N 27W 33-1	NE NW	E. W. La Freniere (WMP 10)	12	36	Qgd	-	1945-46, 58-60	M	3.08	4-29-54	10.75	10- 3-55	2.74	5-3	8.19	3-30	Do.
41N 30W 25-1	NE SW	Dickinson Co.(WMP 1)	20	1¼	Qgd	-	1948-60	M	3.51	10-30-51	dry	10- 3-55	2.66	5-3	dry	9-29	Do.
25-2	NW SE	Wm. Carrolo (WMP 2)	16	36	Qgd	-	1945-46, 48-60	M	2.61	10-30-51	dry	1-30-59	1.69	5-3	8.72	11-1	Do.
25-3	SE NE	Oscar Martinson (WMP 3)	12	48	Qgd	-	1945-46, 48-60	M	1.73	7- 6-53	dry	11- ?-48	1.57	5-3	6.20	9-1	Do.
Eaton County																	
4N 4W 2-1	SW SW	City of Grand Ledge	376	12	Pls	846.59	1948-60	W,R	21.34	5- 5-50	29.72	9-14-59	22.43	6-20	27.57	1-11	P
11-1	NW NE	do.	350	8	Pls	-	1960	R	-	-	-	-	+3.80	9-19	-8.3	12-4	P, Recorder installed 8-11-60
4N 3W 10-1	SE NE	John Schneeberger	121	3	Pls	855.99	1944-60	M	31.28	5-27-48	38.59	10-28-59	36.19	5-27	38.45	12-1	P
12-1	SE SW	F. A. Wheeler	381	6	Pls	861.91	1953-60	R	67.51	11-23-53	79.4	7-16-59	67.7	4-25	76.9	9-9	P
2N 4W 19-1	NW SW	City of Charlotte	25	240	Qgd	889.44	1947-60	Q	8.04	4- 7-47	16.48	9-23-59	11.25	4-12	15.92	12-22	P
Genesee County																	
7N 7E 9-1	SE SW	Consumers Power Co.	288	12	Pls	761.83	1946-60	Q	17.50	4-11-48	45.48	7-20-57	21.74	4-19	37.00	7-1	P
17-1	SE NE	do.	222	12	Pls	757.83	1946-60	R	24.23	2-12-50	37.99	8-24-55	24.41	4-21	33.34	9-9	P
20-2	SW SW	City of Flint	169	2	Qgd	749.48	1947-60	Q	1.09	4-26-50	9.07	9-15-55	3.66	4-19	6.70	10-10	
29-1	SE SW	C. F. Crain	14	1¼	Qgd	776.63	1946-60	Q	1.69	12-22-49	10.46	9-23-58	4.65	4-19	10.66	10-10	
29-2	SW SE	Jack Palmer	8	18	Qgd	779.86	1946-60	Q	+0.20	6-29-48	8.50	12-15-58	3.70	4-19	dry	10-10	
32-1	SW SW	A. W. Arndt	140	2	Qgd	792.27	1946-60	Q	18.51	6- 2-47	35.36	9- 2-59	30.58	4-19	32.74	12-23	P
6N 7E 9-1	SW SE	Fisher Body Div.,GMC	375	6	Pls	841.71	1952-60	R	37.79	11-24-52	57.8	7-15-59	44.7	5-30	59.9	8-9	P
Gladwin County																	
17N 1W 7-1	SW NW	City of Beaverton	93	12	Qgd	721.50	1950-60	D	27.94	4- 6-59	49.35	6-26-50	28.22	4-5	45.95	1-18	P, Meas. by owner
Grand Traverse County																	
27N 9W 4-1	NW NE	MDC (18)	15	2	Qgd	687.01	1934-37, 41-44, 48-52, 55-60	M	0.80	4-14-59	2.54	7-26-35	0.74	5-19	1.47	9-28	
26N 11W 27-1	NW SW	MDC (2)	14	2	Qgd	914.25	1935-37, 41-44, 48-60	Q	1.20	4-14-59	4.02	8-18-36	1.27	4-28	2.83	9-28	
26N 9W 13-1	SW SW	MDC (2)	14	2	Qgd	961.78	1934-37, 41-44 48-60	M	4.72	7-17-57	7.87	10-11-49	4.66	5-19	6.71	3-23	

