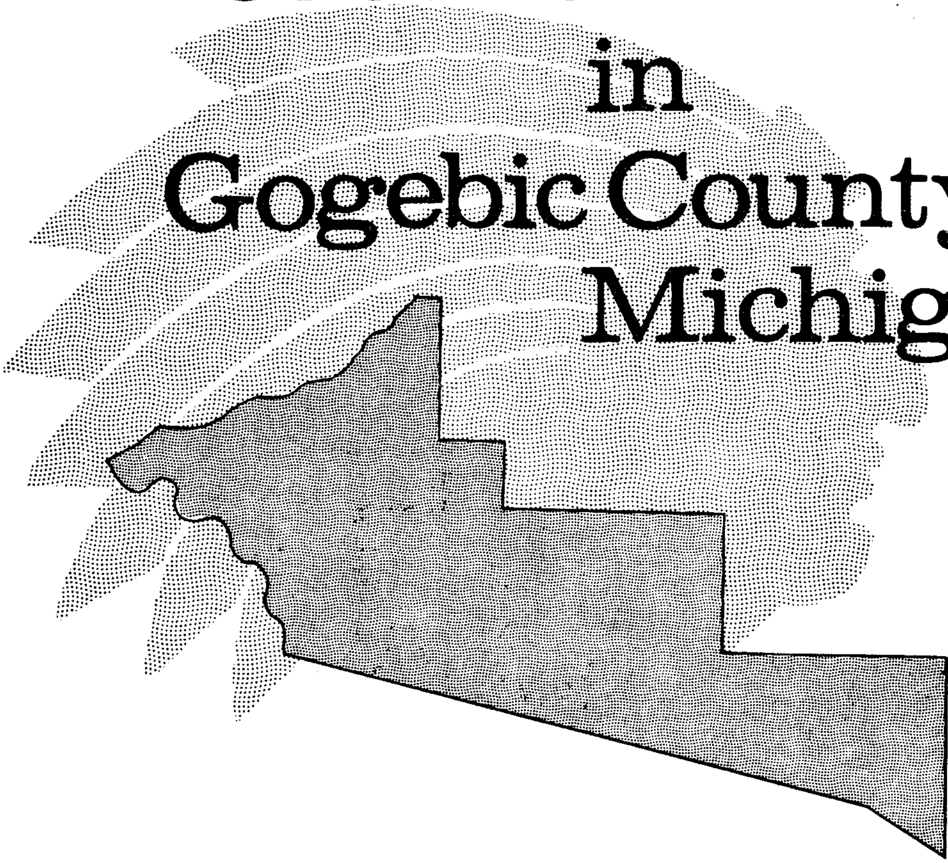
Water Investigation 8

Ground Water in Gogebic County, Michigan



Geological Survey, 1968

Gogebic~ "Where rising
trout make rings on
the water"

Michigan Geological Survey, Water Investigation 8, GROUND WATER IN GOGEBIC COUNTY, 1968

Geological Survey

Water Investigation 8

GROUND WATER IN GOGEBIC COUNTY, MICHIGAN

by

C. J. Doonan and G. E. Hendrickson

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

Lansing, 1968

STATE OF MICHIGAN
George Romney, Governor

DEPARTMENT OF NATURAL RESOURCES
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GEOLOGICAL SURVEY DIVISION
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PREFACE

The Michigan Geological Survey and the United States Geological Survey have cooperated for many years producing basic information on water resources of Michigan. This report is a product of that continuing program.

Information on representative wells and springs is summarized. Geologic and other features causing well yields to vary in different parts of the county are described. The geologic map in pocket should be useful to anyone who wishes to obtain a water supply from wells. This map was adapted from one prepared by F. W. Terwilliger, Michigan Geological Survey, from a field reconnaissance and a soils map by Humphrys and Tucker (1950).

Descriptions of municipal water supplies provide a permanent record of present conditions which should be useful in evaluating effects of future developments.

The cooperation and assistance of personnel of federal, state and county agencies, municipalities, industrial concerns, well drillers and many other individuals made this report possible. Special credit is due F. W. Terwilliger for mapping the surface geology of the county. A. E. Slaughter, also with the State Geological Survey, provided assistance during the investigation and reviewed the report.

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Lansing, Michigan
November 1967

ILLUSTRATIONS

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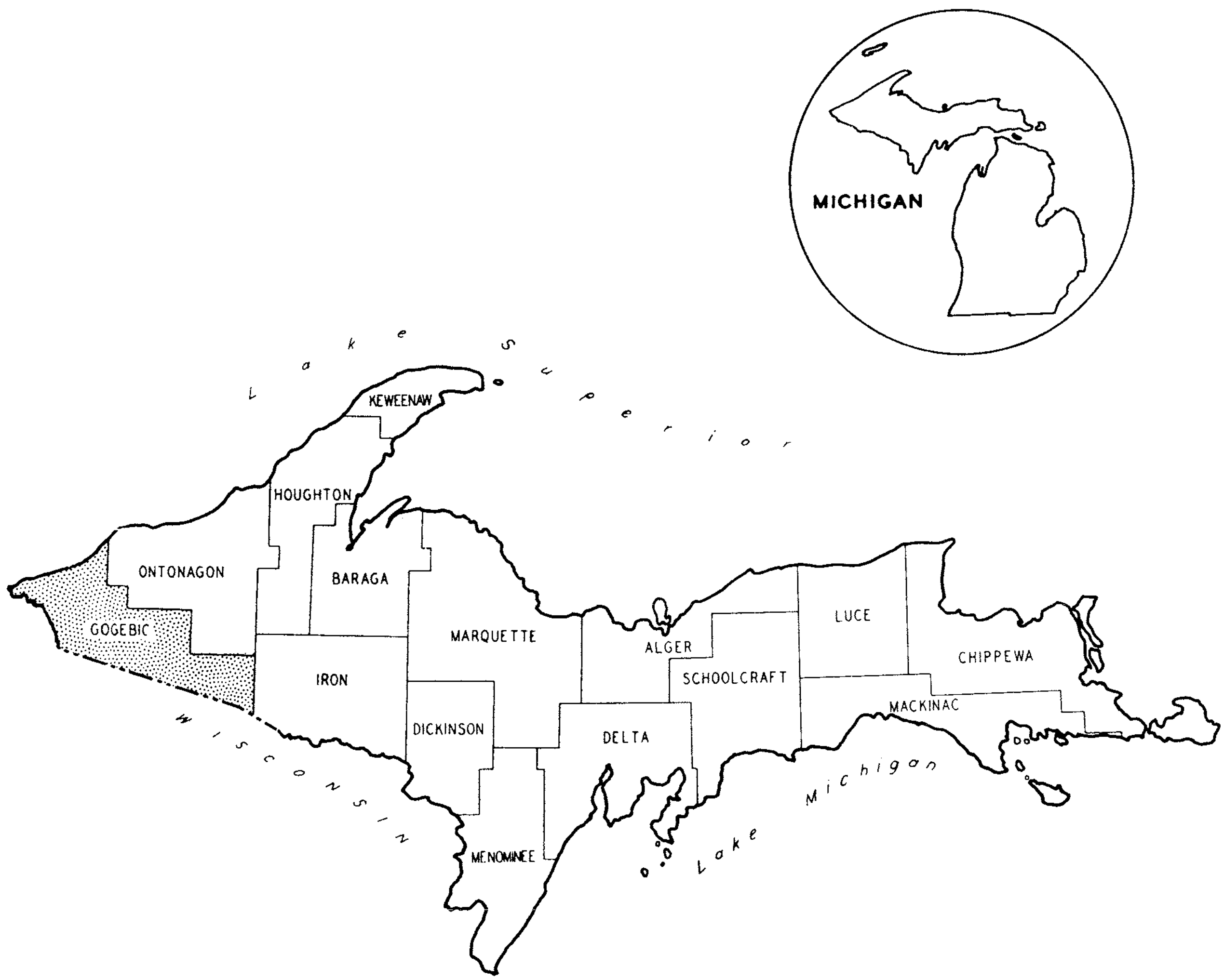
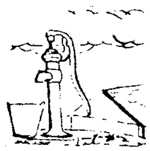


Figure 1.-- Gogebic County, in western end of Michigan's Upper Peninsula



GROUND WATER IN GOGEBIC COUNTY, MICHIGAN

INTRODUCTION

More than 90 percent of the people in Gogebic County depend on ground water for their municipal and domestic water supplies, but this resource is not abundant or evenly distributed. Over large areas rural residents have difficulties obtaining the few gallons per minute needed for household use, whereas in some areas wells yield several hundred gallons per minute. The purpose of this report is to provide information that will be useful to all who use or need water obtained from wells or springs.

Previous Investigations

Brown and Stuart (1951) described the ground-water resources of the Bessemer area. The detailed part of their study included an area of about 60 square miles, whereas their geologic map covered about twice as much area. The geologic map accompanying the present report (in pocket) is adapted from the Brown and Stuart. Information on availability of ground water from the various geologic features has been added. For detailed information on the Bessemer area, however, the original report should be consulted.

Economy

Gogebic County, in the western end of Michigan's Upper Peninsula, was separated from Ontonagon County in 1887, and the county seat established at Bessemer. Of the total land area of 711,680 acres, 83 percent is forest land and 2.5 percent is cultivated agricultural land. Approximately 40 percent of the land is owned by the federal government; the county owns 8 percent; and 2 percent is in state ownership.

Population reached a peak of 33,225 in 1920, after which it declined to 24,370 in 1960. County officials estimated a population of 21,600 in 1965. Most of the people live near U.S. Highway 2, which connects the cities of Ironwood, Bessemer, Wakefield, Marenisco, and Watersmeet.

The county has an excellent network of highways and roads including four state trunklines totaling 129 miles, 565 miles of county roads, and many miles of forest-access roads maintained by the Ottawa National Forest and private timber companies. Common-carrier service is provided by two railroads, two truck lines, one bus line, and one commercial airline.

Mining and lumbering were dominant industries for many years. The county's first iron ore was taken from the Colby mine in Bessemer in 1884. Logging paralleled the upsurge in mining, and the economy boomed until about 1920. The history of economic activity has since been one of gradual decline. In 1963, there were five large and several small sawmills operating. The last iron mine closed in January 1966.

Tourism and resorting have become important all-season businesses, with an estimated annual value of $13,000,000. Natural features important to this activity include 1,129 lakes and ponds one-tenth of an acre or more in size, over 1,200 miles of rivers and streams and about 25 miles of shore line on Lake Superior and 38 waterfalls some of which have drops of 30 feet. Three ski hills are used by 120,000 skiers each season. Average annual snowfall is about 183 inches.

Agriculture has never been important. In 1959, there were 200 farms; in 1964, 138.

Numbering System

The system for numbering wells and springs in this report corresponds to the rectangular system of land subdivisions with reference to the Michigan meridian and base line. The first two parts of a number designate township and range; the last part designates both the section and the well or spring within the section. Thus 44N 38W 16-1 is well number one in section 16, Township 44 North, Range 38 West.

PHYSIOGRAPHY

The surface features of Gogebic County are controlled by the Precambrian bedrock and the unconsolidated glacial deposits which cover the bedrock in about 90 percent of the county. The topography ranges from relatively flat areas of till plains and lake beds, through rolling moraines, to rugged hills of Precambrian rocks. The altitude of most of the county is about 1,300 feet above mean sea level. Many hills rise about 1,700 feet (Fig. 2). South of U.S. Highway 2 in the eastern part of the county is an upland area of sandy moraine and outwash dotted with numerous lakes. Precambrian bedrock is exposed or is near the surface in a broad, wedge-shaped belt, extending from the south end of Lake Gogebic west to the county line. Smaller areas of Precambrian rocks are exposed to the north of this belt. A relatively flat area of till plain and lake beds is located in the north-central area. A steep moraine, underlain at shallow depth by bedrock, parallels the Lake Superior shore line in the northwest.

