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RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF MACKINAC COUNTY, MICHIGAN

BY

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ABSTRACT

The principal aquifers of Mackinac County, Mich., are limestone and dolomite strata of the Niagara series of Silurian age. Other important aquifers include sandstone units of Cambrian age; limestone, dolomite, and breccia of Late Silurian and Middle Devonian age; and sand and gravel deposits of Pleistocene age.

The water-bearing Munising sandstone of Cambrian age is tapped at depths of about 1,000 feet by two wells in the northwestern part of the county, where, locally, water of good quality has not been obtained from shallower aquifers. Many wells tap the Burnt Bluff, Manistique, and Engadine formations of the Niagara series. These rocks form the bedrock surface over most of the county and are sources of relatively large quantities of fresh water. Wells in these rocks obtain water from solution openings along joints and bedding planes.

On the St. Ignace Peninsula, the Salina formation and the Mackinac breccia are important sources of ground water, although the rocks are of low permeability and yields are commonly small. Locally, these formations will not yield water in sufficient quantity even for domestic use. The Mackinac breccia and the St. Ignace and Bois Blanc formations are believed to be potential sources of water to wells on the islands in the Straits of Mackinac.

The glacial drift which mantles the bedrock formations is another important source or potential source of ground water over much of the county. In composition and thickness the drift mantle varies widely, however; in many areas it is thin, impermeable, or situated above the regional water table, and in such areas, of course, it is not a source of water.

Conditions are favorable for ground-water recharge in large areas of the county where the surface is directly underlain by sand and gravel or permeable consolidated rocks.

Ground water in Mackinac County is used mainly for domestic supply. The total amount used is only a small fraction of the total available.

The quality of the ground water varies with the lithology and depth of the aquifers. Limestone and dolomite strata and the glacial drift deposits generally yield water of the calcium magnesium

bicarbonate type. Water of the calcium sulfate type is present in the formations underlying the St. Ignace Peninsula, which contain appreciable quantities of gypsum or are connected hydraulically to gypsum-bearing strata. Some of the sulfate waters are too highly mineralized for most uses. The deeply buried Cambrian sandstones produce fresh water which have higher concentrations of sodium and chloride than water from shallow fresh-water aquifers. Highly mineralized water of the sodium chloride type has been produced from the Trenton and Black River limestones of Ordovician age.

INTRODUCTION

Purpose and Scope of Study

A ground-water reconnaissance survey of the Northern Peninsula on a county-unit basis was begun in 1955 as part of the continuing cooperative investigation by the Michigan Department of Conservation and the U. S. Geological Survey. The objective of the reconnaissance is to gather sufficient information from an inventory of wells, water-sampling program, geologic field check, and study of the literature, and from review of existing hydrologic, topographic, and geophysical data, to determine the source, occurrence, availability, and geochemistry of ground water in the Peninsula. To make the results available to the public with the least possible delay, progress reports are to be released upon completion of the reconnaissance of an appropriate areal unit. This is the second county report of this series and it summarizes ground-water resources data obtained in a brief survey of Mackinac County made during the 1956 field season. Because of the limitation of time, the reconnaissance was not extended to the major islands of the county. The first county report of the present series covered the field reconnaissance of Chippewa County made in 1955 (Vanlier and Deutsch, 1958).

The mode of presenting the data obtained is designed primarily as a general aid to well drillers, contractors, industrialists, farmers, and the public at large in evaluating the ground-water resources of any area of Mackinac County. A summary description of the major lithologic units is presented, since this type of information may have application in future explorations for water or other mineral resources.

Cooperative ground-water investigations by the U. S. Geological Survey in Michigan are directed jointly by A. N. Sayre, chief of the Ground Water Branch, U. S. Geological Survey, and W. L. Daoust, State Geologist, Michigan Department of Conservation, and are under the direct supervision of Morris Deutsch, district geologist of the U. S. Geological Survey at Lansing.

Previous Investigations

Various phases of the geology and hydrology of Mackinac County are described in numerous reports which relate the results of detailed and reconnaissance investigations made in the Northern Peninsula of Michigan since 1821. An investigation of flowing-well districts in the eastern part of the Northern Peninsula was made by Frank Leverett (1906). During the period 1934 to 1936 the Michigan Department of Conservation, in cooperation with the Civilian Conservation Corps, delineated areas of shallow ground-water supplies that might be tapped by future fire-control wells. Some of the unpublished data gathered during the course of that project have been included herein. In 1943, an investigation of the geology of the Mackinac Straits region was made by K. K. Landes, G. M. Ehlers, and G. M. Stanley (1945). Many of the geologic concepts and much of the geology of the Mackinac Straits area expressed herein are based on the report of that investigation. In 1949, a reconnaissance of the water resources in the eastern part of the Peninsula with reference to the probable effect on ground-water levels of a Lake Superior-level canal through the Peninsula was made by J. G. Ferris, L. A. Wood, and E. A. Moulder of the

U. S. Geological Survey for the Corps of Engineers. Many of the basic data used in this report were collected during that survey. Pertinent data contained in a number of the reports listed in the bibliography (p. 60) were used freely as source material for this project; where appropriate, references to specific reports are made in the text.

Acknowledgments

Special thanks are given to the many well drillers and residents of Mackinac County and to personnel of various Federal, State, county, and municipal agencies whose wholehearted cooperation made this report possible. Appreciation is extended to personnel of the Michigan Geological Survey who furnished much valuable advice and assistance.

Well-Numbering System

The well-numbering system used in the report indicates the location of the wells within the rectangular subdivisions of the public lands, with reference to the Michigan meridian and base line. The first two segments of a well number designate the township and range; the third segment designates both the section and the well within the section, its serial number being assigned arbitrarily. Thus, well 44N 12W 7-1 is the first well listed in section 7, Township 44 North, Range 12 West. Numbers formerly assigned to some of the wells and test borings included in this report are listed in table 2.

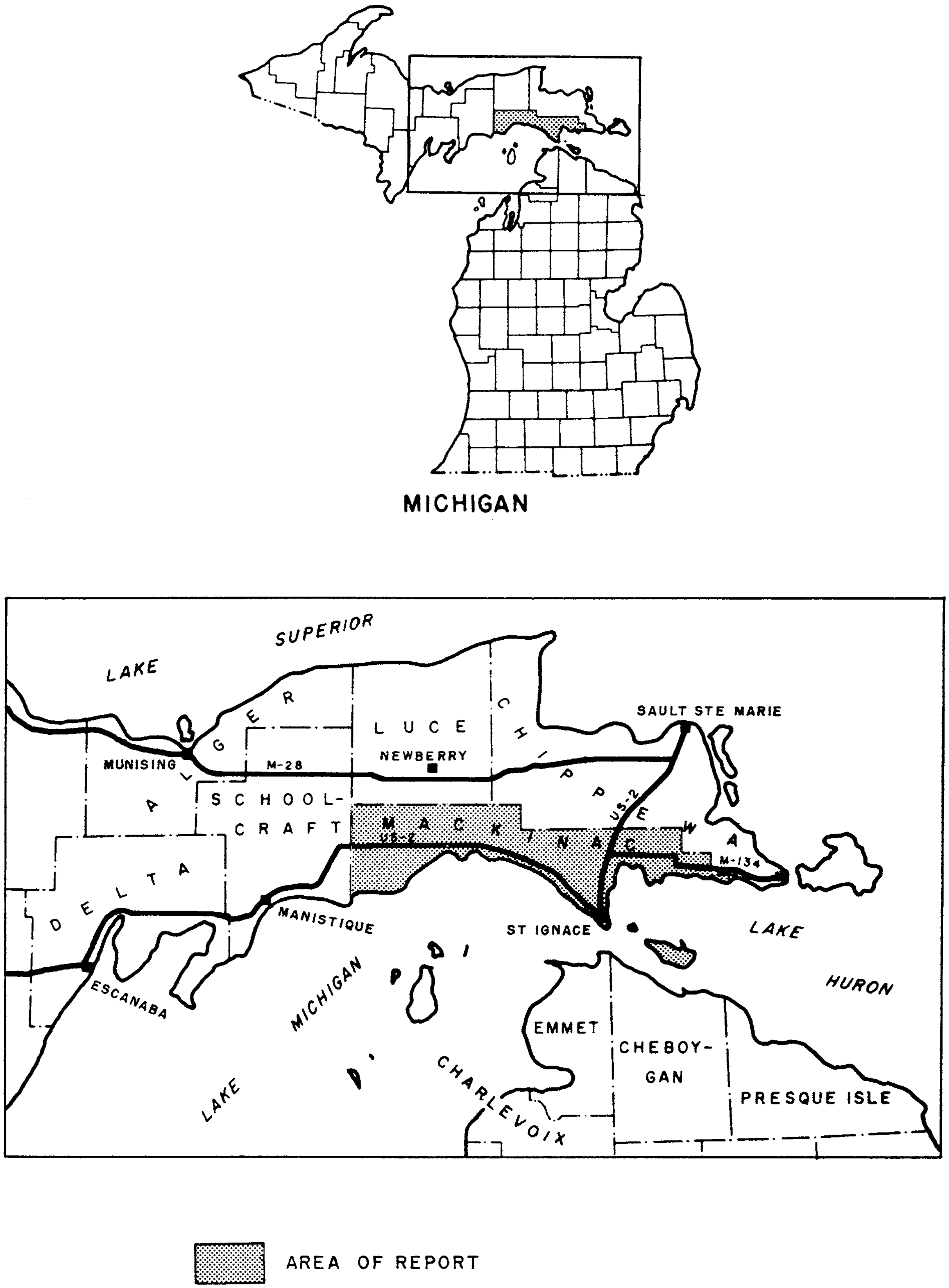

Figure I. Index map showing location of Mackinac County, Mich.

GEOGRAPHY

Location and Extent of Area

Mackinac County is at the eastern end of the Northern Peninsula of Michigan along the northern shores of Lake Michigan, the Straits of Mackinac, and Lake Huron (fig. 1). The land area of the county, including Bois Blanc and Mackinac Islands as well as other smaller islands, is 1,014 square miles. The irregularly shaped county spans an east-west distance of about 85 miles and a north-south distance of about 23 miles (pl. 1). The County is bounded on the west by Schoolcraft County and on the north and east by Luce and Chippewa Counties. It has a total shoreline length of about 225 miles, of which about 150 miles is along the mainland. St. Ignace, the largest city in the county and the county seat, is at the southern tip of the St. Ignace Peninsula. The city is the northern terminus of the Mackinac Bridge.

Population and Economic Development

The population of the county was 8,750 in 1953, 9,287 in 1950, and 9,438 in 1940, as reported by the Bureau of the Census. The population of the City of St. Ignace for the same years was reported as 2,860, 2,960, and 2,669.

The economy of Mackinac County is closely related to its natural resources. Industries include commercial fishing, production of timber and timber products and of sand and gravel, and quarrying of limestone. The wildlife, the natural scenic beauty, the many inland lakes, and the extensive beach frontage on Lakes Michigan and Huron provide for a thriving tourist industry. Less than 10 percent of the county is farmed. About 22 percent of the area of the county is included in the Marquette National Forest and 32 percent is State owned.

U. S. Highway 2, which is connected to highways of the Southern Peninsula by the Mackinac Straits Bridge, and several major State highways serve the area. The county is served also by the Duluth, South Shore and Atlantic Railroad and the Minneapolis, St. Paul and Sault Ste. Marie (M., St. P., and S. Ste. M.) Railroad. Rail connection between the two peninsulas is provided by a ferry between St. Ignace and Mackinac City. Several interstate and international shipping companies operating on the Great Lakes provide passenger and freight service in and to the Straits of Mackinac area.

Physiography

Mackinac County is in the area that was glaciated during the Pleistocene epoch. Much of the county was covered by the waters of glacial Lake Algonquin and other extinct glacial lakes (fig. 2).

The main physiographic feature in the northern part of the county is a north-facing cuesta formed by rocks of the Niagara series. This cuesta, which is known widely as the "Niagaran escarpment", trends in a broad arc from eastern Wisconsin across the Northern Peninsula and southeastern Ontario to New York State. It is formed by strata of hard, resistant limestone and dolomite. In Mackinac County these rocks dip gently southward and are truncated to form a steeper north-facing escarpment. The relief of the cuesta has been subdued by Pleistocene glaciation. The cuesta is breached at the Pine River near U. S. Highway 2 in T. 43 N., Rs. 2 and 3 W.

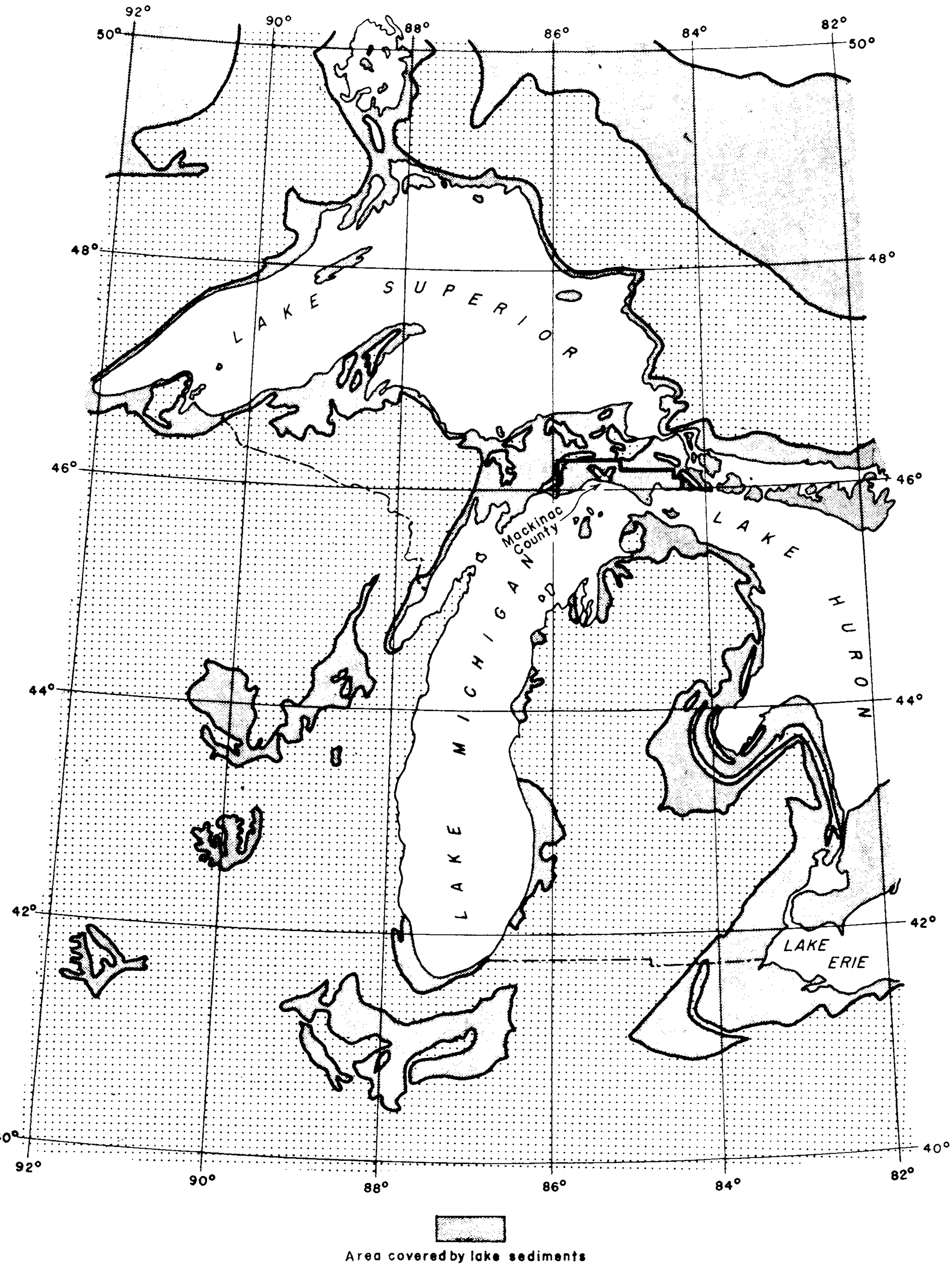

FIGURE 2--Map of the Upper Great Lakes region showing areas of sediment deposition in glacial Lake Algonquin and other extinct glacial lakes. (After Geol. Soc. America, 1949.)

The highland formed by the Niagara cuesta is mantled in many places by morainal and related glacial deposits which form extensive and rather flat highlands. Most of the lowland areas of the county have been mantled by sand and smaller amounts of silt and clay deposited in the glacial lakes which at various times extended over most of the county. Many of these lake-plain areas are poorly drained and contain extensive swamps and wetlands. Throughout the county, bars, beaches, dunes, and wave-cut benches mark the many shorelines of the extinct glacial lakes.

The soft shales, dolomites, limestones, and evaporites of the Salina formation are less resistant than the underlying Niagara rocks, and valleys generally mark the areas where the Salina forms the bedrock surface. These valleys are a part of the basins of Lakes Michigan and Huron in the Mackinac Straits region. The Salina rocks in this region, however, were not everywhere deeply eroded, as is evidenced by the presence above the modern lake level of the St. Ignace Peninsula, most of which is underlain by the Salina formation. Where the Peninsula is underlain by the soft shales, limestones, and dolomites of the Salina formation, topographic relief is low. In the southern part of the St. Ignace Peninsula remnants of the more indurated and resistant Mackinac breccia form small highlands. Mackinac Island also is a remnant of resistant breccia. Round Island and Bois Blanc Island are formed from hard, resistant limestones and dolomites of the St. Ignace and Bois Blanc formations.

A group of elongate hills (drumlins) which are composed of glacial till deposited beneath moving ice sheets, are present along the shore near Hessel and Cedarville at the eastern end of the county. The Les Cheneaux Islands are part of the same group of drumlins, which are partially submerged in Lake Huron (Russell, 1905, p. 69-71).

Relief

The highest areas within Mackinac County are along the rim of the glaciated Niagara cuesta. In the central part of the county this highland locally reaches altitudes greater than 950 feet. In the western part of the county the highland is generally above 800 feet. The lowest areas in the county are along the shorelines of Lakes Michigan and Huron at an altitude of about 580 feet.

Drainage

Mackinac County is drained by a number of streams which flow into the Great Lakes (fig. 3). Most of the streams flow directly into Lakes Huron and Michigan; however, part of the county lies in the Tahquamenon drainage basin, which drains into Lake Superior, and part lies in the Munuscong drainage basin, which empties into Munuscong Bay. Most of the streams flow southward, down the dip slope of the Niagara cuesta. Tributaries of the Munuscong, Tahquamenon, Manistique, and Pine Rivers, however, flow down the escarpment of the cuesta. Parts of the valleys of the Carp, Pine, and Munuscong Rivers have developed parallel to the strike of the Paleozoic rocks. These strike valleys and the Pine River where it crosses the Niagara cuesta traverse drift-filled valleys in the bedrock surface. Hence, these bedrock valleys are reflected in the present drainage system.

Climate

Owing to the effect of the Great Lakes, the annual temperature range in Mackinac County is moderate in comparison to that of other

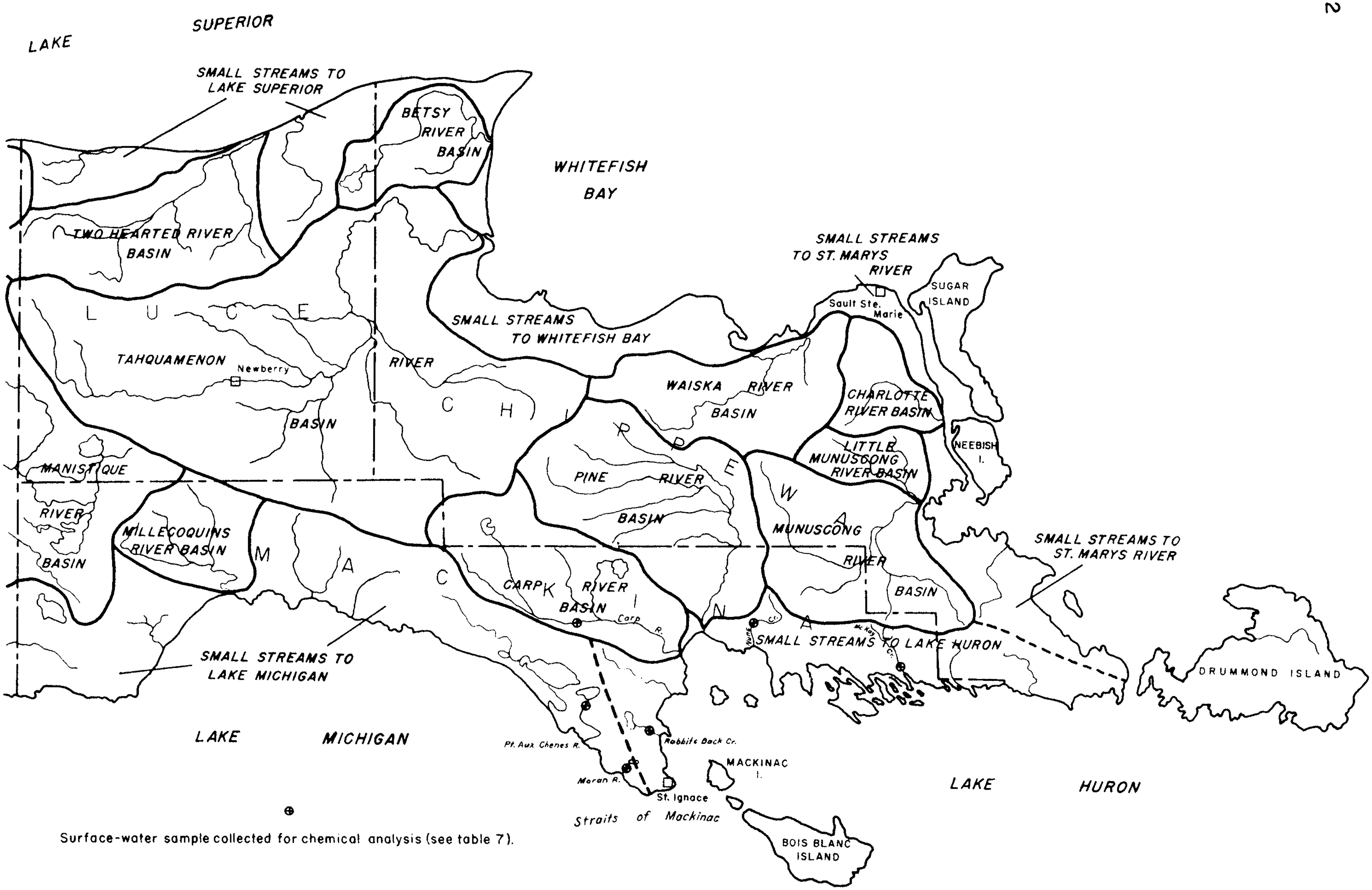

Figure 3. Map of Luce, Chippewa, and Mackinac Counties showing major surface drainage basins and drainage areas tributary to the Great Lakes.

interior continental areas at the same latitude. At Rexton the average annual precipitation is 29.7 inches and average annual temperature is 40.1° F. The estimated average date of the last killing frost in the spring is May 28, and of the first killing frost in the fall, September 23.

Table 1.--Lithology and hydrology of the major geologic units underlying Mackinac County

SYSTEM	SERIES		STRATIGRAPHIC UNIT	THICK-NESS (feet)	HYDROLOGY	NAMES USED BY THE MICHIGAN GEOLOGICAL SURVEY: SERIES	GROUP	FORMATION
QUATERNARY	Pleistocene	Wisconsin stage	Glacial Drift Undifferentiated (Qgd); Sand (Qs); Gravel (Qg); Sand and gravel (Qsg) Heterogeneous assemblange of unsorted to slightly stratified clay, sand, gravel, and boulder till, principally waterlaid; stratified sand and gravel outwash; stratified clay, silt, and sand lake deposits; sand and gravel beach deposits; windblown sand.	0 to 300	Locally important source of ground water. Best yields from sand and gravel outwash deposits. Moderate yields from morainal sand and gravel deposits, and from sand and gravel lenses interbedded with lake clay and silt. Small yields might be obtained from properly constructed wells tapping fine sand and silt lake deposits. Poor yields from clayey till. Layers of clay till and lake clay may be confining beds in artesian systems.		GLACIAL DRIFT (Wisconsin)	
DEVONIAN AND SILURIAN	Middle Devonian and Upper Silurian		Mackinac Breccia (DSm) Assemblage of limestone and dolomite fragments ranging in size from powder to rock slabs measuring hundreds of feet in maximum dimension. Chert, shale, and gypsum blocks are present within the brecciated mass. Cementation of the breccia by calcium carbonate varies widely, and various gradations between completely nonindurated to indurated breccia are present. Brecciation due to collapse of Salina, St. Ignace, and Bois Blanc strata overlying caverns formed by dissolution of salt in the Salina formation.	0 to 400?	Source of water to some wells in the St. Ignace area. Nonindurated or poorly indurated breccia is permeable, but the distribution of relatively impermeable indurated breccia is exceedingly complex. Test drilling is necessary to determine the presence of permeable zones. Water-bearing zones are discontinuous and difficult to correlate from well to well. Much of the water yielded by the breccia is very hard.			MACKINAC BRECCIA
DEVONIAN	Middle Devonian		Bois Blanc formation (Db) Gray to light-gray and buff cherty dolomite and limestone. This formation is brecciated and faulted as a result of collapse of strata overlying caverns in the Salina formation.	250±	Possible source of water to wells on Bois Blanc Island.	ULSTER-IAN	ONESQUETHAW	BOIS BLANC
SILURIAN	Upper Silurian		St. Ignace formation (Si) Light-colored, even-bedded dolomite and some thin shale beds. This formation is brecciated and faulted as a result of collapse of strata overlying caverns in the Salina formation.	250 to 300	Possible source of water to wells on Bois Blanc and Round Islands.	CAYU-GAN	BASS ISLAND	ST. IGNACE
			Salina formation (Ss) Red and green shale interbedded with limestone and dolomite and thin beds and masses of gypsum. The formation is brecciated and faulted as a result of collapse after removal of vast quantities of salt from the formation. Some thin salt beds may remain at depth.	500 to 600	Important aquifer in the St. Ignace Peninsula. Wells produce water from permeable limestone and dolomite beds. These beds often lack continuity as a result of collapse faulting. Much of the water is very hard and is high in sulfate. Locally may yield mineralized water from deep wells.		SALINA	SALINA (PT. AUX CHENES)
	Middle Silurian	Niagara series (Sn)	Engadine dolomite (Se) Hard, resistant white commonly crystalline dolomite, and interbedded limestone. Locally very sandy and cherty.	100 to 175	Important aquifer in large part of the county. Permeable where solution openings have developed along fractures and bedding planes. Very permeable where exposed at the surface. Solution caves formed in Engadine south of Gould City.	NIAGA-RAN	LOCKPORT	ENGADINE
			Manistique dolomite (Sm) Hard, resistant gray to light-gray high-calcium limestone and dolomite. Locally very cherty.	150 to 275	Important aquifer throughout much of the county. Permeable as result of solution along fractures and bedding planes. Very permeable where exposed at surface. Water confined locally under considerable artesian pressure.		CLINTON	MANISTIQUE
			Burnt Bluff formation (Sb) Hard, resistant gray to light-gray lithographic limestone and dolomitic limestone. Some beds of high-calcium limestone.	248	Important aquifer throughout much of the county. Permeability is result of solution along fractures and bedding planes. Locally produces flows under moderate pressure. Very permeable where exposed at surface. Caves in Burnt Bluff near Fiborn Quarry, northeast of Rexton.			BURNT BLUFF
	LOWER SILURIAN		Cataract formation (Sc) Alternate beds of dolomite and greenish-gray shale, with gypsum.	210±	Locally these rocks may yield water to wells where they are directly mantled by glacial drift. Probably of low permeability where covered by younger consolidated rocks.	ALBION	CATARACT	MAYVILLE CABOT HEAD MANITOULIN
ORDOVICIAN	Upper Ordovician	Richmond group and Collingwood formation	Limestone and dolomite of the Richmond group (Or) Hard gray and brown limestone and dolomite, interbedded with shale and shaly limestone and dolomite.	170 to 200	Source of water to deep well at Gilchrist. Wells tapping limestone and dolomite in Rudyard-Pickford area of Chippewa County indicate that these rocks may be productive in adjacent areas of Mackinac County.	CINCIN-NATIAN	RICHMOND	QUEENSTOWN? BIG HILL STONINGTON BILLS CREEK
			Shale unit (Orc) Basal shale beds of the Richmond group underlain by gray dolomitic and black bituminous shale of the Collingwood formation.	240	Permeability low. Will not yield significant amounts of water to wells.			LORRAINE? UTICA? COLLINGWOOD
	Middle Ordovician		Trenton and Black River limestones (Otb) Blue, gray, brown, and buff limestone and dolomite. Unit includes some shaly and sandy beds.	260	Yields mineralized water in the northwestern part of the county. Yields "sulphur" water at Rudyard in Chippewa County. Poor potential source of fresh water in Mackinac County.	MOHAWK-IAN	TRENTON BLACK RIVER	TRENTON BLACK RIVER
CAMBRIAN	Upper Cambrian		Munising sandstone (Єm) White and gray medium- to fine-grained sandstone. Sand grains generally rounded and frosted; locally dolomitic. May include some strata of the Hermansville limestone of Ordovician.	250±	Important aquifer in the northwestern part of Mackinac County and in adjacent areas in Schoolcraft and Luce Counties. Yields water of relatively good quality in this area. May yield water moderately high in mineral content in other areas of the county.		HERMANSVILLE? MUNISING	

GEOLOGY

Mackinac County is underlain by sedimentary rocks of Paleozoic age which are mantled discontinuously by glacial deposits of Pleistocene age. The areal distribution of the Paleozoic rocks is shown in plate 2 and of the surficial deposits, in plate 5. The lithology and hydrology of the various rock units underlying the county are outlined in table 1 and are described in the section on "Ground Water." Data concerning the depth, surface configuration, and nature of the Precambrian igneous and metamorphic rocks underlying Mackinac County are not available.