											Gratiot County										
12N	3W	24-2	NE SE	City of St. Louis (3)	216	16	Qgd	-	1960		R	-	-	-	-	50.0	12-12	67.6	10-28	P, Record started 8-19-60.
		34-1	SW SE	S. J. Brown	55	2	Qgd	727.12	1947-60		M	6.08	4-26-48	40.87	6-28-50	17.69	11-28	24.25	7-25	P
		35-3	NW SW	Walter Stone	26	2	Qgd	732.62	1947-60		M	10.07	5- 3-48	24.30	8-27-58	18.25	5-27	20.12	7-25	P
		35-5	SW NW	Reed Excavating Co.	20	36	Qgd	738.78	1950-60		M	13.74	4- 7-50	17.91	11-12-53	14.47	4-29	17.47	12-30	
12N	2W	18-1	NE NW	Mich. Chemical Co.	1350	5½	Mm	-	1957-60		R	227.5	12-28-59	267.7	8-30-57	212.3	12-31	227.6	1-1	
11N	3W	3-6	NW NW	E. H. Waber	49	2	Qgd	733.20	1946-60		M	4.99	2-27-59	32.98	12-16-55	9.34	7-25	30.22	9-26	P
		4-1	SW NE	City of Alma (TW 6)	165	8	Qgd	732.31	1955-58, 60		R	12.06	6-14-55	21.38	10-15-57	12.42	5-9	27.3	9-9	P, Recorder installed 5-5-60.
		36-1	SE SE	Village of Ithaca	785	8	Ps	804.50	1947-60		M	78.25	1-22-52	83.96	9- 4-49	79.19	5-27	80.40	9-26	
											Hillsdale County										
6S	3W	23-2	NW NW	City of Hillsdale (TW 6)	26	6	Qgd	-	1957-60		W	1.72	2-16-59	12.96	9-18-57	1.62	6-27	2.65	1-11	No pumping in 1960.
											Ingham County										
4N	2W	4-1	NW SW	C & O R.R. (East 1)	38	12	Qgd	842.19	1953-60		M	25.98	3- 3-53	34.38	12-28-59	32.08	12-29	33.17	4-28	P
		9-1	SE NW	City of Lansing (Seymour 1)	401	14	Ps	828.81	1929-60		M,R	15.63	3-26.31	154.77	4-10-56	138.4	4-19	150.1	11-4	P, Recorder installed 8-9-60.
		9-2	SW NW	Consumers Power Co.	370	12	Ps	820.69	1945-60		A	61.26	3-23-46	143.27	12-12-55	121.83	4-19	121.83	4-19	P, Meas. stopped 4-19-60.
		16-1	NE SE	City of Lansing (Cedar)	417	12	Ps	829.11	1945-60		Q,R	42.01	3-11-46	67.0	8-22-49	56.98	11-28	62.92	4-15	P, Recorder installed 7-5-60.
		17-1	NW NE	City of Lansing (Logan)	424	20	Ps	858.72	1929, 31, 33-60		Q,R	34.34	12- ?-29	149.64	4-11-56	134.68	4-19	146.0	9-9	P, Recorder installed 8-17-60.
		17-2	NW NW	Olds Drop Forge (4)	417	12	Ps	872.55	1946-60		Q	104.86	12-10-46	148.47	4-10-56	137.51	4-19	146.65	9-29	P
		19-1	SW SW	Waverly Hills Assoc.	87	2	Ps	833.94	1947-60		Q	0.00	3-29-50	6.31	6-29-59	5.95	4-19	8.74	12-29	P
		21-1	NE NW	City of Lansing (Townsend)	410	14	Ps	834.10	1906, 19, 29-60		Q,R	2.0	5- 9-06	74.33	8-21-59	63.65	12-26	71.07	5-26	P, Recorder installed 8-23-60.
		22-1	SW NW	City of Lansing (P-5)	338	12	Ps	823.64	1930-60		M	7.1	7- ?-32	58.68	10-16-59	50.74	5-27	54.82	12-1	P
		23-1	NE NW	City of Lansing(RS-7)	467	12	Ps	824.86	1930-32, 36-60		M	7.55	11-17-30	116.28	7-23-59	85.86	11-25	103.78	3-31	P, Meas. by owner
		24-1	NE SW	Mich. State Univ.	453	10	Ps	853.45	1945-60		R	25.47	3-25-46	e80.0	7-17-59	53.2	12-28	71.2	7-14	P
		28-1	NE NW	Atlas Drop Forge (2)	425	8	Ps	849.20	1944-45, 48-60		Q	30.28	4-23-48	54.40	8-19-48	49.63	10-31	53.58	4-19	P
		31-1	SW SW	C. A. Weber	204	3	Ps	880.15	1944-60		M	18.92	4-26-52	25.57	2-27-59	22.09	5-27	24.87	12-29	P
4N	1W	18-1	SE NE	Marble School	175	3	Ps	847.85	1952-60		M	20.09	4-27-53	34.05	7-31-59	31.12	6-27	32.96	9-29	P
3N	2W	23-2	SE NE	Delhi Twp. (Holt)	268	8	Ps	e880	1959-60		R	3.75	11-15-59	4.90	10-29-59	2.07	3-31	5.84	12-27	P
2N	1W	5-1	SE SE	City of Mason (old 2)	150	6	Ps	-	1948-60		W	0.08	6-29-49	7.79	8- 1-59	2.11	4-2	8.96	9-10	P, Meas. by owner
											Ionia County										
7N	7W	23-1	NW NW	Michigan Tng. Unit at Ionia	127	6	Qgd	741.65	1960		R	-	-	-	-	28.65	11-12	30.53	12-14	Record started 9-1-60.
		25-1	SW NE	Ionia State Hospital	23	6	Qgd	635.76	1960		R	-	-	-	-	12.51	8-25	13.74	10-19	Record started 8-24-60.
•6N	5W	33-1	- NE	Barley-Earhart Co.	15	180	Qgd	-	1957-60		R	6.19	3-21-59	10.25	7-17-59	4.35	4-1	10.17	9-17	
											Iosco County										
23N	7E	7-1	NE SE	USFS	341	6	Qgd	-	1948-60		Q	25.13	8- 3-52	28.10	4-27-59	25.50	7-28	26.12	4-27	
											Iron County										
46N	34W	14-1	NE NW	Oliver Iron Mining Co. (WMP 18)	12	1¼	Qgd	-	1945-60		M	3.65	6- 2-54	8.60	3-15-49	4.27	5-3	7.80	11-1	Meas. by WMP.
46N	33W	18-1	SW NW	MSHD (WMP 17)	12	1¼	Qgd	-	1948-60		M	2.80	4-18-49	dry	2-28-56	4.37	5-3	7.49	12-30	Do.
45N	37W	23-1	SW NE	USFS (WMP 28)	8	1¼	Qgd	-	1948-60		M	0.75	8-31-51	4.72	9-11-48	1.08	5-2	2.83	9-29	Do.

Table 1.--Records of Michigan observation wells and extremes in water levels observed in 1960 and for the period of record.--Continued