Most of the county drains to Lake Superior; a small area in the southeast drains to Lake Michigan. Four large rivers, the Montreal, Black, Presque Isle, and Ontonagon, flow into Lake Superior. The lower reaches of the Black and Presque Isle are very steep with numerous falls and rapids cut into Precambrian rocks. Headwaters of the Ontonagon River are in Gogebic County, but the main stem is in Ontonagon County. Lake Gogebic, drains to the West Branch of the Ontonagon River. This lake is about 12 miles long and two to three miles wide, only the south half is in Gogebic County.

GROUND-WATER RESOURCES

The water-bearing formations, called aquifers, are chiefly beds of sand and gravel in glacial drift. Some wells obtain water from fractures in the bedrock, and a few obtain small supplies from silty drift, but almost all large-producing wells are in sand and gravel along streams. Water is added to the aquifers by infiltration of rain and melting snow and is discharged chiefly to springs and streams. In areas of shallow water table, some ground water is lost to the atmosphere by evaporation or by transpiration through growing plants.

The amount of ground water stored in the aquifers varies seasonally and from year to year, depending chiefly on the amount of rainfall and melting snow. Variations in the amount of water in storage are reflected in changes in the elevation of water table (Fig. 4). When the rate of recharge is faster than the discharge, as during the time of spring snowmelt, water levels generally rise. When the rate of discharge exceeds recharge, as in late summer and during most of the winter, water levels fall.

Methods of Obtaining Ground Water

Nearly all ground-water supplies in Gogebic County are obtained from wells tapping the glacial drift. A few wells are finished in Precambrian rocks, and some springs have been developed for both domestic and public supplies.

Wells

More than 80 percent of the wells visited during this study were drilled wells; of these almost half were between 50 and 100 feet deep (table 1 in appendix). Several four-inch wells as shallow as 25 feet produced enough water for small public supplies or modern domestic systems. Locations of most of the wells inventoried are shown on map 1 (in pocket). In areas where shallow wells yielded inadequate supplies, drilling to depths greater than 200 feet has been attempted--usually without success. Yield, if any, was very small, and the quality poor. However, one public supply obtains an adequate amount of good quality water from a six-inch well 300 feet deep.

In many areas glacial drift contains water at shallow depths, but silt and fine sand may plug well screens. Under these conditions dug wells may be more successful than drilled wells in satisfying the demands for household and stock use. Most dug wells are 24 or 36 inches in diameter and from eight to as much as 36 feet deep. Wells are cribbed with concrete, vitrified clay pipe, or stone. Poorly-constructed dug wells may be contaminated by surface water. Most dug wells are equipped with hand pumps, but with sufficient yield a modern electric pump and pressure system may be used.

Small-diameter driven wells generally are not successful except in those areas where the glacial drift is composed of coarse sand and gravel. In some areas rocks and boulders make driving a well difficult, if not impossible; in other areas the screen may become plugged with silt and clay. Contaminated water percolating downward from the surface can pollute a shallow well. Regulations governing well-construction for quality control are distributed by the Michigan Department of Public Health.

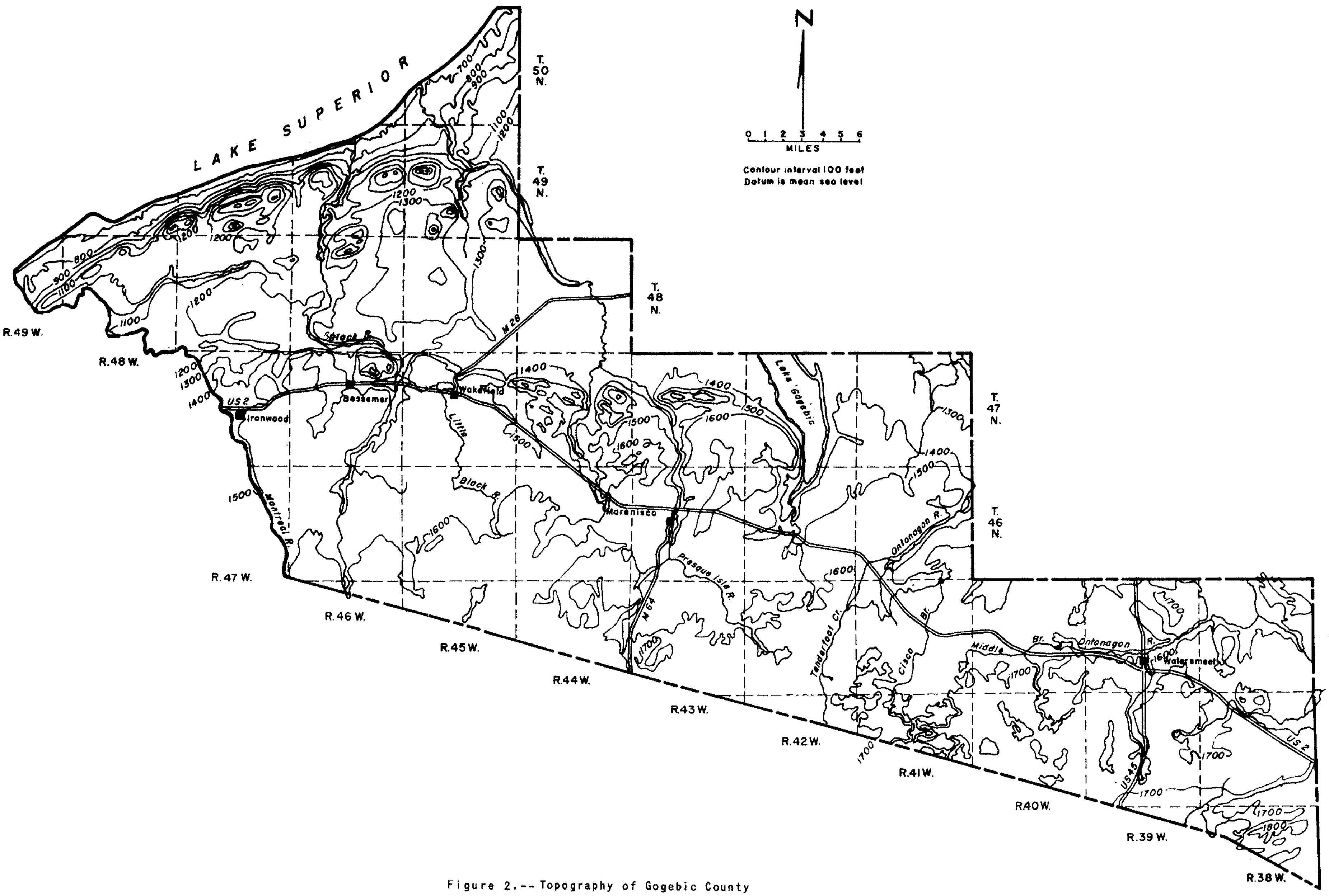


Figure 2.--Topography of Gogebic County

Springs

Springs ranging in size from small seeps to those flowing several gallons per minute are common in the hilly sections in the northern area (table 2 in appendix). Locations of springs are shown on Map 1. Some of these have been developed for public supply in roadside parks and for domestic use. The usual method of development is to enlarge the area of flow and submerge a concrete or tile pipe to collect the water.

About four miles northeast of Watersmeet, spring 45N 38W 17-1 supplies water for a private fish hatchery. Flow from several openings is diverted into ponds and the hatchery building. The owner reported a yield of about 200 gpm.

Spring 48N 46W 19-1 furnishes enough water to meet the needs of a dairy herd and the farm household. The spring opening has been enlarged and is protected with a concrete cribbing and cover. Water is pumped from the spring to the house and barn.

Spring 48N 48W 2-1 emerges from a hillside a few feet above a small roadside parking area. A 3-foot concrete tile fitted with a steel cover is buried in the main discharge area. Water from the tile flows by gravity through a pipe to the outlet which is about four feet above the level of the parking area. Numerous small flows and seeps emerge from the hillside in the vicinity of the tile collector. Many residents of the area obtain drinking water from this spring.

Spring 49N 46W 9-1 has been developed to supply the domestic and stock water on a large mink ranch. A 36-inch covered metal culvert has been sunk into the spring site at the upper end of a deep ravine. A 2-inch overflow pipe discharges about 20 gpm into a small stream in the ravine. A plastic pipeline carries water from the bottom of the culvert to the mink ranch, which is about 40 feet lower than the spring. The combined output of this spring and several smaller ones in the immediate area is about 40 gpm.

Availability of Ground Water

The Availability Key on Map 2 was prepared from records of wells and from surface geology as mapped by Terwilliger. Because the surface formations have different water-bearing characteristics in different areas of the county, the map has been divided into four general areas. Within each of these areas well records indicate relatively uniform conditions of ground-water availability for each surface formation. However, to obtain more detailed information for a specific site, the map should be supplemented by other information. Map 1 should be consulted first because specific data for wells shown on the map can be obtained from tables 1, 3, 4, and 5 in the appendix. The topography can be determined by field inspection or by consulting a topographic map. Generally, wells in valleys are more likely to be successful than those on hilltops. Is bedrock exposed? Is the soil sandy or silty? A visit to the site is needed to answer these and other questions regarding surface materials. Nearby roadcuts may show the character of earth materials below the soil zone. In general, the most favorable areas are those where the soil and subsurface material appears to be sandy. Silt or clay areas are less favorable, and shallow bedrock is least favorable. However, the character of the exposed material does not always indicate the character of materials below the water table. Silt or clay on the surface may overlie a productive sand; or surface sand may conceal an unproductive clay.

Figure 3 illustrates why some wells are successful and others nearby are inadequate. Well "A" penetrates a considerable thickness of saturated sand and gravel and yields several hundred gpm. Well "B" enters Precambrian bedrock at shallow depth and yields only a few gpm from the thin sand and gravel over the bedrock. Well "C" is drilled in bedrock outcrop and yields less than 1 gpm from fractures. Well "D" penetrates a pocket of saturated sand and gravel before encountering relatively impermeable clay and boulders. This well is capable of yielding a moderate supply for a short time, but because of limited storage and recharge, continued pumping will reduce the yield. Well "E" penetrates relatively impermeable clay and boulders, is bottomed in bedrock, and yields less than 1 gpm.

Outwash

Outwash consists chiefly of stratified sand and gravel deposited by meltwaters issuing from the front of a glacier. Beds or lenses of silt and clay may also be present. Areas of outwash generally are flat or gently sloping; however, where isolated blocks of ice were buried by outwash, subsequent melting formed depressions, many of which are today's lakes and swamps.