Summary of Geologic History

The Paleozoic rocks that underlie Mackinac County consist of limestone, dolomite, shale, sandstone, breccia, and evaporites. These rocks were deposited in the shallow seas which covered the Michigan basin during most of the Paleozoic era. The wide diversity of the sediments deposited is evidence of fluctuating sea levels and oscillating shorelines during that era.

A significant geologic event of the Paleozoic era with respect to the Mackinac Straits region was the leaching and removal by percolating ground water of large volumes of salt from the Salina formation of Late Silurian age. The interval of intense leaching is believed to have been limited to Middle Devonian time (Landes, Ehlers, and Stanley, 1945), but it is possible that the leaching process began as early as Late Silurian time. The removal of the salt resulted in the aggregation of a unique formation, the Mackinac breccia. The character of that formation and the effect on the structure of the Salina and superjacent formations deposited during and prior to the removal of the salt are outlined below in the sections on "Structural Geology" and "Ground Water in Consolidated Rocks."

During the Mesozoic and most of the Cenozoic eras, the Paleozoic sedimentary rocks were being subjected to erosion, which resulted in the creation of some of the major physiographic features of Michigan. These features, later modified by Pleistocene glaciation, include the Niagara escarpment and the major valleys which are now part of the basins of the Great Lakes.

A period of glaciation (the Pleistocene epoch) followed the long interval of erosion. During this epoch, ice migrated southward from accumulation centers in Canada during at least four major glacial stages. The glaciers scoured and abraded the surface and transported vast amounts of material torn from it. With melting of the ice sheets, this material was deposited over the eroded Paleozoic rocks.

At the close of the Pleistocene epoch glacial Lake Algonquin (fig. 2) covered nearly all of Mackinac County. Post-glacial uplift of the land mass which had been depressed by the ice changed drainage patterns, lake elevations, and shoreline positions (Leverett and Taylor, 1915, chaps. 21-25). The result of these changes was a succession of postglacial Upper Great Lakes. Lakes Superior, Huron, and Michigan represent the modern stage of this succession. Bars, beaches, wave-cut terraces, and dunes, which are present throughout the county, mark the shorelines of this succession of lakes.

Structure

The Precambrian surface upon which the sedimentary rocks of Mackinac County were deposited slopes generally southward toward the center of the Michigan basin. The Paleozoic rocks of the Michigan basin were deposited in nearly horizontal layers, but gradual subsidence and compaction of the beds, which was contemporaneous with deposition and was greatest in the center of the basin, produced a bowl-shaped structure (fig. 4). The youngest beds are exposed at the surface in the central part of this structure and the formations crop out in roughly concentric bands. Mackinac County is near the northern edge of the basin, where older sedimentary rocks are exposed. The regional dip of these formations in Mackinac County is to the south at about 45 feet per mile. The formations tend to become thicker toward the center of the basin.

Major alteration of the structure of Upper Silurian and Middle Devonian strata of the Michigan basin has occurred in the so-called collapse area in the Straits of Mackinac region (Landes, Ehlers, and Stanley, 1945). In this area (fig. 5) the dissolution of thick salt beds of the Salina formation created large caverns. Strata of the Salina, St. Ignace, and Bois Blanc formations collapsed into the voids, producing a zone of faulted and brecciated rock. Near St. Ignace and on Mackinac Island these formations are so extensively faulted and brecciated, and fragments of all are so completely intermixed, that boundaries of the individual formations cannot be delineated. On Bois Blanc Island and in that part of the Southern Peninsula within the collapse area, however, the formations maintain some straigraphic continuity and can be identified, despite the faulting and brecciation.

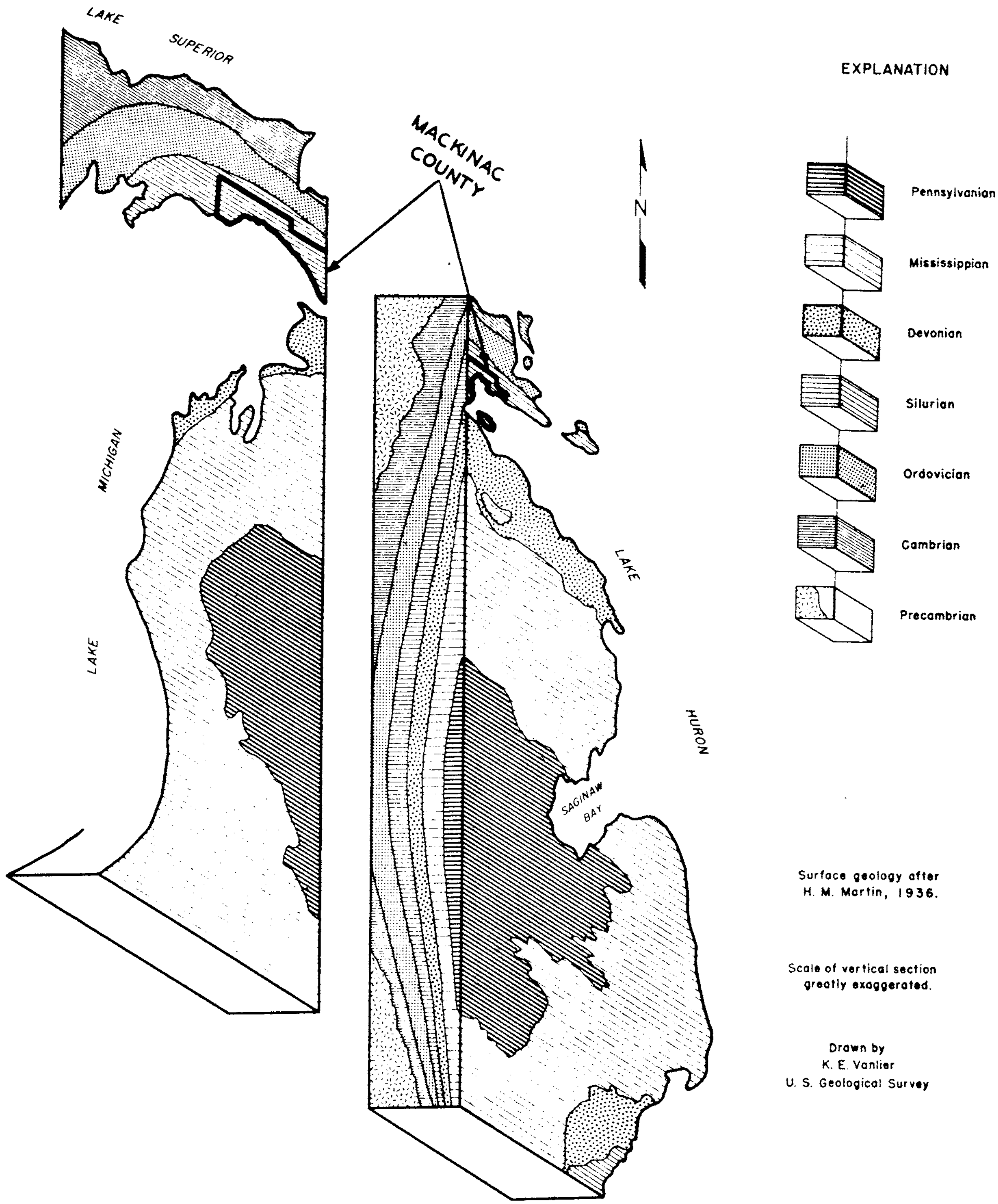

Figure 4. Block diagram showing schematic geologic cross section through the Michigan basin.

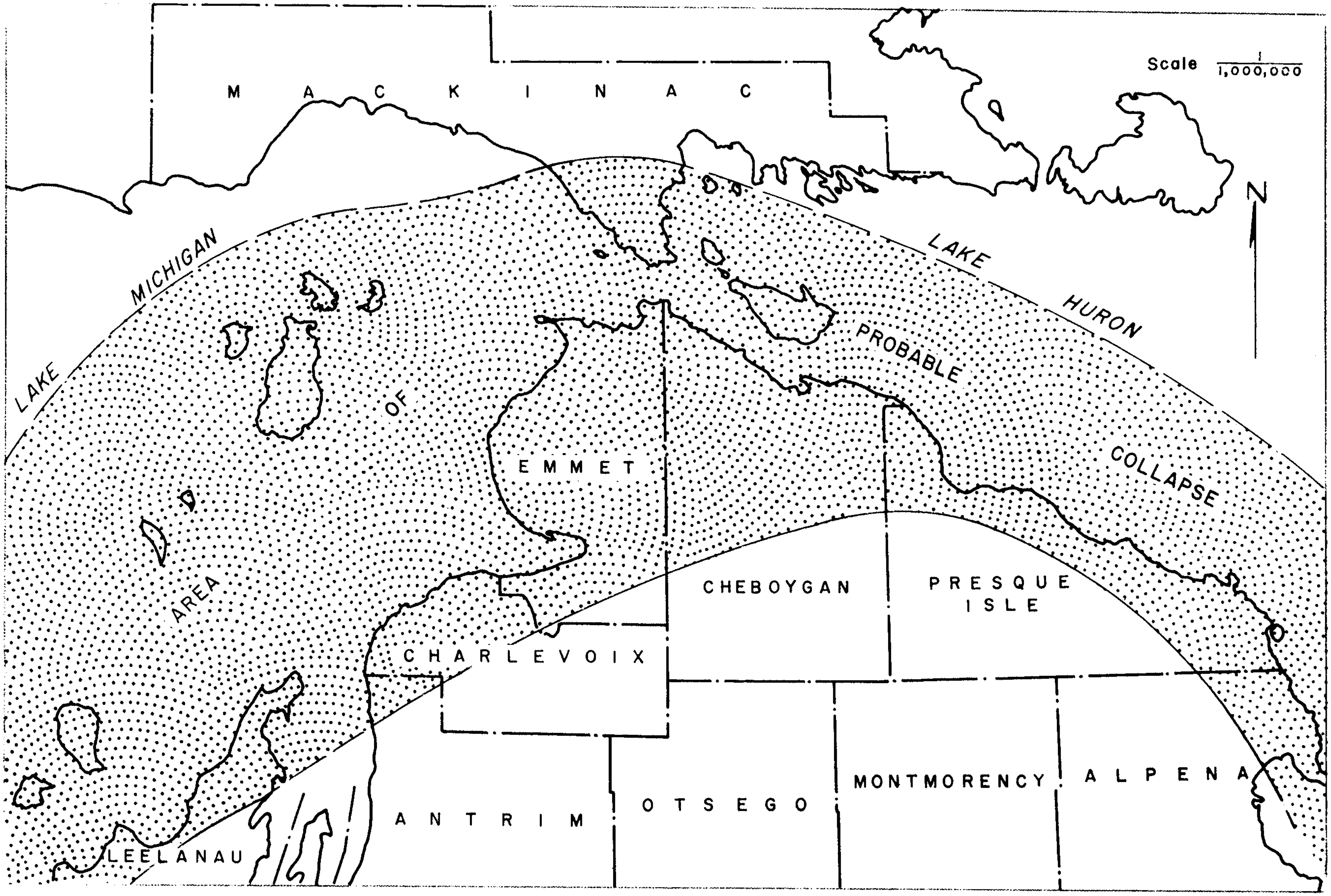

Figure 5. Map of the Straits of Mackinac region showing areas of probable collapse of Upper Silurian and Middle Devonian strata into voids created by leaching of salt from the Salina formation (after Landes, Ehlers, and Stanley, 1945).

GROUND WATER

Occurrence and Availability

A rock formation, part of a formation, or group of formations that yields water in usable quantities is termed an "aquifer." In areas where ground water is difficult to obtain, a formation yielding less than a gallon per minute to a well may be classed as a principal aquifer. In other areas where wells may yield several hundred gallons per minute, a formation from which wells obtain less than a few gallons per minute may be classed as nonproductive.

The amount of water available to a well depends upon the regional and local geologic and hydrologic characteristics of the aquifer, the climatic conditions in the area, and the hydraulic properties of the soils and subsurface units in the recharge areas.

The imaginary surface consisting of all points to which water would rise in wells tapping an aquifer is called piezometric surface. On the basis of water occurrence, aquifers may be classified as water-table or artesian. In a water-table aquifer, ground water is unconfined and the water table may be considered the piezometric surface of that aquifer. In an artesian aquifer, ground water is confined under pressure between relatively impermeable strata (strata through which water does not readily move). Under natural conditions, the water in a well that is finished in an artesian aquifer and that is tightly cased through the overlying confining bed will rise above the bottom of that bed, and therefore, the piezometric surface is above the top of the aquifer. An artesian aquifer is full of water at all times even when water is being removed from it.

Eventually, however, enough water may be pumped to draw the water level below the bottom of the overlying confining bed, thus locally creating water-table conditions.

In topographically low areas, the piezometric surface of an artesian aquifer may be higher than the land surface. Wells tapping artesian aquifers in such areas will flow at or above the land surface.

Ground water in Mackinac County is contained in consolidated-rock aquifers ranging in age from Cambrian to Silurian, in brecciated-rock aquifers of Silurian and Devonian age, and in unconsolidated glacial drift and associated sediments of Pleistocene age. The most important and widespread aquifers of the county are the limestones and dolomites of Middle Silurian age. In scattered areas throughout the county shallow glacial deposits will yield adequate supplies of water. Brecciated-rock aquifers are tapped for water in the St. Ignace Peninsula. In one area in the northwestern part of the county very deep drilling to Cambrian sandstone may be necessary to develop a ground-water supply.

Most areas in Mackinac County are underlain by two or more aquifers. Many of the geologic units described in the following pages may constitute important sources of ground-water supplies in one or more of the areas described in the section of this report entitled "Occurrence of Ground Water by Areas."

Ground Water in Consolidated Rocks

Sedimentary rocks of Paleozoic age which include a number of important aquifers underlie all of Mackinac County. The depth to the surface of the Precambrian rocks underlying the Paleozoic rocks has not been determined at any location in the county. Future development of Precambrian rocks as a source of water supply is unlikely because of their great depth and probably low permeability, and because of the poor quality of water they might contain.

Munising Sandstone of Late Cambrian Age

The Munising sandstone as used herein may include strata of the Hermansville limestone of Cambrian and Ordovician age, which locally is very similar in lithology to the Munising and difficult to distinguish solely on the basis of deep-well logs. Because of the lack of distinguishing characteristics between the formations, delineation of the Munising and Hermansville formations has not been attempted in this report. The Munising is a white to gray locally dolomitic fine- to medium-grained sandstone. The sand grains generally are rounded and frosted. The Hermansville, which is similar lithologically to parts of the Munising, contains greater quantities of dolomite. In some areas it is described as sandy dolomite (Bergquist, 1936a). The thickness of the Munising sandstone in Mackinac County has not been determined, although more than 200 feet of the formation has been penetrated by deep wells.

The Munising, which is often called the "St. Peter sandstone" by drillers, is tapped by two wells (44N 12W 10-1 and 26-1) in the northwestern part of the county, where water of good quality is not present in overlying formations. In this area and along the northern boundary of the county, the Munising sandstone is reached at depths of about 1,000 feet; in the southern part of the county, it is at greater depth (pl. 3).

It is believed that the sandstone is permeable throughout the eastern part of the Northern Peninsula, and may prove to be a useful source of ground water if drilling is economically feasible. In the northwestern part of the county, water from the Munising sandstone is potable and generally of good quality (table 7), but its quality elsewhere in the county is not known.

Black River and Trenton Limestones of Middle Ordovician Age

The Black River and Trenton limestones consist of a thick sequence of gray, buff, and brown limestone and dolomite which overlies the Munising sandstone as defined in the preceding section. The Black River and Trenton are treated as a unit because of the difficulty in distinguishing between them on the basis of drilling records. The limestone and dolomite are generally hard and resistant, but they include some beds of shale and shaly limestone or dolomite. Logs of wells 44N 12W 26-1 and 44N 12W 17-2 indicate that the unit is about 250 feet thick in the northwestern part of the county.

The Black River and Trenton limestones are not a source of fresh ground water in Mackinac County. They did, however, yield mineral water from well 44N 9W 17-2. Mineral water zones within these rocks should be sealed off in wells drilled through them to avoid contamination of fresh water both in the underlying sandstones and in the overlying rocks.

Collingwood Formation and Richmond Group of Late Ordovician Age

Shale unit.--The Black River and Trenton limestones are overlain by a thick sequence of Upper Ordovician shale, limestone, and dolomite strata.

The lower part of this sequence includes gray and black dolomitic and bituminous shales of the Collingwood formation, overlain by the basal shale beds of the Richmond group. The total thickness of this shale sequence in Mackinac County is about 240 feet. Because of the similarity of hydrologic and lithologic characteristics the total shale sequence is treated herein as a single unit. This shale unit is of low permeability and is not a source of ground water in the county.

Limestone and dolomite of the Richmond group.--The upper part of the Richmond group consists of about 160 feet of gray limestone and dolomite. These rocks have not been tapped for water in Mackinac County, as they are nearly everywhere overlain by the limestone and dolomite of the Niagara series, which are excellent sources of ground water. In the northeastern part of the county where the limestone and dolomite of the Richmond group form the bedrock surface (pl. 2), wells have been completed in overlying permeable glacial drift. Well 43N 9W 11-2 at Gilchrist, which was drilled to a depth of 1,111 feet, is believed to have produced water from limestone and dolomite of the Richmond. However, water was encountered also in the overlying Niagara rocks. Water in the Richmond probably occurs in fractures and openings along bedding planes, which generally have been enlarged by solutional activity of ground water.

The limestone and dolomite of the Richmond group are sources of water to many wells in the Rudyard-Pickford area of Chippewa County (Vanlier and Deutsch, 1958). These rocks may be productive also in the adjacent areas of Mackinac County.

Cataract Formation of Early Silurian Age

The Cataract formation is composed predominantly of alternate beds of limestone, dolomite, and shale. The shale is characteristically gypsiferous, calcareous, or dolomitic. The formation is about 210 feet thick in Mackinac County. In the northwestern corner of the county and near the Pine River and at Pickford in the northeastern part of the county, it is mantled by glacial drift. In these areas, the Cataract formation was exposed at the surface in preglacial times, and locally shale beds have been weathered or removed by erosion, allowing increased circulation of ground water. The limestone and dolomite beds may have greater permeability as a result of the development of solution openings along joints and bedding planes. Well 43N 1W 13-2 near Pickford produced a flow of water from dolomite and limestone strata 185 to 200 feet deep. Throughout most of the county, the Niagara rocks overlie the Cataract formation, and limestone and dolomite strata within the Cataract probably are of low permeability because movement of ground water, which normally results in solutional activity, is impeded by shale near the top of the formation. Because adequate water supplies are obtained by most wells drilled into the limestone and dolomite of the Niagara series, the Cataract formation generally has been penetrated only by oil-test wells and is not an important aquifer in Mackinac County.

Niagara Series of Middle Silurian Age

Limestone and dolomite rock strata of the Niagara series, which form the bedrock surface in about 75 percent of Mackinac County, are the most important source of fresh ground water within the county. Each of the formations (Burnt Bluff, Manistique, and Engadine) of the Niagara series is important as an aquifer in large areas of the county. Many wells drilled into carbonate rocks of the Niagara obtain water from openings formed largely by solution and weathering when the rocks were at the surface. Permeable zones have developed also at depth through the solutional activity of percolating ground water moving through joints and minute openings along bedding planes. Solution of the carbonate rock adjacent to these openings permitted an increase in the volume moving through them, consequently increasing the rate of solution. Solution was probably greatest along beds of high-calcium limestone, which is more soluble than high-magnesium dolomite. Many wells in the county tap such deep permeable zones. Not all beds of high-calcium limestone have been made permeable by solutional activity, however. Development of solution openings in some strata probably was blocked by the initial impermeability of the bed or by restriction of ground-water flow in adjacent strata of low permeability.

Generally, permeable zones in rocks of Niagara age are thin and are separated by relatively thick beds of low permeability. Thus the yield of a well that has tapped one permeable zone will not increase significantly until the next permeable zone is reached. This contrasts with the yield of a well tapping a rock such as sandstone, which will increase roughly with the amount of the formation penetrated.

Permeable zones are important avenues of circulation in the carbonate rocks and commonly are areally extensive (pl. 4). Equally extensive beds of low permeability form very efficient confining layers which allow practically no natural vertical leakage from artesian zones within the Niagara series. Hence, in topographically low areas, many wells tapping the formations of the Niagara series are under sufficient artesian pressure to cause a flow of water at or considerably above the land surface (table 2).

Burnt Bluff formation.--The Burnt Bluff formation, the oldest of the Niagara series, crops out or is covered only by glacial drift in the northern part of Mackinac County. The formation is composed of light-gray, gray, and brown dolomite and limestone strata including some beds of high-calcium limestone. The strata are jointed and range from thinly bedded to massive. In Mackinac County the formation is more than 200 feet thick. Beds of high-calcium limestone in the Burnt Bluff formation are quarried at the Hendricks Quarry northwest of Rexton, at the Fiborn Quarry northeast of Rexton, and at the Inland Lime and Stone Quarry near Huntspur. Near the Fiborn Quarry, caves have developed in some of the high-calcium limestone beds.

The Burnt Bluff formation is an important aquifer in much of the county. Generally, it is tapped by wells only in the area where it would be exposed if the glacial-drift mantle were removed, or in adjacent areas where the overlying Manistique dolomite is nonproductive. In the area where the Burnt Bluff is mantled by the younger Manistique and Engadine dolomites, it generally is not utilized as a source of ground-water supply, for water can be obtained at shallower depths. There is no evidence to show, however, that the Burnt Bluff would not be productive at depth in the southern part of the county where it is overlain by younger formations.

Manistique dolomite.--The Manistique dolomite consists of high-magnesium limestone and buff to light-brown cherty dolomite. The formation crops out in a number of places in the northern part of the county. The hard and resistant limestone and dolomite strata are cliff formers, and in many localities the outcrop area of the Manistique is marked by a steep escarpment. The formation is about 200 feet thick in Mackinac County.

Moderate to large supplies of water can be obtained from the Manistique dolomite throughout much of the county. The occurrence of water in the limestone and dolomite of the Manistique is similar to that in the other formations of the Niagara series. In many places water in the formation is confined under artesian pressure sufficient to cause it to flow at the surface. Artesian pressures in some of the wells tapping the Manistique dolomite at Naubinway are great enough to cause water levels to rise as much as 85 feet above the land surface (table 2).

Engadine dolomite.--The Engadine dolomite is a hard crystalline massive white, buff, and light-gray dolomite. In places the escarpment and dip slope of the Niagara cuesta are formed on resistant layers of Engadine dolomite. The area where the Engadine would be exposed if the glacial-drift mantle were removed (pl. 2) covers a major portion of the county.

The Engadine is, as are the other formations of the Niagara series, an important aquifer in Mackinac County. Moderate supplies of fresh water are produced from the more permeable zones which have developed largely as a result of solutional activity. Solution features are evident where the Engadine is exposed at the surface. Reports from drillers indicate that in the eastern part of the county some sandstone beds are included in the Engadine dolomite. These sandstones also may be a source of water to wells. Much of the water in the Engadine is under artesian pressure.

Relatively impermeable beds within the formation commonly form confining layers, but in many places water in the aquifer is confined under artesian pressure by the mantle of glacial drift.

The solution features that developed where the Engadine dolomite is exposed, or was exposed in preglacial time, are significant as they provide a direct avenue for recharge. South of Gould City, solution caves and sinks have formed in the jointed and weathered surface of the Engadine.

Salina and St. Ignace Formations of Late Silurian Age

Salina formation.--The Salina formation, which crops out on the St. Ignace Peninsula, consists of green and red shale and shaly dolomite and thin beds and irregular masses of gypsum. Thick beds of salt also were deposited within the formation, but these beds were subsequently removed by leaching. The log of well 40N 3W 7-1 shows a thin bed of salt at 400 feet. The leaching of the salt beds in the Salina formation produced large caves into which the overlying rock strata collapsed. Thus, much of the Salina is broken and faulted into blocks ranging in size from small fragments to slabs several hundreds of feet in horizontal dimension. As a result of the faulting and brecciation due to collapse, it is generally impossible to correlate strata of the Salina formation on the basis of well logs.

Wells tapping the formation generally produce water from the thin dolomite beds, or in some places from beds of shaly dolomite. The water in the Salina Formation occurs along joints and bedding planes, and the permeability of the formation in some areas probably has been increased as a result of brecciation. In some areas fragments of the broken formation have been recemented by carbonate minerals carried in solution by percolating ground water which has resulted in filling the void spaces and lowering the permeability of the aquifer. Because of the great range in permeability within the Salina formation, test drilling to locate permeable zones or detailed geologic information concerning a specific locality is needed to insure obtaining an adequate water supply. The presence of gypsum, resulting in mineralization of ground water within the formation, adds to the difficulty of obtaining a water supply of good quality.

St. Ignace formation.--The St. Ignace formation is the youngest of the formations of Silurian age that crop out in Mackinac County. This formation also is broken and faulted as a result of collapse of the underlying Salina formation. On the St. Ignace Peninsula and Mackinac Island, these rocks are present only as large segments of strata intermixed within the Mackinac breccia. No attempt was made to delineate segments of the St. Ignace formation within the breccia in the above areas, and hence those areas are mapped as Mackinac breccia (pl. 2).. Relatively intact strata of the St. Ignace formation are present on Round Island and in the northern part of Bois Blanc Island. The St. Ignace formation consists of layers of light-buff and light-gray dolomite and includes several thin layers of varicolored shale. Landes, Ehlers, and Stanley (1945, p. 53-73) published a detailed description of the lithologic character of the formation. They estimated the thickness of the St. Ignace formation to be about 250 to 300 feet.

Little is known of the water-bearing characteristics of the St. Ignace because the present reconnaissance investigation was limited to the mainland portion of the county. It is believed, however, that these rocks may be a source of ground water on Round and Bois Blanc Islands.

Bois Blanc Formation of Middle Devonian Age

The Bois Blanc formation is the youngest of the Paleozoic sedimentary rock units in the Northern Peninsula of Michigan. This formation also is brecciated as a result of collapse. Fragments and faulted blocks of the Bois Blanc formation are present in the Mackinac breccia underlying Mackinac Island and part of the St. Ignace Peninsula. In those areas, however, the formation is too extensively brecciated and intermixed with older rocks to permit delineation of the formation as a stratigraphic unit. Within Mackinac County, the formation is mappable as a stratigraphic unit in the southern two-thirds of Bois Blanc Island. The upper portion of the formation is present also along the northern tip of the Southern Peninsula.

Landes, Ehlers, and Stanley (1945, p. 80-109) described the lithology of the formation in detail. The lower part of the formation, which is estimated to be about 75 feet thick, crops out on Bois Blanc Island and consists of interbedded chert and dolomite. Light-gray to light-buff cherty limestone of the middle part of the formation forms the bedrock surface under the south shore of the island. The upper part of the formation, which consists predominantly of limestone, is present only under the water and along the south shore of the Straits of Mackinac.

Little is known of the water-bearing characteristics of the Bois Blanc formation in Mackinac County. It may be a source of ground water on Bois Blanc Island.

Mackinac Breccia of Devonian and Silurian Age

The Mackinac breccia is composed predominantly of angular blocks of limestone and dolomite and admixtures in varying amounts of chert, shale, and gypsum from the Salina, St. Ignace, and Bois Blanc formations. The Mackinac breccia was formed as a result of collapse of the Salina, St. Ignace, and Bois Blanc into voids formed as a result of leaching of thick salt beds of the Salina. Although many large blocks of the separate formations of which the Mackinac breccia is composed can be recognized, the boundaries of these blocks generally cannot be delineated. Brecciation and other collapse features are recognized over a large area (fig. 5); however, the Mackinac breccia as described in this report is limited to the area where the rocks show no stratigraphic continuity because fragments and blocks from the different formations are jumbled together at random.

Locally, the blocks and fragments composing the Mackinac breccia are indurated (cemented) into resistant, coherent, and generally impermeable masses. These resistant masses of rock form many of the prominent physiographic features of the St. Ignace Peninsula and Mackinac Island. Excellent examples of resistant breccia masses are St. Anthonys Rock and Castle Rock in the St. Ignace area, and Arch Rock and Sugar Loaf on Mackinac Island. Other hills near St. Ignace and on Mackinac Island mark areas underlain by masses of resistant breccia. Most of the breccia, however, is nonindurated or incompletely indurated, and, hence, the permeability of the breccia mass varies widely both vertically and laterally.

The occurrence of water within the Mackinac breccia is as complex as the breccia itself. Just as there is a complete lack of stratigraphic continuity in the breccia, there is a lack of continuity between water-bearing horizons. Much of the permeability of the breccia may be the result of openings along faults and other fractures. These openings may or may not be filled with precipitated calcium carbonate, which forms the cement of the resistant breccia. Thus, masses of impermeable breccia may occur in direct contact with masses of permeable breccia. The masses of impermeable rock may have horizontal and vertical dimensions of hundreds of feet or only a few feet. Some wells drilled only a few tens of feet from productive wells will not yield water. The water produced from the Mackinac breccia generally is hard and high in mineral content.

Although the Mackinac breccia is an important aquifer at the southern end of the St. Ignace Peninsula, specific capacities of wells tapping the formation are generally very low (table 6). Well 40N 4W 5-3 tapping this aquifer yielded 50 gpm with 2 feet of drawdown. Other localities of similar or perhaps greater yields might be located by test drilling, but wells drilled into indurated breccia may yield no water.

Ground Water in Unconsolidated Deposits

Most of the unconsolidated rocks in Mackinac County were deposited during the final or Wisconsin stage of the so-called Ice Age (Pleistocene epoch). These deposits, which consist of a heterogeneous mixture of rock debris known as glacial drift, are important aquifers in some parts of the county. The general term "glacial drift" embraces all types of morainal and associated glacial lake and beach, meltwater-stream, and windblown deposits. The drift generally is closely related in lithology to the underlying bedrock, especially at the base of the drift section, and in many wells the contact between the drift and the bedrock cannot be accurately delineated.