Well number	Location in section (¼ ¼)	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F 60	Observed water level extremes								Remarks
									Through 1959				In 1960				
									Highest	Date	Lowest	Date	Highest	Date	Lowest	Date	
							Iron County (Continued)										
45N 35W 33-1	SE NW	MSHD (WMP 34)	12	1¼	Qgd	-	1948-60	M	1.93	7- 6-53	8.44	3-15-49	2.07	6-30	5.16	3-30	Meas. by WMP.
45N 33W 8-1	SW SW	Basilo Prandi	33	36	Qgd	-	1945-60	M	23.39	10-30-51	32.16	3-15-49	22.71	5-3	26.57	3-1	Do.
44N 37W 14-1	NW NW	USFS (former James Lake CCC)	102	6	Qgd	-	1959-60	R	94.8	10-24-59	95.75	10-22-59	93.8	11-29	95.7	1-9	Do.
44N 35W 6-1	SW SW	USFS (Paint R. 1)	6	1¼	Qgd	1468.15	1948-60	M	+0.10	5- 2-51	2.26	11-15-48	+0.05	5-2	1.94	9-29	Do.
6-2	SW SW	USFS (do. 2)	13	1¼	Qgd	1475.14	1948-60	M	5.08	7- 6-53	8.92	11-15-48	5.21	5-2	8.53	9-29	Do.
6-3	NW SW	USFS (do. 3)	12	1¼	Qgd	1476.35	1948-60	M	4.03	7- 6-53	9.20	11-15-48	4.23	5-2	8.70	9-29	Do.
7-1	NW NW	USFS (do. 4)	4	1¼	Qgd	1469.28	1948-60	M	1.12	5- 2-51	3.73	8- 1-47	1.15	5-2	3.26	9-29	Do.
7-2	NW NW	USFS (do. 5)	13	1¼	Qgd	1471.25	1948-60	M	2.50	7- 6-53	9.44	10-26-48	2.56	5-2	5.17	8-2	Do.
7-3	NW NW	USFS (do. 6)	17	1¼	Qgd	1475.83	1948-60	M	8.48	5- 2-51	13.40	10-26-48	9.48	5-2	12.59	9-29	Do.
44N 33W 10-1	SW SW	Iron Co. (WMP 21)	8	1¼	Qgd	-	1948-60	M	1.95	4-29-54	7.94	1-12-51	2.13	5-3	6.64	11-1	Do.
43N 36W 1-1	SW NE	do. (WMP 27)	9	1¼	Qgd	-	1948-60	M	6.67	4-29-34	9.02	6-30-52	6.48	5-2	8.59	2-29	P, Do.
43N 35W 11-1	SE NE	J. J. Javoroski (WMP 23)	47	36	Qgd	-	1945-60	M	39.33	1-11-52	47.08	8-15-49	38.61	9-1	43.02	2-2	P, Do.
13-1	SW SE	F. V. Gendzwill (5)	65	36	pC	-	1945-60	S	47.90	9-11-46	63.68	11-30-46	50.83	12-15	51.27	5-2	Mine drainage study.
13-2	SW SE	Boyington (hole 4-44)	?	?	?	-	1945, 47-60	S	66.39	1-14-52	71.56	3-24-49	67.67	12-15	67.83	5-2	Do.
20-1	SW SE	Mrs. B. Henriksen (WMP 25)	48	1¼	Qgd	-	1945-60	M	41.66	6-20-53	48.29	8-15-49	42.19	8-2	44.26	3-30	Meas. by WMP.
24-1	SE NE	Spies-Johnson No. 73 (7)	?	3	Qgd?	-	1945-60	S	70.42	11-20-56	86.05	1-19-49	67.57	12-15	70.27	5-2	Mine drainage study.
26-1	SW NE	City of Iron River (1)	130	2	Qgd	-	1945-60	S	21.91	9-16-59	44.58	3-24-50	18.64	5-2	24.02	12-15	P
43N 34W 19-1	NW SW	Spies-Johnson No. 3004 (8)	?	3	Qgd?	-	1945-60	S	63.37	12-20-56	89.5	10-20-45	60.25	12-15	63.13	5-2	Mine drainage study.
19-2	NE SW	Spies-Johnson Co. 3c (9)	?	3	Qgd?	-	1945-60	S	69.35	12-20-56	84.10	12-21-48	66.50	12-15	69.49	5-2	Do.
29-1	SW NE	Rogers Mine (11)	?	48	Qgd	-	1947-53-56-60	S	10.31	8-15-53	20.69	3-24-50	14.48	12-15	15.97	5-2	Do.
43N 32W 26-2	NE SW	Caya Mine (17)	?	?	Qgd?	-	1952-60	M	1.04	5-12-55	86.03	3-18-53	0.68	5-24	9.18	3-28	Do.
26-3	SW NE	Caya Mine	200+	4	?	-	1959-60	M	-	-	-	-	29.79	5-2	36.26	10-27	Record started 10-27-59.
42N 36W 15-1	NE SW	MSHD (Brule R. 1)	6	1¼	Qgd	1543.92	1948-60	M	0.81	4-29-54	3.17	10-26-48	1.35	5-2	2.64	8-2	Meas. by WMP.
15-2	NE SW	MSHD (do. 2)	7	1¼	Qgd	1545.60	1948-60	M	0.46	7- 6-53	3.10	10-26-48	0.87	5-2	2.45	12-29	Do.
15-3	NW SW	W. Young Estate (Brule R. 3)	14	1¼	Qgd	1554.36	1948-60	M	3.67	4-29-54	8.29	10-26-48	3.94	5-2	7.13	12-29	Do.
42N 34W 7-1	SW NE	Zimmerman No. 1 (13)	171	12	Qgd	1165.32	1945-60	S	131.46	10-10-58	153.27	4-21-50	129.02	12-15	135.74	5-2	Mine drainage study.
42N 31W 33-1	NW SE	Iron Co. (WMP 7)	11	1¼	Qgd	-	1948-60	M	+0.03	7- 3-56	6.28	10-13-48	+0.20	5-2	2.97	12-29	Meas. by WMP.
33-2	NW SE	Joseph Giachino (WMP 8)	12	15	Qgd	-	1945-60	M	1.89	10-30-51	12.22	2-25-53	1.96	5-2	9.90	11-1	Do.
41N 31W 10-1	SW NE	Iron Co. (WMP 5)	17	1¼	Qgd	-	1948-60	M	8.47	1- 3-52	dry	12-15-48	9.77	5-31	14.32	12-29	Do.
							Jackson County										
1S 1E 36-9	SE SE	MDC (9)	9	1¼	Qgd	920.28	1956-60	W	0.42	5-10-56	6.80	12-30-58	1.10	2-5	5.27	10-13	Meas. by MDC.
3S 1W 11-2	NE NE	City of Jackson (4a) (Belden Road)	360	6	Pls, Mm	-	1957-60	D	21.1	7- 7-57	93.0	8-26-59	19.2	11-27	86.6	8-31	P, Meas. by owner
10-1	SE SE	Summit Township	323	12	Pls, Mm	-	1960	R	-	-	-	-	14.7	12-26	24.66	12-9	P, Record started 9-28-60.

3S 1W	2-1	SE NW	City of Jackson (Water St.)	221	8	Ps, Mm	-	1960		R	-	-	-	-	17.5	11-28	36.0	10-14	P, Record started 9-27-60.
									Kalamazoo County										
2S 11W	3-60	NE NE	KVP Co. (61)	36	6	Qgd	763.18	1956-60		W	10.05	3-10-58	12.82	9-18-59	9.61	4-4	12.15	10-31	P, Record started 9-28-60.
	15-18	NE SE	Consumers Power Co.	64	12	Qgd	766.17	1946-60		Q	9.20	3-28-50	17.29	12-17-58	12.15	4-13	16.00	12-15	P
	20-7	SW SE	Western Mich. Univ.	78	8	Qgd	868.68	1946-60		Q	33.44	6-19-50	38.15	9-17-59	34.84	7-28	35.55	12-15	
	22-6	NE SW	City of Kalamazoo	115	6	Qgd	777.45	1946-60		R	11.22	3-11-52	31.48	9-11-59	21.65	5-24	e27.85	9-26	P, Meas. by owner
	22-150	SE SW	do. (Stockbridge Ave.)	137	4	Qgd	-	1960		R	-	-	-	-	20.15	12-17	26.53	9-24	P, Record started 8-30-60.
	27-52	NE NE	Allied Paper Co. (7)	113	12	Qgd	802.59	1946-60		R	34.46	5- 5-50	64.37	9- 1-46	42.55	5-30	46.10	10-15	P, Meas. by City of Kalamazoo.
	29-3	SW SE	Oakwood, Inc.	47	2	Qgd	880.72	1946-60		Q	26.12	8- 1-52	30.58	12-30-59	29.10	7-28	30.00	4-13	
4S 11W	21-2	NW SW	Willis Chamberlain	19	1¼	Qgd	-	1957-60		W	12.49	6-10-59	15.12	2- 8-59	10.77	7-20	13.97	1-6	
3S 11W	4-35	SE NE	City of Kalamazoo(A)	135	3	Qgd	854.03	1959-60		R	5.46	10-13-59	12.89	11- 3-59	1.50	10-3	12.35	8-20	P
	4-36	SE NE	do. (A-8)	40	3	Qgd	854.01	1959-60		R	4.93	10-13-59	9.12	11- 4-59	0.21	8-10	3.54	9-10	P
									Kalkaska County										
27N 5W	36-1	SE NW	MDC (100)	16	1¼	Qgd	-	1939-60		W	11.12	7-11-43	14.69	3-12-40	11.58	6-10	13.43	3-25	
									Kent County										
6N 12W	17-1	SE NE	Jervis Corp. (1)	30	12	Qgd	-	1950-60		M	6.88	6- 8-56	16.45	2-12-54	7.79	4-19	12.31	11-8	P, Meas. by owner
	17-2	SE NE	do.	26	6	Qgd	606.05	1950-60		M	7.34	6- 1-56	16.32	2-12-54	8.71	4-19	12.22	11-8	P, Do.
	25-1	SW SW	City of Wyoming (50th St.)	241	12	Mm	e666	1960		R	-	-	-	-	10.0	10-24	45.8	9-8	Record started 6-9-60.
	34-1	SE NE	do. (Boss)	300	8	Mm	e735	1960		R	-	-	-	-	64.82	10-26	68.29	9-9	Do.
6N 11W	19-1	SE	Lear Mfg. Co.	301	8	Mm	e690	1960		R	-	-	-	-	34.3	12-5	68.5	9-8	Do.
									Lake County										
17N 13W	4-1	SE NE	C&O R.R. (West Well)	83	8	Qgd	-	1957-60		Q	18.23	4-14-59	20.36	5-23-58	17.17	7-6	18.62	9-30	
									Livingston County										
2N 4E	3-1	NW SW	Howell State Sanitarium(Deer L.)	148	8	Ps	-	1958-60		R	10.2	4-30-59	27.8	12-13-58	10.5	1-8	25.9	9-7	P, Meas. by owner
	9-1	NW NE	Howell State Sanitarium (TW 3)	280	6	Ps	-	1958-60		R	109.9	4- 3-59	120.1	9- 4-59	110.1	1-8	116.4	3-14	P, Meas. stopped 5-4-60.
									Luce County										
49N 11W	2-5	NW NE	State (5)	7	1¼	Qgd	-	1959-60		M	2.69	12-28-59	6.34	7-30-59	+0.40	5-26	3.92	3-29	Lake Hyd. Study.
49N 10W	6-6	SW SW	State (6)	8	1¼	Qgd	-	1959-60		M	4.67	12-28-59	8.02	8-26-59	1.98	5-31	5.30	12-29	Do.
46N 10W	25-20	NW NW	John Barrett Est.	20	48	Qgd	-	1958-60		M	0.37	10-29-59	0.85	5-28-59	0.11	5-3	0.86	6-29	Freezes in winter.
									Mackinac County										
42N 2W	7-1	NE NE	USFS (Pontchartrain)	102	6	Sm	-	1956-60		R	13.8	5- 7-59	29.35	11- 5-57	13.1	5-11	27.6	3-29	
	9-1	NE NW	Kenneth Kerr	84	2	Sm	-	1956, 59-60		M	+1.0	*	3.87	2-26-59	+0.97	6-30	1.23	7-28	*Often flows. Not measured in winter.
41N 5W	23-1	SW NW	MDC (Round Lake)	47	6	Ss	-	1956-60		M	4.30	5- 7-59	17.48	3-19-59	5.40	5-4	14.14	3-30	
									Macomb County										
2N 12E	1-1	SE NE	B. H. Tolley	29	48	Qgd	-	1959-60		R	-	-	-	-	0.50	1-13	7.45	10-31	Record started 11-10-59.