Most of the outwash occurs in the south-central and southeast areas of the county (Area IV on Map 2) where sandy moraines also occur. Large supplies of ground water have been obtained here in the outwash and where outwash is overlain by recent alluvium or

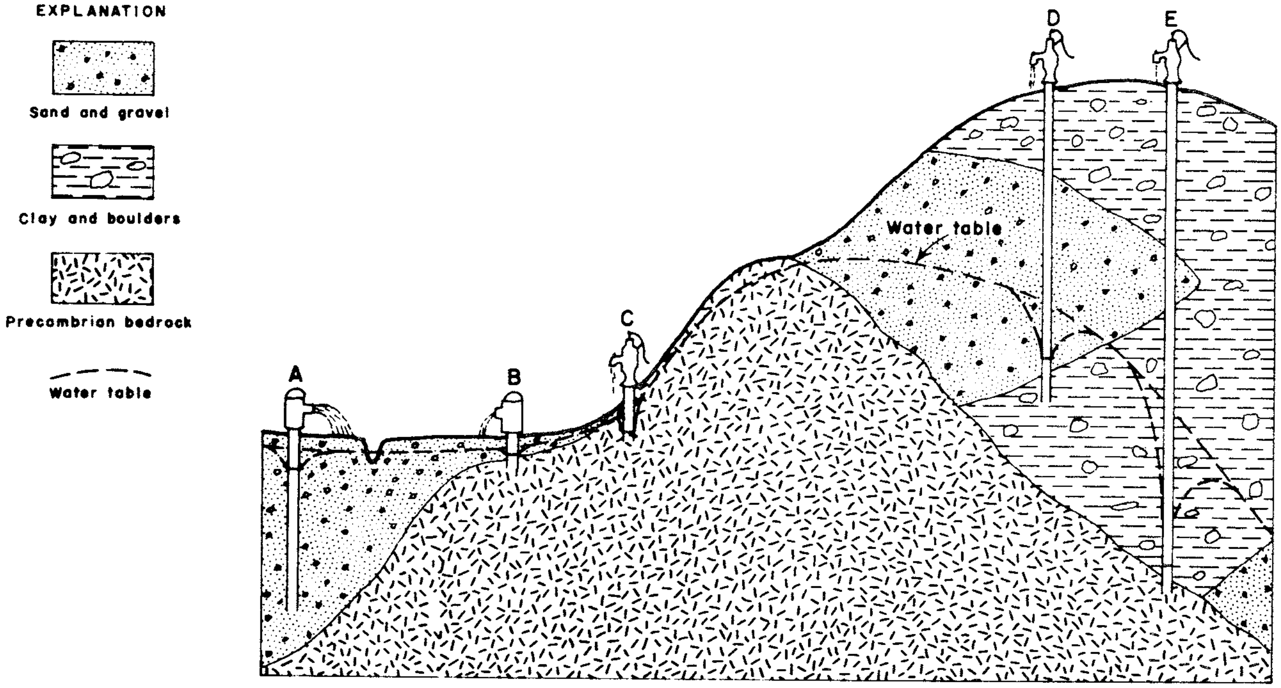


Figure 3.--Favorable and unfavorable locations of wells

swamp deposits. The public supplies for Marenisco and Watersmeet are obtained from wells in these deposits. Almost all wells drilled in outwash have obtained ample supplies for household use.

Swamp Deposits and Recent Alluvium

Swamp deposits and recent alluvium consist of sand, silt, clay, peat, and muck which have accumulated in low areas since the retreat of the glaciers. Topographic expression is generally flat or gently sloping. Materials and thickness of these deposits are extremely variable and can be determined only by sampling and drilling.

Swamp deposits and recent alluvium occur along streams and low areas in various places. Wells penetrating these materials near Spring Creek (north of Ironwood) yield large supplies of water, but the sand and gravel aquifer may be in glacial drift underlying the recent alluvium. Little is known concerning the availability of ground water in swamp deposits and recent alluvium over most of the county. Where these deposits are associated with glacial outwash, as near Marenisco and Watersmeet, moderate to large supplies may be obtained by drilling through them into the underlying sand and gravel.

Moraine

Moraines are hilly ridges of drift deposited along the margin of a glacier. The material is generally an unsorted mixture of clay, silt, sand, gravel, and boulders, called till. Water-sorted sand and gravel may also occur.

Moraines predominate in the eastern half of the county and in a narrow belt near Lake Superior in the northwest (Map 2). Small, scattered patches occur elsewhere. Moderate to large supplies of ground water are obtained from moraines in places (parts of Area II on Map 2). Small to moderate supplies of ground water are obtained in morainal areas in the south-central and southwestern areas (Area IV on Map 2). Small supplies probably can be obtained locally from moraines in other areas.

Till Plains

Till plains, or ground moraines, are gently undulating surfaces of glacial till deposited under the ice or where the ice retreated at such a uniform rate that it did not form distinct ridges parallel to the ice front. The material is similar to moraines, an unsorted mixture of clay, silt, sand, gravel, and boulders, but water-sorted sand

and gravel may also occur, and the proportion of each constituent varies widely from place to place.

Till plains cover most of the west-central area of the county (Map 2) and nearly half the eastern. Moderate to large supplies of ground water are obtained from a few wells penetrating sand and gravel in areas of till plain in the west-central area (Area II on Map 2). Small to moderate supplies for household use are obtained in other areas. Well records show no marked differences in availability of ground water from moraine and till plains. Therefore, the two are grouped together in the availability key on Map 2.

Lake Beds

Lake beds consist of silt, clay, and fine sand deposited in ponded meltwater. Silt and clay are the predominant materials, but lenses of fine sand occur locally.

Lake beds cover a strip along the Lake Superior shore in the northwestern area and a small area east of Lake Gogebic. No information was obtained on wells in lake beds, but the character of the materials suggest that little water could be developed from the lake sediments.

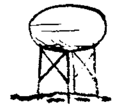
Bedrock Outcrops and Thin Drift

Bedrock is exposed in rugged outcrops in the western area, and is at or near the surface in many places in the central area (Map 2). In these areas few wells may obtain small supplies from the shallow drift or from fractured bedrock just below the drift, but many wells will fail to yield enough for even domestic uses. In general, highland areas underlain by bedrock are the least favorable for obtaining ground water.

Quality of Water

Water from most wells and springs is suitable for household and most other uses (Tables 2 and 5 in appendix). Most samples analyzed were moderately hard, ranging from 60 to 120 mg/l (milligrams per liter) calcium carbonate. A few samples were very hard, with hardness greater than 200 mg/l. Iron was present in objectionable amounts (0.3 mg/l or more) in about one-fourth the samples. Household water-treatment systems usually can reduce hardness and iron content to satisfactory standards.

Only two of the samples contained enough chlorides to taste salty, but salty water was reportedly encountered in some of the deep abandoned wells.



WATER DEVELOPMENT

Municipal Supplies

City of Bessemer

The city of Bessemer supplies water to 1104 customers in the city and part of Bessemer Township. Three well fields furnish about 10 million gallons per month to the system. City officials estimate the existing facilities could produce an additional 5 million gallons per month. Chlorine is added to the water.

Finnegan well (47N 46W 9-1), constructed in 1906, was the source of Bessemer's first municipal water supply. It is a stone-lined dug well 15 feet in diameter by 40 feet deep. The Gravel Pit well (47N 46W 9-2), dug in 1913, is 12 feet by 16 feet deep. Massies' Flowing Spring was developed in 1920. It is now a dug well (47N 46W 9-3) 10 feet in diameter by 12 feet deep. All three wells are finished in gravel. Water from these three units flows by gravity to the sump at the city pumping station.

Cox's Spring, north of the city, has a concrete lined pit 20 feet square by 30 feet deep. Nearby are two concrete-lined dug wells 10 feet square by 12 feet deep with 30-inch casings extending an additional six feet into the ground. These two wells feed into Cox's Spring. Water from all three units, about 200,000 gallons per day, is then pumped into the main system.

The South Boggio field was opened during October 1949 after a test drilling program revealed an adequate supply of water. South Boggio No. 1 (47N 46W 20-1) is a 10-inch well 69 feet deep; No. 2 (47N 46W 20-2) is a 10-inch well 35 feet deep. Both wells are finished in glacial drift. Well No. 1 was test-pumped at 320 gpm; well No. 2 was test-pumped at 350 gpm.

The following tables show the results of chemical analyses and logs of wells drilled for the city of Bessemer.

Analyses of Water of City of Bessemer*
(Dissolved constituents expressed in milligrams per liter**)

	47N 46W 9-1 Finnegan Well	47N 46W 9-2 Gravel Pit Well	Cox's Spring System	47N 46W 20-1 South Boggio Well 1	47N 46W 20-2 South Boggio Well 2
Color	10	10	0	30	0
Total Solids	2	244	102	240	136
Silica (SiO_2)		14	15	17	17
Iron (Fe)		0	0	0	0.4
Manganese (Mn)		0	0	0	0
Calcium (Ca)		48	24	56	28
Magnesium (Mg)		13	6	11	7
Sodium (Na)		12.0	4.4	5.5	3.2
Potassium (K)		2.0	0.9	1.2	0.7
Nitrate (NO_3)		8.9	3.9	8.3	0.7
Chloride (Cl)		52	3	55	0
Sulphate (SO_4)		18	10	22	12
Bicarbonate (HCO_3)		124	95	112	110
Carbonate (CO_3)		0	0	0	0
Hardness ($CaCO_3$)		175	85	185	100
Fluoride (F)		0	0	0.1	0.1
pH		6.9	6.8	7.4	7.7
Conductance (Micromhos at 25°C)		410	185	390	200

* Composite samples collected October 1965.
Analyses by Michigan Dept. of Public Health.

** Equivalent to parts per million in fresh water.

City of Bessemer
Logs of Wells

47N 46W 20-1 (South Boggio well No. 1)
NW¼NE¼ section 20
Altitude: 1460
Drilled: 1949

	Thickness of unit	Bottom of unit
Sand and gravel, yellow to brown, some clayey layers and a few large cobbles	3	3
Sand and gravel, some cobbles	1	4
Sand and gravel, clayey, yellow	7	11
Sand, coarse, and gravel, slightly silty and clayey to 20 ft clean below 20 ft	17½	28½
Sand and gravel, slightly clayey, boulder at 28½	3	31½
Sand and gravel, clayey	1	32½
Clay, sandy and gravelly, red to reddish brown, to clayey sand and gravel (hardpan). Very slightly clayey sand and gravel layers ½ to 1 ft thick at 33½, 36½, 41½ and 56½ which feed water freely. Boulders at 32½ and 44 ft.	27	59½
Clay, sandy, to red, uniform, clayey, medium to fine sand (hardpan)	6	65½
Gravel, fine to medium, clean, uniform, slightly clayey at base	3	68½
Granite	½	69

47N 46W 20-2 (South Boggio well No. 2)
NE¼NE¼ section 20
Altitude: 1480
Drilled: 1949

	Thickness of unit	Bottom of unit
Sand and gravel, coarse with cobbles, dry	4½	4½
Sand and gravel, coarse with fine to medium sand from 15 to 16½ and from 27 to 27½. Boulders at 22, 31 and 33½ ft.	30½	35
Sand, medium to fine, uniform	1½	36½
Clay, sandy and gravelly, red to reddish brown; clayey sand and gravel (hardpan) fine sand and gravel 51½ to 52 ft; boulder at 56½	22½	59
Sand, medium to fine, with some gravel	5½	64½
Sand and gravel, clayey to slightly clayey (hardpan), boulders at 65 and 69 ft	5½	70
Sand and gravel, medium, clean, uniform	½	70½
Granite	½	71

47N 46W 21-1 Test hole, supply limited
SW¼NW¼ section 21
Altitude: 1470
Drilled:

	Thickness of unit	Bottom of unit
Sand, clayey, reddish brown, with cobbles	7	7
Clay, sandy and gravelly, reddish brown (hardpan) with medium to fine sand, boulder at 15 ft	12½	19½
Sand, medium, clayey, (hardpan?)	½	20
Sand and gravel, clayey (hardpan?)	4	24
Clay, sandy and gravelly, reddish brown (hardpan)	2	26
Clay, sandy and gravelly, grayish-brown to brownish gray, (hardpan)	3½	29½
Sand, fine and gravel, clayey	½	30
Clay, sandy and gravelly, reddish-brown with cobbles (hardpan)	2	32
Granite	1½	33½

Bessemer Township

Bessemer Township water department supplies about 240 customers in the towns of Ramsey and Anvil. During 1966 pumpage averaged 85,000 gallons per day.

Water is obtained from the Black River at Ramsey and passed through a standard treatment process including chlorination and filtration. Operation and maintenance costs for the treatment plant are very high, resulting in a substantial deficit each year. Township officials believe their water system could be operated at less cost if a suitable ground-water supply could be located. In 1955, five test wells were drilled south of Ramsey, none of which indicated the presence of water in quantities sufficient for municipal supply. Well 47N 46W 13-1 contained some water but was abandoned because the water was high in sulphates. Logs of three of these wells follow the table of chemical analysis below.