The glacial deposits of the county consist of stratified gravel, sand, silt, clay, and unstratified rock debris (till). Stratified sand and gravel deposits generally are more permeable than the unstratified deposits and in most areas will yield more water to wells. In many areas of the State, stratified drift can readily be differentiated from the unstratified drift by areal geologic mapping. Such is not the case in Mackinac County, as here surface features have been modified by erosion and masked by glacial-lake deposits. Hence, the map of the surficial deposits (pl. 5) should be used only as a general aid in locating ground-water supplies. Test drilling is essential in order to appraise adequately the ground-water resources of the drift aquifers in the county.

The drift has a great range in thickness in the county. At the Pine River near Chippewa County the drift is as much as 300 feet thick. In this area it fills a deep preglacial valley eroded into the bedrock surface extending from St. Martin Bay on Lake Huron to Whitefish Bay on Lake Superior. In large areas of the county, however, the drift mantle is thin or discontinuous. In such areas, underlying bedrock formations are the best sources of ground water.

Morainal Deposits

The moraines of Mackinac County (pl. 5) are ridges of glacial till which was deposited for the most part in the waters of glacial Lake Algonquin along the relatively static front of glaciers melting back at approximately the rate of movement of the ice sheet. Only two deposits of land-laid morainal till have been described in Mackinac County. These deposits were mapped by Leverett (1929, pl. 1) in T. 43N., R. 4 W., and in Tps. 42 and 43 N., R. 1 W.

The glacial till of which the moraines are composed is a mixture of rock debris transported by ice and deposited by melting of the ice without subsequent transport by wind or water. Commonly the moraines include, and are associated with, deposits of stratified outwash. Accurate delineation of the various types of morainal till in the county, however, is beyond the scope of the present reconnaissance report.

Land-laid till tends to be unsorted and unstratified, but most of the till in Mackinac County was deposited in water or later reworked and sorted or stratified to some degree by lake waters. The degree of sorting of the till varies greatly. In some areas the sorting is rudimentary; elsewhere the till is difficult to distinguish from well-sorted outwash deposits. Moraines in the western half of the county, which are composed largely of sand, may yield moderate supplies of water. Those in the eastern part of the county generally are composed of clayey till, which is a relatively poor source of water. The clayey morainal deposits, however, include some small lenses of stratified sand and gravel that will yield small amounts of water to wells. Well 42N 1W 3-1 (table 4) penetrated several layers of permeable sand within the moraine.

Till

The till plains of Mackinac County are underlain by glacial till similar in physical character to that described above in the section entitled "Morainal Deposits." Most of the till is now thin and discontinuous as a result of wave-washing by the glacial lakes, which at various times covered much of the county. Till-plain areas are not shown on plate 5, as the deposits generally form only a veneer over the bedrock surface. In many places the till deposits are above the zone of saturation, although locally they yield small amounts of water to shallow wells. In general, however, the till-plain deposits are not important sources of water to wells in Mackinac County.

Outwash

Outwash is composed of stratified sand and gravel deposited by glacial melt-water streams. In Mackinac County, much of the outwash was deposited as deltas in glacial lakes and is composed mainly of sand. The outwash deposits are closely related to, and in places are incorporated within, morainal deposits. They are permeable and generally yield small to moderate supplies of ground water. Several areas of such deposits are shown on plate 5. Subsurface outwash deposits in other areas may be located by test drilling or, perhaps, by geophysical methods.

Glacial-Lake Deposits

Stratified clay, silt, and fine sand deposited in the waters of glacial Lake Algonquin and other extinct glacial lakes mantle much of Mackinac County. These sediments can be divided into two major types: The clayey lake-plain deposits, which are composed mainly of pebble-free red and gray varved clay, and the sandy lake-plain deposits, which are composed of fine sand and silt.

The clayey lake deposits are of low permeability and are not a source of water to wells; they act as confining layers in some artesian systems. The sandy lake deposits may yield small amounts of water to wells.

Dune Sand and Beach Deposits

Dune sand and beach deposits associated with glacial Lake Algonquin and post-Algonquin lakes are found throughout the county. These sediments consist of permeable windblown sand and beach-deposited sand and gravel. Most of the dune areas are associated with the beach deposits. Dune and beach areas have not been delineated on plate 5. Locally, these deposits may yield small to moderate supplies of water to wells. They have high infiltration capacities and, where situated above the water table, they provide an important avenue of recharge to the underlying ground-water reservoirs.

Ground-Water Phase of the Hydrologic Cycle

Source and Recharge Areas

The initial source of nearly all the ground water of Mackinac County is precipitation, which averages about 30 inches annually. If all the moisture that fell upon the county entered into uniformly distributed permeable aquifers, a bountiful supply, more than enough to satisfy any foreseeable needs, would be insured. However, much of this water does not enter the ground-water reservoirs, but is lost by evaporation, by transpiration, and by direct runoff to the Great Lakes drainage system.

The amount of precipitation that enters the aquifers is influenced by a number of factors, including the duration, intensity, and type of precipitation; the density and types of vegetation; the topography; and the porosity and permeability of the soil, subsoil, and underlying rock formations. Ferris and others (1954) discuss the hydrologic cycle in greater detail, particularly as applied to drift and rock aquifers in Oakland County, Mich.

In Mackinac County, areas of small recharge are the clayey lake and till plains which have soil and subsoil of low permeability. In the lake-plain areas, where the soils promote runoff, complex surface drainage features have developed. Areas of high recharge are in the permeable morainal, outwash-plain, sandy lake- and till-plain, and dune and beach deposits. In these areas, surface drainage courses are poorly developed or nonexistent. Some rock highlands which are permeable because of fracturing and solution also are major areas of high recharge.

Movement

The movement of ground water is somewhat similar to that of surface streams in that the water moves by gravity from high to low levels. Percolation of water through the interstices between rock particles below the surface involves a great amount of friction and hence is much slower than flow of water upon the surface. Rates of ground-water movement range widely from a few feet per year to many feet per day.

Water may travel great distances underground from recharge areas to areas downgradient where it may once more reach the surface and join the flow of streams, appear as a seep or spring, enter a lake, or escape directly to the atmosphere by evaporation and transpiration. Where undistrubed by man-made diversions, the piezometric surface of an aquifer near the surface conforms generally to the configuration of the overlying land surface. In the deeper artesian aquifers, however, the piezometric surface may differ considerably from the overlying land surface, and locally its gradient may be in a direction opposite to the slope of the land surface. Where more than one aquifer underlies the same area, water will migrate or leak from an aquifer of high head to an overlying or underlying one of lower head. In this way, water will leak slowly through the confining beds of an artesian system. Artesian pressures in the Naubinway area, where water levels more than 75 feet above the land surface are not uncommon, are evidence of efficient confining beds which allow relatively little natural vertical leakage from the aquifer.

Many areas of Mackinac County are underlain by two or more aquifers differing considerably in water level, and some natural seepage or leakage occurs between them. The greatest leakage between aquifers in some areas, however, takes place through wells that are open to more than one aquifer. Where considerable interaquifer leakage occurs, it may be difficult to define the piezometric surface of an individual aquifer.

Discharge

Water is discharged from the ground-water reservoirs by evaporation and transpiration and through wells, springs, and drains. Because much of the county is covered by dense growths of forest and swamp vegetation, the amount lost by evapotranspiration is presumed to represent a large percentage of the total discharge. A considerable amount of water is also discharged from the ground-water reservoir through springs. Most of the springs in the county are along the edge of the moraine and outwash highlands and along the Niagara escarpment.

The greatest amount of discharge by wells is that from aquifers tapped by numerous flowing wells, the perennial flow from these wells greatly exceeding the discharge from pumped wells. The total discharge by all wells, however, is small compared with the total natural ground-water discharge.

Fluctuations of the Water Table

Climatic Influences

Water levels in the county fluctuate with seasonal changes in the rate of recharge to and discharge from the ground-water reservoirs. During the spring thaw, water levels in wells normally rise in response to the infiltration of rain and melting snow. Summer temperatures cause an increase in evapotranspiration and a resulting decrease in recharge and decline in water levels. Rainfall during the growing season normally has slight effect on the rate of decline, as vegetation in the county utilizes most of the available moisture. In the fall, evapotranspiration losses are reduced and precipitation may be adequate to replenish soil moisture and then to cause rises in water levels. However, the decline in stage common during the summer may be continued during the fall if precipitation is deficient or if there is an early general freeze which tends to impede normal infiltration.

The relation of climate to ground water is illustrated by the fluctuation of water level in well 42N 2W 7-1, which is compared with the average of the daily precipitation at Kinross in Chippewa County and at Brevort and with the range in average monthly temperature at Kinross (fig 6). The water level in this well, which taps the Engadine dolomite, rose rapidly in response to rainfall during the last part of June and early part of July 1956. Much of the rain that fell during this period entered the ground-water reservoirs, as the soil-moisture and plant requirements had been supplied by snowmelt and earlier spring rains.

The rapid rise in water level in response to rainfall shows the accessibility of the Engadine dolomite to recharge from precipitation.

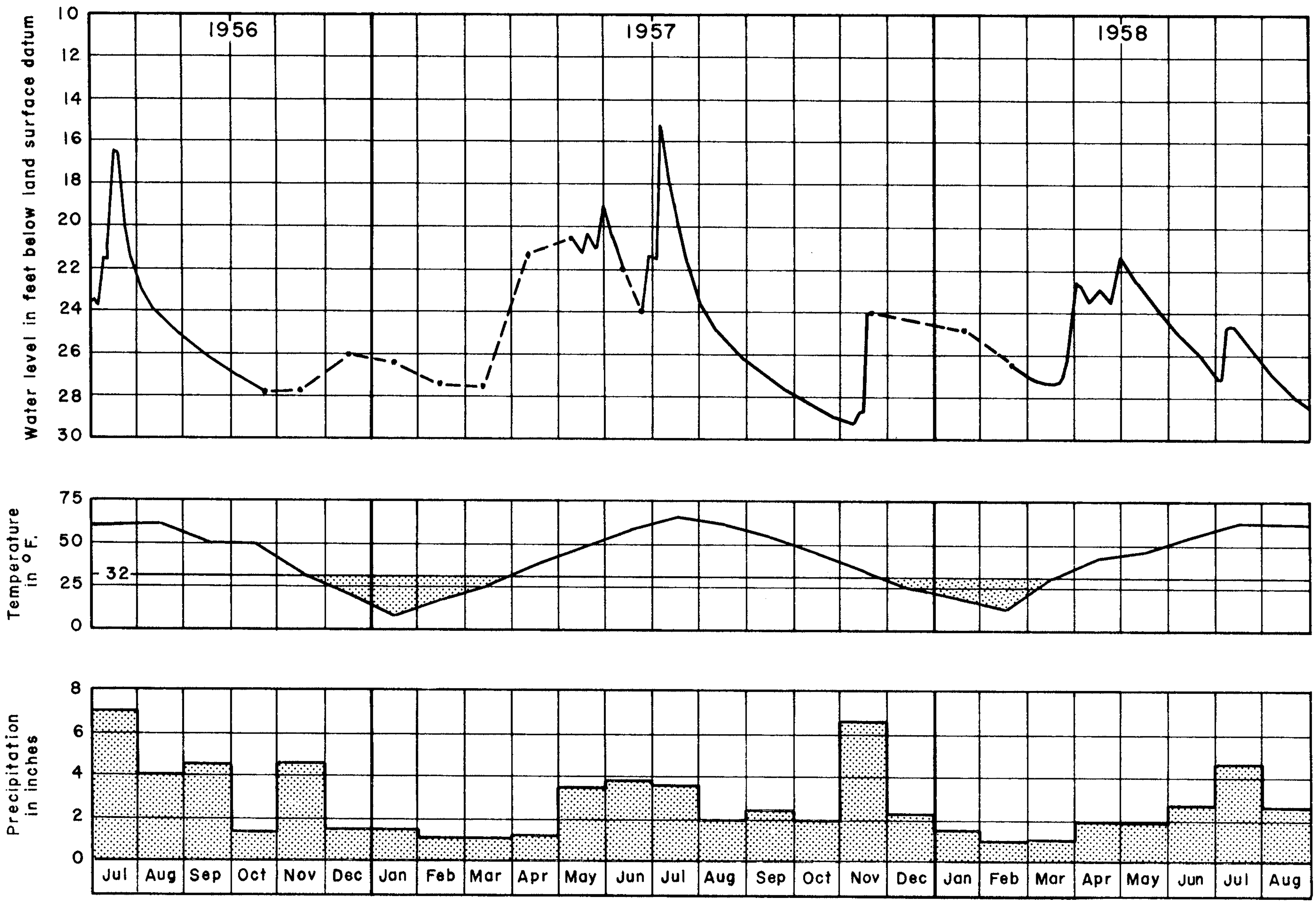

Figure 6. Hydrograph of well 42N 2W 7-1 compared with the average monthly temperatures and monthly precipitation at Kinross.

Solution openings along joints provide direct access to the aquifer. Precipitation during later summer months, however, had very little effect on the water level in the well. All available moisture during the hot months was utilized by plants or went to replenish soil moisture which had been depleted by plant use. During the summer months the water level declined gradually as water within the aquifer was slowly discharged to springs and seeps. The use of water by plants declined in the fall, and during these months precipitation caused a slight rise in the water table. During the winter, when precipitation fell as snow, little or no recharge took place and the water level slowly declined.

Fluctuations Due to Discharge from Wells

Generally, ground water is a renewable natural resource, as it is intermittently or continually being replaced directly or indirectly by precipitation. If an aquifer is to be developed by means of wells so that a long-term yield can be obtained without substantially dewatering the aquifer, then equilibrium must exist between the rate of recharge to the aquifer and the rate of discharge from it (Theis, 1940). Any aquifer in its natural state (before it is tapped by wells) is in approximate dynamic equilibrium. When water is discharged from an aquifer by means of a well, a temporary change in the rate of total discharge from the aquifer results. The increase in discharge causes a cone-shaped depression in the piezometric surface around the discharging well. With continued discharge, the cone of depression expands until the resultant lowering of water levels causes a decrease in discharge from the aquifer or an increase in recharge to the aquifer, restoring the aquifer to a state of equilibrium.

Wells within the cone of depression are affected by the lowering of water level. Thus, a well tapping an aquifer is affected by the discharge of other nearby wells that tap the same aquifer. If there are several or many discharging wells, a composite cone of depression results, which may extend over a large area. The lowering of water levels over a large area may cause a considerable increase in the rate of recharge to or a considerable decrease in the rate of natural discharge from the aquifer. A lowering of the water level, therefore, is necessary in the development of a ground-water reservoir. Waste of water, however, as from unrestricted flowing wells or by underground leakage from poorly constructed wells or deteriorated well casings, results in an unnecessary lowering of the piezometric surface, which may cause some wells to stop flowing, decrease yields, and increase the cost of producing water. The same effects result as the aquifer is further developed by installation of additional flowing wells. Many of the flowing wells in Mackinac County are reported to show effects of decreased artesian pressures, and in the Engadine area many wells have stopped flowing.

Utilization of Ground Water

Much of Mackinac County is bounded by the waters of the Great Lakes system, which provide a practically unlimited source of fresh water. St. Ignace, the largest municipality in the county, obtains its water supply from Lake Huron. Other towns and villages and nearly all the farm residences, resorts, motels, and other users tap ground-water sources.

Utilization of the ground-water resources of the county has been limited for the most part to domestic purposes and watering of stock, and the amount used represents an insignificant fraction of the total resource available. Engadine is the only municipality that has a public ground-water supply. Other villages and towns are supplied by privately owned wells. The tourist industry, which is one of the important users of ground water during the vacation season, does not require such large quantities of water as would be needed in industrialized areas or in irrigated agricultural areas. Comparatively minor amounts of ground water are used by other industries in the county, and no water is known to be used for air conditioning.

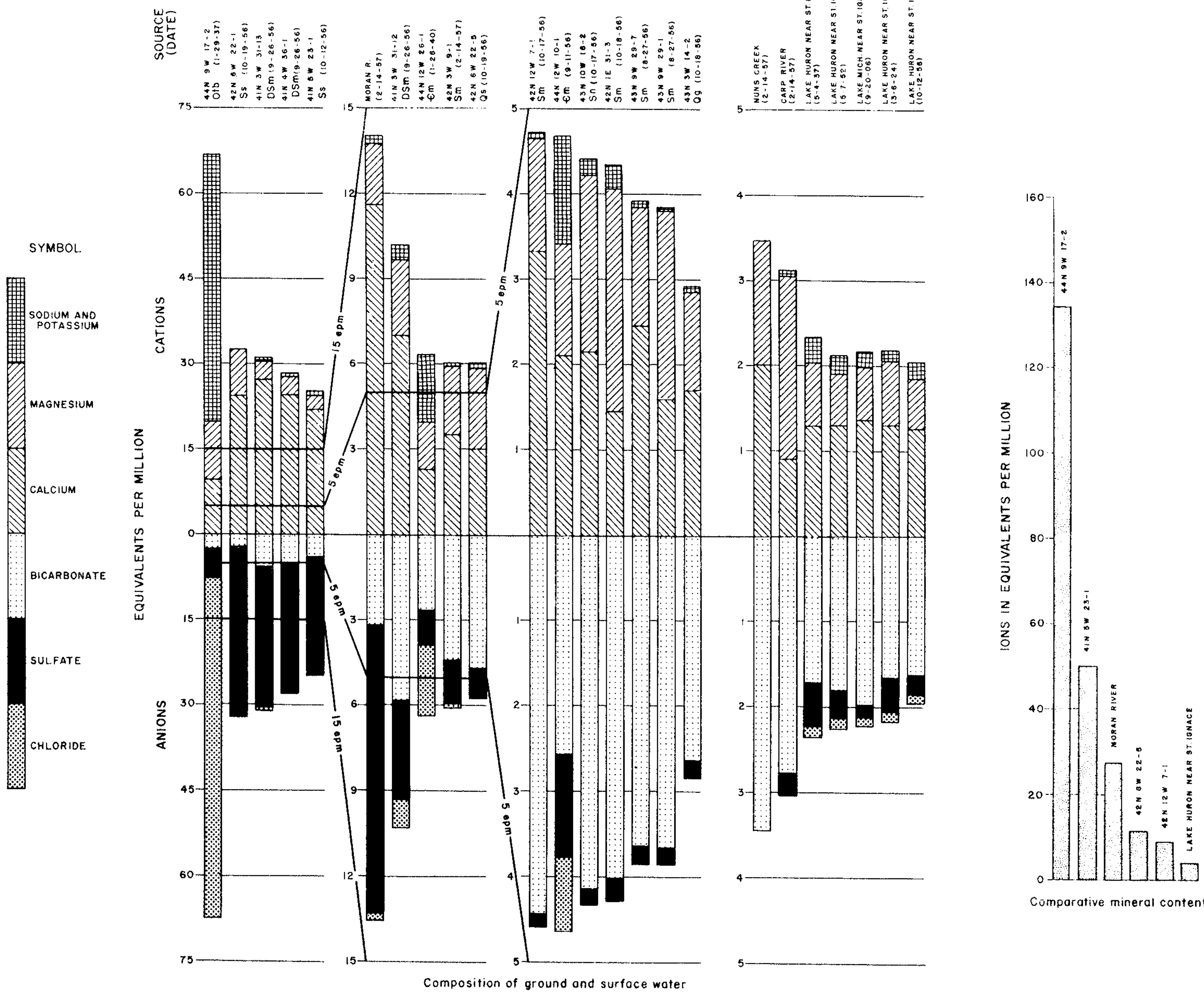

Figure 7. Diagrams showing chemical quality of water in Mackinac County.

QUALITY OF WATER

A listing of chemical analyses and records of various physical properties of the waters of Mackinac County is provided in table 7. Despite the fact that it was not possible to engage in a comprehensive program of chemical analysis of the waters of the county and geochemical interpretation during the present reconnaissance, sufficient data were gathered to reveal the general nature of the water from each of the major aquifers.

Figure 7 is a graphic presentation of the chemical quality of the waters in Mackinac County, which illustrates the great range in mineral content of ground and surface waters from various sources. Fresh water, as defined herein, is water containing less than 1,000 parts per million (ppm) of dissolved minerals. This concentration represents the maximum that should be permitted in drinking water, according to the U. S. Public Health Service (Michigan Department of Health, 1948). However, the dissolved-solids content of water of good chemical quality should not exceed 500 ppm. All waters containing more than 1,000 ppm of dissolved mineral matter are referred to in this report as "mineralized." The source of the dissolved solids present in the mineralized ground waters in Mackinac County is believed to be connate water entrapped at the time of deposition of sediments in the Michigan basin, and formations containing soluble minerals, which are being dissolved and removed in solution by percolating ground waters. Variations in mineral content result from the mixing of mineralized and fresh waters in various proportions, the solubility of mineral constituents in the aquifer, and the quantity of fresh ground water moving through the aquifer.

The waters in the aquifers of Mackinac County are of two predominant types: calcium magnesium bicarbonate and calcium sulfate. Waters from the glacial drift, sandstone, and limestone aquifers are relatively high in calcium bicarbonate, compared to waters from dolomite and dolomitic limestone aquifers, which are relatively high in magnesium bicarbonate. Thus, a high magnesium-to-calcium ratio generally indicates that the source aquifer is dolomite or that some of the water has migrated through dolomitic rock. Water high in calcium sulfate content commonly indicates that gypsum is present in the source aquifer. Water of the sodium chloride type in the Munising sandstone and Trenton and Black River limestones may represent connate water migrating from the interior of the Michigan Basin. Water from the Salina formation locally may contain sodium chloride dissolved from residual salt beds present within the formation (see log of well 40N 3W 7-1, table 4).

Fresh Ground Water

Supplies of fresh ground water varying widely in chemical quality are present in the glacial drift and most of the bedrock formations of Mackinac County.

The Munising sandstone of Late Cambrian age yields potable water in the northwestern part of Mackinac County and in adjacent areas of Schoolcraft and Luce Counties. The type, source, and occurrence of the water in this aquifer within Mackinac County are not fully known. Wells 44N 12W 10-1 and 44N 12W 26-1 both yielded water of the calcium bicarbonate type. However, water from the latter well contained 92 ppm of chloride, compared to 30 ppm in the former well. In general the chloride content is believed to increase from north to south, or downdip. The chloride content of fresh water from all other aquifers sampled in the county was less than 18 ppm. The chloride is believed to indicate greatly diluted connate water migrating from the interior of the Michigan basin. The calcium bicarbonate probably represents calcium carbonate taken into solution by ground water percolating from the recharge area through glacial drift or overlying bedrock formations.

The aquifers within the Niagara series each yield water of the calcium magnesium bicarbonate type. Water from the Engadine dolomite, which is composed predominantly of that mineral, has a relatively high magnesium-to-calcium ratio. Most of the water taken from the Manistique and Burnt Bluff formations is of the calcium bicarbonate type, indicating that these formations are composed predominantly of limestone. Dolomite or dolomitic limestone also is present within the formations and results in local increases of the magnesium-to-calcium ratio. The hardness of water sampled from the formations of the Niagara series ranged from 191 ppm in the Manistique to 335 ppm in the Engadine.

The Salina, St. Ignace, and Bois Blanc formations and the Mackinac breccia lie at the surface or directly beneath the drift in the St. Ignace Peninsula and the islands in the Straits of Mackinac and St. Martins Bay. These rocks which are important or potentially important aquifers contain gypsum and, in general, yield hard water of the calcium sulfate type. The sulfate content varies greatly, and water from wells tapping these aquifers is highly mineralized locally. In areas where glacial drift overlies these gypsum-bearing formations the drift may yield water of the calcium sulfate type. Chemical analyses of water supporting this assumption were not available at the time of the preparation of this report.

The glacial drift mantling much of the county contains relatively large percentages of limestone and dolomite fragments which are important sources of constituents causing hardness. Water taken from the drift is hard and of the calcium magnesium bicarbonate type; the hardness of samples analyzed ranged from 142 to 360 ppm and was comparable to that of water produced from drift aquifers in other parts of the State.

The iron content of water samples from most of the fresh-water aquifers of the county generally was less than 1 ppm. Well 43N 11W 21-2, tapping the Manistique dolomite, yielded water containing 2.8 to 3.0 ppm of iron, or about 10 times the maximum concentration of iron and manganese suggested by the U. S. Public Health Service for drinking water (Michigan Department of Health, 1948).

Mineralized Ground Water

Several of the aquifers of Mackinac County yield mineralized water. A sample of water was taken from the Black River and Trenton limestones during the drilling of well 44N 9W 17-2. The very high sodium and chloride content of this sample (table 7) indicates that connate water from within the Michigan Basin is percolating through the aquifer in the area of the well, for salt strata are not present in the Black River and Trenton limestones. The source, direction of movement, and extent of mineralization of ground water in the Black River and Trenton, however, are not fully known.

Wells 42N 6W 22-1 and 41N 5W 23-1 tapping the Salina formation yield water high in sulfate. Water of similar chemical quality was taken from wells 41N 4W 36-1 and 41N 3W 31-13, which tap the Mackinac breccia.

The presence of sulfate in the water results from the solution of gypsum in these formations. In the Mackinac Straits area (fig. 5), the Salina, St. Ignace, and Bois Blanc formations have been undermined by the removal of salt from the Salina formation and have collapsed into the voids previously occupied by the salt strata. The absence of significant quantities of sodium and chloride in water taken from the breccia demonstrates the difference in solubility between gypsum and salt. Nearly all the salt was removed in Devonian time and the amount still present is insufficient to increase materially the chloride content of the water. The gypsum that was deposited with the salt in the Salina formation has dissolved very slowly, and large quantities are still present in the Salina formation and the Mackinac breccia.

The distribution of mineralized water in the Mackinac breccia and brecciated portions of the Salina formation is very complex. Locally, water having high concentrations of sulfate is present at or near the surface, but in nearby areas wells of considerable depth yield fresh water. The extensive brecciation of the strata rules out the possibility of correlating reports of gypsum in wells spaced more than a few tens of feet apart. Thus reliable prediction of the occurrence of high-sulfate water in various portions of the aquifer cannot be made. In general, however, it may be assumed that the likelihood of obtaining mineralized water will increase with depth. Because of the random but widespread distribution of gypsum, extensive pumping of fresh water from wells tapping the brecciated rocks may induce migration of mineralized water into the fresh-water-bearing portions of the aquifers. Pumping of fresh water from aquifers hydraulically connected with the breccia may result in a similar condition.

The occurrence of mineralized water in Chippewa and Mackinac Counties suggests that highly mineralized water from the interior of the Michigan basin is migrating along undetermined paths through the deeper formations underlying Mackinac County. Extensive pumping from deep wells or deep test drilling might reveal that mineralized water is widespread in the deeper aquifers.

The existence of highly mineralized water in the various aquifers of the county necessitates caution in well drilling and water utilization to avoid contamination of nearby fresh-water aquifers. A deep uncased well or unplugged test hole may provide a conduit along which mineralized water may flow to the surface or into fresh-water aquifers above or below aquifers containing mineralized water.

Surface Water

Analyses of water from some of the streams in the county and from Lake Huron and the Straits of Mackinac are listed in table 7. Water from the Great Lakes in the Straits area is of the calcium magnesium bicarbonate type. The maximum dissolved-solids content noted was 146 ppm, and the hardness ranged from 92 to 130 ppm.

Water from the Carp River, Nuns Creek, and McKay Creek, which are fed in part by ground water from the glacial drift and the Niagara series, is of the calcium magnesium bicarbonate type and contains approximately one-third more mineral matter than water from the Great Lakes. The Pointe Aux Chenes River is lower in mineral content than any other water sampled in the area. Most of the water taken at the time of sampling probably represents direct runoff from precipitation.

The effects of effluent discharge of ground water to a stream are well illustrated by comparison of the mineral content of water from the Salina formation, the Mackinac breccia, and the Moran River into which water from these formations is discharged (fig. 7). The river water at the sampling point is high in calcium sulfate, as is water from wells 42N 6W 22-1 and 41N 5W 23-1.