Table 1.--Records of Michigan observation wells and extremes in water levels observed in 1960 and for the period of record.--Continued

Well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F 60	Observed water level extremes: Through 1959 Highest	Date	Lowest	Date	In 1960 Highest	Date	Lowest	Date	
Manistee County																	
23N 14W 21-1	NE SW	Village of Kaleva	70	8	Qgd	-	1959-60	R	9.50	11-10-59	10.65	9-22-59	8.49	5-15	10.90	10-23	P
Marquette County																	
49N 30W 22-1	SW NE	Marquette Co. (WMP 13)	17	1¼	Qgd	-	1948-60	M	0.64	5- 3-51	13.32	9- 2-48	7.36	5-3	11.40	9-2	Meas. by WMP.
45N 30W 1-1	SW NW	Arnold Janofski (WMP 4)	31	36	Qgd	-	1945-60	R	24.38	12-13-51	29.28	3-15-49	23.82	7-18	26.75	4-10	
45N 25W 28-1	NE NW	MDC (Gwinn CCC)	18	6	Qgd?	-	1958-60	M	2.60	10-29-59	4.82	3-31-59	0.67	4-26	4.20	2-25	
44N 26W 28-1	NE SE	MDC (Escanaba R. CCC)	31	6	Qgd	-	1953-60	M	2.05	5-10-54	2.83	8-30-57	1.90	5-17	2.28	3-10	Meas. by MDC.
Mason County																	
17N 15W 3-1	SE SW	USFS	32	6	Qgd	737.37	1948-60	M	14.44	5-15-52	19.45	8-24-58	13.90	6-30	17.00	1-30	
Menominee County																	
37N 26W 19-1	NE SE	MSHD	16+	4	Otb	-	1959-60	M	3.87	10-27-59	4.62	11-23-59	3.70	5-2	5.13	10-27	
Montcalm County																	
9N 8W 10-1	SW NW	City of Greenville (1)	29	12	Qgd	-	1957-60	R	3.35	11-17-57	7.90	8- 6-59	3.98	1-17	6.30	10-18	P
15-1	SW NW	City of Greenville (9)	65	12	Qgd	-	1950-60	M	11.40	4- 1-50	17.40	8- 1-58	12.80	7-5	15.26	3-1	P, Meas. by owner.
Montmorency County																	
32N 2E 34-1	NW NE	MDC	24	2	Qgd	-	1948-60	Q	17.41	5-15-52	21.12	12- 3-58	17.56	7-12	18.51	12-2	
29N 3E 21-1	NW NE	MDC (32)	14	2	Qgd	-	1945-60	Q	2.63	5-15-52	5.91	1-27-56	2.54	7-6	4.43	4-4	
Oakland County																	
3N 10E 31-1	NE SW	City of Pontiac (Orchard Lake Rd.)	173	12	Qgd	926.4	1952-60	R	107.7	2-16-59	128.0	8-16-55	111.5	1-2	122.8	8-3	P
32-1	SE NW	City of Pontiac (6)	160	8	Qgd	921.88	1939-60	R	59.55	4-22-40	129.5	8- 5-55	110.9	1-3	122.1	8-3	P
3N 9E 36-1	NW NE	Waterford Twp. (Josephine St.)	134	12	Qgd	-	1960	R	-	-	-	-	96.03	11-16	97.49	12-28	P, Record started 7-18-60.
2N 10E 22-1	NE NW	Cranbrook School (3)	65	6	Qgd	-	1950-60	W	11.00	4-30-56	17.60	9-26-55	11.35	4-25	16.30	10-10	P, Meas. by owner
Ogemaw County																	
23N 1E 4-1	SE NE	MDC (15)	21	4	Qgd	-	1934, 55-60	Q	1.49	4-21-59	4.26	10-10-55	1.14	4-27	2.71	9-8	
23N 2E 2-1	NE NW	Charles Hudson	7	36	Qgd	-	1951-60	R	0.37	5- 5-52	4.30	3- 5-59	0.83	5-17	3.08	12-25	
Ontonagon County																	
51N 41W 8-1	SE NW	Mich. Corrections Dept.	100	6	pef	620±	1958-60	R	8.18	4-15-59	13.3	7-31-59	8.2	4-26	18.12	10-13	
52N 39W 30-1	NW NW	Village of Ontonagon	22	20	Qgd	-	1960	R	-	-	-	-	6.3	12-6	13.1	12-9	P, Record started 12-2-60.