During 1966 a new test-drilling project was started. At the time of this investigation one well, 47N 46W 24-1, had been drilled and was reported to have been pumped at 50 gpm (see log following chemical analysis).

The following tables show the results of a Michigan Department of Public Health chemical analysis of an untreated water sample collected during April 1965 from the Black River near the township intake.

Analysis of Untreated Water from Black River near Bessemer Township's water-supply intake.
(Dissolved constituents in mg/l)
(by Michigan Department of Health)

April, 1965

Color	100
Turbidity	5
Total solids	80
Silica (SiO_2)	6
Iron (Fe)	0.6
Manganese (Mn)	0
Calcium (Ca)	7.5
Magnesium (Mg)	1.2
Sodium (Na)	2.0
Potassium (K)	0.6
Nitrate (NO_3)	0.5
Chloride (Cl)	0
Sulphate (SO_4)	3
Bicarbonate (HCO_3)	23
Carbonate (CO_3)	0
Hardness ($CaCO_3$)	24
Fluoride (F)	0
pH	7.0
Conductance, micromhos at 25°C	50

Bessemer Township
Logs of Wells

	Thickness of unit	Bottom of unit
47N 46W 13-1 Test hole, high in sulphates, never developed NW¼SE¼ section 13 Altitude: 1480 Drilled: 1955		
Boulders and hardpan	16	16
Coarse gravel, sand, a little clay	4	20
Clay, gravel	5	25
47N 46W 13-2 Test hole, dry SE¼SW¼ section 13 Altitude: 1460 Drilled: 1955		
Hardpan, clay & boulders	25	25
Coarse gravel	1½	26½

	Thickness of unit	Bottom of Unit
47N 46W 13-3 Test hole, dry NE¼SW¼ section 13 Altitude: 1440 Drilled: 1955		
Gravel	8	8
Clay and boulders	5	13
Coarse gravel	1	14
47N 46W 24-1 Test hole, reportedly pumped at 50 gpm NE¼NE¼ section 24 Altitude: 1540 Drilled: 1966		
Clay, hardpan, boulders	36	36
Coarse gravel	6	42
Ledge at 42 ft		

City of Ironwood

Ironwood's water supply comes from two well fields, both of which tap sand and gravel deposits near Spring Creek about 4 miles north of the city.

Spring Creek well field was developed about 1920 in a marshy area along the creek. A small dam and diversion ditch were built to increase recharge of the aquifer from Spring Creek. Mine waste water pumped into Siemens Creek, a tributary of Spring Creek upstream from the well field, increased the hardness and chloride content of water from this field.

In 1948, after extensive test drilling, production wells one, two, and three were put into operation in the Big Spring field about 3 miles west of Spring Creek field (Fig. 4). The old wells at Spring Creek were then abandoned because of poor quality.

About 1950 the mine waste water was diverted to Black River instead of Siemens Creek. Production well four drilled in 1948, and number five, drilled in 1962, are now in operation.

Water is pumped to the pumping station in the Spring Creek area, then pumped to a storage reservoir on Mt. Zion. Chlorine is added to water from both fields.

Production well 1 (48N 47W 31-4) is of gravel-pack construction, the outer casing is 48 inches in diameter, the 17-foot screen and inner casing are 22 inches, and total depth is 42 feet.

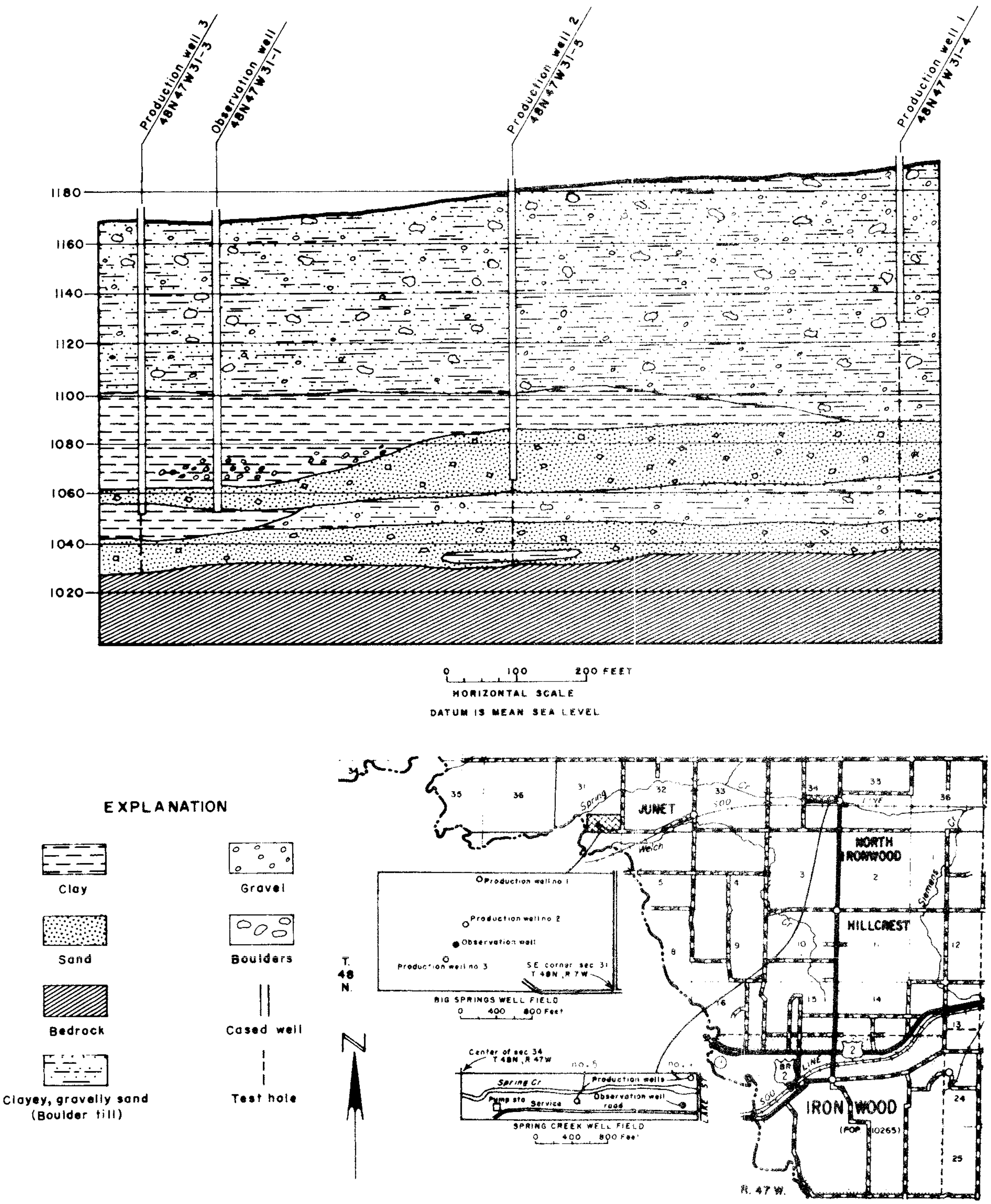


Figure 4.--Geologic section of Big Spring Well Field, Ironwood, Michigan.

Production well 2 (48N 47W 31-5), also of gravel-pack construction, has a 38-inch outer casing, the inner casing and both screens are 12-inch. This is a two-screen well, the top screen is set between 30 and 45 feet, the lower screen between 96 and 116 feet.

Production well 3 (48N 47W 31-3) is also a two-screen well of gravel-pack construction. The upper screen, placed between 33 and 43 feet is 26 inches in diameter, the lower screen between 108 and 118 feet is 18 inches in diameter. The 22-inch casing rises from the top of the upper screen to the surface. Fifteen chemical-feed nozzles are evenly distributed around the upper and lower screens for cleaning purposes. A shut-off device for use during periods of low water is attached to the upper screen.

Well 48N 47W 31-1 is an observation well maintained by the U.S. Geological Survey in cooperation with the City of Ironwood to observe ground-water levels in the Big Spring well field (figure 5).

Production well 4 (48N 47W 34-1) is of gravel-pack construction and has 38-inch outer and 16-inch inner casings. A screen 16 inches by 25 feet long completes the well.

Production well 5 (48N 47W 34-4) has a 12-inch casing and 10 feet of screen, the upper five feet of which is 100 slot and the lower 5 feet 50 slot.

Logs of wells and a table of chemical analyses of water samples follow.

City of Ironwood
Logs of Wells

	Thickness of unit	Bottom of unit
47N 47W 6-1 (Test hole)		
NE¼NE¼ section 6		
Altitude: 1180		
Drilled: 1948		
Test hole, never developed		
Gray clay	7	7
Sandy red clay	6	13
Red clay and boulders, some gravel	7	20
Dirty fine gravel, very tight	5	25
Hardpan	5	30
Rock ledge	6	36
48N 47W 28-1 (Test hole)		
SW¼SE¼ section 28		
Altitude: 1180		
Drilled: 1947		
Test hole, dry		
Red clay with soft hardpan	18	18
Red clay with hardpan	17	35
Hardpan and boulders	19	54
Muddy, sandy clay	9	63
Hardpan and clay	12	75
Hardpan	82	157
48N 47W 31-5 (Production well 2)		
SW¼SE¼ section 31		
Altitude: 1180		
Drilled: 1949		
Topsoil and sandsoil	3	3
Sand, gravel, silt and clay	5	8
Medium to coarse gravel with boulders, streaks of hardpan	4	12
Coarse gravel, clay streaks	4	16
Streaks of semi-hardpan and cobbles	2	18
Fine to coarse gravel, some streaks of clay and boulders	8	26
Fine to coarse gravel, streaks of silt	11	37
Fine to medium coarse gravel	3	40
Semi-hardpan seamed with clay	40	80
Clay	13	93
Sandy clay	1	94
Medium to coarse sand and gravel	22	116
Very fine muddy sand	3	119
Hard brown clay and some seams of medium fine sand	6	125
Tight, dirty fine to coarse sand and gravel, some light streaks of semi-hardpan and paint rock	7	132
Medium to coarse sand and gravel, some dirty sand and heavy gravel	2	134
Tight, dark, medium and coarse sand and gravel, heavy gravel streaks and paint rock. Water dark red	11	145
Semi-hardpan	2	147
Medium fine dirty sand, some gravel and rock cuttings	1	148
Ledge	1	149
48N 47W 31-3 (Production well 3)		
SW¼SE¼ section 31		
Altitude: 1180		
Drilled: 1955		