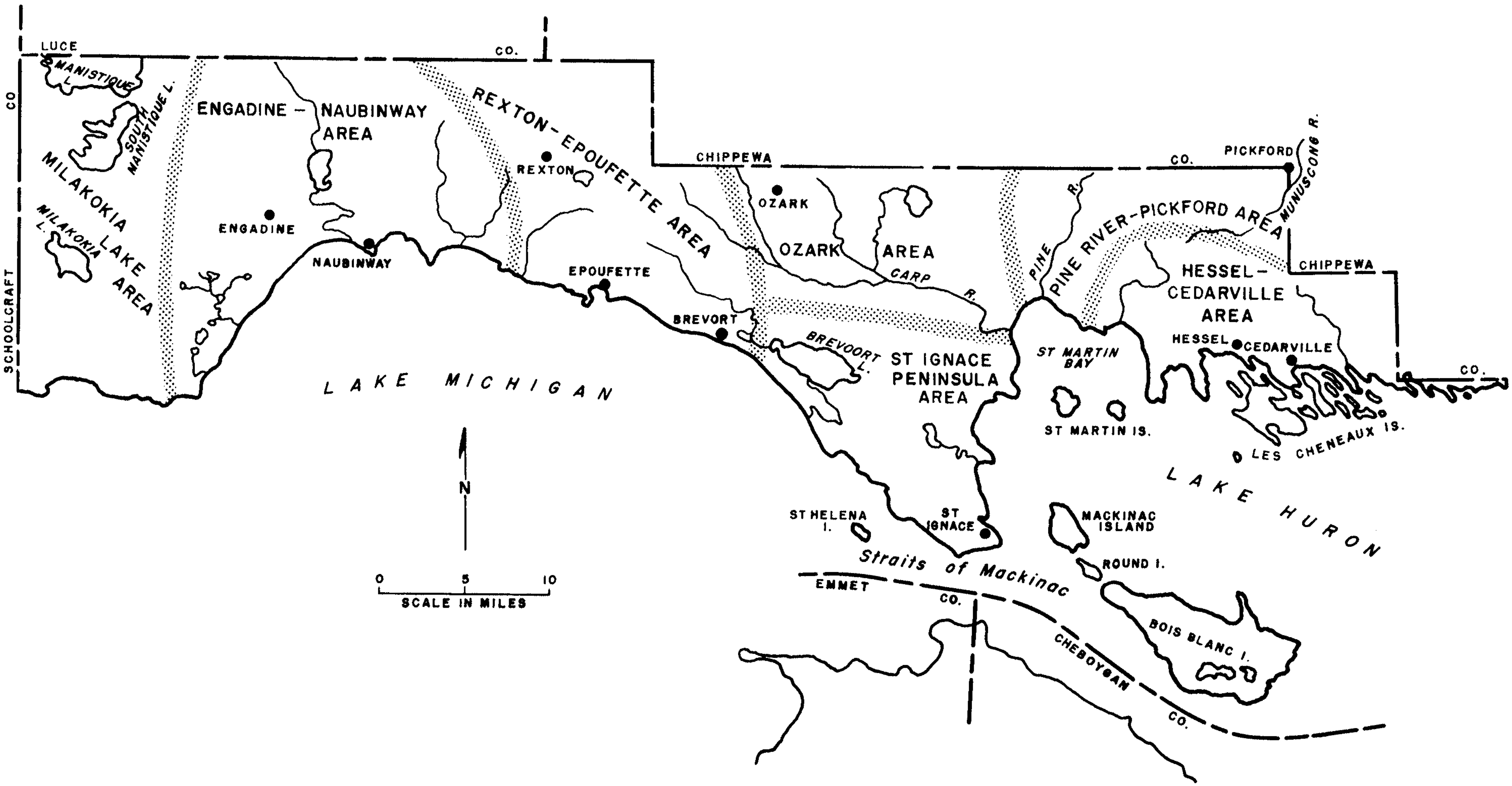

Figure 8. Map of Mackinac County showing ground-water areas.

OCCURRENCE OF GROUND WATER BY AREAS

The following section summarizes briefly the general occurrence of water in the areas shown on figure 8.

Milakokia Lake Area

Most of the wells in the Milakokia Lake area are completed in the glacial drift or in limestones of the Burnt Bluff formation. The wells tapping the drift aquifers are generally less than 75 feet deep and produce small to moderate supplies of water. The wells tapping the Burnt Bluff are generally less than 150 feet deep, although a few wells in the limestone are deeper than 170 feet. The Burnt Bluff formation in this area is believed to be capable of yielding large supplies of ground water. Generally, the water from the drift and from the limestones of the Burnt Bluff is of good quality, although moderately hard. In topographically low areas, water in the bedrock and drift aquifers is under sufficient artesian pressure to flow.

In the northwestern corner of this area, near the Manistique Lakes, at least two wells (44N 12W 10-1 and 26-1) tap the Munising sandstone at a depth greater than 1,000 feet. In this vicinity the Burnt Bluff formation is not present and locally the drift is of low permeability; hence the only source of fresh ground water may be the Munising sandstone (pl. 3), which produces water of good quality. The sandstone throughout most of the Milakokia Lake area contains water under sufficient artesian pressure to flow above the land surface.

Engadine-Naubinway Area

Most of the wells in the Engadine-Naubinway area are completed in the limestone and dolomite of the Niagara series. The rest are completed in glacial drift. Wells tapping the glacial drift generally will provide sufficient quantities of water for domestic uses or the demands of small resorts. The bedrock aquifers are capable of yielding large amounts of water, from rather thin but areally extensive weathered zones along fractures and bedding planes. One permeable zone, which is about 190 feet below the level of Lake Michigan, can be traced for many miles (see pl. 4).

Nearly all the wells in this area are less than 250 feet deep and most are less than 200 feet deep. Wells tapping the glacial drift are generally less than 60 feet deep. Many wells in this area flow. In general, the deep aquifers are under greater artesian pressure than the shallow aquifers, and many wells are drilled through one or more water-producing zones in search of a zone under sufficient artesian pressure to provide an adequate flow. Thus, the depth of wells in this area does not indicate the depth to the most accessible source of ground water. Shallow permeable zones also are present, but many of these zones have not been developed extensively as a source of supply because the water is not under sufficient pressure to flow. In many wells where the upper permeable zones are not sealed off, interaquifer leakage (leakage from an aquifer under high pressure to one under lower pressure) occurs. As a result of this leakage, the artesian head of water in wells ending in the same permeable zone varies widely throughout the area. The loss of pressure and related decline in flow of many of the wells is a result of such leakage. Subsurface leakage may increase gradually in a well as the result of solutional enlargement of openings in the vicinity of the well. An example of the amount of water that can be lost by underground leakage was shown at well 43N 10W 26-3. This well would not flow at the surface until a permeable zone in the upper part of the well was sealed off. After this zone was sealed, the well had sufficient artesian pressure to raise the water 55 feet above the land surface, and it flowed in excess of 75 gallons per minute (gpm). Thus the loss by subsurface leakage before the upper permeable zone was sealed was in excess of 75 gpm. A similar loss of water by subsurface interaquifer leakage occurs in many wells in the area. The amount of subsurface leakage may exceed the amount of uncontrolled surface flow.

Although it is believed that considerable loss of artesian pressure has resulted from subsurface flow in the Engadine area, only a small change in artesian pressure has been observed near Naubinway. Well 43N 9W 29-7, which has the highest artesian pressure measured in any well in Mackinac County, shows little or no decline in pressure from the time when the well was drilled in 1948. As new wells are drilled, however, the artesian pressure in the Naubinway area also may decline eventually, unless the wells are properly maintained and are shut off when water is not needed.

Rexton-Epoufette Area

Most of the wells in the Rexton-Epoufette area are completed in glacial drift. Generally, these wells are less than 40 feet deep.

At Epoufette, however, wells tapping the drift are considerably deeper. The drift generally yields small to moderate supplies of water of good quality.

A large part of this area is underlain by sandy outwash deposits (pl. 5), which are a source of water to many wells. At Brevort (fig. 8) and Epoufette some wells are completed in dune sands along the Lake Michigan shoreline. Difficulties in developing and maintaining wells tapping fine sand may be overcome by the use of properly constructed gravel-packed wells. Springs, a few of which have been improved and utilized for water supplies, issue from drift deposits.

Water is produced also from the Niagara series and Salina formation, which underlie the area. The water from wells tapping these rocks is generally of poorer quality than that from the glacial drift. Water from the Salina formation is especially hard and high in sulfate content. The depths of wells tapping the bedrock aquifers vary considerably in the area. Wells 42N 7W 2-2 and 2-3 at Epoufette, which tap aquifers in the Niagara series, were drilled to depths of 338 and 288 feet respectively and are the deepest known wells in this area.

Ozark Area

Wells in the Ozark area generally are less than 110 feet deep and are completed in limestone and dolomite of the Engadine dolomite. Bedrock in this area, which marks the crest of the Niagara cuesta, is at or near the surface. Permeable zones probably are present at depth in all the formations of the Niagara series in this area. The Engadine dolomite, however, yields water of good quality in sufficient quantity for most present and anticipated needs, and it has been unnecessary to drill to the older Niagara rocks for additional supplies of ground water.

Pine River-Pickford Area

The Pine and Munuscong Rivers mark the position of valleys in this area which were eroded into the underlying bedrock in preglacial time, and which are now filled with glacial sediments. Much of the fill in these valleys is glacial-lake clay (pl. 5). Wells produce small to moderate supplies of water of good quality from permeable drift which mantles the bedrock along these buried valleys. Most of these wells will flow above land surface. Wells along the Pine River generally are 150 to 200 feet deep. At Pickford along the Munuscong River, those wells are generally less than 150 feet deep.

St. Ignace Peninsula

The St. Ignace Peninsula is in the area of collapse (fig. 5), and wells in this area that tap the Salina formation and Mackinac breccia differ greatly in depth, in specific capacity, and in quality of the water they produce.

Test drilling is necessary to determine whether the Salina formation and the Mackinac breccia of the St. Ignace Peninsula will yield a supply of water suitable in quantity and quality at a specific site. Specific capacities of wells drilled into these rocks are generally low (table 6), and in some areas the rocks are almost impermeable. One area of "impermeable" rocks is at the approach of the Mackinac Straits Bridge. Wells 40N 3W 19-2, 19-3, and 19-4, which were drilled into the Mackinac breccia, did not yield an appreciable quantity of water. Other scattered areas of varying size where the breccia is impermeable have been found throughout the St. Ignace Peninsula.

The drift mantle of the St. Ignace Peninsula generally is thin and discontinuous. Locally, however, the sandy lake deposits and the gravel of some of the till plains yield small supplies of water to shallow wells. Large-diameter gravel-packed wells equipped with screens may provice sufficient water for domestic or resort uses in areas where conventional wells have not proved satisfactory. In many places on the peninsula, the drift is composed largely of clay derived from the shale of the underlying Salina formation. Where the drift contains large quantities of clay, it will not yield significant quantities of water to wells.

The limestone and dolomite of the Niagara series, which are important aquifers throughout most of Mackinac County, underlie the Salina formation and the Mackinac breccia of the St. Ignace Peninsula. The Niagara rocks are exposed north of the St. Ignace Peninsula, dip to the south, and are about 600 feet below the surface at St. Ignace (pl. 3). The records of wells 41N 3W 31-15 and 40N 3W 7-1 near St. Ignace, which were drilled into rocks of Niagara age, are incomplete, but they furnish evidence that water of good quality may be produced locally from these rocks underlying the St. Ignace Peninsula. Good water was reported from well 41N 3W 31-15 in the Niagara rocks at a depth of 575 feet. This well is also reported to have yielded "sulfur" water (water containing hydrogen sulfide) at a depth of 681 feet (Michigan Geological Survey, 1901, p. 228). Test drilling of the Niagara rocks is needed in areas where water of good quality cannot be obtained at shallower depths, to determine the quality of water and the hydrologic characteristics of the aquifers within the Niagara series.

To date the Niagara series underlying the St. Ignace Peninsula has not been developed as a major source of fresh water. Its future utilization will depend on the outcome of exploration for fresh-water supplies, the need for additional supplies in the peninsula, and the economic feasibility of deep drilling. The depth to the Niagara in the peninsula decreases northward and everywhere would be considerably less than the depth to the Munising sandstone in the northwestern part of the county.

Cedarville-Hessel Area

The Cedarville-Hessel area is underlain by limestone and dolomite of the Niagara series. Most of the wells in the area produce adequate supplies of water from the Engadine dolomite, which forms the bedrock surface. The wells tap weathered zones near the bedrock surface, where solution openings are common. A few wells tap deep permeable zones which occur along distinct horizons. The areal extent of these permeable zones has not been determined because of the lack of topographic maps. Some wells are completed in the morainal or outwash deposits that mantle the Niagara rocks in the northern part of the area, and others are completed in the shallower drift deposits at Hessel and Cedarville.

Most wells of the Cedarville-Hessel area are less than 100 feet deep, although many are as much as 200 feet deep and a few exceed that depth.

The Les Cheneaux Islands south of Cedarville and Hessel are glacial drumlins (streamlined drift deposits) which are partly submerged by Lake Huron. The glacial drift may be rather thick, but its water-bearing properties have not been determined.

Islands in the Straits of Mackinac

Little is known of the occurrence of ground water on the major islands in the Straits of Mackinac, because the reconnaissance was not extended beyond the mainland. As a result, well records which would provide details concerning the hydrologic characteristics of the Mackinac breccia and the St. Ignace and Bois Blanc formations were not obtained for Mackinac, Round, and Bois Blanc Islands.

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Table 2.--Records of wells and test holes in Mackinac County

Chief aquifer: Symbols used are those listed and described in table 1.

Owner: MDC, Michigan Department of Conservation; MSHD, Michigan State Highway Department; USFS, United States Forest Service.

Year drilled: 1905. Data pertaining to wells reported drilled in 1905 are taken from Water-Supply Paper 160 and from unpublished records of field investigations made by Frank Leverett, of the U. S. Geological Survey, in 1905. Many of the wells so listed were drilled prior to 1905.

Use: D, domestic; I, industrial; N, not used; O, observation well; P, public supply; S, stock well; T, test well; Tf, fire control test well; To, oil test well.

Water level: M, measured; R, reported.

Former USGS No.: Mackinac County prefix designation (Mc) is omitted. Political township designations are as follows: Bv - Brevort; Ck, Clark; Ga, Garfield; He, Hendricks; Hu, Hudson; Mq, Marquette; Mo, Moran; Ne, Newton; Po, Portage; St, St. Ignace. ST, City of St. Ignace.

Remarks: MDC log, Complete log of well available from Michigan Department of Conservation, Geological Survey Division. Refer to permit number if listed.

Well Designation T. R.	sec.-No.	Location in Sec. ¼ of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
44N 12W	7-1	NW SW	Harry Young	W. J. Rodgers	1948	59	4	Qg	DS	--		--	Po 3	
	7-2	SE SW	MDC	MDC	1934	14	2	Qsg	Tf	1.6	M	11- 7-34	Po 56	Destroyed in 1935
	8-1	SW SE	Paul Kesler	--	--	67	2	--	P	--		--	--	
	8-2	NW SW	MDC	MDC	1934	12	2	Qgd	Tf	+.3	M	11- 7-34	Po 57	do.
	9-1	SE SE	E. L. Smith	--	--	68	6	--	P	--		--	--	
	10-1	SE SE	D. Rioux	W. J. Rodgers	--	1,035	6	Cm	P	+12	R	1956	Po 5	Flows
	10-2	SE SE	Floyd Russell	do.	1948	52	6	Sb	P	--		--	Po 4	Cased to 17 ft., shale at 33 ft.
	10-3	SE SE	Emma Blonde	--	--	42	4	--	P	--		--	--	
	11-1	SW SW	T. J. Rader	W. J. Rodgers	1948	58	-	--	P	--		--	Po 2	
	11-2	SE SW	Glen Kuhn	--	--	72	3	--	P	--		--	--	
	13-1	NW SE	Curtis School	--	--	80	4	--	P	--		--	Po 11	
	13-2	-- SW	A. C. Meyers	--	--	30	1¼	Qgd	P	--		--	Po 16	
	13-3	SW SE	D. W. Humphreys	--	--	84	1¼	--	P	--		--	Po 17	
	13-4	SE SE	Alvin Greenfield	--	--	24	1¼	Qgd	P	--		--	Po 20	
	13-5	SE SE	do.	--	--	73	6	--	P	--		--	--	
	13-6	NE SE	W. Brown	--	--	30	1¼	Qgd	P	--		--	Po 21	
	13-7	SW SE	C. B. Patton	--	1935	80	4	--	P	--		--	Po 23	
	13-8	NW NW	Kenneth Clark	--	--	61	2	--	P	--		--	Po 24	Flows
	13-12	SE SW	S. E. Farr	--	--	73	4	--	P	--		--	--	
	16-1	SE SE	MDC	MDC	1934	11	2	Qs	Tf	5.2	M	11- 7-34	Po 59	
	16-2	NE NE	M. B. Goostree	--	--	150	5	--	P	--		--	--	
	17-1	NW NW	Diller School	--	--	60	1	--	P	--		--	Po 10	
	17-2	NW NW	MDC	MDC	1934	13	2	Qgd	Tf	.9	M	11- 7-34	Po 58	
	20-1	NE SE	MDC	MDC	1934	14	2	Qgd	Tf	+.2	M	11-24-34	Po 61	Destroyed in 1935
	21-1	NW SE	MDC	MDC	1934	14	2	Qsg	Tf	.6	M	12-31-34	Po 62	do.
	23-1	NE NW	MDC	MDC	1934	13	2	Qs	Tf	1.5	M	11- 7-34	Po 60	
	24-1	SW NW	Harold Seil	--	--	82	6	--	P	--		--	--	
	24-2	NE SE	E. S. Probst	Ross Payton	1956	60	2	Sb	D	--		--	--	Cased to 31 ft.
	25-1	NE SW	Paul Boyer	--	--	130	6	Sb	P	--		--	--	
	26-1	NW SE	Stack Lumber Co.	William Bowman	1938	1,055	6	Cm	P	+15	R	1956	Po 28	Flows
	26-2	NE SW	Harry Nelson	Harry Nelson	--	14	1½	Qs	D	12	R	1956	--	Equipped with sand screen
	26-3	NE SW	A. A. Holbrook	Norton	--	42	1½	Qgd	D	12	R	1956	--	do.
	26-4	NE SW	J. M. Pettijohn	J. M. Pettijohn	--	13	36	Qgd	D	12	R	1956	--	
	26-6	NE SW	Curt Eineman	Norton	--	50	1¼	Qgd	D	12	R	1956	--	do.
	32-1	NW NW	MDC	MDC	1934	10	2	Qs	Tf	0.1	M	11-13-34	Po 63	
	35-1	SE SE	Cecil Rosenberg	Harry Salter	--	128	5	Sb	D	--		--	--	On island; flows
	36-1	SE SW	Don Ferris	W. J. Rodgers	1948	74	6	Sb	P	18	R	1948	--	
	36-2	SE SW	do.	--	--	82	5	Sb	P	24	R	1956		
	36-3	SE SW	Dr. C. M. Jones	W. J. Rodgers	--	60	6	Sb	D	--		--	--	
	36-4	NE SW	Harry Williams	--	--	--	4	Sb	P	--		--	--	Flows
	36-5	NE SW	H. W. Kugler	Harry Salter	--	128	6	Sb	P	+5	R	1956	--	do.
	36-6	NE SW	Al Bruss	--	--	150	4	Sb	P	+4	R	1956	--	do.
	36-7	NE SW	Marie Elsner	W. J. Rodgers	--	104	6	Sb	P	--		--	--	do.; cased to 16 ft.
	36-8	NW NE	Harold De Shetler	--	--	78	4	--	P	7.52	M	7-27-56	--	Water reported hard
44N 11W	1-1	SW SE	MDC	MDC	1934	19	2	Qsg	Tf	6.0	M	11-14-34	Po 39	
	1-2	NE NE	MDC	MDC	1934	18	2	Qs	Tf	13.1	M	11-14-34	Po 37	
	2-1	NW NW	MDC	MDC	1934	14	2	Qs	Tf	--		--	Po 36	Flowed; destroyed in 1935
	2-2	SW SW	MDC	MDC	1934	19	2	Qs	Tf	2.2	M	11-14-34	Po 38	
	2-3	NE SE	MDC	MDC	1934	11	2	--	Tf	Dry	R	1934	Po 51	Drilled in sand and gravel
	6-1	NE NE	Ludwig Eppler	--	--	45	1¼	Qgd	P	--		--	Po 8	
	6-2	NE NE	do.	--	1945	60	6	--	P	--		--	Po 9	
	6-3	NW SE	W. Sanders	--	--	18	1¼	Qgd	P	--		--	Po 19	
	6-4	NW SE	do.	--	--	78	5	--	P	--		--	--	
	6-5	SE SE	MDC	MDC	1934	14	2	Qs	Tf	2.5	M	11-14-34	Po 55	Destroyed
	7-1	SW SW	Victor Litzinger	--	--	35	1¼	Qgd	P	--		--	Po 18	do.
	7-2	SW SW	do.	--	--	46	5	Qgd	P	--		--	--	
	7-3	SW SW	do.	Elwin Anderson	1956	56	6	Qsg	P	14	R	1956	--	Screen from 53 to 56 ft.
	7-4	SW NE	Martin Stahel	Arthur Gilroy	1956	75	6	--	N	3	R	1956		Poor yield; bedrock at 17 ft.
	7-6	SW NE	W. T. Grinsted	do.	1955	46	4	Sb	P	8	R	1955	--	Bedrock at 13 ft., crevice at 36 ft.
	7-7	SE NE	E. A. Dudley	W. J. Rodgers	--	90	6	Sb	D	4	R	1956	Po 6	Cased to 36 ft.
	7-8	NE NE	T. and R. De Shetler	--	--	94	6	Sb	P	--		--	Po 15	
	10-1	NE SE	MDC	MDC	1934	14	2	Qs	Tf	8.3	M	11-14-34	Po 40	
	12-1	-- NE	Michael Hayes	--	1905	66	-	Qs	-	10	R	1905	Po 35	
	12-2	SW NW	MDC	MDC	1934	15	2	Qs	Tf	8.6	M	11-14-34	Po 41	Destroyed in 1935
	12-3	SW SW	MDC	MDC	1934	19	2	Qs	Tf	7.6	M	11-14-34	Po 42	
	13-1	NE NE	MDC	MDC	1934	15	2	Qs	Tf	0.8	M	11-14-34	Po 43	
	14-1	NE NE	Buehlow School	--	--	24	2	Qgd	P	--		--	Po 13	
	14-2	SE SE	MDC	MDC	1934	16	2	Qs	Tf	4.7	M	11-14-34	Po 47	
	15-1	SE NW	MDC	MDC	1934	15	2	--	Tf	Dry	R	1934	Po 44	Drilled in sand, destroyed in 1934
	16-1	NW SE	MDC	MDC	1934	14	2	Qs	Tf	1.6	M	11-14-34	Po 46	
	17-1	SW SW	MDC	MDC	1934	14	2	Qs	Tf	.1	M	11-14-34	Po 45	Destroyed in 1935
	18-1	SW SW	Walter Waites	W. J. Rodgers	1948	73	6	Sb	D	--		--	Po 1	Cased to 70 ft.
	18-3	SW SW	Dewey Wright	--	--	70	1¼	Qgd	P	--		--	Po 22	
	18-4	SW SW	C. A. Lewis	--	--	83	4	--	P	--		--	--	

Table 2.--Records of wells and test holes in Mackinac County, (Continued)

Well Designation T. R.	sec.-No.	Location in Sec. ¼ of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
44N 11W	19-1	-- NE	William Carpenter	--	1905	35	-	--	-	--		--	Po 34	
	19-2	NE NW	F. L. Updyke	--	--	73	2	--	P	+2	R	1956	Po 14	Flows
	19-3	NE NW	Curtis Roriek	Dunbar Drilling Co.	1952	70	6	Sb	D	+3	R	8-29-52	--	do.; Bedrock at 60 ft.
	19-4	NE NW	Leslie Travers	Elwin Anderson	1956	79	5	Sb	P	--		--	--	do.; Cased to 63 ft.
	19-5	NE NW	do.	--	--	63	2	Qgd	P	--		--	--	Destroyed
	19-6	NW SW	Harold Crusoe	--	1860	121	4	Sb	P	+1.0	R	1956	--	Flows
	19-7	SW NW	do.	--	1952	68	2	Qgd	P	--		--	--	do.; Bedrock reported at 84 ft.
	20-1	NE SW	MDC	MDC	1934	15	2	Qs	Tf	1.6	M	11-14-34	Po 54	Destroyed in 1935.
	21-1	NW NW	MDC	MDC	1934	15	2	Qs	Tf	4.3	M	11-14-34	Po 48	
	28-1	SE SW	MDC	MDC	1934	15	2	Qs	Tf	3.1	M	11-14-34	Po 50	
	30-1	SE SW	MDC	MDC	1934	12	2	Qs	Tf	3.5	M	11-15-34	Po 52	do.
	32-1	SE NW	MDC	MDC	1934	15	2	Qs	Tf	3.8	M	11-15-34	Po 53	
	33-1	NW NE	MDC	MDC	1934	12	2	Qsg	Tf	1.1	M	11-14-34	Po 49	
44N 10W	3-1	NW NW	MDC	MDC	1934	16	2	Qgd	Tf	--		--	Ga 92	
	3-2	NW SW	MDC	MDC	1934	13	2	Qgd	Tf	0.0	M	9-25-34	Ga 93	
	5-1	NE NE	MDC	MDC	1934	14	2	Qgd	Tf	2.9	M	10-19-34	Ga 94	
	6-1	NE NE	MDC	MDC	1934	13	2	Qs	Tf	2.6	M	10-19-34	Ga 95	
	6-2	SE SE	MDC	MDC	1934	18	2	Qs	Tf	14.2	M	10-19-34	Ga 96	
	10-1	SW SW	MDC	MDC	1934	13	2	Qgd	Tf	--		--	Ga 97	Destroyed in 1934
	11-1	SE NW	MDC	MDC	1934	14	2	Qs	Tf	3.6	M	10-17-34	Ga 98	
	12-1	SE NW	MDC	MDC	1934	14	2	Qs	Tf	2.3	M	10-17-34	Ga 99	
	13-1	SW SE	MDC	MDC	1934	13	2	Qs	Tf	3.2	M	9-24-34	Ga 100	
	13-2	NE SW	MDC	MDC	1934	14	2	Qsg	Tf	4.9	M	9-24-34	Ga 101	
	16-1	NE SE	Ewald Fergin	--	1951	80	6	--	DS	30	R	~~1956~~	--	
	16-2	SW NW	Earl Fergin	W. J. Rodgers	1955	60	6	Qgd	DS	18	R	1955	--	
	17-1	NE NE	MDC	MDC	1934	19	2	Qs	Tf	3.3	M	10-19-34	Ga 102	
	18-1	SW SW	MDC	MDC	1934	13	2	Qs	Tf	1.0	M	10-19-34	Ga 103	
	18-2	-- --	William Stoddard	--	1905	34	3	Qg	-	--		--	Ga 40	
	21-1	SW SW	Pauly Cheese Co.	Harry Salter	1925	130	5	Sb	I	75	R	1956	--	Cased to 20 ft.
	28-1	NE NW	William Fillman	--	--	101	2	Sb	D	--		--	Ga 20	
	29-1	NW NE	Julius Fenske	W. J. Rodgers	--	140	6	Sb	DS	72	R	1949	--	Cased to 21 ft.
	30-1	SE NW	Ervin Kovar	do.	1948	42	6	Qg	DS	4	R	1956	--	Bedrock at 42 ft.
	32-1	NW SW	Anderson School	--	--	25	2	--	-	--		--	Ga 21	
44N 9W	1-1	SE SE	MDC	MDC	1934	4	2	--	Tf	Dry	R	1934	Ga 41	Bedrock at 4 ft.
	2-1	SE NW	MDC	MDC	1934	19	2	Qs	Tf	11.0	M	10-30-34	Ga 42	
	3-1	SE SW	MDC	MDC	1934	13	2	Qs	Tf	7.9	M	10-16-34	Ga 43	
	4-1	SE NW	MDC	MDC	1934	14	2	--	Tf	Dry	R	1934	Ga 44	
	5-1	NE SE	MDC	MDC	1934	18	2	--	Tf	Dry	R	1934	Ga 45	
	6-1	NE NE	MDC	MDC	1934	13	2	--	Tf	Dry	R	1934	Ga 46	
	6-2	NW NW	MDC	MDC	1934	15	2	--	Tf	Dry	R	1934	Ga 47	
	6-3	SW SE	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	Ga 48	Destroyed
	7-1	SW SW	MDC	MDC	1934	14	2	Qs	Tf	4.7	M	9-24-34	Ga 49	
	7-3	SW NE	MDC	MDC	1934	14	2	--	Tf	Dry	R	1934	Ga 51	do.
	8-1	NW NW	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	Ga 52	do.
	8-2	NW SW	MDC	MDC	1934	12	2	--	Tf	Dry	R	1934	Ga 53	
	9-1	NE NE	MDC	MDC	1934	13	2	Qs	Tf	11.6	M	10-16-34	Ga 54	
	9-2	SE SE	MDC	MDC	1934	12	2	--	Tf	Dry	R	1934	Ga 55	
	15-1	SW SW	MDC	MDC	1934	14	2	--	Tf	Dry	R	1934	Ga 56	
	16-1	SW SW	MDC	MDC	1934	18	2	--	Tf	Dry	R	1934	Ga 57	Destroyed in 1934
	17-1	NE NW	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	Ga 58	do.
	17-2	NE SW	Hiawatha Club	A. K. Sarver	1937	1,500	5	Cm and Ow	To	--		--	Ga 24	Produced mineralized water from the Trenton-Black River fm. MDC log 3397
	21-1	SW SE	MDC	MDC	1934	13	2	--	Tf	Dry	R	1934	Ga 59	
	21-2	NE NW	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	Ga 60	
	23-1	NE NW	MDC	MDC	1934	14	2	Qs	Tf	4.3	M	10-16-34	Ga 61	
	26-1	NW NW	MDC	MDC	1934	14	2	Qsg	Tf	5.5	M	10-16-34	Ga 62	
	27-1	SW NW	MDC	MDC	1934	14	2	Qs	Tf	2.55	M	9-24-34	Ga 63	
	27-2	SE SE	MDC	MDC	1934	14	2	Qs	Tf	8.1	M	10-16-34	Ga 71	
	29-1	NE NE	MDC	MDC	1934	19	2	--	Tf	Dry		1934	Ga 64	
	29-2	SE SW	MDC	MDC	1934	14	2	Qs	Tf	5.3	M	10-17-34	Ga 65	
	30-1	NW NE	MDC	MDC	1934	13	2	Qs	Tf	5.9	M	10-17-34	Ga 66	
	32-1	NE SW	MDC	MDC	1934	19	2	Qs	Tf	15.0	M	10-17-34	Ga 67	
	33-1	NW SW	MDC	MDC	1934	19	2	Qs	Tf	4.3	M	10-17-34	Ga 68	
	34-1	NW NW	MDC	MDC	1934	16	2	--	Tf	Dry		9-18-34	Ga 69	
	34-2	SW SE	MDC	MDC	1934	13	2	Qsg	Tf	6.0	M	10- 5-34	Ga 70	
	34-3	SW SW	MDC	MDC	1934	19	2	Qs	Tf	15.6	M	10- 5-34	Ga 72	
44N 8W	1-1	NW NE	MDC	MDC	1934	13	2	Qs	Tf	3.4	M	8- 1-34	Hu 7	
	1-2	NE SE	MDC	MDC	1934	14	2	Qs	Tf	7.6	M	8- 1-34	Hu 8	
	1-3	SW SE	MDC	MDC	1934	14	2	Qs	Tf	5.3	M	10-18-34	Hu 9	
	4-1	SW SW	MDC	MDC	1934	19	2	--	Tf	Dry		1934	Hu 10	
	5-1	NE SW	MDC	MDC	1934	17	2	Qs	Tf	9.0	M	9-11-34	Hu 11	
	5-2	SE NE	MDC	MDC	1934	14	2	Qs	Tf	8.2	M	9-11-34	Hu 12	
	6-1	SE SW	MDC	MDC	1934	13	2	Qs	Tf	7.5	M	10-18-34	Hu 13	
	6-2	NE SW	Ray Mills	--	--	13	-	Qsg	D	--		--	Hu 14	
	6-3	NW NE	MDC	MDC	1934	13	2	Qs	Tf	4.7	M	9-11-34	Hu 15	
	6-4	NW NW	Union Carbide Co.	--	1917	280	4	Sb	I	--		--	Hu 102	Bedrock at 4 ft.
	6-5	NE NW	do.	--	--	100	-	Sb	-	80	R	1905	Hu 101	Bedrock at surface.
	7-1	-- NW	MDC	MDC	1936	6	-	--	Tf	--		--	Hu 64	Bedrock at 6 ft.
	8-1	SE SW	MDC	MDC	1934	9	2	Qs	Tf	3.3	M	10-30-34	Hu 16	
	9-1	SW SW	MDC	MDCL	1934	14	2	Qs	Tf	2.8	M	10-18-34	Hu 17	
	11-1	NW NE	MDC	MDC	1934	14	2	Qs	Tf	1.0	M	10-18-34	Hu 18	
	12-1	SE SW	MDC	MDC	1934	13	2	Qs	Tf	5.4	M	8- 1-34	Hu 19	
	12-2	NW NE	MDC	MDC	1934	13	2	Qsg	Tf	8.5	M	8- 1-34	Hu 20	
	13-1	SE SE	MDC	MDC	1934	14	2	Qs	Tf	1.4	M	8- 1-34	Hu 21	
	15-1	SW SE	MDC	MDC	1936	7	-	--	-	--		--	Hu 70	Bedrock at 7 ft.
	16-1	SE SW	MDC	MDC	1934	13	2	Qs	Tf	4.2	M	9-21-34	Hu 22	Bedrock at 13 ft.
	16-2	SW SW	MDC	MDC	1934	14	2	Qs	Tf	4.4	M	9-21-34	Hu 23	
	17-1	SW SE	MDC	MDC	1934	5	2	--	Tf	--		--	Hu 24	
	21-1	SW SW	MDC	MDC	1934	13	2	Qsg	Tf	0.3	M	9-21-34	Hu 25	
	21-2	SE NW	MDC	MDC	1934	15	2	Qs	Tf	5.3	M	1934	Hu 26	
	22-1	SE NE	MDC	MDC	1934	6	2	Qsg	Tf	2.1	M	9-21-34	Hu 27	
	22-3	NE NE	MDC	MDC	1934	9	2	Qsg	Tf	8.6	M	10-30-34	Hu 29	Bedrock at 9 ft.
	22-4	SW NW	MDC	MDC	1936	11	-	--	Tf	--		--	Hu 71	Bedrock at 11 ft.
	24-1	SE SE	MDC	MDC	1934	13	2	Qs	Tf	1.0	R	--	Hu 30	
	25-1	SE SE	MDC	MDC	1934	11	2	Qs	Tf	1.0	M	8- 1-34	Hu 31	
	25-2	SE SW	MDC	MDC	1936	4	-	--	Tf	--		--	Hu 63	Bedrock at 4 ft.
	26-1	SW NW	MDC	MDC	1934	10	2	Qsg	Tf	5.1	M	9-21-34	Hu 32	
	26-4	NE SW	MDC	MDC	1936	7	-	--	Tf	--		--	Hu 66	Bedrock at 7 ft.
	26-5	NE SW	MDC	MDC	1936	10	-	--	Tf	--		--	Hu 67	Bedrock at 10 ft.