										Otsego County									
29N	3W	29-1	SW SE	MDC (106)	15	2	Qgd	-	1933-60	Q	5.56	5-14-47	9.74	10- 7-58	7.07	9-15	7.90	4-11	
										Ottawa County									
5N	15W	28-71	SE SE	City of Holland	108	1¼	Qgd	-	1946-55, 57-60	M	56.44	8- 8-46	dry	9-14-54	76.13	12-1	82.15	1-29	Meas. by owner.
										Presque Isle County									
33N	2E	30-1	NE SE	MDC (19)	14	2	Qgd	-	1934-44, 48-60	Q	1.80	5-23-38	5.69	1-27-56	0.61	7-12	2.90	12-2	
33N	6E	8-1	NW NW	Albert Styma	61	6	Dt	-	1959-60	M	7.82	12-14-59	14.49	8- 7-59	5.66	4-4	15.92	12-1	Record started 8-7-59.
		15-1	NW NW	Harley Ennest	31	5	Dt	-	1959-60	R	-	-	-	-	2.8	5-10	11.6	8-26	Record started 2-15-59.
		21-1	NE NE	Mike Ardycan	43	5	Dt	-	1959-60	M	5.06	12-14-59	7.20	8- 6-59	2.04	4-4	7.04	6-20	Record started 8-6-59.
										Roscommon County									
24N	2W	20-1	NE NW	MDC (1)	14	8	Qgd	1145.30	1934-60	R	2.78	5- 3-51	6.23	12- 6-49	3.10	5-13	5.15	12-31	Federal key well
23N	1W	3-1	SE SE	MDC (50)	12	2	Qgd	1188.95	1939-60	Q	1.62	6-15-43	7.31	12-14-49	2.25	4-27	4.48	12-21	
22N	3W	22-1	SE NE	MDC (7)	14	2	Qgd	1170.58	1934-60	Q	3.25	4-17-52	8.25	12-13-49	2.56	4-27	4.85	12-8	
										Saginaw County									
9N	3E	16-2	SE NW	Ray Ellis	129	3	Ps	-	1958-60	W	35.41	1-27-59	53.84	9- 8-59	44.25	11-15	52.27	4-26	P
										Sanilac County									
12N	13E	33-1	SE SE	MSHD	150	3	Mm	-	1948-60	W	15.45	4-25-51	23.60	2-11-59	16.20	4-13	22.80	12-28	
										Schoolcraft County									
47N	16W	30-1	NW NW	MDC (Cusino)	57	6	Op	-	1957-60	R	7.95	4-30-59	15.51	11- 7-57	5.7	5-10	14.1	3-21	
45N	18W	31-1	NE SW	USFS	229	5	Otb	-	1958-60	M	15.65	11-27-59	16.69	1-27-59	13.71	6-29	15.94	1-29	
45N	13W	16-1	SW SW	U. S. Fish and Wildlife Service	154	4	Or	-	1952-60	R	5.09	4-12-54	6.28	9-26-55	4.80	5-8	5.68	8-27	
										Shiawassee County									
5N	2E	16-1	NE SE	A. B. Cobb	26	1	Qgd	896.00	1948-60	Q	17.28	5- 3-50	22.18	2-27-59	18.84	6-2	21.90	12-23	
										Washtenaw County									
3S	6E	16-1	SW NW	City of Ann Arbor	23	2	Qgd	817.43	1920-60	W	e+2.5	2- ?-30	e10.0	11- ?-27	1.07	4-20	6.65	2-3	P, Meas. by owner
		16-2	SE NW	do.	23	192	Qgd	-	1948-60	W	+2.00	6-30-51	15.50	8-21-57	0.50	2-17	13.90	2-3	P, Do.
3S	7E	9-1	SW SE	City of Ypsilanti (3-N)	67	8	Qgd	-	1944-46, 48-53, 60	A	6.33	11- 5-45	26.1	11-12-49		(28.24	- 6-2)		P
		9-2	SW NE	City of Ypsilanti (NR)	50	6	Qgd	-	1944-46, 48-53, 60	A	29.12	11- 5-45	40.8	7- 2-49		(35.01	- 6-2)		P
		9-3	SE NE	City of Ypsilanti (GP)	94	6	Qgd	-	1944-46, 48-53, 60	R	29.12	11- 5-45	42.13	9-13-52	56.50	12-26	59.15	10-1	P, Recorder installed 6-16-60
		24-1	NE SW	Ford Motor Co. (104)	87	4	Qgd	665.56	1943-45, 49-60	M	5.79	1- 5-50	16.43	10-16-56	14.48	7-8	15.34	4-22	P, Meas. by Ypsilanti Twp.
		24-2	NE SW	do. (106)	53	4	Qgd	664.51	1943-45, 49-60	M	11.81	7-13-43	34.37	7-10-59	33.28	7-8	35.11	8-5	P, Do.
		24-4	NE SW	do. (107)	53	4	Qgd	664.05	1943-45, 49-60	M	11.55	1- 5-50	36.32	7-10-59	35.30	5-27	36.93	8-5	P, Do.
		24-5	NW SW	do. (109)	77	4	Qgd	665.56	1943-45, 49-60	M	15.15	6- 6-45	38.54	7-31-59	37.60	4-22	40.04	12-20	P, Do.
		24-6	SW SW	Federal Works Agency (117)	75	6	Qgd	657.83	1944-45, 49-60	R	5.69	2-15-50	30.06	7-10-59	27.62	10-30	e31.25	8-5	P, Recorder installed 7-19-60

Table 1.--Records of Michigan observation wells and extremes of water levels observed in 1960 and for the period of record.--Continued

Well number	Location in section (¼ ¼)	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F 60	Observed water level extremes								
									Through 1959				In 1960				
									Highest	Date	Lowest	Date	Highest	Date	Lowest	Date	
							Washtenaw County (Continued)										
3S 7E 24-7	- SW	Ford Motor Co. (124)	90	24	Qgd	686.5	1955-60	M	23.47	12-29-55	36.05	10-16-56	34.98	6-21	35.37	12-20	P, Meas. by owner
4S 6E 9-1	NW NW	Ypsilanti State Hosp. (TW 20)	184	6	Qgd	-	1946-60	W	51.22	5-15-48	88.14	6-17-49	69.29	6-22	73.79	11-23	P, Do.
10-1	SW NW	Ypsilanti State Hosp. (TW 22)	173	6	Qgd	-	1946-60	W	61.48	6-12-53	88.27	7- 8-55	62.65	5-24	78.83	9-7	P, Do.
							Wayne County										
4S 9E 32-1	SW SE	Village of Waltz Improvement Assoc.	190	6	Ds	-	1959-60	R	7.46	12-12-59	9.22	10- 9-59	6.75	2-10	13.44	8-3	P
							Wexford County										
24N 9W 19-1	SW NW	MDC (38)	11	2	Qgd	944.16	1935-37, 41-44, 49-60	Q	0.49	4- 6-59	3.74	8-19-36	0.87	4-12	2.60	9-9	
21N 11W 13-1	NW NE	USFS	62	6	Qgd	-	1948-60	M	46.28	6- 5-52	51.13	11- 1-58	47.00	8-8	49.23	3-21	
21N 9W 4-1	NW NE	City of Cadillac	277	6	Qgd	-	1949-60	Q	19.99	7- 6-53	23.83	10- 6-58	20.98	9-9	22.30	4-12	