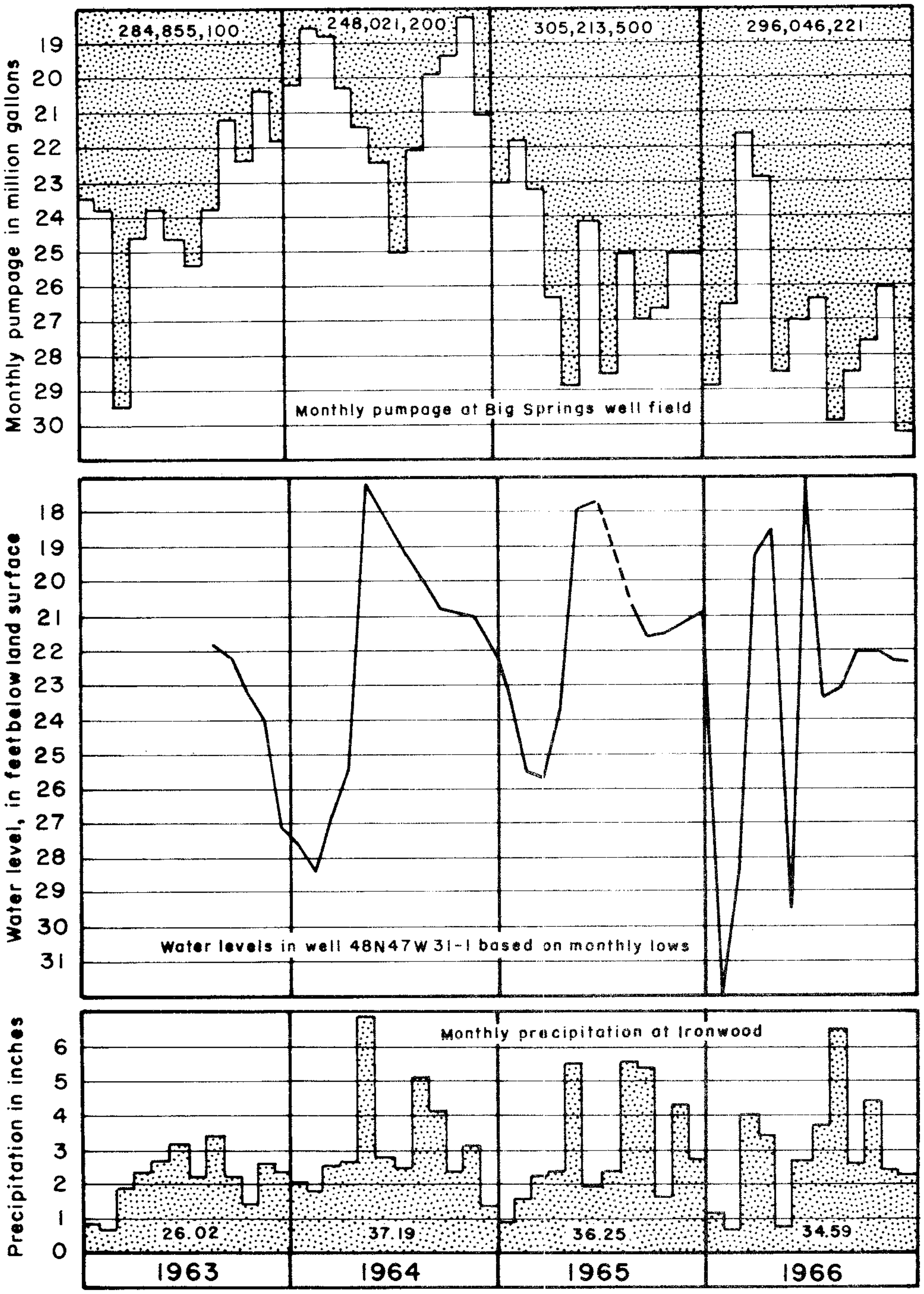


Figure 5.--Water-level fluctuations in Big Spring Well Field, Ironwood, Michigan.

	Thickness of unit	Bottom of unit
Tight dirty sand and gravel	4	4
Little sand and coarse gravel, with clay on the gravel	1	5
Little coarse sand, coarse and heavy gravel streaks	14	19
Small to very coarse gravel and heavy gravel, cobbles, seamed with hardpan	10	29
Small to very coarse gravel, heavy gravel, cobbles	1	30
Very coarse and some heavy gravel, cobbles, hardpan	4	34
Small to very coarse gravel, some medium coarse sand, and hardpan streaks	4	38
Medium to coarse sand, some fine sand and gravel, sand heaves	2	40
Medium to coarse sand, some fine sand like silt, some gravel. Water is red colored.	3	43
Boulders and semi-hardpan	1	44
Dirty, tight medium coarse sand, gravel, cobbles	2	46
Tight medium to coarse sand and gravel, some very heavy gravel and streaks of hardpan	9	55
Hardpan, little sand and gravel seams	14	69
Semi-hardpan and clay, sticky	21	90
Brownish gray clay, hard	9	99
Medium to coarse sand, clean gravel and some coarse gravel	4	103
Clean coarse sand and gravel, very coarse gravel	11	114
Brown clay and sandy clay	13	127
Coarse sand and gravel, streaks of clay	4	131
Medium to coarse sand, some very coarse sand & gravel	3	134
Some muddy fine sand, medium to coarse sand and gravel	3	137
Tight, dark, medium coarse sand and gravel and paint rock with some seams of coarse sand and gravel, light colored	4	141

48N 47W 31-4 (Production well 1)
SW¼SE¼ section 31
Altitude: 1180
Drilled: 1948

	Thickness of unit	Bottom of unit
Boulders and topsoil	1	1
Very coarse gravel and clay with cobbles	10	11
Coarse gravel, cobbles, some fine sand with clay streaks	4	15
Very coarse gravel with some fine sand	6	21
Very coarse gravel and cobbles with thin streaks of hardpan	9	30
Gravel and cobbles	11	41
Medium coarse sand and gravel, some clay streaks	8	49
Very fine to medium sand with clay streaks	18	67
Medium to coarse sand and gravel, streaks of clay	4	71
Hard clay with streaks of sand and gravel	31	102
Medium to coarse sand and medium gravel	14	116
Coarse sand, some medium sand and gravel streaks	8	124
Coarse sand and gravel, and clay	3	127
Fine to coarse sand, streaks of silt	16	143
Fine to coarse sand, gravel streaks and cobbles	4	147
Decomposed rock and hardpan	5	152

48N 47W 33-1 Test hole, very little water, never developed
SW¼NW¼ section 33
Altitude: 1180
Drilled: 1947

	Thickness of unit	Bottom of unit
Very coarse dirty gravel and boulders	17	17
Dirty coarse gravel	2	19
Dirty coarse gravel and boulders	9	28
Very coarse gravel. Static water level 35 ft	18	46
Medium coarse gray sand	2	48
Medium coarse gravel, sand and coarse gravel	3	51
Clay and hardpan	90	141
Clay, hardpan and broken rock	23	164

48N 47W 34-1 (Production well 4)
NE¼SE¼ section 34
Altitude: 1200
Drilled: 1948

	Thickness of unit	Bottom of unit
Surface soil, rock & boulders	5	5
Boulders and hardpan	17	22
Coarse gravel	2	24
Coarse gravel, boulders and clay	6	30
Medium fine sand	8	38
Medium fine sand and medium gravel	3	41
Fine sand	3	44
Coarse sand to medium coarse gravel	20	64
Coarse sand with coarse gravel and boulders	5	69

	Thickness of unit	Bottom of unit
48N 47W 34-4 (Production well 5) NW¼SE¼ section 34 Altitude: 1180 Drilled: 1962		
No sample	10	10
Sand, dark brown, predominance of medium grained with some fines and a little coarse grained	5	15
Sand, dark brown, medium and coarse, very little fine grained, with some gravel, fine	5	20
Sand, dark brown, coarse grained with gravel fine to medium	5	25
Sand, dark brown, medium to coarse grained with some gravel, fine to medium grained	5	30
Gravel, dark brown, medium to coarse grained	10	40
Sand, dark brown, medium grained with gravel, coarse	5	45
Gravel, dark brown, coarse grained and sand, coarse	5	50
Sand, dark brown, medium grained, silty	20	70

Analysis of Water of City of Ironwood*
(Dissolved constituents expressed in milligrams per liter)

	Big Springs Field			Spring Creek Field	
	48N 47W 31-4 Production Well 1	48N 47W 31-5 Production Well 2	48N 47W 31-3 Production Well 3	48N 47W 34-1 Production Well 4	48N 47W 34-4 Production Well 5
Color	0	0	0	0	0
Total Solids	70	94	108	228	250
Silica (SiO_2)	10	11	13	12	11
Iron (Fe)	0	0.1	0	0	0.1
Manganese (Mn)	0	0	0	0	0
Calcium (Ca)	15	19	23	54	46
Magnesium (Mg)	3.7	5.3	5.6	12	9
Sodium (Na)	2.3	4.6	4.6	7.0	12.0
Potassium (K)	0.4	0.4	0.4	0.8	1.4
Nitrate (NO_3)	6.0	3.0	5.0	3.0	1.0
Chloride (Cl)	4	5	10	23	23
Sulphate (SO_4)	5	3	5	8	10
Bicarbonate (HCO_3)	55	78	82	192	106
Carbonate (CO_3)	0	0	0	0	0
Hardness ($CaCO_3$)	53	69	81	186	150
Fluoride (F)	0	0	0	0	0
pH	7.1	7.1	7.1	7.7	7.3
Conductance (Micromhos at 25°C)	120	160	200	400	420
Date Sampled	4/62	4/62	4/62	4/62	12/64

*Analysis by Michigan Department of Public Health.

Marenisco Township

Marenisco Township operates a water system at the town of Marenisco which supplies about 200 customers within the town and along a pipeline extending about three-quarters of a mile north of town. Pumpage averages about 125,000 gallons per day. Two closely spaced wells are pumped alternately a month at a time. The water is not treated. Production well 1 (46N 43W 16-2) is a 10-inch well with the screen set between 34 and 54 feet. Production well 2 (46N 43W 16-3), of gravel-pack construction, has 65 feet of 12-inch casing.

Kimberly-Clark Corporation uses water from the municipal system for domestic use in their mill and office. Water from the Presque Isle River is used in their fire fighting system, which includes a large elevated storage tank.

The results of chemical analysis of water samples collected from Marenisco Township's wells are shown below. The log of a test hole at the site of the two production wells follows the table of analyses.

Analyses of Water of Marenisco Township*
(Collected October, 1965)
(Dissolved constituents in mg/l)

	Production Well 1 (46N 43W 16-2)	Production Well 2 (46N 43W 16-3)
Total solids	178	220
Silica (SiO_2)	16	17
Iron (Fe)	0.2	0.2
Manganese (Mn)	0	0
Calcium (Ca)	40	52
Magnesium (Mg)	13	12
Sodium (Na)	3.0	3.2
Potassium (K)	0.9	0.9
Nitrate (NO_3)	3.3	5.1
Chloride (Cl)	5	46
Sulphate (SO_4)	10	10
Bicarbonate (HCO_3)	150	128
Carbonate (CO_3)	0	0
Hardness	135	180
Fluoride (F)	0	0
pH	7.6	7.8
Conductance, micromhos at 24°C	270	370

*Analyses by Michigan Department of Health

Marenisco Township
Log of Test Hole

46N 43W 16-1 (Test hole at site of production wells)
46N 43W 16-2 and 16-3
NE¼SW¼ section 16
Altitude: 1495
Drilled: 1945

	Thickness of unit	Bottom of unit
Fill and boulders	4	4
Clay and muck	4	8
Red clay	10	18
Clay and gravel	2	20
Medium to coarse gravel	12	32
Medium fine sand	2	34
Fine sand with clay streaks	4	38
Coarse sand	7	45
Medium to coarse gravel	11	56
Fine gravel and clay streaks	4	60
Clay and sand	11	71
Hardpan	4	75

Ojibway Job Corps Center

The Ojibway Job Corps Center, located south of Marenisco in sec. 17, T 45N, R 43W, operates its own water system. In September the center was occupied by 265 people. At that time one well was in production and another, to be used as a standby unit, was under construction. Well 1 (45N 43W 17-1) is 153 feet deep and has a 6-inch casing.

The following table shows the results of a chemical analysis of a sample of water collected on March 22, 1966, from well 45N 43W 17-1. The log of this well follows the table of analysis.

Analysis of Water at Ojibway Job Corps Center*
(Dissolved constituents in mg/l)

Color	5
Total Solids	172
Silica (SiO_2)	17
Iron	0.1
Manganese (Mn)	0.1
Calcium (Ca)	40
Magnesium (Mg)	11
Sodium (Na)	3.7
Potassium (K)	1.6
Nitrate (NO_3)	0
Chloride (Cl)	0
Sulphate (SO_4)	0
Bicarbonate (HCO_3)	190
Carbonate (CO_3)	0
Hardness ($CaCO_3$)	145
Fluoride (F)	0.3
pH	8.3
Conductance, micromhos at 25°C	260

* Analysis by Mich. Department of Health

Ojibway Job Corps Center
Log of well

	Thickness of unit	Bottom of unit
45N 43W 17-1		
NW¼NE¼ section 17		
Altitude: 1622		
Drilled: 1965		
Clay, gravel, sand	20	20
Clay	70	90
Fine sand and clay	40	130
Hardpan	18	148
Sand and gravel	2	150
Gravel	3	153

City of Wakefield

Wakefield's municipal water system supplies about 900 customers in the city and adjacent areas of Wakefield Township. One well, one spring and an abandoned mine shaft comprise the city's sources of water.