Table 2.--Records of wells and test holes in Mackinac County, (Continued)

Well Designation T. R.	sec.-No.	Location in Sec. ¼ of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
44N 8W	28-1	SW NW	MDC	MDC	1936	3	-	--	Tf	--		--	Hu 59	Bedrock at 3 ft.
	28-3	NE NW	MDC	MDC	1936	7	-	--	Tf	--		--	Hu 61	Bedrock at 7 ft.
	29-1	NE NE	MDC	MDC	1934	11	2	Qs	Tf	8.7	M	4-16-35	Hu 34	Bedrock at 11 ft.
	29-3	SW SE	MDC	MDC	1936	4	-	--	Tf	--		--	Hu 55	Bedrock at 4 ft.
	32-1	SE SE	MDC	MDC	1936	4	-	--	Tf	--		--	Hu 43	Bedrock at 4 ft.
	32-4	SW NE	MDC	MDC	1936	4	-	--	Tf	--		--	Hu 46	Bedrock at 4 ft.
	32-7	SE NW	MDC	MDC	1936	8	-	--	Tf	--		--	Hu 49	Bedrock at 8 ft.
	32-11	NW NE	MDC	MDC	1936	8	-	--	Tf	--		--	Hu 53	Bedrock at 8 ft.
	33-1	SE SE	MDC	MDC	1936	7	-	--	Tf	--		--	Hu 36	Bedrock at 7 ft.
	33-3	NW SE	MDC	MDC	1936	--	-	--	Tf	--		--	Hu 38	Bedrock at surface.
	33-4	SE SW	MDC	MDC	1936	--	-	--	Tf	--		--	Hu 39	do.
	33-7	SW SW	MDC	MDC	1936	4	-	--	Tf	--		--	Hu 42	Bedrock at 4 ft.
	35-1	SE SE	MDC	MDC	1934	12	2	--	Tf	Dry	R	1934	Hu 35	Drilled in sand and gravel
	36-1	SE SE	P. J. Quinlan	P. J. Quinlan	--	38	1¼	Qg	P	11.0	R	1956	--	
	36-2	SE SE	W. Cobe	W. Cobe	--	44	1¼	Qg	D	--		--	--	
	36-3	SE SE	Rexton School	--	--	14	-	Qs	P	--		--	Hu 103	
44N 7W	1-1	NW SW	MDC	MDC	1934	14	2	Qs	Tf	6.3	M	8- 2-34	He 3	
	6-1	NW NW	MDC	MDC	1934	14	2	Qs	Tf	6.5	M	8- 1-34	He 4	
	7-1	SE NW	MDC	MDC	1934	14	2	Qs	Tf	5.0	M	8- 1-34	He 5	
	7-2	NE SE	MDC	MDC	1934	14	2	Qs	Tf	9.2	M	8- 1-34	He 6	
	8-1	NW SE	MDC	MDC	1934	19	2	Qs	Tf	15.0	M	9-20-34	He 7	
	10-1	NW NE	MDC	MDC	1934	14	2	Qs	Tf	3.0	M	8- 2-34	He 8	
	10-2	SW SE	MDC	MDC	1934	13	2	Qs	Tf	10.2	M	8- 2-34	He 9	
	11-1	NW SW	MDC	MDC	1934	12	2	Qs	Tf	6.3	M	8- 2-34	He 10	
	13-1	SE NE	MDC	MDC	1934	14	2	Qs	Tf	5.4	M	9-20-34	He 11	
	16-1	SW NE	MDC	MDC	1934	18	2	--	Tf	Dry	R	1934	He 12	Drilled in sand
	16-2	NE NW	MDC	MDC	1934	13	2	Qs	Tf	9.0	M	8- 1-34	He 13	
	17-1	SW NE	MDC	MDC	1934	21	2	--	Tf	Dry	R	1934	He 14	do.
	18-1	NW NW	MDC	MDC	1934	13	2	Qs	Tf	8.4	M	8- 1-34	He 15	
	22-1	SW SW	MDC	MDC	1934	14	2	Qsg	Tf	2.3	M	8- 2-34	He 16	
	22-2	SE SE	MDC	MDC	1934	14	2	Qgd	Tf	10.5	R	1934	--	
	23-1	SW SW	MDC	MDC	1934	13	2	Qs	Tf	10.0	M	8- 2-34	He 17	
	24-1	SE SW	MDC	MDC	1934	14	2	Qs	Tf	4.8	M	8- 2-34	He 18	
	25-1	NW SE	MDC	MDC	1934	12	2	Qsg	Tf	2.9	M	8- 2-34	He 19	
	26-1	SE SW	MDC	MDC	1934	11	2	Qsg	Tf	2.2	M	8- 2-34	He 20	
	28-1	SE NE	MDC	MDC	1934	13	2	Qs	Tf	1.6	M	8- 2-34	He 21	
	29-1	NE SE	MDC	MDC	1934	13	2	Qs	Tf	2.9	M	8- 2-34	He 22	
	31-1	SE NW	MDC	MDC	1936	4	-	--	Tf	--		--	He 31	Bedrock at 4 ft.
	32-1	SW NE	MDC M	MDC	1934	12	2	--	Tf	Dry	R	1934	He 23	Drilled in sand, bedrock at 12 ft.
	32-2	NW SW	MDC	MDC	1934	10	2	Qs	Tf	3.0	M	8- 2-34	He 24	Bedrock at 10 ft.
	32-3	SW NW	MDC	MDC	1934	5	2	Qs	Tf	1.5	M	12-18-34	He 25	Bedrock at 5 ft.
	32-4	NW SW	MDC	MDC	1936	3	-	--	Tf	--		--	He 33	Bedrock at 3 ft.
	33-1	SW NW	MDC	MDC	1934	11	2	--	Tf	Dry	R	1934	He 26	Drilled in sand, bedrock at 11 ft.
	33-2	NW NW	MDC	MDC	1934	10	2	Qsg	Tf	2.6	M	8- 2-34	He 27	Bedrock at 10 ft.
	34-1	SE SE	MDC	MDC	1934	9	2	--	Tf	Dry	R	1934	He 29	Drilled in sand and gravel, bedrock at 9 ft.
	34-2	NE SE	MDC	MDC	1934	13	2	Qsg	Tf	2.1	M	8- 2-34	He 30	
43N 12W	1-1	NE NW	R. J. Dunkle	Harry Salter	1945	114	6	Sb	P	+2.0	R	7- 2-56	--	Flows; cased to 13 ft.
	1-2	SW SE	MDC	MDC	1934	14	2	Qs	Tf	+1.3	R	1934	Ne 38	Flowed
	2-1	NE SW	A. E. Armstrong	--	--	4	72	Qgd	D	--		--	--	Improved spring
	3-1	NW SE	H. O. Brotherton	W. J. Rodgers	1939	33	1¼	Qgd	P	--		--	Ne 5	
	4-1	NE NW	D. R. Hemphill	--	1905	31	-	Qgd	D	29	R	1905	Ne 30	
	5-1	NE NE	MDC	MDC	1934	15	2	Qs	Tf	0.3	M	11-13-34	Ne 39	
	8-1	NE NW	MDC	MDC	1934	14	2	Qsg	Tf	1.8	M	11-13-34	Ne 41	
	10-1	SW NW	MDC	MDC	1934	16	2	--	Tf	Dry	R	1934	Ne 37	Drilled in sand
	11-1	SW SE	MDC	MDC	1934	17	2	Qs	Tf	--		--	Ne 36	
	12-1	SE NE	MDC	MDC	1934	10	2	--	Tf	Dry	R	1934	Ne 40	Drilled in sand and gravel
	17-1	SE SW	MDC	MDC	1934	10	2	Qg	Tf	0.3	M	11-13-34	Ne 35	
	19-1	SE SE	Claude Duncan	W. J. Rodgers	1949	95	6	Sb	P	30	R	1949	--	Bedrock at 9 ft.
	22-1	SE SW	O. E. Fuller	--	--	32	6	Qgd	P	--		--	--	Bedrock at 32 ft.
	24-1	SE SW	MDC	MDC	1934	14	2	Qsg	Tf	0.4	M	11-15-34	Ne 34	
	27-1	NW SW	MDC	MDC	1934	13	2	Qs	Tf	+1.8	M	11-13-34	Ne 31	
	28-1	SW SE	Frank Gwitt	W. J. Rodgers	1955	55	6	Sb	P	12.96	M	8-27-56	--	Bedrock at 35 ft.
	28-2	SE SW	D. E. Warner	--	--	150	6	Sb	P	--		--	--	Cased to 46 ft.
	28-3	SW SE	Leo Jaskiewicz	W. J. Rodgers	--	40	6	Qgd	P	6	R	1956	--	Bedrock at 40 ft.
	29-1	NE NW	MDC	MDC	1934	14	2	Qgd	Tf	0.1	M	11-13-34	Ne 33	
	29-2	NW SE	W. E. Fuller	--	--	80	4	Sb	P	--		--	Ne 4	
	29-3	NW SE	C. W. Erb	W. J. Rodgers	--	110	6	Sb	P	--		--	Ne 52	Bedrock at 4 ft.
	29-4	SW NE	Ralph Steinberger	--	--	176	5	Sb	P	--		--	--	
	29-6	NW SE	M. Holzgrede	--	--	83	5	Sb	P	--		--	--	
	29-7	NW NW	J. H. Runyon	Harry Salter	--	95	6	Sb	P	--		--	--	
	34-1	SE SE	MDC	MDC	1934	17	2	Qs	Tf	2.2	M	11-13-34	Ne 42	
43N 11W	6-1	NW SW	MDC	MDC	1934	15	2	Qs	Tf	2.9	M	11-13-34	Ne 46	
	9-1	NW SW	MDC	MDC	1934	14	2	Qs	Tf	0.1	M	11-15-34	Ne 45	
	19-1	SE SW	Cecil Miller	W. J. Rodgers	1938	92	6	Sb	P	--		--	Ne 53	Cased to 25 ft.
	20-1	SW SE	William Watts	Harry Salter	1922	200	6	Sb	P	10	R	1956	--	Bedrock at 5 ft.
	21-1	NW SW	MDC	MDC	1934	12	2	Qg	Tf	1.1	M	11-15-34	Ne 44	
	21-2	SW SW	Mary McDonald	Harry Salter	1952	90	5	Sm	P	10	R	1952	--	Cased to 18 ft.
	24-1	SW NW	F. H. Freeman	do.	1934	100	-	Sm	DS	4	R	1934	--	
	28-1	NE NE	MDC	MDC	1934	15	2	Qs	Tf	1.0	M	11-15-34	Ne 43	
	28-2	SW SW	Newton Twp. School	Harry Salter	1928	155	6	Sb	P	12	R	1949	Ne 3	Cased to 60 ft.
	30-1	NW NW	F. H. Edwards	W. J. Rodgers	1946	99	6	Sb	P	--		--	Ne 1	Cased to 25 ft.
	33-1	-- NE	McEachern	--	1905	80	-	Sm	N	--		--	Ne 27	Bedrock at 14 ft.
43N 10W	1-1	SW SW	F. H. Day	W. J. Rodgers	1945	178	-	Sb	D	--		--	Ga 1	Flows; cased to 101 ft.
	1-2	SW SW	Harold Ingraham	do.	1945	192	6	Sb	D	--		--	Ga 11	do; cased to 108 ft.
	1-3	SW SW	Tubbs and Wagonner	do.	--	192	6	Sb	D	+4.5	R	1956	--	do.; cased to 102 ft.
	1-4	SE NW	Irene Norton	do.	1945	116	6	Qgd	D	--		--	--	do.; cased to 116 ft.
	2-1	NW NW	Ethel Mumro	do.	1938	120	6	Sb	D	--		--	--	do.; bedrock at 45 ft.
	2-2	NE SW	A. G. Durling	do.	1948	167	6	Sb	D	--		--	--	do.; bedrock at 51 ft.
	4-1	SE NE	Russell School	--	--	25	2	--	N	--		--	Ga 17	
	4-2	-- SE	Proton Sisters	--	1905	60	-	Sn	DS	--		--	Ga 36	Flowed
	5-1	NE SE	Fred Bessler	W. J. Rodgers	1946	112	6	Sb	DS	--		--	Ga 7	Formerly flowed; cased to 21 ft.
	8-1	NE NE	C. W. Comfort	Harry Salter	1935	106	5	Sn	DS	--		--	--	Flows, cased to 26 ft.
	10-1	NE SE	Edward Nichols	W. J. Rodgers	1947	152	6	Sm	DS	+2	R	1956	--	do.; cased to 22 ft.
	10-2	SE NE	Fred Perchinsky	do.	1947	335	6	Sb	DS	--		--	--	do.; cased to 35 ft.
	11-1	NE SE	William McNamara, Jr.	do.	1946	90	6	Qgd	P	--		--	Ga 2	Cased to 85 ft.
	11-2	NE SE	do.	William McNamara, Jr.	1954	26	1¼	Qgd	P	--		--	--	Equipped with sand point

Table 2.--Records of wells and test holes in Mackinac County, (Continued)

Well Designation T. R. sec.-No.	Location in Sec. ¼ of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
43N 10W 12-1	NW SW	Hueter and Heben	W. J. Rodgers	1946	190	6	Sb	P	--		--	Ga 3	Flows; cased to 108 ft.
12-2	SW NW	Hiawatha Club	do.	--	178	6	Sb	P	--		--	Ga 29	Flows; cased to 101 ft.
16-1	SE SW	Engadine School	--	1937	198	5	Sm	P	--		--	Ga 19	
16-2	SW SW	Freeman Lumber Co.	--	1905	232	4	Sn	P	22	R	1937	Ga 39	Engadine Village supply, bedrock at 30 ft.
16-3	SW SW	Frank Quinn	W. J. Rodgers	1938	140	6	Sm	D	--		--	--	Formerly flowed, cased to 34 ft.
17-1	SE SE	Engadine Mill	--	1905	146	-	Sm	N	--		--	Ga 38	Abandoned
17-3	SE SE	J. T. Freeman	W. J. Rodgers	--	150	6	Sm	D	5	R	1956	--	
19-1	SW SW	W. T. Johnston	Elwin Anderson	--	286	6	Sn	P	5.57	M	8-27-56	--	Bedrock at 11 ft.
21-1	SW SW	A. Beisel	--	--	100	3	Sm	P	--		--	--	Flows
25-1	NE NE	D. M. Schoonover	W. J. Rodgers	1952	176	6	Sm	P	+58	R	1952	--	do.
26-1	SW SW	M. B. Caldwell	do.	1944	189	6	Sm	D	--		--	Ga 23	do.; bedrock at 30 ft.
26-2	NE SW	Paul Thorlakson	do.	1956	207	6	Sm	D	+55	M	7-10-56	--	do.; bedrock at 42 ft.
26-3	SW SW	F. H. Day	A. H. Bowman	1938	194	6	Sm	D	+12	M	8-27-56	--	do.; bedrock at 20 ft.
26-4	SW SW	G. W. Dunn	W. J. Rodgers	--	189	6	Sm	D	--		--	--	do.
26-5	SW SW	E. H. Christopher	--	--	192	6	Sm	D	+17	R	1956	--	do.; cased to 14 ft.
26-6	SE NE	R. P. Peckham	Elwin Anderson	--	188	6	Sm	D	+67	R	1956	--	do.; cased to 39 ft.
34-1	NE NE	Carnegie Brothers	W. J. Rodgers	--	205	6	Sm	D	+49	M	8-27-56	--	do.; cased to 18 ft.
43N 9W 1-1	SW SE	MDC	MDC	1934	14	2	Qs	Tf	1.1	M	10-15-34	Ga 73	
2-1	NW SW	MDC	MDC	1934	14	2	Qs	Tf	4.5	M	10-16-34	Ga 74	
4-1	SE SE	MDC	MDC	1934	19	2	Qs	Tf	12.0	M	10-16-34	Ga 75	
4-2	SW NW	MDC	MDC	1934	19	2	Qs	Tf	7.4	M	10-17-34	Ga 76	
7-1	SW SW	MDC	MDC	1934	11	2	Qs	Tf	2.7	M	10-19-34	Ga 78	Bedrock at 11 ft.
7-2	NE NE	MDC	MDC	1934	13	2	Qs	Tf	--		--	Ga 77	
8-1	SW SE	MDC	MDC	1934	14	2	Qs	Tf	1.8	M	10-19-34	Ga 79	
10-1	NW SE	MDC	MDC	--	18	2	Qgd	P	--		--	Ga 12	
11-1	NE NE	M., St. P., and S. Ste. M. R.R.	--	--	20	10	Qgd	I	--		--	Ga 14	
11-2	NE NE	do.	H. W. Whitman	1917	1,111	-	Obb	I	63	R	1917	Ga 15	Bedrock at 120 ft.
11-4	SW NE	MDC	MDC	1934	14	2	Qs	Tf	1.2	M	10-15-34	Ga 80	
14-1	NE NW	MDC	MDC	1934	14	2	Qs	Tf	2.9	M	10-15-34	Ga 81	
14-2	NE SE	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	Ga 82	Drilled in sand and gravel
14-3	SW NW	MDC	MDC	1934	19	2	Qs	Tf	10.5	M	10-15-34	Ga 83	
15-1	NE NE	MDC	MDC	1934	14	2	Qs	Tf	2.2	M	10-17-34	Ga 84	
15-2	SE SE	MDC	MDC	1934	17	2	Qs	Tf	2.0	M	10-15-34	Ga 85	
15-3	NW SW	MDC	MDC	1934	14	2	Qs	Tf	6.2	R	11- 1-34	Ga 86	
16-1	NW NE	MDC	MDC	1934	14	2	Qs	Tf	1.8	M	10- 5-34	Ga 87	
17-1	NE SE	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	Ga 88	
17-2	NE SW	MDC	MDC	1934	13	2	Qs	Tf	3.5	M	11- 1-34	Ga 89	
19-1	SE SW	Frederick Post	W. J. Rodgers	1938	160	6	Sm	D	+12	R	1956	Ga 28	Flows; cased to 42 ft.
19-2	SW SW	Stratton and Smethurst	do.	1949	76	6	Se	D	+6	R	1956	--	do.; cased to 20 ft.
19-3	NE NE	MDC	MDC	1934	9	2	Qsg	Tf	--		--	--	
20-1	SW SE	Hiawatha Club	--	1941	225	6	Sm	P	--		--	Ga 27	Flows intermittently, used for irrigation
21-1	SE SE	Dr. William McNamara	--	--	200	4	Sm	D	--		--	Ga 26	Flows; bedrock at 25 ft.
21-2	SE SE	K. W. Peters	--	1955	39	6	Qgd	D	--		--	--	do.;
21-3	SE SE	Dr. Henry Wass	--	1955	46	4	--	D	--		--	--	do.
22-1	SW SW	D. D. Stewart	W. J. Rodgers	1945	128	6	Sm	P	+32	M	9- 4-56	--	do.; cased to 30 ft.
22-2	SW SE	G. K. McJennett	Dunbar Drilling Co.	1956	205	6	Sm	D	+13	M	9- 4-56	--	do.; cased to 53 ft.
24-1	NE NW	MDC	MDC	1934	17	2	--	Tf	Dry	R	1934	Ga 91	Drilled in sand
26-1	SE NE	S. Jarowski	W. J. Rodgers	--	242	6	Sm	P	--		--	--	Flows 72 gpm
26-3	NE NW	MSHD	Elwin Anderson	--	110	5	Sm	P	+ +4	R	1956	--	do.; bedrock at 90 ft.
27-1	NE NE	John Dix	W. J. Rodgers	--	200	6	Sm	P	--		--	--	do.; crevices at 120, 150, and 200 ft.
28-1	NW NE	B. C. Fowler	--	--	80	5	--	D	+7	R	1956	--	Flows
28-2	NW SW	Peter King	Dunbar Drilling Co.	1956	55	6	Qs	N	2.97	M	9- 4-56	--	Screened from 52 to 55 ft.
28-3	SW NW	MDC	do.	1952	56	6	Qs	P	5	R	1952	--	Screened from 51 to 56 ft.
28-4	SW NW	Leo Baudoin	do.	1952	44	6	Qs	D	17	R	1952	--	Screened from 39 to 44 ft.
29-1	NE SW	Dr. E. A. Baber	--	--	175	6	Sm	D	+71	M	8-24-56	Ga 26	Flows
29-2	-- SE	Naubinway School	--	1932	80	4	-	P	--		--	Ga 18	
29-3	NE SW	E. R. Rowe	W. J. Rodgers	--	215	6	Sm	D	--		--	--	do.; cased to 94 ft.
29-4	SW NE	Forest Baker	Harry Salter	--	250	6	Sm	P	--		--	--	do.
29-5	NE SE	Naubinway Hotel	--	--	247	4	Sm	P	--		--	--	do.
29-6	SE NE	Albert Marks	Dunbar Drilling Co.	--	39	6	Qs	P	12	R	9- 1-52	--	Screened from 39 to 42 ft.
29-7	NE SW	Merritt Lucas	do.	1948	215	6	Sm	P	+84	M	8-27-56	Ga 25	Bedrock at 70 ft.
29-8	SW NE	George Beckman	do.	1956	28	2	Qsg	D	13	R	1956	--	Screened from 25 to 28 ft.
29-9	NW SE	Forest Baker	do.	1956	83	6	Qs	D	13.32	M	9- 4-56	--	Screened from 80 to 83 ft.
30-1	NW NE	R. C. Lynn	W. J. Rodgers	1945	209	6	Sm	D	--		--	--	Flows; cased to 67 ft.
30-2	NW NW	P. A. Newman	--	--	---	6	Sm	D	+81	M	9- -56	--	do.
43N 8W 1-1	NW SE	MDC	MDC	1934	12	2	Qsg	Tf	6.9	M	9-22-34	Hu 72	
1-2	NE NE	Mackinac County	Mackinac County	--	30	1¼	Qgd	P	--		--	--	Equipped with sand point
2-1	SW SW	MDC	MDC	1934	9	2	Qsg	Tf	4.8	M	11- 1-34	Hu 73	
2-2	SW NE	MDC	MDC	1934	13	2	Qsg	Tf	6.5	M	9- 4-34	Hu 74	
3-1	NE NE	MDC	MDC	1934	13	2	Qs	Tf	4.3	M	9- 4-34	Hu 75	
3-3	SE NW	MDC	Litzner Bros.	1950	65	4	Sn	P	13.7	R	3- 7-50	--	Bedrock at 61 ft.
4-1	SE NE	MDC	MDC	1934	9	2	Qsg	Tf	2.2	M	9-21-34	Hu 77	
5-1	NW NW	MDC	MDC	1934	6	2	--	Tf	Dry	R	1934	Hu 78	Drilled in sand, destroyed
6-1	SW SE	MDC	MDC	1934	19	2	Qs	Tf	10.5	M	9-21-34	Hu 79	
6-2	NW NE	MDC	MDC	1934	9	2	Qsg	Tf	6.2	M	9-21-34	Hu 80	
6-3	SE SE	MDC	MDC	1934	9	2	Qsg	Tf	4.5	M	9-21-34	Hu 81	
11-1	NW NE	MDC	MDC	1934	8	2	Qsg	Tf	5.1	M	11- 1-34	Hu 82	
13-1	NE SE	MDC	MDC	1934	19	2	Qsg	Tf	11.2	M	9- 4-34	Hu 83	
13-2	NW SE	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	Hu 84	Destroyed
16-1	SW NW	MDC	MDC	1934	10	2	Qs	Tf	2.6	M	10-15-34	Hu 87	Bedrock at 10 ft.
18-1	SW SW	MDC	MDC	1934	19	2	Qs	Tf	5.2	M	10-15-34	Hu 88	
19-1	NE SW	MDC	MDC	1934	20	2	--	Tf	Dry	R	1934	Hu 89	
21-1	SW SW	MDC	MDC	1934	19	2	Qsg	Tf	4.0	M	10-15-34	Hu 90	Bedrock at 19 ft.
21-2	NW NW	MDC	MDC	1934	20	2	Qs	Tf	7.0	M	10-15-34	Hu 91	
22-1	SW NE	MDC	MDC	1934	6	2	Qsg	Tf	3.2	M	10-15-34	Hu 92	
22-2	NE SW	MDC	MDC	1934	10	2	Qs	Tf	1.8	M	10-15-34	Hu 93	
24-1	SE NW	MDC	MDC	1934	14	2	Qs	Tf	3.0	M	10-15-34	Hu 94	
24-2	SW SE	MDC	MDC	1934	17	2	Qs	Tf	9.7	M	9- 4-34	Hu 95	
26-1	NW SE	MDC	MDC	1934	14	2	Qs	Tf	4.5	M	9- 4-34	Hu 96	
26-2	SW SW	MDC	MDC	1934	6	2	Qs	Tf	2.0	M	9- 4-34	Hu 97	
28-1	NE NE	MDC	MDC	1934	11	2	Qs	Tf	1.3	M	10-15-34	Hu 98	
28-2	SE NW	MDC	MDC	1934	18	2	Qs	Tf	6	R	8-16-34	Hu 99	
29-1	NW SE	Stanley Bowman	W. J. Rodgers	1954	215	6	Sm	P	--		--	--	do.; cased to 52 ft.
29-2	SW NW	C. P. Becker	C. P. Becker	1956	192	4	Sm	D	--		--	--	do.; cased to 54 ft.
29-3	NW SW	E. Snyder	MSHD	--	45	4	Qgd	P	--		--	--	do.; highway boring
29-4	SE NW	Ralph Schlink	W. J. Rodgers	1937	210	8	Sm	P	--		--	--	do.; cased to 52 ft.