e - estimated

Table 2.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1960 Total
ALCONA COUNTY													
City of Harrisville	.720	.720	.900	.792	.900	1.080	1.800	1.620	1.080	.900	.720	.720	11.952
ALGER COUNTY													
Burt Township	1.30	1.30	1.61	1.50	1.67	1.98	3.29	3.72	1.35	1.46	1.56	2.11	22.85
ALLEGAN COUNTY													
City of Allegan	20.4	20.0	17.2	19.6	24.1	23.3	32.7	36.3	25.3	13.9	19.8	24.0	276.6
City of Otsego	16.3	15.0	17.3	17.7	20.9	21.9	21.9	21.6	21.3	15.7	16.3	13.5	219.4
City of Plainwell	10.52	8.93	10.03	10.61	11.53	11.81	14.45	12.52	12.23	11.04	7.82	8.76	130.25
BARRY COUNTY													
City of Hastings	27.3	27.3	30.1	30.6	31.2	33.0	40.0	39.7	41.2	33.9	31.3	32.6	398.2
Village of Nashville	3.19	2.89	2.85	2.66	2.77	2.66	3.41	3.70	3.51	e3.00	e3.00	2.85	36.49
BENZIE COUNTY													
City of Frankfort	7.16	6.17	7.16	8.40	7.50	9.05	12.83	9.41	6.29	5.51	5.39	6.52	91.39
BERRIEN COUNTY													
City of Buchanan	48.3	36.1	38.5	36.5	35.2	38.1	45.2	48.4	47.9	42.2	39.1	40.8	496.3
City of Coloma	4.20	3.75	4.20	4.35	4.65	4.80	5.10	5.25	4.95	4.65	4.20	4.65	54.75
City of Niles	41.5	38.4	43.9	42.8	47.2	56.2	59.9	68.5	64.6	47.6	41.3	46.0	597.9
City of Watervliet	--	--	--	--	--	--	--	--	--	--	--	--	36.7
BRANCH COUNTY													
City of Coldwater	41.9	38.3	42.9	38.9	45.1	52.8	60.1	66.2	60.8	57.7	50.6	43.3	598.6
State Home and Training School at Coldwater	12.3	11.9	13.5	12.8	13.2	13.1	13.9	13.8	13.3	13.1	12.7	12.4	156.0
CALHOUN COUNTY													
City of Albion	122	120	129	119	124	122	100	114	119	123	108	112	1,412
City of Battle Creek	271	245	270	274	288	322	331	357	337	290	273	298	3,556
Battle Creek Township	18.1	19.4	20.5	22.9	22.5	28.9	38.5	45.9	41.5	22.9	20.4	24.4	325.9
American Legion Hospital at Battle Creek	.415	.410	.381	.412	.406	.398	.403	.411	.399	.403	.383	.409	4.830
Village of Bellevue	--	--	--	--	--	--	--	--	--	--	--	--	e24.0
City of Marshall	27.4	26.2	26.9	27.6	30.2	33.9	35.2	e32.2	37.4	30.5	25.6	25.4	358.5
CASS COUNTY													
City of Dowagiac	15.8	15.1	15.3	14.8	13.9	17.2	23.4	26.9	30.1	17.9	24.6	16.5	231.5
CHARLEVOIX COUNTY													
City of East Jordan	12.01	11.81	12.93	13.67	14.59	16.65	18.42	17.75	14.89	10.71	8.48	7.57	159.48
CHEBOYGAN COUNTY													
City of Cheboygan	9.00	10.00	9.00	11.00	11.80	12.60	13.70	14.60	12.10	10.40	10.00	8.40	132.60
CLARE COUNTY													
City of Clare	13.0	10.4	12.7	14.2	17.4	25.8	34.7	37.2	36.3	25.0	15.4	12.5	254.6
CLINTON COUNTY													
City of St. Johns	18.7	21.0	22.6	23.5	25.7	27.7	28.5	29.9	28.5	24.7	23.3	26.0	300.1
CRAWFORD COUNTY													
City of Grayling	5.93	10.47	7.56	11.20	10.49	17.08	15.21	15.17	10.66	10.74	8.00	6.26	128.77
EATON COUNTY													
City of Charlotte	30.9	29.0	31.3	30.7	33.2	34.1	29.2	38.3	39.9	32.7	30.5	29.2	389.0
City of Grand Ledge	11.9	11.9	11.3	11.0	11.6	12.9	14.6	14.8	13.8	12.2	11.6	12.5	150.1
City of Olivet	--	--	--	--	--	--	--	--	--	--	--	--	e18.0
EMMET COUNTY													
City of Harbor Springs	7.33	7.02	8.44	8.10	7.69	9.91	27.10	23.85	14.90	7.20	7.68	6.43	135.65
GENESEE COUNTY													
Beecher Metropolitan District	18.6	17.8	19.6	18.7	19.9	22.0	29.4	25.7	25.0	22.0	20.0	21.5	260.2
City of Davison	6.87	7.02	7.43	6.46	6.52	9.34	13.72	10.22	10.09	8.65	8.34	7.72	102.38
Village of Fenton	13.8	13.2	14.5	13.1	15.3	15.3	21.3	18.3	17.2	18.5	15.7	15.9	192.1
Village of Flushing	7.58	7.05	7.33	6.91	6.43	7.62	9.80	7.97	8.74	7.24	6.63	7.73	91.03
City of Grand Blanc	3.57	3.34	3.72	3.60	4.03	4.65	5.56	5.96	4.80	4.65	3.90	3.72	51.50
Fisher Body Division (GMC) at Grand Blanc	5.03	7.20	7.48	6.40	6.31	6.41	7.32	7.69	6.94	6.93	5.93	6.13	79.76
City of Mt. Morris	6.24	5.86	6.33	5.56	5.73	5.68	6.96	6.56	6.37	6.35	6.33	6.74	74.71
Village of Otisville	.738	.690	.753	.788	.767	.965	1.211	.936	.790	1.121	1.073	.960	10.792
GLADWIN COUNTY													
City of Beaverton	1.23	1.24	1.89	1.80	1.27	1.74	1.40	1.63	1.50	2.29	1.86	2.48	20.33
GOGEBIC COUNTY													
City of Bessemer	13.1	12.9	14.0	11.4	11.9	12.3	13.4	13.4	12.3	11.4	10.4	10.9	147.4
City of Ironwood	28.2	26.2	31.1	27.2	28.1	27.3	28.0	31.0	30.3	28.0	27.0	30.1	342.5
City of Wakefield	e1.64	e1.57	e1.62	e1.29	e1.56	e1.98	e1.73	e1.92	e1.58	e1.48	e1.54	e1.68	e19.59
GRAND TRAVERSE COUNTY													
State Hospital at Traverse City	15.6	15.4	15.1	15.0	14.7	14.5	14.5	17.0	19.7	20.1	19.6	20.2	201.4