Several unsuccessful test drilling programs have been conducted by the city, resulting in either dry holes or wells of insufficient capacity. One well, (47N 45W 16-1, production well 4) was test-pumped at 200 gpm and is presently being pumped at 116 gpm. One-half mile north of town a 48-inch by 18-foot concrete pipe has been sunk into a large spring (Wertanen Road Spring) which yields about 80,000 gallons per day during the spring but drops to 40,000 gpd in dry summer months. About 100 gpd are being pumped from the abandoned Chicago mine on the north shore of Sunday Lake. During January 1966 pumpage from the mine averaged 200,000 gpd. The 6-by 7-foot shaft is 400 feet deep. Chlorine is added to the water.

Chemical analyses of samples from Wakefield's water supplies in October 1965, and logs of wells and test holes follow.

Analyses of Water of City of Wakefield*
(Dissolved constituents in mg/l)

	Chicago Mine	Wertanen Rd. Spring	Production Well 4 (47N 45W 16-1)
Color	0	0	0
Total solids	150	146	262
Silica (SiO_2)	10	20	18
Iron (Fe)	0	0	0
Manganese (Mn)	0	0	0
Calcium (Ca)	34	32	66
Magnesium (Mg)	12	7	12
Sodium (Na)	6.0	3.7	3.5
Potassium (K)	1.3	0.5	0.9
Nitrate (NO_3)	0.3	3.5	2.8
Chloride (Cl)	2	2	5
Sulphate (SO_4)	4	6	26
Bicarbonate (HCO_3)	178	126	222
Carbonate (CO_3)	0	0	0
Hardness ($CaCO_3$)	135	110	210
Fluoride (F)	0	0.1	0
pH	7.7	7.7	7.4
Conductance, micromhos at 25°C	280	220	390

*Analyses by Michigan Department of Health

City of Wakefield
Logs of Wells

47N 45W 3-1 Test hold, not enough water for municipal supply
Center of section 3
Altitude: 1380
Drilled: 1944

	Thickness of unit	Bottom of unit
Surface soil, red	1	1
Clay, red, very sandy, some stone	4	5
Clay, red, very sandy, with boulders, does not stand up well	16	21
Broken ledge gravel, very dirty red sand, almost a hardpan, does not stand up very well for drilling	21	42
Sand, tan, dirty, fine, streaked with sandy red clay and gravel	41	83
Boulders and clay fine, gravelly, gray, more clay than in above formation	8	91
Clay, sandy, gray, & gravel	18	109
Clay, red, sandy, & gravel, not in rock	12	121
Clay, sandy, red and gravel	35	156
Clay, red, and hardpan	46	202
Clay, sandy, and hardpan	12	214
Hardpan and boulders	56	270
Hardpan	16	286
Hardpan with open ledge	26	312
Solid ledge at 312		

47N 45W 4-1 Test hole, not enough water for municipal supply
NW¼SE¼ section 4
Altitude: 1400
Drilled: 1947

	Thickness of unit	Bottom of unit
Hardpan	3	3
Gravel, medium coarse	35	38
Hardpan, some streaks of clay, red	32	70
Gravel, medium fine, red clay	19	89
Gravel, coarse, and streaks of hardpan	16	105
Hardpan	1	106
Ledge	4	110

47N 45W 16-1 (Production well 4)
SW¼NW¼ section 16
Altitude: 1530
Drilled: 1963

	Thickness of unit	Bottom of unit
No sample	5	5
Sand, red, coarse, and gravel, fine to coarse with sand, red, fine, silt & trace of clay	5	10
Sand, red, coarse, and gravel, fine to coarse with sand, red, fine , silts, free of clay	5	15
Sand, red, very fine through coarse, and gravel pea size and smaller with silt & clay	5	20
Sand, blue-gray, fine through coarse, and gravel, pea size and smaller, clean	5	25
Sand, purple, coarse and gravel, to pea size with a trace of medium sand	5	30
Gravel, purple, fine to pea size, small show of sand, coarse	5	35
Gravel, purple ½-inch size and smaller with show of sand, coarse	3	38
Gravel, purple, 3/4-inch size and smaller with show of sand, medium to coarse	3	41

47N 45W 21-2 (Test hole, not enough water for municipal supply)
SW¼SE¼ section 21
Altitude:
Drilled: 1944

	Thickness of unit	Bottom of unit
Sand	5	5
Sand, coarse	6	11
Gravel, dirty, coarse, and hardpan	14	25
Hardpan and boulders	18	43
Hardpan and broken ledge	18	61
Ledge rock	6	67
Hardpan	25	92
Ledge at 92'		

47N 45W 33-1 (Production well 1, well abandoned, not enough water for municipal supply)
SW¼NE¼ section 33
Altitude: 1557
Drilled:

	Thickness of unit	Bottom of unit
Sand, medium, fine, and some gravel	7	7
Sand, medium fine, and fine gravel	6	13
Sand, medium, coarse, and medium fine gravel, rusty	2	15
Sand, medium fine, and gravel, medium to coarse	10	25
Sand, fine to medium coarse gravel, some clay	5	30
Sand, very fine, muddy	4	34
Sand, fine medium coarse gravel, dirty	4	38
Semi-hardpan	15	53
Granite (broken ledge) at 53		

	Thickness of unit	Bottom of unit
47N 45W 33-2 (Production well 2, well abandoned, not enough water for municipal supply)		
Sand, medium fine	5	5
Clay, red, sandy	1	6
Sand, fine, clean	13	19
Sand, very fine, muddy	3	22
Sand, medium fine, and gravel, medium to coarse, a little muddy	2	24
Gravel, medium to coarse, clean, a little sand	5	29
Gravel, medium to very coarse, some sand a little clay	6	35
Sand and gravel, medium fine	3	38
Boulders and clay	5	43
Rock, hard, gray	3	46
Granite	1	47
48N 45W 21-1 Test hole, never developed. All samples heavily stained with iron. SE¼SE¼ section 21 Altitude: 1260 Drilled: 1958		
Gravel, fine to medium, clean (except for staining largely composed of fragments of dark colored rocks)	110	110
Sand, coarse, dirty	10	120
Sand, fine to coarse, clean	5	125
Gravel, fine to medium	5	130
Sand, coarse, gravelly, clean	10	140
Sand, fine to coarse, gravelly	10	150
Gravel, fine to medium, sandy, silty, dirty	20	170
Sand, fine to medium gravelly, very silty and very clayey	5	175
48N 45W 32-1 Test well, small flow at about 315 ft site abandoned. Samples to 345 ft. SE¼NW¼ section 32 Altitude: 1270 Drilled: 1958		
Sand, medium to coarse, some gravel, dirty	5	5
Gravel, coarse, very clayey and silty	15	20
Clay, sandy	5	25
Clay, silty and sandy	5	30
Gravel, coarse, very clayey	10	40
Clay, sandy	5	45
Gravel, medium to coarse, sandy, clean	5	50
Clay, sandy and gravelly, and silty, brown	75	125

	Thickness of unit	Bottom of uni
Jacobsville Sandstone, fine to medium with silty matrix, deep red color, reduction spots on large rock samples, size of grains variable from horizon to horizon. Continuous to below 925 feet.	220	345

Wakefield Township

Wakefield Township furnishes water to 35 homes and businesses in the village of Thomaston. The township acquired well 48N 45W 34-1 from the Duluth South Shore and Atlantic Railroad to furnish water to the township hall which is about ¼ mile from the well. Residents of the area have connected their water systems to the township line. Each user constructs and maintains his own branch line, and the township makes no charge for water consumed.

The well was dug to a depth of 125 feet about 1900. The stone cribbing is 20 feet in diameter at the top, reduced to 17 feet at the bottom. Sometime about 1925 the well was deepened, by drilling, to 300 feet and a 6-inch casing installed.

An electric pump runs continuously, delivering 17 gpm.

Watersmeet Township

Watersmeet Township supplies water to about 170 customers in the town of Watersmeet. The water system includes one production well and a 50,000-gallon overhead storage tank.

Well 45N 39W 28-1 has an 8-inch casing with 4½ feet of 20 slot screen set between 56 and 60½ feet. The well is equipped with a 7½ horsepower pump having a capacity of 100 gpm.

Test hole 45N 39W 27-3 was abandoned because yield was not sufficient for municipal needs.

The following table shows the results of chemical analysis of a sample of water collected in March, 1967, from well 45N 39W 28-1. Logs of the well and test hole follow the analysis.

Analysis by Michigan Department of Health
(Dissolved constituents in mg/l)

Color	0
Total solids	140
Silica (SiO_2)	18
Iron (Fe)	0.2
Manganese (Mn)	0
Calcium (Ca)	28
Magnesium (Mg)	7
Sodium (Na)	2.3
Potassium (K)	1.6
Nitrate (NO_3)	0
Chloride (Cl)	0
Sulphate (SO_4)	8
Bicarbonate (HCO_3)	115
Carbonate (CO_3)	0
Hardness ($CaCO_3$)	100
Fluoride (F)	0.15
pH	8.0
Conductance (Micromhos at 25°C)	220

Watersmeet Township
Logs of Wells

	Thickness of unit	Bottom of unit
45N 39W 27-3 Test hole, not enough for municipal use		
SE¼NW¼ section 27		
Altitude: 1590		
Drilled: 1964		
No sample	2	2
Sand, black, very, very fine to coarse, and organic material	4	6
Sand, dark gray, very, very fine to coarse, and gravel, fine to pea-sized	6	12
Sand, dark gray, very fine to coarse and gravel, fine to pea-sized	5	17
Sand, brown, very fine to coarse and gravel, fine to near pea-sized, silty	3	20
Sand, tan, very fine to coarse, and gravel, fine to medium, with gastropod shell	5	25
Sand, tan, very fine to coarse, and gravel fine to pea-sized	5	30
Sand, tan, very, very fine, to medium	5	35
Clay, brown, and silt	35	70
Silt, tan, with some sand, fine to coarse and gravel, fine to just above pea-sized	10	80
Clay, brown, and silt	10	90
Bedrock, biotite granite gneiss at 90		

	Thickness of unit	Bottom of unit
45N 39W 28-1 (Township well no. 1)		
NE¼NE¼ section 28		
Altitude: 1600		
Drilled: 1964		
Sand, brown fine to medium, with very fine and coarse; slight show of gravel, fine to medium	10	10
Sand, tan, fine to coarse with gravel, fine and show of medium	5	15
Sand, tan, very fine to fine with trace of medium and of gravel, fine	5	20
Sand, tan, very fine to fine, silty with slight show of gravel, fine to medium	5	25
Sand, tan, fine to medium, with gravel, fine to coarse slightly silty	9	34
Gravel, fine to coarse with very slight show of sand, fine to medium	3	37
Clay and silt with gravel, coarse; and trace of sand fine to medium	19	56
Sand, tan, fine to medium with coarse and show of gravel, fine to coarse	3	59
Gravel, fine to coarse and sand, fine to medium	3	62
Gravel, coarse with fine to medium, with sand fine, silty	9	71
Gravel, fine to coarse, and sand, fine to coarse	4	75
Gravel, fine to coarse, and sand, fine, silty	8	83
Sand, tan, medium, small trace of gravel, pea-sized	4	87
Sand, tan, very fine to medium, small trace of gravel, pea-sized	2	89
Gravel, coarse, with fine to medium	4	93
Gneiss, bedrock	7	100

Parks

Gogebic State Park

Three wells have been drilled at the Gogebic Lake State Park. Well 47N 42W 21-2 was abandoned and the pipe pulled because of excessive bending of the casing. Well 47N 42W 21-3 would yield only about 1 gpm and was abandoned. Well 47N 42W 21-1 had been pumped at 5 gpm and was used for many years, but was abandoned in 1966 because of high bacteria counts. The park presently is drawing it's water supply from Lake Gogebic and adding chlorine.