Table 2.--Records of wells and test holes in Mackinac County (Continued)

Well Designation T. R.	sec.-No.	Location in Sec. ¼	of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
43N 8W	30-1	NE	SW	Dr. G. L. Willoughby	W. J. Rodgers	1947	215	6	Sm	D	--		--	--	Flows; cased to 72 ft.
	30-2	SW	NW	Anthony Salvatore	do.	1944	224	6	Sm	P	74	R	1955	--	do.; cased to 69 ft.
	30-3	SE	NE	Darrell Brown	Dunbar Drilling Co.	1952	125	6	Sm	P	--		--	--	do.; cased to 61 ft.
	35-1	NW	SW	MDC	MDC	1934	9	2	Qsg	Tf	2.6	M	9- 4-34	Hu 100	
43N 7W	1-1	SW	SW	MDC	MDC	1934	14	2	Qs	Tf	4.1	M	8- 3-34	He 45	
	1-2	SW	SE	MDC	MDC	1934	--	2	Qs	Tf	6.2	R	1934	He 44	
	3-1	NW	NW	MDC	MDC	1934	15	2	--	Tf	Dry	R	1934	He 46	Drilled in sand and gravel
	3-2	NW	SW	MDC	MDC	1934	19	2	Qsg	Tf	11.6	M	10-10-34	He 47	
	3-3	NE	SE	MDC	MDC	1934	13	2	Qs	Tf	10.7	M	8- 3-34	He 48	
	5-1	SW	SW	MDC	MDC	1934	13	2	Qs	Tf	4.0	M	8- 3-34	He 49	Destroyed
	6-2	SE	SW	MDC	MDC	1934	11	2	Qsg	Tf	3.0	M	8- 3-34	He 51	
	6-3	SW	NE	MDC	MDC	1936	2	-	--	Tf	--		--	He 83	Bedrock at 2 ft.
	6-4	SE	NW	MDC	MDC	1936	3	-	--	Tf	--		--	He 84	Bedrock at 3 ft.
	6-5	SW	SW	MDC	MDC	1936	3	-	--	Tf	--		--	He 85	do.
	8-1	NE	NE	MDC	MDC	1934	18	2	Qs	Tf	12.0	M	10-10-34	He 52	
	8-2	NE	SE	MDC	MDC	1934	18	2	--	Tf	Dry	R	1934	He 53	Drilled in sand, destroyed
	9-1	SE	NE	MDC	MDC	1934	13	2	Qs	Tf	5.1	M	10-10-34	He 54	
	13-1	SW	SW	MDC	MDC	1934	13	2	Qsg	Tf	6.0	M	8- 3-34	He 55	
	16-1	NW	NE	MDC	MDC	1934	13	2	Qsg	Tf	6.5	M	8- 3-34	He 56	
	18-2	NW	NE	MDC	MDC	1934	15	2	Qs	Tf	8.2	M	9- 4-34	He 58	
	18-3	SE	NW	MDC	MDC	1934	16	2	Qs	Tf	16.4	M	9- 4-34	He 59	
	19-1	SW	NE	MDC	MDC	1934	20	2	Qs	Tf	11.0	M	9- 4-34	He 61	
	19-2	SE	NW	MDC	MDC	1934	19	2	Qs	Tf	14.3	M	9- 4-34	He 62	
	20-1	NE	NE	MDC	MDC	1934	13	2	Qs	Tf	3.3	M	9- 4-34	He 63	
	20-2	NE	SE	MDC	MDC	1934	17	2	--	Tf	Dry	R	1934	He 64	Drilled in sand and gravel
	21-1	NW	SE	MDC	MDC	1934	19	2	Qs	Tf	14.6	M	9- 4-34	He 65	
	21-2	SW	SW	MDC	MDC	1934	19	2	Qsg	Tf	18.6	M	9- 4-34	He 66	
	22-1	NW	NW	MDC	MDC	1934	13	2	Qs	Tf	2.1	M	7-11-34	He 67	
	23-1	SW	SW	MDC	MDC	1934	11	2	Qs	Tf	1.5	M	10-10-34	He 68	
	23-2	SE	NE	MDC	MDC	1934	13	2	Qs	Tf	2.1	M	8- 3-34	He 69	
	26-1	SE	SW	MDC	MDC	1934	14	2	Qs	Tf	2.3	M	8- 3-34	He 70	
	28-1	SW	SE	MDC	MDC	1934	14	2	Qs	Tf	6.4	M	9- 4-34	He 71	
	28-2	NW	NW	MDC	MDC	1934	8	2	Qs	Tf	5.4	M	9- 4-34	He 72	
	28-3	NE	SW	MDC	MDC	1934	13	2	Qs	Tf	3.3	M	8- 6-34	He 73	
	29-1	NE	SW	MDC	MDC	1934	19	2	Qs	Tf	0.7	M	9- 4-34	He 74	
	29-2	SE	NW	MDC	MDC	1934	18	2	Qs	Tf	6.6	M	9- 4-34	He 75	
	29-3	NE	SE	MDC	MDC	1934	11	2	--	Tf	Dry	R	1934	He 76	Drilled in fine sand, destroyed
	30-1	NW	NW	MDC	MDC	1934	18	2	Qsg	Tf	6.0	M	9- 4-34	He 79	
	32-1	NW	NW	MDC	MDC	1934	19	2	Qs	Tf	9.6	M	9- 4-34	He 80	
	35-1	SE	SE	MDC	MDC	1934	13	2	Qs	Tf	7.0	M	8- 3-34	He 81	
	35-2	SW	SW	MDC	MDC	1934	19	2	Qsg	Tf	18.1	M	9-22-34	He 82	
43N 6W	13-1	SW	SW	MDC	MDC	1934	20	2	Qs	Tf	12.1	M	9-22-34	Mo 30	
	14-1	SW	SE	MDC	MDC	1934	8	2	--	Tf	Dry	R	1934	Mo 31	Drilled in fine sand
	23-1	SE	NE	MDC	MDC	1934	12	2	Qsg	Tf	11.5	M	9- 6-34	Mo 32	
	24-1	SE	SW	MDC	MDC	1934	19	2	Qs	Tf	15.0	M	9-22-34	Mo 33	
	25-1	NW	NW	MDC	MDC	1934	13	2	Qs	Tf	9.5	M	9- 5-34	Mo 34	
	33-1	SE	SE	MDC	MDC	1934	16	2	Qs	Tf	4.5	M	9- 5-34	Mo 35	Destroyed
	35-1	NW	SE	MDC	MDC	1934	19	2	Qsg	Tf	6.5	M	9- 5-34	Mo 36	
	35-2	NE	NE	MDC	MDC	1934	17	2	Qsg	Tf	7.0	M	9- 5-34	Mo 37	
	35-3	SW	SE	MDC	MDC	1934	14	2	Qsg	Tf	4.7	M	9- 5-34	Mo 38	
43N 5W	3-1	NW	NW	Allie Ball	Harry Salter	1920	49	4	Se	DS	29	R	1956	--	Bedrock at 6 ft.
	4-1	NW	NW	Carl Wise	--	--	105	-	Se	DS	--		--	Mo 22	Bedrock at 3 ft.
	5-1	SW	SE	William Lindemuth, Sr.	--	--	65	5	Se	DS	20	R	1956	--	
	8-1	NW	NE	William Lindemuth, Jr.	--	--	105	5	Se	N	--		--	--	Bedrock near surface
	8-2	SW	NE	Fiborn Limestone Co.	--	1905	100	6	Se	N	37.12	M	9-12-56	Mo 26	do.
	8-3	NW	NE	George Rapson	--	--	85	-	Se	P	--		--	Mo 13	
	8-4	NW	NW	Russell Clark	--	--	75	5	Se	N	6.36	M	5-20-52	--	do.
43N 4W	3-1	NE	NE	USFS	George Brunner	1937	253	4	Se	P	201	R	1939	Bv 4	do.
43N 3W	4-1	--	NW	Alfred Tennant	--	1904	117	2	--	-	--		--	St 14	Flowed in 1905
	5-1	NE	SE	Henry Vincent	--	--	84	3	Qgd	N	3.00	M	10- 6-55	--	Formerly flowed
	14-1	SE	NE	Lawrence Yax	Harry Yirs	--	175	2	Qg	P	+23.5	M	9- 5-56	St 26	Flows
	14-2	NE	SE	L. R. Yellan	W. J. Rodgers	1953	210	6	Qg	D	+34.3	M	10-18-56	--	do.
	14-3	SW	SE	Paul McGlauphlin	F. A. Bell	--	188	1½	Qgd	P	+5	R	1956	--	do.
	23-2	SE	NW	Peter Gamble	Glass Drilling Co.	1948	150	6	Qgd	D	19.39	M	9- 4-56	--	
	23-3	SW	SW	John Strong	Litzner Bros.	1954	100	4	--	D	+12	R	1956	--	Flows 15 gpm
	23-4	SE	NW	Sam Saitis	A. L. Litzner	--	150	4	Qs	P	--		--	--	
	27-1	NE	NE	Linderman	Ulric Mayer	1949	234	2	Qg	D	6	R	1949	St 28	Gravel at 234 ft.
43N 2W	5-2	SW	NE	Gordon Hawkins	--	--	195	-	Qgd	-	--		--	Mq 37	Flows; bedrock not encountered
	7-1	NE	NW	Rudolph Pfeifer	--	--	185	-	Qgd	-	--		--	Mq 35	do.
	25-1	SE	NE	Charles Leonard	Archie Huff	1953	110	2	Se	D	60	R	1953	--	Bedrock at 90 ft.
	27-1	NE	NE	USFS	George Brunner	--	155	5	Sm	N	130.45	M	7-17-56	Mq 1	Bedrock at 150 ft.
	30-1	SE	NE	Gordon Hawkins	--	--	50	1½	--	D	--		--	Mq 29	Flows
	30-2	NE	NW	Mrs. Bert Simmons	Bert Simmons	1954	127	2	Qsg	DS	--		--	--	Small flow
	30-3	SE	NE	Theodore Gill	Theodore Gill	1955	100	2	Qg	DS	--		--	--	do.
	30-4	SE	NW	George Izzard	--	--	140	-	Qgd	-	--		--	Mq 33	Flows; bedrock not encountered
43N 1W	1-1	NW	NE	Leonard Rutledge	Judson Daley	1901	88	2	Qg	D	+6	R	1905	Mq 5	Formerly flowed.
	1-2	NE	NE	George Leach	do.	1901	130	2	Qg	I	4	R	1905	Mq 8	
	1-3	NE	NE	William Blair	do.	1901	122	2	Qg	D	0	R	1905	Mq 22	
	1-4	NE	NE	Agnes Morrison	do.	1901	140	2	Qg	D	1.5	R	1905	Mq 23	High yield reported
	1-5	NE	NE	MSHD	William Roe	--	135	3	Qs	P	--		--	Mq 38	Bedrock at 135 ft.
	1-6	SE	SW	Denzel Huyck	do.	--	157	-	--	-	--		--	Mq 41	Bedrock at 157 ft.
	1-7	SE	SE	W. A. Blair	Jack Meehan	1948	134	4	Qgd	-	--		--	--	Flows; bedrock at 134 ft.
	2-1	NE	NW	James Sterling	Judson Daley	1905	88	2	Qg	D	10	R	1905	Mq 6	Bedrock not encountered
	3-1	SW	SW	Jack Wise	--	--	65	-	Qs	D	15	R	1905	Mq 19	
	4-1	NE	NE	Percy Harrison	Percy Harrison	1893	70	48	Qgd	S	10.20	M	8-24-55	Mq 41	
	4-2	NE	NE	do.	Judson Daley	1905	92	2	Qg	D	14	R	1905	Mq 4	
	4-3	SE	SE	Carl Lockhart	--	1915	140	2	Qg	D	--		--	Mq 43	
	5-1	NW	NE	Russell Cottle	Judson Daley	--	104	3	Qsg	D	23	R	1905	Mq 25	
	5-2	NE	NW	F. A. Wallis	--	1905	120	-	Qs	D	27	R	1905	Mq 24	
	6-2	NE	NW	George Smith	Judson Daley	1905	160	2	Qg	D	30	R	1905	Mq 3	do.
	8-1	SE	SE	George Leach	--	--	75	2	--	D	--		--	Mq 28	
	9-1	NE	NE	Lorne Hillock	--	--	145	2	Qg	D	--		--	Mq 40	

Table 2.--Records of wells and test holes in Mackinac County, (Continued)

Well Designation T. R.	sec.-No.	Location in Sec. ¼ of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
43N 1W	10-1	NW NW	Ivan Leach	Judson Daley	1903	112	2	Qg	D	--		--	Mq 2	Flowed 0.2 gpm
	10-2	NW NW	do.	--	--	32	36	Qg	-	--		--	Mq 44	Dug well
	10-3	NE NE	Harry Smith	Judson Daley	--	80	2	--	-	--		--	Mq 31	
	11-1	NW NW	Donald Nettleton	do.	--	120	2	Qg	D	--		--	Mq 9	
	12-1	NE NE	Robert Wilson	do.	1902	98	2	Qs	D	+4	R	1905	Mq 14	Flowed 0.25 gpm
	12-2	SE SE	Ford Bawks	--	--	100	2	Qgd	D	--		--	Mq 42	
	13-1	NW NE	Clifford Taylor	Judson Daley	1905	114	2	Qg	D	+8	R	1905	Mq 21	Flowed 6 gpm
	13-2	SW NE	Straits Oil and Gas	Elvin Anderson	1951	810	-	Se	To	--		--	--	MDC log 16953
	26-1	SE SW	Maple Leaf School	--	--	50	2	--	P	--		--	Mq 27	
	27-1	NW NW	Elmer Shiplett	Archie Huff	--	40	2	Qg	D	--		--	--	Cased to 25 ft.
	29-1	SE SE	Archie Huff	--	--	25	-	--	D	--		--	Mq 18	
	29-2	SW SE	do.	Archie Huff	1950	50	2	Qg	D	19	R	1950	--	
	29-3	SE SE	do.	do.	1956	75	2	Qs	D	5.72	M	8- 1-56	--	
	31-1	SE NE	Clarence Knoy	--	--	--	-	Se	D	--		--	Mq 15	Bedrock at 35 ft.
	32-1	NE NW	Wilmer Sullivan	L. Brown	--	53	-	Qs	D	--		--	Mq 16	Bedrock not encountered
	32-2	NE NW	do.	Ernest Windsor	--	135	-	Qsg	D	40	R	1949	Mq 39	
	34-1	NE NE	Joseph Smith	--	--	100	-	--	D	--		--	Mq 17	
42N 12W	2-1	NW SW	M., St. P., and S. Ste. M. R.R.	--	--	26	144	Qgd	N	4	R	1956	Ne 48	
	2-2	NW SW	do.	--	--	11	72	Qgd	N	4	R	1956	Ne 47	
	3-1	SW SE	Fred Douglas	Dunbar Drilling Co.	1952	160	6	Sb	D	5	R	1952	--	Specific capacity 15 gpm/ft. of drawdown, bedrock at 52 ft.
	6-1	NE SE	Inland Lime and Stone	Inland Lime and Stone	--	135	6	Sb	P	15	R	1956	Ne 6	Flowed when first drilled
	7-1	SW SE	do.	--	--	67	4	Sb	N	+5.0	M	10-17-56	--	Flows
	18-1	NE NW	do.	--	--	82	4	Sb	N	+5.6	M	10-17-56	Ne 49	do.; capped
	18-2	NE NW	do.	--	--	--	4	Sb	N	--		--	--	do.
	18-3	NE NW	do.	--	--	--	4	Sb	P	--		--	--	do.
	18-4	NW NW	do.	--	1890	--	3	Sb	N	--		--	Ne 24	do.
42N 11W	23-1	NW SW	Wisconsin Land and Lumber Co.	--	1905	108	2	Sm	I	0	R	1905	Ne 29	Flowed intermittently, bedrock near surface
42N 8W	2-1	NW NW	J. F. Miller	W. J. Rodgers	--	193	6	Sm	P	--		--	--	Flows; cased to 49 ft.
42N 7W	1-1	SW SE	MDC	MDC	1934	20	2	--	Tf	Dry	R	1934	He 39	Destroyed in 1934
	1-2	SE NE	MDC	MDC	1934	13	2	Qs	Tf	5.3	M	8- 3-34	He 40	
	2-1	NE SE	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	He 42	
	2-2	SW SW	Joseph Bellant	Dunbar Drilling Co.	1948	338	6	Sn	P	81	R	1948	--	Bedrock at 185 ft.
	2-3	SW SW	John Talkowski	do.	1952	288	6	Sn	P	91	R	1952	--	Bedrock at 197 ft.
	3-1	SW SW	Epoufette School	--	--	56	3	Qgd	N	--		--	He 1	Destroyed
	3-3	NW NE	MDC	MDC	1934	19	2	--	Tf	Dry	R	1934	He 43	Drilled in sand
	3-4	NE SW	Frank Bigelow	--	--	--	-	Qs	D	--		--	--	Improved spring
	3-5	NE SW	John Jackle	Litzner Bros.	--	122	4	Qs	P	--		--	--	Screened at 122 ft.
	10-1	NE NE	James McIsaac	--	--	171	6	Qgd	D	--		--	--	
	12-1	SW SE	MSHD	--	--	152	5	--	P	101	R	1956	--	
42N 6W	1-1	NE NE	MDC	MDC	1934	20	2	Qs	Tf	6.9	M	11- 8-34	Mo 39	
	3-1	NW NW	MDC	MDC	1934	19	2	Qsg	Tf	5.0	R	9- 5-34	Mo 40	Destroyed
	3-2	SE NE	MDC	MDC	1934	19	2	Qs	Tf	6	R	9- 5-34	Mo 41	
	5-1	SE SE	MDC	MDC	1934	12	2	Qs	Tf	5.7	M	9- 6-34	Mo 42	
	5-2	NW SW	MDC	MDC	1934	11	2	Qs	Tf	8.1	M	9- 6-34	Mo 43	
	6-1	NW NW	MDC	MDC	1934	13	2	Qs	Tf	3.8	M	8- 3-34	Mo 44	
	7-1	SW NE	MDC	MDC	1934	20	2	Qs	Tf	7.7	M	8-28-34	Mo 45	
	8-1	SE NW	MDC	MDC	1934	20	2	Qs	Tf	9.7	M	9- 6-34	Mo 46	
	9-1	SW SE	MDC	MDC	1934	13	2	Qs	Tf	10.2	M	9-22-34	Mo 47	
	9-2	SW NE	MDC	MDC	1934	13	2	Qs	Tf	6.3	M	9- 6-34	Mo 48	
	10-1	SW SE	MDC	MDC	1934	19	2	Qs	Tf	8.5	M	9-22-34	Mo 49	
	10-2	NE NW	MDC	MDC	1934	19	2	Qs	Tf	6.1	M	9- 6-34	Mo 50	
	10-3	NE NE	MDC	MDC	1934	19	2	Qs	Tf	11.7	M	9- 5-34	Mo 51	
	11-1	NE NW	MDC	MDC	1934	19	2	Qs	Tf	10.8	M	9-22-34	Mo 52	
	12-1	NE NW	MDC	MDC	1934	17	2	Qs	Tf	7.5	M	9-22-34	Mo 53	
	12-2	NE NE	MDC	MDC	1934	19	2	Qs	Tf	8.4	M	11- 8-34	Mo 54	
	14-1	NW SE	MDC	MDC	1934	20	2	Qs	Tf	16.8	M	9-22-34	Mo 55	
	15-1	NW SW	MDC	MDC	1934	15	2	--	Tf	Dry	R	1934	Mo 56	Destroyed in 1934
	15-3	SE NW	MDC	MDC	1934	20	2	Qs	Tf	16.3	M	9-22-34	Mo 58	
	16-2	NW SW	MDC	MDC	1934	20	2	--	Tf	Dry	R	1934	Mo 60	
	17-1	NE NE	MDC	MDC	1934	14	2	Qsg	Tf	4.7	M	9-22-34	Mo 61	
	17-2	NE SW	MDC	Jack Meehan	--	70	4	Ss	N	--		--	Bv 15	Bedrock at 40 ft.
	22-1	NW SE	Chester Smith	Litzner Bros.	1949	83	6	Ss	P	10	R	1949	Mo 7	Cased to 58 ft.
	22-2	NW SE	Carl Gustafson	Carl Gustafson	--	30	4	Qs	P	10	R	1956	--	Equipped with screen
	22-3	NW SE	do.	do.	--	19	1¼	Qs	P	--		--	--	Equipped with sand point
	22-4	NE SW	T. Gustafson	T. Gustafson	--	32	1¼	Qs	P	--		--	--	do.
	22-5	NW SE	Robert Hoover	Dunbar Drilling Co.	1956	30	2	Qs	P	16	R	1956	--	Equipped with screen, gravel packed
	22-6	NW SE	Dallas Heenan	Dallas Heenan	1955	34	2	Qs	P	--		--	--	Equipped with sand point
	22-7	NW SE	do.	W. J. Rodgers	1955	80	6	Ss	N	12	R	1955	--	Cased to 50 ft., water reported hard
	22-8	NW SE	Mrs. Carl Gustafson	Carl Gustafson	--	4	30	Qs	D	0	R	1956	--	Improved spring
	22-9	NE SW	John Carlson	--	1936	118	4	Ss	D	--		--	Bv 14	High iron content reported
	22-10	NE SW	do.	--	--	50	5	Qs	P	--		--	--	
	23-1	SW NE	MDC	MDC	1934	20	2	Qs	Tf	5.3	M	9-22-34	Mo 62	
	23-2	NW NW	MDC	MDC	1934	10	2	--	Tf	Dry	R	1934	Mo 63	
	23-3	NE NE	MDC	MDC	1934	18	2	--	Tf	Dry	R	1934	Mo 64	Drilled in sand and gravel
	25-1	SE SE	Miswick Motel	J. Miswick	1955	28	2	Qs	P	18	R	1955	--	Equipped with sand point
42N 5W	13-1	NW SE	R. G. Gille	A. L. Litzner	1916	106	5	Sm	N	28.70	M	7- 9-56	--	
	27-1	NE NW	Robert Dubay	Robert Dubay	--	14	60	Qgd	P	--		--	Bv 13	Improved spring
	30-1	SE NE	USFS	George Brunner	1939	--	5	Qgd	N	--		--	Mo 3	Equipped with sand point
	30-2	NE NE	USFS	do.	1939	--	5	Qgd	P	--		--	Mo 2	do.
	31-1	NW SE	C. and D. Dowd	--	--	50	2	Qgd	P	--		--	--	
	31-2	SE SE	USFS	George Brunner	1939	241	5	Ss	P	--		--	Mo 1	Flows
	35-1	SW SE	Massey House	--	1905	38	-	Ss	N	--		--	Bv 10	
	36-1	NW SW	A. F. Conrad	Litzner Bros.	1949	108	4	Ss	D	9	R	9-21-49	Bv 1	Cased to 37 ft.
	36-2	SW NW	Duke Christensen	--	--	30	1¼	Qgd	P	--		--	Bv 7	
42N 4W	32-1	SW NE	Albert Novenski	Litzner Bros.	--	52	4	Ss	D	35	R	1949	Bv 17	Bedrock near surface
	32-3	SE NW	Moran School	do.	1953	308	5	--	P	--		--	Bv 5	
	32-4	SW NE	Village of Moran	Philip Luepnitz	--	21	24	Qgd	P	--		--	--	
	32-5	NE NW	Charles Blanck	A. L. Litzner	--	193	4	Ss	D	--		--	--	Water reported hard
	32-6	NE NW	Arnold Kallio	Litzner Bros.	1954	200	4	Ss	D	--		--	--	Cased to 42 ft.

Table 2.--Records of wells and test holes in Mackinac County, (Continued)

Well Designation T. R.	sec.-No.	Location in Sec. ¼ of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
42N 3W	1-1	SW SE	Howard Simmons	Meredith Windsor	1943	165	4	Sm	D	30	R	1944	St 31	Cased to 27 ft.
	1-2	SW SE	Edward Listerman	Litzner Bros.	1956	50	5	Se	D	1.75	M	7-20-56	--	
	3-1	SE SE	Chicken Shack	Glass Drilling Co.	--	62	6	Se	P	--		--	St 10	Flows
	3-2	SE SE	R. V. Mills	do.	1949	108	6	Se	P	+8	M	9- 6-56	St 13	do.; cased to 90 ft.
	3-3	NE SE	Al Simmons	Litzner Bros.	1955	60	4	Se	D	+1.5	M	8- 5-56	--	Flows 2 gpm
	4-1	SW SW	Joseph Kogl	do.	1955	101	6	Se	P	9.70	M	9- 5-56	--	Flows intermittently
	9-1	NE NW	W. M. Platz	do.	1954	125	4	Se	D	--		--	--	Flows
	10-1	NE NE	George Izzard	Glass Drilling Co.	1924	84	6	Se	DS	+8	R	1956	St 12	do.
	10-2	NE NE	John Ellison	John Ellison	1948	52	2	Qsg	D	+2	R	1948	--	Equipped with sand point
	10-3	NE NE	Harry Teafoe	Roy Hart	1949	33	2	Qg	N	2	R	9- 8-49	St 8	Bedrock at 33 ft.
	10-4	NE NE	do.	Litzner Bros.	1949	79	4	Se	P	+16	R	1949	--	Flows, bedrock at 48 ft.
	10-5	NE NE	Canfield and Koebel	Glass Drilling Co.	1949	135	6	Se	D	+23	R	1956	St 11	Flows 10 gpm; bedrock at 70 ft.
	10-6	SE NE	Bert Simmons	Bert Simmons	1949	32	$1\frac{1}{4}$	Qs	D	+3	R	1949	--	Flows
	12-1	NW NE	John Simmons	Litzner Bros.	1954	36	5	Se	D	8.37	M	7-20-56	--	Cased to 16 ft.
	18-1	NE SE	USFS	George Brunner	1937	79	5	--	P	6.66	M	8- 1-56	St.1	Cased to 67 ft.
	19-2	SE NE	E. A. Smith	--	--	45	4	--	N	5.60	M	9-18-56	--	
	20-1	SW SW	Leslie Johnson	--	--	70	4	--	P	--		--	--	
	20-2	SW SW	do.	Leslie Johnson	1955	33	3	Qgd	N	11.79	M	8- 7-56	--	Limestone at 33 ft.
	29-1	SW SW	Peter Larson	--	--	21	3	Qgd	D	--		--	St 17	
	29-2	SE SW	Clark Alkire	--	--	12	-	Ss	D	5.06	M	9- 8-49	St 9	Bedrock near surface
	30-1	SE SE	William Johnston	A. L. Litzner	--	42	-	Ss	D	35	R	1949	St 7	Limestone at 22 ft.
	30-3	SW SE	Frank Rice	Litzner Bros.	--	198	4	Ss	P	--		--	--	Cased to 115 ft.
	30-4	NW SE	W. B. Johnson	W. B. Johnson	--	50	3	Ss	P	--		--	--	
	31-1	NE NE	Carp River School	A. L. Litzner	--	85	6	Ss	P	--		--	St 22	
	31-2	NE NE	do.	Litzner Bros.	--	42	$3\frac{1}{2}$	Qg	P	20	R	1949	St 23	
42N 2W	4-1	SE SE	George Lamoreaux	George Lamoreaux	--	20	-	Qs	DS	15	R	1956	--	
	4-2	SW SE	Kenneth Kerr	A. L. Litzner	1923	96	6	Qsg	N	--		--	--	
	4-3	SW SE	do.	Kenneth Kerr	--	50	36	Qgd	D	25	R	1955	--	
	7-1	NE NE	USFS	William Dunn	--	103	6	Sm	O	20.84	M	6- 7-56	--	Bedrock at 3 ft.
	9-1	NE NW	Kenneth Kerr	Roy Hart	1937	86	2	Qgd	N	+0.5	M	6-27-56	Mq 26	Flows intermittently
	9-2	NW NE	do.	--	--	30	30	Qs	S	20	R	1956	--	
	10-1	NW NE	USFS	--	--	23	6	--	N	2.44	M	7- 6-56	--	
42N 1W	3-1	SW NW	Narberg Przybylski	Archie Huff	1956	134	2	Qs	D	114	R	8- -56	--	Yielded 6 gpm, screened from 130 to 134 ft.
	5-1	SE SW	Terry Finland	Litzner Bros.	1946	146	3	Qg	D	116	R	1946	Ck 40	Screened from 144 to 146 ft.
	10-1	SW NW	Marvin Chard	do.	1948	52	5	Qsg	I	50	R	1948	Ck 42	
	24-1	NE NE	Larry Weston	do.	--	223	4	Sm	D	70	R	1955	--	Bedrock at 87 ft.
	24-2	SE NE	Albert Nordquist	do.	1955	101	4	Se	D	19	R	1955	--	Cased to 71 ft.
	24-3	SE NE	Mike Mangene	--	1945	18	-	Qs	D	--		--	Ck 8	
	25-1	SE SE	McDonald Lumber Co.	Litzner Bros.	1955	42	4	Se	I	5	R	1955	--	Cased to 21 ft.
	25-2	SE SE	Bethel Lutheran Church	do.	1955	101	-	Se	P	45	R	1955	--	Cased to 70 ft.
	25-3	SE SE	Morrice Daniel	do.	1955	34	4	Se	P	9	R	1955		Bedrock at 16 ft.
	27-1	NW SW	Marvin Chard	do.	--	35	3	Se	D	--		--	--	Cased to 20 ft.
	28-1	NW SE	Ernest Windsor	Ernest Windsor	1948	20	2	Qg	D	7	R	1948	Ck 35	Equipped with screen
	28-2	SE NW	Mrs. Ernest Birge	Litzner Bros.	1956	80	4	Se	D	1.47	M	7-18-56	--	Bedrock at 26 ft.
	28-3	SW NE	Hessel School	--	1934	70	2	--	P	--		--	Ck 24	
	28-4	SE NW	John Brenek	Douglas Holzem	1955	60	6	Se	D	35	R	1955	--	Cased to 60 ft.
	30-1	NE SE	Oliver Birge	Ernest Windsor	1949	54	4	Se	D	18	R	1949	Ck 36	Bedrock at 38 ft.
	34-1	SE NE	M. D. Gast	Litzner Bros.	1956	84	4	Se	D	3	R	1956	--	Bedrock at 57 ft.
	36-1	NE SE	Gerald Dunn	Robert Dunn	--	127	6	Sm	D	--		--	Ck 38	Bedrock at 52 ft.
	36-2	SE NW	Archie Dunn	Archie Dunn	1953	57	2	Qg	D	35	R	1953	--	Equipped with screen; bedrock at 57 ft.
	36-3	SE SW	Les Cheneaux Lodge	Litzner Bros.	1953	115	6	Se	P	32	R	1953	--	
	36-4	SE NW	Marvin Tassier	do.	1954	83	4	Se	D	35	R	1954	--	Cased to 63 ft.
	36-5	SW SW	Les Cheneaux Lodge	Glass Drilling Co.	1944	106	4	Se	P	30	R	1944	Ck 10	
	36-6	SE SW	Clark O'Brien	Litzner Bros.	1955	64	4	Se	D	36	R	1955	--	Cased to 61 ft.
	36-7	SE SW	Les Cheneaux Inc.	do.	1956	73	4	Se	D	36.84	M	8-13-56	--	Bedrock at 58 ft.
	36-8	NW NE	Pearson and Firack	do.	1956	38	4	Se	D	6.57	M	8-13-56	--	Cased to 27 ft.
	36-9	SE SW	C. E. Burch	--	--	30	3	Qg	P	--		--	Ck 7	
42N 1E	6-1	NE NE	Mrs. C. H. Heuck	--	1915	98	4	--	-	--		--	Ck 11	
	15-1	NE NW	Robert White	Litzner Bros.	1954	104	4	Sm	D	92	R	1954	--	Bedrock at 18 ft.
	18-1	NW NW	Albert Winberg	--	--	83	6	--	DS	--		--	Ck 1	
	18-2	SW SW	Ford Izzard	Litzner Bros.	--	62	4	Se	DS	--		--	--	do.
	19-1	SW NW	Russell Horn	do.	--	101	4	Se	D	19	R	1956	--	Cased to 71 ft.
	30-1	SW SW	Albert Winberg	do.	1955	101	4	Se	D	45	R	1955		Cased to 70 ft.
	31-1	NW NW	Dave Visnaw	William Dunn	1925	66	4	Se	P	4	R	1926	Ck 16	Bedrock at 18 ft.
	31-2	SW SW	W. Shoberg	--	--	80	4	Se	P	8	R	--	Ck 15	Bedrock at 40 ft.
	31-3	NE NW	Cedarville School	--	1933	120	6	Sm	P	--		--	Ck 25	
	31-4	NW NW	Robert Hamel	Robert Hamel	--	12	6	Se	D	--		--	Ck 30	Flows, bedrock at 8 ft.
	31-5	SW SW	Conrad Shoberg	Litzner Bros.	1956	134	5	Sm	P	15.19	M	8-10-56	--	Bedrock at 50 ft.
	31-6	NE NW	Guy Hamel	--	--	135	-	Sm	D	18	R	1949	Ck 32	Bedrock at 48 ft.
	31-9	NW NW	C. C. Gerdan	--	1935	44	$1\frac{1}{4}$	Qgd	P	--		--	Ck 19	
	31-11	NE NW	Lawson Macklim	Litzner Bros.	1956	77	4	Se	D	17.86	M	6-28-56	--	Bedrock at 31 ft.
	31-12	NW NW	Guy Hamel	do.	1953	83	4	Se	N	32.02	M	7- 5-56	--	Bedrock at 50 ft.
	31-13	NW NW	Jack McKay	do.	1955	40	4	Se	D	6	R	1955	--	Bedrock at 30 ft.
	31-14	NE NE	C. R. Ringler	do.	1953	90	6	Se	P	+5	R	1953	--	Bedrock at 20 ft., flows.
	32-2	NW NW	Archie Thon	--	1940	220	4	Sm	P	--		--	Ck 14	Flows
	32-3	NW SE	Peter Gardulski	--	--	185	4	Sm	P	--		--	Ck 17	
	32-4	NW NW	S. L. Dana	Litzner Bros.	1955	62	4	Se	D	10.45	M	8-15-56	--	Cased to 38 ft.
	32-5	NW NW	E. W. Cleary	do.	1955	37	5	Se	D	4	R	1955	--	Bedrock at 12 ft.
	32-6	NW NW	E. C. Rudd	do.	--	60	5	Se	D	--		--	--	
	32-7	SW NE	L. Baronski	--	--	175	2	Sm	P	--		--	--	
	33-1	SW NW	H. A. VanHala	Litzner Bros.	1956	42	4	Se	D	6	R	1956	--	Bedrock at 21 ft.
	34-1	SE NW	S. Secunda	--	--	25	$1\frac{1}{4}$	Qgd	P	--		--	Ck 12	
	34-2	NE NW	Dale Ferrill	Litzner Bros.	1956	169	4	Sm	D	4	R	1956	--	Bedrock at 65 ft.
41N 11W	4-1	NW NW	Newton Twp. School	--	1905	40	-	Qgd	N	--		--	Ne 23	Abandoned
41N 5W	1-1	NW NW	Norman Davey	Litzner Bros.	1949	181	4	Ss	P	9	R	1949	Bv 2	Bedrock at 42 ft.
	1-2	NE NW	John Christensen	--	--	70	6	--	P	--		--	Bv 6	
	2-1	NW NW	Shaw Bros.	--	--	96	4	--	P	--		--	Bv 11	
	2-2	NW NE	Mrs. Elsie Kent	--	--	40	$1\frac{1}{4}$	Qgd	P	--		--	Bv 12	
	2-3	NW NE	Frank Johnson	--	--	20	2	Qgd	P	--		--	Bv 9	
	2-4	NW NW	W. M. Cornelius, Jr.	Litzner Bros.	--	100	4	Qgd	P	5.0	M	7-13-56	--	Water from 30 ft.
	15-1	NW SW	Duncan McMillan	Duncan McMillan	--	24	$1\frac{1}{4}$	Qgd	P	--		--	--	Equipped with sand point
	16-1	NW NE	USFS	George Brunner	1939	22	5	Qgd	N	10	R	1939	Mo 4	Equipped with screen
	23-1	SW NW	MDC	--	--	48	6	Ss	O	9.98	M	5-20-52	Bv 15	Bedrock near surface
	25-1	SW SE	H. D. Knight	Theron Brewer	1953	40	4	Ss	N	2	R	1953	--	Cased to 12 ft.
	25-2	SW SE	do.	do.	1953	170	4	--	-	Dry	R	1953	--	Well destroyed
	25-3	SW SE	do.	H. D. Knight	--	91	2	Ss	P	--		--	--	Water reported hard
	26-1	NE NW	R. D. Slaybaugh	Theron Brewer	1953	40	4	Ss	P	5	R	1953	--	Cased to 34 ft.