Table 2.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).--Continued

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1960 Total
GRATIOT COUNTY													
City of Alma	43.2	42.9	50.2	46.6	52.5	64.5	65.4	62.0	59.8	57.6	52.2	48.5	645.4
City of Ithaca	4.51	4.35	4.51	5.25	5.42	6.00	6.20	6.97	6.75	6.97	5.40	5.42	67.75
City of St. Louis	19.0	17.4	20.3	18.9	18.4	19.6	27.6	30.1	23.4	31.6	18.8	17.3	262.4
HILLSDALE COUNTY													
City of Reading	--	--	--	--	--	--	--	--	--	--	--	--	8.05
INGHAM COUNTY													
City of East Lansing	34.5	33.5	33.1	35.2	38.0	36.6	51.8	39.7	45.2	41.1	35.9	32.8	457.4
City of Lansing	514	481	520	513	524	551	607	570	595	552	506	507	6,440
Lansing Township	33.4	30.9	29.7	31.2	37.5	19.2	36.9	38.6	41.7	43.6	31.2	40.0	413.9
City of Mason	10.11	9.67	10.44	11.44	13.24	11.93	13.78	14.21	13.10	11.60	10.75	10.57	140.84
Meridian Township	11.0	11.9	13.3	11.8	10.2	15.0	16.5	11.0	16.9	10.7	e10.0	11.0	149.3
Michigan State University at East Lansing	66.2	70.2	68.9	67.4	76.4	74.0	79.7	75.2	76.2	92.2	82.5	71.3	913.7
IONIA COUNTY													
City of Ionia	23.6	24.8	25.6	23.8	27.7	32.7	35.0	32.4	34.9	35.9	31.2	29.4	357.0
State Hospital at Ionia	10.27	9.27	9.93	10.55	10.81	10.52	10.99	10.60	10.16	11.32	10.11	10.78	125.31
Michigan Reformatory at Ionia	18.9	18.8	20.4	19.2	20.2	21.7	25.7	24.1	23.0	21.8	21.4	22.7	257.9
Michigan Training Unit at Ionia	2.15	2.20	1.16	1.35	1.74	1.20	1.77	1.44	1.46	1.58	1.05	0.78	17.88
City of Portland	8.21	7.99	8.54	9.15	9.81	10.75	14.20	11.57	11.21	10.03	7.38	8.95	117.79
IRON COUNTY													
City of Stambaugh	7.13	6.79	7.19	6.90	7.28	7.08	7.01	7.47	6.93	6.76	6.81	7.28	84.63
ISABELLA COUNTY													
City of Mt. Pleasant	58.6	55.5	62.3	58.2	58.2	56.5	63.5	50.9	53.5	54.6	52.1	51.5	675.4
JACKSON COUNTY													
City of Jackson	340	319	327	321	334	361	365	382	363	314	288	283	3,997
State Prison of Southern Michigan at Jackson	39.0	39.6	39.2	37.3	43.3	45.5	45.8	54.2	52.5	42.5	39.2	35.3	513.4
KALAMAZOO COUNTY													
City of Kalamazoo	370	333	359	396	397	442	522	544	553	413	378	379	5,086
State Hospital at Kalamazoo	22.5	20.6	21.2	19.7	19.8	18.1	20.3	19.1	20.4	20.9	18.2	20.5	241.3
City of Parchment	6.97	6.72	6.72	7.73	8.14	9.66	12.50	11.62	9.05	4.38	3.34	3.37	90.20
KALKASKA COUNTY													
Village of Kalkaska	4.37	4.23	3.42	4.21	3.95	4.37	4.81	3.22	4.09	3.19	3.11	3.36	46.33
KENT COUNTY													
City of Grandville	9.83	10.34	11.60	12.33	13.26	19.36	29.13	24.03	23.18	14.82	11.74	11.52	191.14
Jervis Corp. at Grandville	12.7	10.8	12.0	14.6	11.8	10.8	12.1	11.8	11.8	11.8	6.7	6.6	133.5
City of Lowell	11.6	11.5	12.1	12.3	12.5	13.4	16.3	14.6	14.4	12.5	12.3	12.1	155.6
Paris Township	25.5	21.9	24.2	24.1	27.3	31.3	37.6	36.4	33.1	29.3	24.2	24.3	339.2
Village of Sparta	13.4	13.2	15.7	14.9	13.5	15.2	17.0	15.4	15.5	15.4	13.8	13.5	176.5
City of Wyoming	97.3	92.5	93.9	99.6	110.8	155.6	195.4	171.6	164.3	132.0	116.8	99.8	1,529.6
LAKE COUNTY													
Village of Sheridan	.91	.92	1.13	1.09	1.16	1.63	2.63	1.72	2.46	1.48	1.13	1.12	17.38
LAPEER COUNTY													
City of Lapeer	12.9	13.7	15.7	13.1	16.0	14.1	20.1	16.9	14.1	14.4	13.2	13.5	177.7
State Home and Training School at Lapeer	18.1	17.9	18.3	19.6	17.6	18.8	18.0	18.7	18.4	21.3	19.9	21.3	227.9
LENAWEE COUNTY													
City of Hudson	8.24	7.81	8.40	8.02	7.46	7.33	8.45	9.34	8.47	7.19	6.91	5.63	93.25
City of Morenci	4.01	3.74	4.16	4.23	4.82	5.21	5.76	5.81	5.54	5.50	5.08	5.49	59.35
City of Tecumseh	65.8	53.7	56.0	55.5	55.3	66.2	69.3	61.3	74.1	72.6	66.6	67.9	764.3
LIVINGSTON COUNTY													
City of Brighton	5.74	4.60	4.88	5.07	5.45	6.95	15.13	12.06	8.98	6.11	5.71	6.81	87.49
City of Howell	19.4	18.0	19.1	18.3	19.3	19.8	22.9	20.6	19.7	19.5	18.4	19.9	234.9
State Hospital at Howell	2.94	2.78	2.85	2.70	2.89	3.07	7.35	4.17	4.03	3.13	3.34	3.20	42.45
LUCE COUNTY													
State Hospital at Newberry	9.10	9.30	11.70	9.31	9.62	11.99	9.81	11.93	12.89	8.91	9.49	10.82	124.87
MACOMB COUNTY													
City of Fraser	11.0	10.0	11.0	11.3	13.0	15.3	25.9	22.2	19.4	14.5	11.7	11.5	176.8
MANISTEE COUNTY													
City of Manistee	30.8	30.4	30.3	31.6	35.8	44.1	55.9	40.1	36.4	33.8	38.8	37.6	445.6