Porcupine Mountain State Park

The Presque Isle section of the Porcupine Mountains State Park extends into the northeast part of Gogebic County. This section obtains its water supply from Lake Superior through a temporary pipe line which is removed each autumn. Chlorine is added to the water.

Black River County Park

Black River County Park is located on Lake Superior at the mouth of the Black River. Water for the park's supply is provided by four 30-inch tile, with concrete covers, buried 10 to 12 feet beneath the beach. These tiles have perforated pipe collectors extending outward under the beach. The water is pumped from the tiles to a sand filter bed on a hill 120 feet above the park site. After passing through the filter it is pumped to a 5000-gallon storage tank from which it is gravity fed to outlets in the park. Water consumption is about 2000 gpd during the height of the summer tourist season.

Little Girls Point County Park

Little Girls Point County Park, on Lake Superior about 4 miles east of the Wisconsin-Michigan boundary, obtains its water supply from Lake Superior. A chlorinator is included in the water system.

Gogebic Lake County Park

The Gogebic Lake County Park on the southwest corner of Lake Gogebic obtains its water supply from one well (46N 42W 3-1). The water is quite hard, containing 200 ppm hardness, but otherwise is of good quality. A pressurized storage tank forces the water to outlets in the camping and picnic areas.

National Forest Campgrounds

The United State Forest Service operates ten campgrounds in Gogebic County. Nine of these have one or more wells equipped with handpumps. Field analyses indicated iron was present in concentrations of 0.2 ppm in water from six of these wells. Very little data is available on the eight wells in the Sylvania Tract acquired by the Forest Service late in 1966.

Several roadside rest areas have water available, either from wells with hand pumps or from springs. Parks within cities and villages in the county get their water from municipal systems.

Households, Camps and Cabins

Household water supplies in rural areas are obtained from drilled, driven or dug wells, or springs. In most parts of the county a domestic supply can be obtained from a drilled well 4 to 6 inches in diameter. There are a few areas, especially in the southeastern part of the county where a domestic supply may be obtained from a drive point. Where the water-bearing formation contains large amounts of silt and clay, or where boulders are numerous, dug wells are commonly used. Some springs have been developed into good domestic supplies. Some of the dug wells and springs have been equipped with electric pumps, and supply enough water for modern domestic systems. One residence, with a small creek running through the yard, has the intake for an electric pump in a tile collector sunk below the creek bed. Water for general use comes from this source, but water used for drinking is carried from a spring half a mile away.

Hunting camps and cabins may obtain water from any of the above sources, but dug wells and springs are the most common. Many cabins that are used only a few days each year have no local water-supply.

Motels and Resorts

Most motels in Gogebic County are within the service area of one of the municipal water systems; a few, however, have their own ground-water supplies. Lakeside resorts having several cottages for rent generally obtain their water from one or more wells.

At one of the two commercial ski resorts in the county water used for domestic purposes is brought in by tank trunk. Springs at the base of the ski hill are being developed and may supply enough water to meet domestic demands. Water for snow-making is pumped from a small stream at the bottom of the slope. At the other ski resort two 6-inch wells, one 38 feet deep and the other 32 feet deep, supply all the water needed, as snow-making equipment is not used.

Irrigation

Toumey Nursery, operated by the U. S. Forest Service at Watersmeet, uses water from Duck Creek to irrigate nursery stock. Two pumps supply a total of 25,000 gph, 16 hours a week from the middle of May to September. Each year, 45 acres of the 70-acre nursery are irrigated. Water for use in the buildings is obtained from a 4-inch well (45N 39W 27-1) 34 feet deep.

Two other irrigation systems are used to prevent late spring and early fall frost damage, and to supply additional water during dry periods. The smaller of these systems uses municipal water as an aid to growing tomatoes; the other uses water from a creek in an overhead sprinkler system on strawberries and sweet corn.

Water Power

Gogebic County rivers have not been extensively developed as a source of electric power. The Lake Superior District Power Co. plant on the Montreal River is the only hydroelectric installation in the county.

FUTURE NEEDS

Because ground-water resources are not abundant in most places in the county, future expansion of population or industry may bring water-supply problems. The seemingly limitless supply of water available from Lake Superior could provide for all foreseeable needs, but this source would be too expensive for most parts of the county at present. All sources of water -- wells, springs, lakes, and streams -- must be considered in determining the most dependable and economical supply. As each source of water is related to other sources, development of one may influence the availability of another.

Management decisions must be based on a thorough knowledge of streamflow, ground-water levels, lake levels, and quality of water. Also needed are data on water use, ground-water pumpage, surface-water diversions, and waste disposal. When collected over a sufficient period of time, these records provide more reliable information on the effect of future development than would an intensive short-term study.

SUMMARY

The ground-water resources of Gogebic County are neither abundant nor evenly distributed. Well yields of several hundred gallons per minute are available in a few small areas, but over most of the county well yields are small to moderate, and in some areas the relatively small amount needed for a domestic supply is difficult or impossible to obtain.

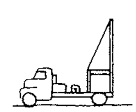
The most favorable areas for obtaining large supplies of water from wells are sand and gravel deposits along streams. Least favorable are areas where the Precambrian bedrock is exposed or is covered by only a few feet of glacial drift.

Most wells are drilled, almost half of which are between 50 and 100 feet deep. Attempts to obtain water by drilling to depths greater than 200 feet have usually failed because of small yields or poor quality of water.

Water from most wells and springs is moderately hard, and some wells and springs yield water with objectionable amounts of iron. Household water-treatment systems can usually reduce hardness and iron content to satisfactory standards.

Public water supplies are obtained from wells, springs, and an abandoned mine.

Ground-water resources may be inadequate to meet the needs of expanding population or industry in many places in the county. Lakes and streams are potential alternate sources. Long-term records of streamflow, ground-water levels, lake levels, and quality of water will be needed for making informed management decisions.



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# # #

APPENDIX

Tables 1 through 5

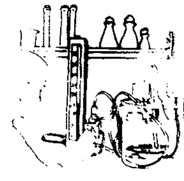

Table 1.—Well Records

Explanation

Wells are identified according to their geographical township location, for example, "44N 38W 15-1 NE NW" refers to well #1 situated in the northeast quarter of the northwest quarter of section 15, of Township 44 North, Range 38 West. Altitudes are estimated from topographic maps. Water level in feet below land surface.

Pc . . . . Precambrian	D . . . . Domestic	I . . . . . . Industrial
Gd . . . . Glacial Drift	S . . . . Stock	O . . . . . . Observation
	P . . . . Public Supply	T . . . . . . Test Hole

Well Number	Location in section ¼	¼	Owner	Driller	Date drilled	Diameter	Depth	Aquifer	Use	Water level	Date	Altitude	Depth to bedrock	Remarks
44N 38W														
15-1	NE	NW	Mich. Highway Dept.	——	——	6	——	Gd?	P	——	——	1720	——	Supplies roadside park.
16-1	NW	NW	U. S. Forest Service	——	——	5	79	Gd	P	72	——	1725	——	Imp Lake Campground (North).
16-2	NW	NW	U. S. Forest Service	——	——	5	76	Gd	P	59	——	1725	——	Imp Lake Campground (South).
16-3	SW	NW	U. S. Forest Service	——	——	5	179	Gd	P	168	——	1850	——	Imp Lake Tower.
16-4	NW	NW	U. S. Forest Service	——	——	5	65	Gd	P	39	——	1725	——	Imp Lake Picnic area.
24-1	NE	SE	Mich. Highway Dept.	Mich. Highway Dept.	——	-	62	Gd	T	——	——	1660	62	Bridge boring.
44N 39W														
32-1	NE	SE	Mich. Highway Dept.	——	——	4	112	Gd	P	15	——	1715	——	Finished at 76 feet.
44N 40W														
5-1	SW	NW	U. S. Forest Service	——	——	1¼	30±	Gd	P	——	——	1720	——	Water unsafe, well destroyed.
10-1	SW	SW	U. S. Forest Service	——	——	-	50±	Gd	P	——	——	1730	——	
11-1	SW	NE	U. S. Forest Service	——	——	1¼	30	Gd	P	——	——	1720	——	Unpleasant taste & odor. Well will be destroyed.
15-1	NW	NW	U. S. Forest Service	——	——	-	50±	Gd	P	——	——	1730	——	
15-2	SW	NW	U. S. Forest Service	——	——	-	50±	Gd	P	——	——	1740	——	
18-1	NE	SW	U. S. Forest Service	——	——	1¼	30	Gd	P	——	——	1710	——	
23-1	NW	NE	U. S. Forest Service	——	——	1¼	30	Gd	P	——	——	1720	——	
44N 41W														
3-1	NW	NW	R. Krummrei	Hedberg	1966	4	109	Gd	D	20	1966	1690	——	At 68 ft. water had sulphur smell. Water has yellow tint.
3-2	NW	NW	R. Krummrei	——	——	4	36	Gd	P	——	——	1690	——	Supplies tavern & residence.
3-3	NW	NW	R. Krummrei	Hedberg	——	4	65	Gd	P	Lsd	1966	1690	——	Supplies 4 cottages.
3-4	NW	NW	R. Krummrei	Mayo	——	4	32	Gd	P	——	——	1690	——	Supplies 6 cottages.
44N 42W														
6-1	SE	NW	U. S. Forest Service	——	1964	5	98	Gd	P	40	1964	1650	——	Water cloudy.
45N 38W														
29-1	NW	SE	U. S. Forest Service	Johnson	1964	5	76	Gd	P	52	1964	1630	——	Marion Lake Campground well #4.
29-2	NW	SE	U. S. Forest Service	Johnson	1964	5	74	Gd	P	34	1964	1620	——	Marion Lake Campground well #5.
34-1	SE	SW	U. S. Forest Service	Johnson	1964	4	94	Gd	P	63	1964	1680	——	
45N 39W														
15-1	SE	NW	Watersmeet Township	——	——	2	——	Gd	P	——	——	1580	——	Supplies Budd Wilber Beach.
22-1	SE	SW	U. S. Forest Service	Lentz	1963	5	120	Gd?	P	——	——	1600	——	Supplies office & shops.
27-1	SW	NW	U. S. Forest Service	——	1944	4	34	Gd	P	12	1944	1600	——	Supplies nursery buildings.
27-2	NE	NW	U. S. Forest Service	U. S. Forest Service	1944	4	42	Gd	D	4	1961	1600	——	Supplies 3 dwellings.
27-3	SE	NW	Watersmeet Township	Hahala	1964	-	90	--	T	——	——	1590	90	Not enough water for municipal supply.
28-1	NE	NE	Watersmeet Township	Hahala	1964	8	60	Gd	P	——	——	1600	100	Test hole to 100 ft.
45N 40W														
31-1	SE	SW	U. S. Forest Service	——	——	6	150	--	P	——	——	1780	——	
35-1	SE	SW	Alice Hough	——	1951	2	45	Gd	D	——	——	1720	——	
35-2	SW	SW	A. Van Dam	——	——	-	75	Gd?	D	——	——	1715	——	
45N 41W														
27-1	SW	SE	Alvin Scheu	Hedberg	1962	4	58	Gd	D	40	1962	1700	——	Swampy taste.
34-1	NE	NE	John Scheu	Hedberg	1963	4	59	Gd	D	——	——	1690	59	Bottomed on bedrock.
45N 42W														
21-1	NW	SW	U. S. Forest Service	——	1963	5	105	Gd?	P	——	——	1640	——	Pomeroy Lake North Campground.
21-2	NE	SW	U. S. Forest Service	——	1943	6	80	Gd?	P	——	——	1640	——	Pomeroy Lake cabin sites.
25-1	NE	NE	U. S. Forest Service	——	1938	6	57	Gd?	P	——	——	1680	——	Longford Lake Campground.
45N 43W														
17-1	NW	NE	U. S. Forest Service	——	1965	6	153	Gd	P	50.6	1965	1622	——	Ojibway Job Corps Center.
45N 44W														
2-1	SW	SW	U. S. Forest Service	U. S. Geological Survey	1966	-	31	Gd	T	10	1966	1585	——	Augered test hole.
3-1	NW	NE	U. S. Forest Service	——	1964	5	80	Gd	P	52	1964	1590	——	Henry Lake Campground.
13-1	NW	NW	U. S. Forest Service	U. S. Geological Survey	1966	-	72	Gd	T	37	1966	1605	——	Augered test hole.
46N 41W														
23-1	NE	NW	U. S. Forest Service	U. S. Geological Survey	1966	1¼	44	Gd	T	15	1966	1520	——	Augered test hole.
46N 42W														
3-1	NW	SW	Gogebic County	——	——	6	55	——	P	17	1966	1300	——	Supplies County park.
21-1	NW	SE	Mich. Highway Dept.	Mich. Highway Dept.	——	-	23	Gd	T	——	——	1455	——	Bridge boring.
46N 43W														
4-1	NW	NW	U. S. Forest Service	U. S. Geological Survey	1966	1¼	27	Gd	T	6.10	10- 7-66	1500	——	Augered test hole.
4-2	NW	NW	U. S. Forest Service	U. S. Geological Survey	1966	1¼	42	Gd	T	35.88	10- 7-66	1500	——	Augered test hole. Bottom of screen at 39 feet.
16-1	NE	SW	Marenisco Township	Layne Northwest	1945?	-	75	Gd	T	——	——	1495	——	
16-2	NE	SW	Marenisco Township	Layne Northwest	1950	10	56	Gd	P	16±	1950	1495	——	Screen set at 34-54 feet.
16-3	NE	SW	Marenisco Township	Layne Northwest	1966	12	65	Gd	P	——	——	1495	——	Gravel pack construction.
16-4	NE	NW	Mich. Highway Dept.	Mich. Highway Dept.	——	-	27	Gd	T	——	——	1500	——	Bridge boring.
27-1	SW	NE	U. S. Forest Service		1964	5	29	Gd	P	——	——	1550	——	Bobcat Lake Picnic Grounds.
46N 45W														
4-1	SW	SW	C. Cervasio	——	——	36	7.5	Gd	D	3.47	10-10-66	1560	——	Dug well at hunting camp.
4-2	SW	SW	C. Cervasio	U. S. Geological Survey	1966	-	13	Gd	T	7	1966	1560	13?	Augered test hole adjacent to 4-1.
30-1	SE	SE	Gogebic County	U. S. Geological Survey	1966	-	34	Gd	T	13±	1966	1635	——	Augered test hole. Refusal at 34 feet.