Table 2.--Records of wells and test holes in Mackinac County, (Continued)

Well Designation T. R.	sec.-No.	Location in Sec. ¼ of ¼	Owner	Driller	Year drilled	Depth of well (ft.)	Diameter (in.)	Chief aquifer	Use	Water level: Above (+) or below land surface (ft.)		Water level: Date of measurement	Former USGS No.	Remarks
41N 4W	5-1	NW NE	Morse McCalley	Litzner Bros.	--	48	4	Ss	D	35	R	1949	Bv 16	
	24-1	SE NW	USFS	George Brunner	1939	24	5	Qgd	P	3.38	M	8- 2-56	St 2	Screened from 20 to 24 ft.
	24-2	SE NW	USFS	do.	1939	18	5	Qgd	P	3.99	M	8- 2-56	St 3	Screened from 14 to 18 ft.
	31-1	SW NW	Oliver Gauthier	Litzner Bros.	1949	37	4	Ss	P	4	R	1949	Mo 6	Bedrock at 21 ft.
	31-3	SW NW	Emma Proulx	--	--	49	4	--	P	--		--	--	
	31-5	NW SE	Louis Zaborsky	Litzner Bros.	--	32	4	--	P	--		--	--	Pumped 20 gpm
	36-1	SE NE	Lucille Krouse	do.	--	81	5	DSm	P	10	R	1953	--	
	36-2	SW NE	USFS	George Brunner	1937	110	5	DSm	N	72.60	M	8- 1-56	St 5	Pumped 15 gpm
	36-3	SE NE	Lucille Krouse	Litzner Bros.	1955	48	4	DSm	P	9	R	10- 4-55	--	Bedrock at 40 ft.
41N 3W	30-1	SW NE	Homer Smith	W. S. Chalker	1892	65	-	DSm	N	--		--	St 29	Destroyed; bedrock near surface
	30-2	SW NW	Rabbits Back School	--	--	12	3	--	P	--		--	St 24	
	30-4	SW NW	Homer Smith	Litzner Bros.	--	103	4	DSm	P	--		--	--	
	31-1	NW SW	G. A. Campbell	--	1907	50	-	DSm	T	--		--	St 15	Destroyed
	31-2	SW SW	C. N. Matson	Litzner Bros.	1949	70	4	DSm	P	9	R	1949	St 4	Cased to 55 ft.; water reported hard
	31-4	SW NW	Mrs. Edna Couey	--	--	28	1¼	Qgd	P	--		--	St 18	
	31-8	NW SW	Lydia McGuinty	--	--	80	8	--	P	--		--	--	
	31-10	SW SW	C. N. Matson	--	--	38	6	DSm	P	--		--	--	
	31-12	NW SW	Foster Lee	Litzner Bros.	--	52	3	DSm	P	10	R	1956	--	Bedrock at 20 ft.
	31-13	NW SW	Ainsworth Bassett	do.	1952	40	4	DSm	P	9	R	1952	--	Bedrock at 30 ft.
	31-14	SW SW	Clarence Yost	do.	1952	31	4	DSm	P	9	R	1952	--	Bedrock at 20 ft.
	31-15	SW SW	St. Ignace Well No. 2	--	1901	1,166	-	Sn	N	--		--	--	MDC log; fresh water reported at 575 ft., flowed
41N 1W	1-1	NW SE	Chris Harris	--	1938	38	4	--	P	--		--	Ck 21	
	1-3	NW NW	Henry Paquin	--	--	108	4	Se	P	--		--	Ck 20	
	1-4	NE NW	--	Ernest Windsor	1949	--	4	Se	-	--		--	Ck 24	Limestone at 60 ft.
	1-6	NE NW	Squire	Litzner Bros.	1956	62	4	Se	D	6	R	1956	--	Cased to 46 ft.
	1-7	SW NE	Dr. E. F. Bohn	--	--	186	6	Sm	P	--		--	--	
	1-8	NE NW	Bruce Patrick	Ernest Windsor	1951	45	4	Se	P	6	R	1956	--	Bedrock at 38 ft.
	1-9	NE NW	J. J. Anderson	Litzner Bros.	1956	60	4	Se	D	4	R	1956	--	Cased to 42 ft.
	1-10	SE NE	John Torsky	--	--	60	4	--	P	--		--	--	Water very hard
41N 1E	2-1	NE NW	Michigan Limestone Co.	Litzner Bros.	1954	132	6	Sm	I	27	R	1954	--	Bedrock at 75 ft.
	2-2	SE NW	do.	do.	1955	126	-	Sm	I	--		--	--	
	2-3	NE NW	do.	do.	1956	93	-	Se	I	6	R	1956	--	Bedrock at 52 ft.
	4-1	SE NE	Ronald Tuck	do.	1956	190	-	Sm	D	--		--	--	Bedrock at 113 ft.
	4-2	NE NE	J. S. Gordon	do.	1956	104	4	Se	D	44	R	1956	--	Cased to 82 ft.
	4-3	NW NE	Norman Barnhill	do.	1956	134	4	Sm	P	14	R	1956	--	Cased to 105 ft.
	4-4	NE NW	G. W. Crockatt	do.	1954	72	4	Se	D	6	R	1956	--	Bedrock at 43 ft.
	4-5	NE NW	Donald Markey	do.	1955	72	5	Se	D	3	R	1955	--	Cased to 37 ft.
	4-6	NE NW	J. G. Hapeman	do.	1955	73	4	Se	D	3	R	1955	--	Cased to 51 ft.
	4-7	SE NE	Charles Johnson	--	--	142	6	Sm	P	--		--	--	
	6-1	NE NW	Dorn Eddy	Robert Dunn	--	245	4	Sm	N	6	R	1949	Ck 39	Water reported sulfurous
	6-2	NW NE	Islington Hotel	--	--	77	6	Se	P	7.54	M	8- 7-56	--	
41N 2E	6-1	SE NE	Christian Camps	Litzner Bros.	1956	47	5	Se	P	3.92	M	7- 2-56	--	Bedrock at 37 ft.
40N 4W	5-1	NE NW	Paul Buris	Litzner Bros.	1954	56	4	Qgd	P	18	R	1954	--	Equipped with screen
	5-2	NE NW	do.	do.	--	156	-	--	-	Dry	R	1954	--	Drilled in breccia
	5-3	NE NW	H. J. Rogers	Theron Brewer	--	27	-	DSm	P	8	R	1954	--	Yielded 50 gpm, cased to 22 ft.
	8-1	SE SE	Louis Bolan	--	--	43	2	DSm	P	--		--	Mo 12	
	8-2	SE SE	Gros Cap School	--	--	70	4	DSm	P	--		--	Mo 10	
	8-4	SE NW	L. E. Garries	Litzner Bros.	1945	220	4	DSm	P	70	R	1945	Mo 8	Cased to 220 ft.
	8-6	NE SE	Dwight Watson	--	1948	224	4	DSm	D	37	R	1956	Mo 5	
	8-7	SE NW	Adam Adamian	Litzner Bros.	1956	135	-	DSm	D	--		--	--	
	8-8	SW SE	Mack Gudmundsen	do.	--	141	4	DSm	D	15	R	1949	Mo 9	Bedrock at surface
	9-1	NW SW	Fribilee	do.	1954	175	4	DSm	P	60	R	1954	--	do.
	9-2	NE NW	Emil Syverson	do.	1956	250	4	DSm	D	69.12	M	7- 6-56	--	
	9-3	SW SE	Kress Reavie	do.	--	141	4	DSm	P	--		--	--	
	9-4	NW SE	W. Tennyson	do.	1956	300	4	--	-	Dry	R	1956	--	Destroyed
	9-5	NW SE	do.	do.	1956	80	8	DSm	D	18	R	1956	--	Cased to 11 ft.
	9-6	-- SW	Thomas Taylor	do.	1956	143	4	DSm	D	4	R	1956	--	Yielded 8 gpm
	10-1	SW SW	Gros Cap Cemetery	Glass Drilling Co.	--	120	6	DSm	P	10	R	1956	--	
	10-2	SW SW	Orr Greenless	Litzner Bros.	--	128	4	--	-	Dry	R	1956	--	Bedrock at 20 ft.
	10-3	SW SW	do.	Orr Greenless	--	21	48	Qs	P	--		--	--	
	12-2	SW SW	J. W. Josephson	--	--	60	6	--	P	--		--	Mo 18	
	12-3	SW NE	Dr. J. S. Hawley	Litzner Bros.	--	79	4	Qsg	D	11.85	M	7-26-56	--	
	13-2	SW SW	Oliver Huyck	--	--	84	5	DSm	P	--		--	--	
	13-3	SE SE	Ralph Henderson	W. J. Rodgers	--	65	2	--	P	--		--	--	
	14-1	SW SW	Vernon Brown	Litzner Bros.	1949	82	6	DSm	D	30	R	1949	Mo 21	Bedrock at surface
	14-4	SE SW	Clarence Dean	--	--	82	6	DSm	P	--		--	--	
	15-1	SE SE	Jacob Spietes	--	--	98	6	DSm	P	--		--	Mo 16	
	15-2	SE NW	--	Litzner Bros.	1949	38	-	DSm	D	28	R	1949	Mo 20	do.
	15-4	NW NW	Clyde Gilmore	do.	--	60	4	DSm	P	8	R	1956	--	
	23-1	NW NE	Earl Warner	--	--	68	6	DSm	P	--		--	Mo 14	
	23-2	NE NW	Ralph Graham	--	--	65	6	DSm	P	--		--	--	
40N 3W	7-1	-- SW	Mackinaw Lumber Co.	Henry Erratta	1887	919	-	Sn	T	--		--	--	MDC log
	7-2	-- NW	Aaron Sweeney	Litzner Bros.	--	122	4	DSm	D	20	R	1949	ST 1	Cased to 121 ft.
	19-1	SE NE	MDC	Theron Brewer	1951	50	1¼	DSm	P	--		--	--	Bedrock at 5 ft.
	19-2	SW NE	Merritt, Chapman, and Scott	Litzner Bros.	1954	127	-	--	T	Dry	R	1954	--	Drilled in breccia
	19-3	SW NE	American Bridge Co.	do.	1955	160	-	--	T	Dry	R	1955	--	do.
	19-4	SW NE	do.	do.	1955	220	-	--	T	Dry	R	1955	--	do.

Table 3.--Records of Michigan State Highway Department test borings in Mackinac County

Altitude reported or estimated in feet above sea level.

Boring Designation T. R. sec.-No.			Location in sec. ¼	¼	Test hole No.	Depth (ft.)	Altitude	Remarks
44N	11W	18-6	NW	SW	1	44	691	Sand from 10 to 44 ft.
43N	11W	22-6	SW	SE	9	24	728	Limestone at 24 ft.
		27-8	NW	NE	16	36	727	Drilled in sand; limestone at 36 ft.
43N	10W	5-2	SE	SE	1	9	668	Limestones at 9 ft.
43N	9W	30-5	SW	NE	3	24	580	
43N	8W	29-10	SW	NW	6	44	583	Bedrock at 44 ft.
43N	1W	12-3	NE	NE	1	76	610±	Drilled in glacial drift.
42N	7W	12-3	SE	SE	13	34	656	
		12-4	SE	SE	15	23	624	6-inch auger hole.
		12-5	SE	SE	16	32	662	Do.
		12-6	SE	SE	17	32	719	Do.
		12-7	SE	SE	4	97	672	
		12-8	SE	SE	8	77	665	
		12-9	SE	SE	10	62	726	Drilled in yellow sand.
42N	3W	10-7	NE	NE	1	42	-	Rock at 42 ft.
42N	2W	16-1	NE	SW	1	35	580±	Flow of water from gravel at 33 ft.
42N	1E	34-3	NW	NW	2	16	580±	Drilled in clay and fine sand.
40N	3W	18-2	NE	NE	4	21	563±	Drilled under 17 ft. of water; finished in clay till.
		19-7	SW	SE	18	13	568	Drilled under 10 ft. of water; finished in soft blue clay.
		19-8	SW	SE	19	10	565	Drilled under 13 ft. of water; finished in soft sandy blue clay.
		19-11	NW	SE	1A	32	572	Drilled under 6 ft. of water; finished in loose stones.
		30-1	NW	NE	2	8	559	Drilled under 19 ft. of water; finished in soft, silty blue clay.

Table 4.--Selected logs of wells and test borings in Mackinac County

Altitude: Approximate or estimated in feet above sea level. Altitude of some wells is not known.

	Thickness (feet)	Depth (feet)
44N 12W 26-1 Altitude 695		
(Log from samples)		
Glacial drift	80	80
Burnt Bluff **formation:**		
Limestone and dolomite, buff	55	135
Cataract **formation:**		
Shale, gray and reddish-gray	15	150
Shale, gray, dolomitic	50	200
Dolomite, gray, light-brown, and buff	45	245
No record	35	280
Richmond group **and Collingwood formation:**		
Shale, soft, red, with gypsum	10	290
Shale, gray, dolomitic, with gypsum	55	345
Dolomite, brown, gray, with dolomitic shale	165	510
Shale, gray and brownish-gray	240	750
Trenton **and Black River limestones:**		
Limestone, dark- to light-brown	75	825
Dolomite, gray and buff, dense	60	885
Limestone, grayish-brown, light-brown	100	985
Limestone, light-brown, sandy	15	1000
Hermansville **(?) limestone:**		
Dolomite, light-brown, with some sandstone	25	1025
Munising **sandstone:**		
Sandstone, gray, water-bearing	30	1055
44N 11W 7-4 Altitude 690		
Glacial drift:		
Clay till, boulders	17	17
Burnt Bluff **formation:**		
Limestone	58	75
Cataract **formation:**		
Shale, blue	10	85
44N 11W 18-6 Altitude 691		
Water	1	1
Glacial drift:		
Sand, red, medium to fine, gravelly, bouldery	4	5
Clay, red, sandy	3	8
Sand, red, medium to fine, silty	6	14
Sand, red, medium to fine	30	44
44N 11W 19-3 Altitude 697		
Glacial drift:		
Soil	3	3
Sand and clay	52	55
Hardpan	10	65
Burnt Bluff **formation:**		
Limestone	5	70
44N 9W 17-2 Altitude 856		
Glacial drift:		
Sand	120	120
Burnt Bluff **formation:**		
Dolomite and limestone, brown and buff	65	185
Limestone, grayish, brownish-buff, and buff	35	220
No record (fresh water reported **at** 235-300 ft.)	50	270
Dolomite and limestone, gray, brown, and buff	70	340
Cataract **(?) formation:**		
Dolomite, gray, brown, and buff, little gypsum	65	405
Dolomite, gray and brown	30	435
Shale, greenish-gray	25	460
Dolomite, brown, light-brown, with gray shale	60	520
Richmond group:		
Shale, red, green, and gray	15	535
Gypsum with buff dolomite and gray shale	10	545
Dolomite, gray and brown	255	800
Shale, gray and black	180	980
Collingwood **formation:**		
Shale, dark-gray and black (show of oil and gas at 1005 ft.)	41	1021
Trenton **and Black River limestones:**		
Limestone, gray, brown, and buff	54	1075
Dolomite, gray, brown, and buff (water at 1097 ft., salt water at 1108-1120 ft.)	88	1163
Limestone, gray, brown, and buff (show of oil at 1170-1175 and 1195 ft.)	52	1215
Limestone and dolomite, light-brown, buff, and gray (salt water at 1215-1220 ft.)	65	1280
Dolomite, light-brown, grayish-brown, with sand	10	1290
Munising **sandstone:**		
Sandstone, gray, rounded, frosted	210	1500
44N 8W 6-4		
Glacial drift	4	4
Burnt Bluff **formation:**		
Limestone, gray	276	280
43N 11W 22-6 Altitude 728		
Glacial drift:		
Sand, layered, and limestone fragments	24	24
Engadine **dolomite:**		
Limestone at	--	24
43N 11W 27-8 Altitude 727		
Glacial drift:		
Sand, layered, and limestone fragments	36	36
Engadine **dolomite:**		
Limestone, hard, at	--	36
43N 10W 1-3 Altitude 625		
Glacial drift:		
Sand, clay, and gravel	96	96
Burnt Bluff **formation:**		
Limestone, broken	9	105
Limestone	87	192
43N 10W 2-1 Altitude 620		
Glacial drift	45	45
Manistique **dolomite:**		
Limestone, gray to buff, dense, cherty	5	50
Burnt Bluff **formation:**		
Limestone, buff, dense	10	60
Limestone, light-gray	10	70
Limestone, light-gray to buff, dense	10	80
Limestone, white to buff	10	90
Limestone, light-gray, dense	5	95
43N 10W 5-2 Altitude 668		
Glacial drift:		
Clay, plastic, sandy	2	2
Limestone, fragments and slabs	3	5
Sand, red, fine, with limestone slabs and fragments	3	8
Manistique **dolomite:**		
Limestone, shattered (bedrock)	1	9
43N 10W 26-3 Altitude 590		
Glacial drift:		
Sand	20	20
Niagara **series:**		
Limestone	174	194
43N 9W 11-2 Altitude 780		
Glacial drift:		
Sand	15	15
Sand, fine	105	120
Niagara **series:**		
Limestone and dolomite (crumbly, water-bearing limestone at 258 ft.)	430	550
Cataract **(?) formation:**		
Shale	1	551
Limestone	279	830
Shale	1	831
Richmond group:		
Limestone, water-bearing	139	970
Shale, hard, with limestone	141	1111
43N 9W 19-1 Altitude 590		
Glacial drift	65	65
Engadine **dolomite:**		
Limestone, white to buff, and sand grains	10	75
Dolomite, buff	45	120
Manistique **dolomite:**		
Limestone, buff, dense, cherty	35	155
Limestone, gray, sandy, very cherty	5	160
43N 9W 20-1		
Glacial drift	175	175
Engadine **dolomite:**		
Dolomite, gray to buff, cherty	10	185
Manistique **dolomite:**		
Limestone, gray, dense, some white chert	39	224
Shale, gray to brown, limy, carbonaceous	1	225
43N 9W 21-1 Altitude 590		
Glacial drift:		
Sand	25	25
Niagara **series:**		
Limestone, yellow, white, and blue	175	200
43N 9W 22-2 Altitude 595		
Glacial drift:		
Clay and sand till	52	52
Niagara **series:**		
Limestone (Creviced at 52-60, **95-110, and 205 ft)**	153	205
43N 9W 26-3 Altitude 588		
Glacial drift:		
Sand	30	30
Gravel	30	60
Sand	30	90
Manistique **dolomite:**		
Limestone	20	110
43N 9W 28-2 Altitude 588		
Glacial drift:		
Sand and stones	3	3
Clay, sandy	5	8
Clay and boulders	32	40
Sand, dirty	3	43
Clay	3	46
Sand	9	55
43N 9W 28-3 Altitude 595		
Glacial drift:		
Clay, red	49	49
Sand, clean, fine, yellow	7	56
43N 9W 28-4		
Glacial drift:		
Clay and boulders	15	15
Sand	24	39
Sand, clean	5	44
Sand, fine	1	45
43N 9W 29-1 Altitude 585		
Glacial drift	80	80
Engadine **dolomite:**		
Dolomite, white to buff	40	120
Manistique **dolomite:**		
Limestone, buff, dense, little chert	35	155
Dolomite, light-gray to buff, dense	20	175
43N 9W 29-6		
Glacial drift:		
Hardpan	15	15
Sand, coarse	23	38
Sand, coarse, and gravel	2	40
Sand, coarse	2	42
43N 9W 29-7 Altitude 590		
Glacial drift	70	70
Niagara **series:**		
Limestone, shattered	12	82
Limestone, hard	132	214
43N 9W 29-9		
Glacial drift:		
Boulders and clay	29	29
Clay	42	71
Sand, clayey, and boulders	9	80
Sand, fine	3	83
43N 9W 30-5 Altitude 580		
Glacial drift:		
Sand, gray	9	9
Sand and gravel with limestone slabs	3	12
Gravel	4	16
Sand and boulders	8	24
43N 8W 3-3		
Glacial drift:		
Sand, fine, dry	15	15
Sand, wet	10	25
Sand, fine, wet	6	31
Quicksand	18	49
Sand	2	51
Clay, gumbo, sandy, gravelly	7	58
Sand and limestone	3	61
Niagara **series:**		
Limestone, water-bearing	4	65
43N 8W 29-10 Altitude 583		
Glacial drift:		
Sand, yellow	6	6
Sand, gray	14	20
Quicksand	11	31
Quicksand and clay	4	35
Quicksand	8	43
Gravel	2	45
Engadine **(?) dolomite at**	--	45
43N 8W 30-2 Altitude 600		
Glacial drift:		
Sand	55	35
Boulders and sand	2	57
Niagara **series:**		
Limestone, broken (?)	12	69
Limestone	155	224

Table 4.--Selected logs of wells and test borings in Mackinac County. (Continued)