Table 2.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).--Continued

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1960 Total
MARQUETTE COUNTY													
Branch Prison at Marquette	8.38	7.61	8.29	8.30	9.06	7.79	9.05	8.99	7.56	7.39	7.06	8.57	98.05
MASON COUNTY													
City of Scottville	3.59	3.53	3.80	4.83	4.99	5.71	6.67	6.36	7.04	6.08	5.49	4.48	62.57
MONROE COUNTY													
Village of Carleton	2.83	2.22	2.37	2.49	2.33	2.59	2.84	2.96	3.14	2.63	2.38	3.12	31.90
MONTCALM COUNTY													
City of Greenville	54.5	26.4	28.1	20.9	24.8	30.6	30.9	32.9	30.6	23.1	31.4	29.1	363.3
MUSKEGON COUNTY													
City of Montague	3.86	3.64	4.12	5.29	5.40	7.75	11.22	8.03	7.28	6.00	5.86	5.87	74.32
City of Whitehall	9.45	9.24	10.20	10.26	11.44	15.23	19.27	15.98	12.51	9.74	8.98	9.59	141.89
NEWAYGO COUNTY													
City of Fremont	16.9	19.6	14.8	12.5	15.2	15.6	22.9	23.1	23.0	15.9	13.7	12.9	206.1
OAKLAND COUNTY													
City of Birmingham	5.02	3.42	3.57	3.96	5.49	7.78	11.72	7.08	11.60	12.89	8.67	6.22	87.42
Cranbrook School	8.11	7.84	7.82	8.38	16.13	14.22	16.36	14.38	14.11	12.41	8.40	7.53	135.69
City of Farmington	20.9	18.0	16.1	22.5	19.0	21.5	34.7	25.3	35.7	20.5	17.8	21.9	273.9
City of Lathrop Village	8.23	7.76	9.02	8.41	9.62	14.98	27.38	25.45	24.63	12.08	9.16	8.04	164.76
City of Pontiac	319	309	344	328	326	332	394	302	285	285	280	294	3,798
State Hospital at Pontiac	13.3	12.9	17.5	14.5	15.3	15.9	13.7	14.8	14.1	14.0	13.4	13.4	172.8
Village of Rochester	33.2	34.3	39.0	39.8	47.1	47.4	59.1	53.3	49.6	42.8	37.3	37.3	520.2
City of South Lyon	27.1	26.0	27.7	30.2	31.9	31.7	32.0	32.2	30.9	30.0	31.1	31.8	362.6
City of Troy	24.6	21.9	23.6	23.2	27.2	34.3	46.3	42.4	46.0	32.5	25.5	26.5	374.0
Waterford Township	e18.0	e18.0	e18.0	e20.0	e24.0	e29.0	e32.0	e34.0	29.6	25.3	19.1	17.5	e284.5
OCEANA COUNTY													
City of Hart	NA	NA	NA	NA	NA	14.4	30.5	19.5	18.7	21.5	15.5	11.4	NA
OGEMAW COUNTY													
City of West Branch	7.47	7.29	7.91	7.38	6.44	6.23	8.01	6.83	6.97	6.46	5.84	5.51	82.34
OSCEOLA COUNTY													
City of Evart	e36.0	e36.0	e36.0	e38.0	e38.0	e38.0	e35.0	e35.0	e35.0	e41.0	e41.0	e41.0	e450.0
OTSEGO COUNTY													
City of Gaylord	10.58	9.73	10.95	11.00	11.02	10.93	11.57	11.51	10.58	9.34	8.61	8.76	124.58
Northern Michigan T. B. San. at Gaylord	0.90	0.96	1.05	1.08	1.15	1.14	1.18	1.18	1.48	1.24	1.38	1.43	14.17
ONTONAGON COUNTY													
Village of Ontonagon	8.74	9.40	11.9	12.1	11.4	12.7	13.1	14.2	12.7	11.9	12.7	10.8	141.64
OTTAWA COUNTY													
Village of Coopersville	4.09	3.36	3.86	3.14	2.89	2.64	3.26	3.34	3.44	3.42	2.97	3.39	39.80
City of Hudsonville	--	--	8.91	--	--	12.67	--	--	26.32	--	--	11.08	58.98
Village of Spring Lake	10.01	9.21	9.23	10.06	11.17	16.70	20.74	16.28	16.16	11.99	10.57	8.96	151.08
City of Zeeland	24.6	24.1	16.5	26.6	25.0	22.8	26.4	28.2	27.1	22.6	20.8	21.0	285.7
PRESQUE ISLE COUNTY													
City of Rogers City	6.77	6.01	6.42	7.04	6.81	7.10	8.79	9.85	6.94	6.08	5.93	6.56	84.30
SANILAC COUNTY													
City of Croswell	13.86	8.56	8.56	8.30	11.33	12.72	17.03	27.23	19.73	15.52	14.39	9.83	167.06
Village of Deckerville	2.10	1.97	2.36	2.27	2.25	2.38	3.09	5.12	4.53	2.87	3.00	3.21	35.15
City of Sandusky	e14.6	e15.0	e14.8	e13.3	e15.9	e16.2	e14.3	e14.5	e14.1	e13.2	e12.2	e13.2	e171.3
ST. CLAIR COUNTY													
City of Yale	3.63	3.61	4.40	4.79	5.26	5.43	7.87	5.20	5.81	4.21	4.12	4.97	59.30
ST. JOSEPH COUNTY													
City of Sturgis	46.5	45.1	48.6	47.0	49.0	52.7	57.3	61.9	57.4	48.2	42.8	45.1	601.6
SHIAWASSEE COUNTY													
City of Corunna	5.68	5.40	6.11	5.87	5.85	5.70	7.52	6.31	6.11	5.46	5.28	5.31	70.60
City of Durand	9.47	9.47	10.39	10.11	8.79	9.58	12.51	10.61	9.81	10.08	10.78	10.13	121.73
City of Owosso	69.5	66.1	61.5	70.1	68.8	77.4	99.4	82.3	80.7	72.3	67.5	70.2	885.8
Village of Perry	1.47	1.30	1.51	1.80	1.82	2.00	2.93	1.95	2.10	1.90	1.61	1.68	22.07
TUSCOLA COUNTY													
State Hospital at Caro	9.99	9.24	9.80	8.90	8.88	8.34	10.87	10.58	10.19	9.40	9.43	9.54	115.16
Village of Cass City	9.76	9.44	11.37	10.30	9.76	8.34	e9.00	8.96	e8.50	8.37	7.96	8.11	e109.87
City of Vassar	12.9	13.1	13.8	11.5	12.6	15.0	21.7	15.8	16.0	12.3	10.8	11.4	166.9

Table 2.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).--Continued

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1960 Total
WASHTENAW COUNTY													
City of Ann Arbor	89.0	58.5	45.3	54.0	73.0	87.3	113.0	119.0	116.2	94.7	60.8	57.5	e968.3
Cassidy Lake Technical School	e1.26	e1.26	e1.26	e1.26	e1.27	e1.27	e1.27	e1.27	e1.26	e1.26	e1.27	e1.27	e15.18
Boys Training School at Whitmore Lake	e.500	e.500	e.500	e.500	e.500	e.500	.764	.584	.620	.484	.520	.645	e6.617
City of Ypsilanti	108.2	101.1	104.6	97.8	104.2	105.2	105.3	101.1	105.7	95.0	80.6	77.2	1,186.0
Ypsilanti Township	171	167	167	160	168	186	205	206	201	195	183	182	2,191
State Hospital at Ypsilanti	16.7	15.5	17.7	16.8	19.1	20.2	24.0	23.0	21.2	20.0	16.1	16.9	227.2
WAYNE COUNTY													
City of Belleville	--	--	16.46	--	--	16.17	--	--	15.59	--	--	14.96	a63.18
State Hospital at Northville	19.5	18.1	19.8	17.6	16.7	16.6	19.2	20.1	21.0	20.8	20.6	21.2	231.2
City of Plymouth	48.1	47.4	46.7	44.4	45.2	48.0	68.4	80.7	86.3	79.8	72.4	59.1	726.5
State Home and Training School at Plymouth	--	--	--	--	--	--	b2.01	3.19	2.02	1.84	2.15	1.90	13.11
WEXFORD COUNTY													
City of Manton	1.67	1.61	1.74	1.88	1.74	1.77	3.12	1.91	1.42	0.81	0.83	0.64	19.14

a) Surface water used to supplement ground-water supply
b) Pumping started
c) Ground water used to supplement surface-water supply
e) Estimated
NA) Not available