	Thickness (feet)	Depth (feet)
43N 8W 30-3 Altitude 590		
Glacial drift:		
Top soil	3	3
Sand	50	53
Hardpan	7	60
Engadine dolomite:		
Limestone, brownish-white	40	100
Limestone, brown and white	15	115
Manistique(?) dolomite:		
Limestone, brown	10	125
43N 4W 3-1		
Glacial drift	2	2
Niagara series:		
Limestone, hard, crevices filled with red clay and fine sand	78	80
Limestone, solid	122	202
Limestone	51	253
43N 3W 14-1		
Glacial drift:		
Boulder till	125	125
Clay and sand	50	175
Gravel, coarse, at	--	175
43N 3W 23-4		
Glacial drift:		
Boulder till	140	140
Sand and quicksand	20	160
43N 2W 5-2 Altitude 652		
Glacial drift:		
Clay	150	150
Sand and hardpan	45	195
43N 2W 27-1		
Glacial drift:		
Clay and sand	35	35
Sand	105	140
Hardpan	10	150
Niagara series:		
Limestone	5	155
43N 1W 1-1 Altitude 620		
Glacial drift:		
Clay, red	45	45
Quicksand	40	85
Gravel	3	88
43N 1W 1-2 Altitude 620		
Glacial drift:		
Clay, red	115	115
Gravel	15	130
43N 1W 1-4 Altitude 620		
Glacial drift:		
Clay, red	120	120
Quicksand	13	133
Gravel	7	140
43N 1W 5-1 Altitude 650		
Glacial drift:		
Sand	87	87
Gravel	17	104
43N 1W 10-1 Altitude 620		
Glacial drift:		
Clay, red	110	110
Gravel	2	112
43N 1W 12-1 Altitude 610		
Glacial drift:		
Clay, red	52	52
Quicksand	46	98
43N 1W 12-3 Altitude 610±		
Glacial drift:		
Gravel and clay	1	1
Clay, soft, red	4	5
Clay, soft, blue (trace of peat)	17	22
Peat, woody	2	24
Clay, firm, red	2	26
Clay, soft, red	10	36
Clay, soft, blue	20	56
Sand, medium and fine, silty	4	60
Sand, medium and fine, silty and gravelly	3	63
Sand, gravel, and stones, coarse	13	76
43N 1W 13-1 Altitude 610		
Glacial drift:		
Clay, red	110	110
Gravel	4	114
43N 1W 13-2 Altitude 613		
Glacial drift:		
Clay, red	60	60
No record	100	160
Gravel	10	170
Cataract formation:		
Dolomite, grayish-buff	25	195
Limestone, gray	80	275
Richmond group:		
Dolomite, gray	160	435
Shale, gray	5	440
Dolomite, gray	5	445
Shale, gray	205	650
43N 1W 13-2--Continued		
Collingwood formation:		
Shale, brown to black	35	685
Limestone, brown	5	690
Trenton and Black River limestones:		
Dolomite, gray to buff	65	755
Limestone, gray to buff	10	765
Dolomite, buff	5	770
Limestone, gray	35	805
No record	5	810
43N 1W 27-1		
Glacial drift:		
Sand	4	4
Clay	17	21
Gravel, dirty	4	25
Gravel, hard	15	40
43N 1W 29-3		
Glacial drift:		
Sand	5	5
Sand, red and black	3	8
Sand, coarse, and gravel	13	21
Hardpan	4	25
Sand, fine (dry)	10	35
Sand and boulders	5	40
Sand, dirty, and boulders	18	58
Clay, blue	3	61
Sand, coarse, water-bearing	14	75
42N 12W 3-1 Altitude 710		
Glacial drift:		
Sand	5	5
Gravel	35	40
Hardpan, stony	12	52
Burnt Bluff formation:		
Bedrock, hard	3	55
Limestone, porous, water-bearing	5	60
Limestone (creviced at 155 ft.)	100	160
42N 7W 2-2		
Glacial drift:		
Sand, dry	120	120
Quicksand	26	146
Clay, red	9	155
Sand	15	170
Clay, till	8	178
Hardpan	7	185
Niagara series:		
Limestone, brown	105	290
Limestone, blue (hot water reported)	46	336
Rock, soft, white, porous	1	337
Limestone, blue	1	338
42N 7W 2-3		
Glacial drift:		
Sand	160	160
Quicksand	13	173
Clay	3	176
Quicksand, dirty	7	183
Clay, red, stony	14	197
Niagara series:		
Limestone, hard	4	201
Limestone, crevices filled with clay	20	221
Limestone, soft	24	245
Limestone	5	250
Limestone, hard	10	260
Limestone, water-bearing	15	275
Limestone, hard	13	288
42N 7W 12-3, 4, 5, 6 Altitude (12-4) 624 (Composite log)		
Glacial drift:		
Sand, coarse	32	32
No record	25	57
Sand	10	67
Sand, coarse to fine	17	84
Sand, medium and fine	5	89
Sand	28	117
Sand, water-bearing	1	118
42N 7W 12-7 Altitude 672		
Glacial drift:		
Sand	43	43
Clay, till, sandy	6	49
Gravel, compact	3	52
Gravel, sandy	3	55
Sand, yellow	2	57
Clay till, sandy	6	63
Sand, yellow	34	97
42N 7W 12-8, 9 Altitude (12-8) 665 (Composite log)		
Glacial drift:		
Sand, yellow	62	62
No record	2	64
Sand, yellow	35	99
Gravel, clayey, compact	4	103
Sand, yellow	35	138
42N 6W 17-1		
Glacial drift	40	40
Salina:		
Shale, blue	30	70
42N 6W 22-1		
Glacial drift:		
Sand	6	6
Hardpan	3	9
Quicksand	32	41
Sand and gravel, water-bearing	2	43
Clay	11	54
Gravel and quicksand, water-bearing	4	58
Salina formation:		
Shale	12	70
Limestone, gray, soft, water-bearing	13	83
42N 5W 31-2 Altitude 605		
Glacial drift:		
Sand, dry	16	16
Sand, coarse, water-bearing	19	35
Sand, fine	13	48
Salina(?) formation:		
Clay, blue	77	125
Clay, blue, and sand	82	207
Limestone	34	241
42N 5W 36-1 Altitude 630		
Glacial drift:		
Muck and gumbo clay	16	16
Gravel	1	17
Clay or shale	25	42
Salina formation:		
Shale	48	90
Limestone	18	108
42N 4W 32-1		
Salina formation:		
Shale	45	45
Limestone	7	52
42N 4W 32-6		
Glacial drift	42	42
Salina formation:		
Shale and limestone	158	200
Limestone, porous, water-bearing, at	--	200
42N 3W 1-1 Altitude 638		
Glacial drift:		
Gravel	27	27
Niagara series:		
Limestone	138	165
42N 3W 3-1 Altitude 590		
Glacial drift	30	30
Engadine dolomite:		
Shale	19	49
Rock, hard and soft	13	62
42N 3W 3-2 Altitude 588		
Glacial drift:		
Clay, blue	40	40
Engadine dolomite:		
Rock, layers	33	73
Rock, hard, gray	35	108
42N 3W 10-1 Altitude 585		
Glacial drift:		
Sand	50	50
Engadine dolomite:		
Limestone	34	84
Rock, hard, at	--	84
42N 3W 10-4 Altitude 590		
Glacial drift	48	48
Engadine dolomite:		
Limestone	10	58
Limestone, crevices filled with quicksand	2	60
Limestone	19	79
42N 3W 10-5 Altitude 590		
Glacial drift:		
No record	40	40
Boulder at	--	40
Gravel and sand	30	70
Engadine dolomite:		
Limestone	65	135
42N 3W 10-7 Altitude 578		
Glacial drift:		
Sand, silt, gravel	3	3
Peat	6	9
Sand and silt, red	2	11
Clay, red, silty, plastic	5	16
Sand with gravel	4	20
Clay, red, soft, pebbly	2	22
Sand	2	24
Gravel (small flow of water)	3	27
Sand, fine, yellow, compact	17	44

Table 4.--Selected logs of wells and test borings in Mackinac County, (Continued)

	Thickness (feet)	Depth (feet)
42N 3W 20-2		
Glacial drift:		
Clay, boulders, some hardpan	27	27
Gravel	3	30
Salina formation:		
Limestone	3	33
42N 3W 30-1 Altitude 625		
Glacial drift	20	20
Salina formation:		
Limestone	22	42
42N 2W 4-2 Altitude 600		
Glacial drift:		
Clay	50	50
No record	42	92
Quicksand	4	96
42N 2W 4-3 Altitude 600		
Glacial drift:		
Clay, red, plastic	50	50
Quicksand at	--	50
42N 2W 16-1 Altitude 580±		
Glacial drift:		
Muck and gravel	1	1
Clay, red, silty	24	25
Clay, blue and red, with sand	4	29
Silt	1	30
Gravel (small flow of water)	3	33
Engadine dolomite:		
Limestone, boulder (bedrock?)	2	35
42N 1W 3-1		
Glacial drift:		
Sandy loam	7	7
Boulder till	27	34
Sand, fine	16	50
Hardpan (till)	40	90
Sand, fine, water-bearing	15	105
Clay, red, plastic	3	108
Sand, fine, silty	4	112
Sand, coarser	2	114
Clay	1	115
Sand, fine	5	120
Boulder till	10	130
Sand, water-bearing	4	134
42N 1W 24-1		
Glacial drift	63	63
Niagara series:		
Dolomite	87	150
Dolomite, white	73	223
42N 1W 28-2 Altitude 582		
Glacial drift	26	26
Engadine dolomite:		
Dolomite (water at 39 ft.)	13	39
Limestone	41	80
42N 1W 36-2 Altitude 620		
Glacial drift:		
Hardpan (till)	51	51
Gravel	6	57
Engadine dolomite at	--	57
42N 1W 36-7 Altitude 620		
Glacial drift:		
Gravel	13	13
Sand	5	18
Hardpan (till)	40	58
Engadine dolomite:		
Dolomite (water at 65 ft.)	13	71
Limestone, water-bearing	2	73
42N 1W 36-8		
Glacial drift	26	26
Engadine dolomite:		
Dolomite	12	38
42N 1E 31-5 Altitude 610		
Glacial drift:		
Clay, boulders	50	50
Niagara series:		
Limestone	84	134
42N 1E 31-11 Altitude 610		
Glacial drift:		
Clay and hardpan	51	51
Engadine dolomite:		
Dolomite, gray	21	72
Dolomite or limestone	5	77
42N 1E 31-12 Altitude 610		
Glacial drift:		
Hardpan	50	50
Limestone	33	83
42N 1E 31-13 Altitude 595		
Glacial drift	30	30
Engadine dolomite:		
Limestone	10	40
42N 1E 34-3 Altitude 580±		
Glacial drift:		
Clay, blue	5	5
Clay and fine sand	11	16
41N 5W 1-1 Altitude 700		
Glacial drift:		
Clay, gumbo and muck	10	10
Clay	32	42
Salina formation:		
Shale	48	90
Limestone	8	98
41N 5W 25-1 Altitude 590		
Glacial drift:		
Clay	3	3
Salina formation:		
Limestone, brown	27	30
41N 5W 25-2 Altitude 590		
Glacial drift:		
Sand and clay	6	6
Clay	10	16
Salina formation:		
Limestone, brown and white	24	40
Limestone breccia, brown and white	100	140
Limestone, brown, hard	10	150
Limestone, brown and white	20	170
41N 5W 26-1 Altitude 590		
Glacial drift:		
Sand and clay	22	22
Salina formation:		
Limestone	12	34
41N 4W 5-1 Altitude 700		
Salina formation:		
Shale	45	45
Limestone	3	48
41N 4W 31-1 Altitude 600		
Glacial drift:		
Clay	21	21
Salina formation:		
Shale	10	31
Limestone	6	37
41N 4W 36-2		
Glacial drift:		
Gravel and cobbles	15	15
Clay, red	25	40
Mackinac breccia:		
Rock, soft	70	110
41N 3W 30-1		
Mackinac breccia:		
Clay, limestone, some gypsum	23	23
Limestone	9	32
Gypsum, white	21	53
Limestone, shaly	3	56
Gypsum	9	65
41N 3W 31-1 Altitude 600		
Glacial drift:		
Clay	7	7
Mackinac breccia:		
Gypsum	1	8
Shale, gray and red, soft	2	10
Gypsum	1	11
Shale, red and gray	39	50
41N 3W 31-2 Altitude 595		
Mackinac breccia:		
Shale, soft, or clay	55	55
Limestone	15	70
41N 3W 31-15		
Glacial drift:		
No record	34	34
Gravel, with gypsum	11	45
Mackinac breccia:		
No record	18	63
Dolomite	26	89
No record	11	100
Dolomite, dark	4	104
No record	70	174
Gypsum	13	187
Shale, red and blue	68	255
Gypsum	5	260
Shale, red and blue	40	300
Gypsum at	--	300
Shale, blue, with gypsum	126	426
Salina(?) formation:		
Dolomite, gypsiferous	18	444
Dolomite, light	19	463
Dolomite, dark brown	47	510
Niagaran series:		
Dolomite, light	60	570
Dolomite, white, sandy (good water at 575 ft.)	15	585
Dolomite, hard, cherty	7	592
Dolomite, white, sandy (sulphur water from 681-781?)	196	788
Dolomite, brown	232	1020
Limestone	90	1110
41N 3W 31-15--Continued		
Cataract(*) formation:		
Dolomite, blue, shaly	35	1145
Dolomite, brown, cherty	5	1150
Dolomite, light	16	1166
41N 1W 1-8 Altitude 590		
Glacial drift:		
Clay, boulders	38	38
Engadine dolomite:	7	45
41N 1E 2-1 Altitude 610		
Glacial drift	75	75
Engadine dolomite:		
Sandstone (?)	15	90
Limestone	42	132
41N 1E 2-2 Altitude 605		
Glacial drift	70	70
Engadine dolomite:		
Sandstone (?)	18	88
Limestone	38	126
41N 1E 2-3 Altitude 595		
Glacial drift	52	52
Engadine dolomite:		
Rock, brown, black	7	59
Dolomite	34	93
41N 1E 4-1 Altitude 605		
Glacial drift:		
Boulder till	91	91
Gravel, cemented	22	113
Niagara series:		
Limestone, blue-gray, hard	3	116
Limestone, brown, hard, abrasive	74	190
41N 1E 4-2 Altitude 615		
Glacial drift:		
Boulder till, fine sand, cemented gravel	82	82
Engadine dolomite:		
Limestone	22	104
41N 1E 4-6 Altitude 683		
Glacial drift:		
No record	12	12
Gravel, cemented	38	50
Engadine dolomite:		
Dolomite, hard, and limestone	23	73
41N 2E 6-1 Altitude 588		
Glacial drift:		
Gravel	6	6
Clay, blue, soft	13	19
Quicksand and clay	16	35
Boulder till	2	37
Engadine dolomite:		
Dolomite	10	47
40N 4W 5-3 Altitud		
Glacial drift:		
Sand and clay	22	22
Mackinac breccia:		
Limestone, gray	5	27
Limestone breccia, shaly, at	--	27
40N 4W 8-4		
Mackinac breccia:		
Limestone	50	50
Shale, soft,(water at 220 ft.)	170	220
40N 4W 8-6		
Mackinac breccia:		
No record (shale)	146	146
Shale	76	222
Shale breccia (water)	2	224
40N 4W 8-8 Altitude 620		
Mackinac breccia:		
Shale, soft	60	60
Shale, red, hard (water at 141 ft.)	81	141
40N 4W 12-3		
Glacial drift:		
Boulder till	45	45
Sand, water-bearing, at	--	45
Clay till, sandy	27	72
Sand and gravel, water-bearing	7	79
40N 3W 7-1 Altitude 600		
Fill	15	15
Mackinac breccia:		
Shale, red and blue (salt water)	385	400
Shale, red (salt vein)	4	404
Salina(?) formation:		
Shale, blue	100	504
Niagara series:		
Limestone, buff, with dolomite and gypsum	300	804
Sandstone, oily, and white limestone, with gypsum	95	899
Sandstone, calcareous, gray	20	919

Table 4.--Selected logs of wells and test borings in Mackinac County, (Continued)

	Thickness (feet)	Depth (feet)
40N 3W 7-2 Altitude 620		
Glacial drift:		
Gravel and clay	15	15
Mackinac breccia:		
Shale, soft (water at 121 ft.)	106	121
Limestone	1	122
Sand, water-bearing, at	--	122
40N 3W 18-2 Altitude 580 ±		
Water	17	17
Glacial drift:		
Silt, soft	8	25
Clay, hard, stony, red	13	38
40N 3W 19-1 Altitude 585		
Glacial drift:		
Clay	5	5
Mackinac breccia:		
Limestone, white	5	10
Limestone	35	45
Shale, gray	5	50
40N 3W 19-2 Altitude 594		
Fill	10	10
Glacial drift:		
Sand, beach	7	17
Mackinac breccia:		
Shale and clay (quicksand at 117 ft.)	100	117
Rock, loose, and water	10	127
40N 3W 19-3 Altitude 605		
Glacial drift:		
Sand and gravel	17	17
Hardpan	5	22
Mackinac breccia:		
Clay, blue (little water at 23 ft.)	26	48
Limestone	16	64
Shale, red and blue	96	160
40N 3W 19-4 Altitude 605		
Glacial drift:		
Sand and gravel, clay (small water flow)	16	16
Mackinac breccia:		
Limestone, soft	9	25
Clay, blue	19	44
Limestone	16	60
Shale, blue	10	70
Shale, red	100	170
Shale, light-gray	28	198
Shale, gray	12	210
Shale, red	10	220
40N 3W 19-7 Altitude 568		
Water	10	10
Glacial drift:		
Sand, yellow, gray, gravelly	1	11
Clay, firm, blue, silty	10	21
Clay, soft, blue, silty	2	23
40N 3W 19-8 Altitude 565		
Water	13	13
Glacial drift:		
Gravel, fine	1	14
Clay, firm, blue, silty, gravelly	4	18
Clay, soft, sandy, blue, with seams of gray sand	5	23
40N 3W 19-11 Altitude 572		
Water	6	6
Glacial drift:		
Clay, hard, red, gravelly	12	18
Clay, soft, red	11	29
Clay, stiff, green	4	33
Stones, loose	5	38
40N 3W 30-1 Altitude 559		
Water	19	19
Glacial drift:		
Sand, "stream-washed"	1	20
Clay, firm, blue, silty	1	21
Clay, soft, blue	6	27

Table 5.--Summary of data from seismic study of the bedrock surface in Mackinac County. (Adapted from U. S. Corps of Engineers, 1949.)

Location ¼	¼	Sec.	T.	R.	Corps of Engineers Line No.	Depth to Bedrock 1/
NE	NW	25	43N	3W	4	70
NW	SE	35	43N	3W	27	85
SW	SW	36	43N	3W	3	42
NW	NW	36	43N	3W	25	15
NE	NW	5	43N	2W	7	Below 131 2/
NE	NE	7	43N	2W	6	Below 143 2/
NE	NW	19	43N	2W	5	Below 110 2/
SE	SW	2	42N	3W	18	36
SW	SW	2	42N	3W	19	42
SE	SE	2	42N	3W	2	12
NW	SW	2	42N	3W	22	32
NW	NE	2	42N	3W	23	75
SW	SW	2	42N	3W	20	36
SE	SE	3	42N	3W	24	46
NE	SE	3	42N	3W	21	51
SE	SE	3	42N	3W	26	63
SW	SE	3	42N	3W	1	71

1/ Depth to bedrock given in feet below land surface.

2/ Depth to bedrock not known. Seismic data indicate glacial drift present at depth given.

Table 6.--Specific capacities of wells in Mackinac County

E - Drawdown or discharge estimated; M - drawdown and discharge measured; R - drawdown or discharge reported.

Well Number	Aquifer Symbol1/	Aquifer Lithology	Drawdown (feet)	Rate of discharge (gpm)		Specific capacity (gpm/ft)
43N 9W 28-3	Qgd	Sand, fine, yellow	5	50	R	10
43N 9W 28-4	Qgd	Sand	5	30	R	6
43N 9W 29-6	Qgd	Coarse sand	6.5	22	R	3.4
43N 3W 14-1	Qgd	Sand and gravel	20	60	E	3
43N 3W 14-2	Qgd	Do.	4.6	4	M	.9
41N 3W 31-13	Qgd	Do.	10	15	R	1.5
41N 4W 36-1	DSm	Brecciated limestone	20	15	R	.75
41N 4W 36-3	DSm	Do.	15	6	R	
40N 4W 5-3	DSm	Limestone, broken	2	50	R	25
40N 4W 8-4	DSm	Shale	110	6.5	R	.06
40N 4W 9-1	DSm	Shale, sandy	90	17	R	.19
40N 4W 9-2	DSm	Shaly sandstone ?	25	15	R	.6
40N 4W 9-6	DSm	Shale ?	36	8	R	.22
40N 3W 7-2	DSm	Limestone and sand ?	50	8	R	.16
42N 4W 32-1	Ss	Limestone	10	6.6	R	.66
41N 5W 23-1	Ss	Limestone and shale	1.88	36	M	19
41N 5W 26-1	Ss	Limestone	5	50	R	10
41N 4W 31-1	Ss	Do.	10	15	R	1.5
42N 3W 3-2	Se	Dolomite	8	10.5	M	1.3
42N 3W 12-1	Se	Do.	1	15	R	15
42N 1W 25-1	Se	Limestone	2	12	R	6
42N 1W 25-2	Se	Do.	25	7.5	R	.3
42N 1W 25-3	Se	Dolomite	9	15	R	1.7
42N 1W 34-1	Se	Limestone	13	15	R	1.1
42N 1W 36-3	Se	Do.	28	13	R	.46
42N 1E 30-1	Se	Do.	35	9	R	.25
42N 1E 31-12	Se	Do.	.5	13	R	26
41N 1E 4-2	Se	Do.	10	10	R	1
41N 2E 6-1	Se	Dolomite	6	25	R	4
43N 10W 26-2	Sm	Limestone	50	75	E	1.5
43N 9W 22-2	Sm	Do.	10	150	E	15
43N 9W 29-7	Sm	Do.	84	500	R	6
42N 1W 24-1	Sm	Dolomite	40	6	R	.15
41N 1E 4-3	Sm	Limestone	50	13	R	.26
44N 11W 19-3	Sb	Limestone	.84	1.0	R	1.2
42N 12W 7-1	Sb	Do.	2.5	60	M	24
42N 12W 3-1	Sb	Do.	1	100	R	100
42N 7W 2-2	Sc	Limestone	30	25	R	.8
42N 7W 2-3	Sc	Do.	4	30	R	7.5
43N 8W 3-3	Sc	Do.	2.3	6	R	2.6
43N 9W 11-2	Or?	Limestone	2	200?	R	100

1/ See table 2.

Table 7.--Chemical analyses of water samples in Mackinac County

Aquifer: Symbols used are those listed and described in table 1.

Analyst: U, U. S. Geological Survey; M, Michigan Department of Health.

Remarks: WSP 236, data taken from U. S. Geological Survey Water-Supply Paper 236; Ice, water collected through hole broken in ice; Turb., turbidity; Temp., temperature in ° F.; Li, lithium; Cu, copper; Zn, zinc; Al, aluminum; PO_4, phosphate; N. C., non-carbonate hardness (as $CaCO_3$).

Well designation T. R. sec.-No. or source	Aquifer sampled	Analyst	Date collected	Chemical constituents, parts per million: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) / Na + K	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Specific conductance (micromhos at 25°C)	pH	Remarks
Fresh Ground Water																					
44N 12W 10-1	Cm	U	9-11-56	5.1	.14	.04	42	16	27	3.9	156	0	59	30	.7	0.0	263	171	460	7.4	N.C., 43; Color 2
26-1	Cm	M	2-21-39	-	Tr.	-	-	-	-	-	-	-	-	92	-	-	-	230	-	-	
26-1	Cm	M	1-26-40	12	-	-	46	20	55		141	8	59	91	-	-	372	199	-	-	
36-5	Sb	M	9-15-50	-	0	-	-	-	-	-	-	-	-	18	-	-	-	1,640	-	-	
43N 11W 21-2	Sm	M	11-17-52	-	2.8	-	-	-	-	-	-	-	-	14	-	-	-	280	-	-	
21-2	Sm	M	11-21-52	-	3.0	-	-	-	-	-	-	-	-	11	-	-	-	260	-	-	
43N 10W 16-2	Sm	M	10-17-56	9.0	0	0	43	25	4.1	1.1	252	0	9.0	0	1.0	0	210	210	400	7.6	Odor, none; Turb., 0; Color, 2
43N 9W 28-3	Qs	M	3-13-57	-	-	-	46	13	-	-	200	-	-	-	-	-	-	170	390	-	
29-1	Sm	-	1937	-	-	-	52	16	-	-	227	-	-	7.3	-	-	-	-	-	-	Computed from hypothetical combinations
29-1	Sm	U	8-27-56	7.4	.15	-	32	27	0.8	0.2	223	0	9.1	1.2	.0	1.0	193	191	358	7.6	N.C., 8.0; Color, 4
29-7	Sm	U	8-27-56	8.5	0	0	49	17	0.9	0.8	222	0	9.9	.6	.0	.8	191	192	356	7.8	Temp., 44; N.C., 10; Color, 2
43N 3W 14-2	Qgd	U	10-18-56	8.6	.05	.03	34	14	0.8	1.1	160	0	12	0	.1	.0	147	142	267	7.8	Temp., 43; N.C., 11; Color, 4
43N 1W 13-1	Qs	M	3-11-57	-	-	-	77	40	-	-	205	-	-	-	-	-	-	360	820	-	Temp., 45
42N 12W 7-1	Sb	U	10-17-56	8.0	.97	0	67	16	0.8	1.1	270	0	8.0	0	.4	.1	238	233	427	7.3	Temp., 44; N.C., 12; Color, 6
42N 6W 22-5	Qs	U	10-19-56	21	.20	0	59	35	3.9	2.1	287	0	54	.2	1.2	.0	311	291	528	7.7	N.C., 56; Color, 2
22-10	Qgd	M	9-29-36	-	-	-	-	-	-	-	-	-	29	-	-	-	-	-	-	6.9	
42N 3W 3-2	Se	M	2-14-57	-	-	-	-	33	-	-	325	-	-	-	-	-	284	285	550	-	
9-1	Se	U	2-14-57	6.8	.09	.01	71	29	2.5	1.0	273	0	71	2.8	.7	.9	324	296	550	7.5	Temp., 44; N.C., 72; Color, 1
10-2	Qsg	M	3-11-57	-	-	-	65	29	-	-	340	-	-	-	-	-	-	280	570	-	Temp., 44
42N 1E 31-3	Se	U	10-18-56	10	.46	0	29	32	4.5	1.9	245	0	12	.7	.9	.1	226	204	402	7.9	Li, 0; Cu, 0; Zn, 0; Al, 0.1; PO_4, 0; N.C., 3; Color, 4
41N 5W 31-12	DSm	M	9-26-56	4.0	0	0	140	32	11	3.5	358	0	165	14	.6	38	640	485	1,000	7.2	Odor, none; Turb., 0; Color, 15
41N 1W 1-8	Se	M	7-21-53	-	0	-	-	-	-	-	-	-	-	5.0	-	-	-	335	-	-	
1-10	Se	M	7- 9-52	.10	-	-	-	-	-	-	-	-	-	6.0	-	-	-	270	-	-	
Mineralized Ground Water																					
44N 9W 17-2	Otb	M	1-29-37	-	-	-	195	121	1,090		146	0	245	2,120	-	-	4,160	-	-	-	Drilled into Css; Specific gravity at 15° C., 1.005
42N 6W 22-1	Ss	U	10-19-56	12	0.99	0	486	98	3.8	3.2	122	0	1,460	0	1.5	0.0	2,310	1,620	2,290	7.4	Li, 1.1; N.C., 1520; Color, 1
22-9	Ss	M	9-13-36	-	-	-	-	-	-	-	-	-	520	-	-	-	-	-	-	6.5	
22-9	Ss	M	10- 1-36	-	-	-	-	-	-	-	-	-	544	-	-	-	-	-	-	6.9	
41N 5W 23-1	Ss	U	10-12-56	5.6	.02	0	460	24	6.5	1.7	248	0	996	5.3	.4	4.1	1,790	1,250	1,910	7.6	Li, 0.4; Temp., 44; N.C., 1040; Color, 7
41N 4W 36-1	DSm	M	9-26-56	4.0	.07	0	495	40	9.0	3.1	302	0	1,110	6.0	.8	0	2,000	1,400	2,400	7.5	Odor, none; Turb., 3; Color, 8
41N 3W 31-13	DSm	M	9-26-56	4.0	.40	0	545	39	11	2.38	356	0	1,190	8.0	.7	0	2,130	1,520	2,400	7.3	Odor, none; Turb., 0; Color, 7
40N 4W 9-6	DSm	M	11-24-56	-	.90	-	-	-	-	-	-	-	-	11	-	-	-	1,920	-	-	SO_4 reported very high
Surface Water																					
Straits of Mackinac at Midchannel		U	9-20-06	17	.02	-	27	7.7	4.9		109	3.9	6.6	2.6	-	0.2	126	-	-	-	WSP 236; Turb., 1
do.		U	10-20-06	9.2	.02	-	26	7.4	4.4		103	6.6	6.5	2.6	-	.3	115	-	-	-	WSP 236; Turb., 1
do.		U	11-20-06	9.5	.05	-	28	8.8	3.4		117	2.4	6.4	2.9	-	.3	120	-	-	-	WSP 236
do.		U	12-20-06	10	.06	-	25	7.1	4.7		104	1.6	6.2	2.6	-	Tr.	108	-	-	-	WSP 236; Turb., 1
do.		U	1-20-07	6.2	.04	-	26	8.1	3.2		110	1.6	6.2	2.8	-	.4	110	-	-	-	WSP 236; Turb., 1
do.		U	2-19-07	12	.03	-	26	8.4	5.4		113	3.4	7.6	2.8	-	.3	120	-	-	-	WSP 236
do.		U	3-20-07	14	.03	-	25	7.9	5.0		111	Tr.	7.9	2.6	-	.4	117	-	-	-	WSP 236
do.		U	4-21-07	8.4	.04	-	26	8.1	4.7		112	0	9.5	2.4	-	.3	115	-	-	-	WSP 236
do.		U	5-20-07	9.5	.03	-	27	8.7	5.4		115	2.6	7.8	2.5	-	.2	121	-	-	-	WSP 236
do.		U	6-20-07	8.6	.04	-	26	8.4	6.6		116	4.5	7.7	3.0	-	.5	120	-	-	-	WSP 236
do.		U	8-20-07	11	.04	-	28	9.4	4.2		120	3.5	7.4	3.2	-	.4	123	-	-	-	WSP 236
L. Huron at St. Ignace		M	3- 6-24	7.2	-	-	26	9.3	3.0		101	-	19	4.5	-	-	105	-	-	-	
do.		M	7-30-27	12	-	-	28	7.5	Tr.		101	-	11	5.0	-	-	146	130	-	-	
do.		M	5- 4-37	2.4	.45	-	26	8.7	7.3		104	0	24	4.5	-	-	122	100	-	-	
do.		M	5- 7-52	2.9	1.1	-	26	7.8	11		116	0	13	4.0	0	0	126	98	200	7.6	Turb., 2.5; Color, 5
do.		M	10-12-56	4.0	0	0	25	7.3	4.4	0.8	98	0	12	4.0	0	0	110	92	220	7.8	Odor, none; Turb., 0; Color, 3
Carp R.-Sec. 19, T. 42 N., R. 3 W.		U	2-14-57	7.4	.42	0	38	14	1.2	.6	170	0	9.8	.6	.1	.9	165	153	282	7.5	Ice; Color, 24
Nuns Cr.-Sec. 4, T. 42 N., R. 2 W.		M	2-14-57	-	-	-	40	18	-	-	210	-	-	-	-	-	206	175	390	-	Ice
McKay Cr.-Sec. 34, T. 42 N., R. 1 E.		M	3-11-57	-	-	-	46	25	-	-	224	-	-	-	-	-	-	220	450	-	Ice
Pt. Aux Chenes R. Sec. 25, T. 41 N., R. 5 W.		M	3-12-57	-	-	-	14	1.2	-	-	46	-	10	.0	-	-	-	40	160	-	Ice
Rabbits Back Cr. Sec. 30, T. 41 N., R. 3 W.		M	2-14-57	-	-	-	140	-	-	-	-	-	300	-	-	-	610	430	800	-	Ice
Moran R.-Sec. 10, T. 40 N., R. 4 W.		U	2-14-57	9.5	.01	0	233	26	5.8	1.3	193	0	487	6.0	.3	2.3	936	689	1,170	7.4	Ice; Color, 45