Table 1.--Well Records.--Continued

Well Number	Location in section ¼	¼	Owner	Driller	Date drilled	Diameter	Depth	Aquifer	Use	Water level	Date	Altitude	Depth to bedrock	Remarks
46N 46W														
3-1	SE	SW	A. Keranen	----------	1911	48	20	Gd	D	14±	1948	1520	---	Abandoned dug well.
3-2	SW	SW	T. Jacobson	Owner	----	36	16	Gd	D	---	----	1520	---	Dug well.
11-1	NW	SW	P. Jenolrzejewski	Owner	----	24	21	Gd	D	---	----	1580	---	Dug well. Supply sometimes inadequate during dry season.
18-1	SW	SW	A. Bianchi	Owner	----	24	16	Gd	D	---	----	1535	---	Dug well with electric pump.
47N 41W														
3-1	NW	SW	U. S. Forest Service	----------	----	5	--	Gd?	P	---	----	1312	---	Matchwood Tower well.
13-1	NE	SW	U. S. Forest Service	U. S. Geological Survey	1966	-	20	Gd	T	9.30	10- 6-66	1260	---	Augered test hole.
47N 42W														
6-1	SE	NE	S. Davey	Bennetti	1965	4	65	Pc	D	18	7-65	1300	48	Cased to 48 feet.
21-1	SE	NW	Mich. Dept. of Cons.	Kiney	1932	3	60	Gd	P	10	1932	1300	60?	Cased to 56 ft. Abandoned 1966.
21-2	NW	SW	Mich. Dept. of Cons.	Kiney	1932	3	66	Gd	-	---	----	1300	66	Boulders caused pipe to bend, pipe pulled 10-13-32.
21-3	SW	NW	Mich. Dept. of Cons.	Kiney	1932	3	55	Gd	-	---	----	1300	---	Abandoned, yield 1 gpm.
23-1	NW	NW	W. Nyman	H. O. Rice	1966	6	34	Gd	D	---	----	1310	---	Water slightly turbid.
26-1	NW	NW	Society of Divine Word	----------	----	6	--	Gd?	P	---	----	1305	---	Supplies up to 100 guests.
47N 45W														
3-1	Center		City of Wakefield	----------	1944	-	312	--	T	---	----	1380	312	Test well #2.
4-1	NW	SE	City of Wakefield	----------	1947	-	110	--	T	---	----	1400	110	Test well #5. Not enough water to develop.
16-1	SW	NW	City of Wakefield	DeRonco	1963	12	45	Gd	P	14.43	12- 3-63	1530	47	Production well #4.
21-2	SW	SE	City of Wakefield	----------	1944	-	92	--	T	5	----	----	92	Test well #3. Not enough water to develop.
33-1	SW	NE	City of Wakefield	Layne-Northwest	----	16	53	Gd	P	6	----	1557	53	Production well #1. Inadequate supply, well abandoned.
33-2	NE	NE	City of Wakefield	Layne-Northwest	----	16	47	Gd	P	7	----	1553	47	Production well #2. Inadequate supply, well abandoned.
47N 46W														
13-1	NW	SE	Bessemer Township	DeRonco	1955	4	25	Gd	T	---	----	1480	---	Test #5. Abandoned, high in sulphates.
13-2	SE	SW	Bessemer Township	DeRonco	1955	4	26	Gd	T	Dry	10-11-55	1460	---	Test #3.
13-3	NE	SW	Bessemer Township	DeRonco	1955	4	14	Gd	T	Dry	10-13-55	1440	---	Test #4.
20-1	NW	NE	City of Bessemer	Dunbar	1949	10	69	Gd	P	6.50	7-21-49	1460	68	Production well #1.
20-2	NE	NE	City of Bessemer	Dunbar	1949	10	35	Gd	P	4.36	7-21-49	1480	70	Production well #2.
21-1	SW	NW	City of Bessemer	----------	----	6	33	Gd	T	6	1949	1470	32	Water supply limited.
24-1	NE	NE	Bessemer Township	Hakala	1966	6	42	Gd	T	---	----	1540	42	
47N 47W														
6-1	NE	NE	City of Ironwood	Layne-Northwest	1948	-	36	--	T	10	1948	1180	30	Test #12.
48N 44W														
22-1	NW	NW	U. S. Forest Service	U. S. Geological Survey	1966	1¼	23	Gd	T	7	1966	1340	---	Too much silt for suction pump.
23-1	NW	NW	Mich. Highway Dept.	Mich. Highway Dept.	----	-	53	Gd	T	---	----	1315	---	Bridge boring.
48N 45W														
16-1	SE	SE	Connor Lumber & Land Co.	Johnson	1953	6	65	Gd	I	---	----	1280	---	Production #1 stand-by unit for mill and office. Marginal producer.
16-2	SE	SE	Connor Lumber & Land Co.	Johnson	1953	6	55	Gd	I	---	----	1280	---	Production #2 Main source for mill and office.
16-3	NE	SE	Connor Lumber & Land Co.	Lang	1940	8	233	Pc	-	---	----	1280	159	Abandoned, high chlorides.
21-1	SE	SE	City of Wakefield	Dunbar	1958	-	175	Gd	T	10±	1958	1260	---	Not enough water to develop
32-1	SE	NW	City of Wakefield	Dunbar	1958	-	925	Pc	T	---	----	1270	125	municipal supply.
34-1	NW	NW	Wakefield Township	D. S. S. & A. R. R.	1925	6	300	Pc	P	115	1949	1350	125?	Dug to 125', drilled to 300'
48N 46W														
19-2	SE	SE	H. Soari	U. S. Geological Survey	1966	-	23	Gd	T	---	----	1200	---	Augered test hole.
48N 47W														
8-1	NE	NW	A. Abramson	Owner	1960	42	36	Gd	D	34	1960	1140	---	Supplies residence and mink ranch.
9-1	NE	SE	J. Krenzel	DeRonco	1962	4	37	Gd	D	4	1962	1090	35	Screen set 33'-35'.
10-1	NW	SW	Gogebic Co. Road Comm.	U. S. Geological Survey	1966	-	38	Gd	T	4±	1966	1090	38	Augered test hole.
23-1	NE	NE	Gogebic Co. Road Comm.	U. S. Geological Survey	1966	-	21	Gd	T	---	----	1180	---	Very little water.
25-1	NW	SW	Gogebic Co. Airport	Tuominen	----	6	25	Gd	P	8	----	1230	---	Supplies airport terminal.
28-1	SW	SE	City of Ironwood	Layne Northwest	1947	-	157	Gd	T	Dry	1947	1180	---	
31-1	SW	SE	City of Ironwood	Layne Northwest	1953	6	115	Gd	O	---	----	1180	---	
31-3	SW	SE	City of Ironwood	Layne Northwest	1955	18	118	Gd	P	---	----	1180	---	Production well #3. Test hole to 141'.
31-4	SW	SE	City of Ironwood	Layne Northwest	1948	22	42	Gd	P	---	----	1180	---	Production well #1. Test hole to 152'.
31-5	SW	SE	City of Ironwood	Layne Northwest	1949	12	116	Gd	P	16	1949	1180	148	Production well #2. Test hole to 149'.
33-1	SW	NW	City of Ironwood	Layne Northwest	1947	-	164	Gd	T	35	1947	1180	---	Very little water.
34-1	NE	SE	City of Ironwood	Layne Northwest	1948	16	69	Gd	P	---	----	1200	110?	Production well #4. Test hole to 110'.
34-4	NW	SE	City of Ironwood	DeRonco	1962	12	44	Gd	P	8.38	7- 2-62	1180	---	Production well #5. Test hole to 70'.
34-5	SE	NE	City of Ironwood	Layne Northwest	1947	-	148	--	T	Dry	1947	1230	148	
49N 45W														
9-1	NW	NW	A. Lake	----------	----	5	--	Gd?	D	---	----	980	---	Yields ½ gal. before failure.
17-1	NE	NE	Connors Lumber & Land Co.	U. S. Geological Survey	1966	-	17	Gd	T	6	1966	1110	---	Augered test hole.
49N 46W														
10-1	NE	NW	Gogebic Co. Road Comm.	Melin	1938	-	190	Pc	P	---	----	640	82	Poor yield, high chloride, abandoned.
15-1	NW	NW	U. S. Forest Service	Johnson	1940	-	95	Gd	-	Dry	1940	880	---	
16-1	SE	NE	U. S. Forest Service	Johnson	1940	-	35	Gd	-	Dry	1940	900	---	
32-1	SE	NW	Gogebic Range Ski Club	Soil Testing Service of Wisconsin	1965	-	16	Gd	T	8	1965	1200	---	
49N 48W														
29-1	SW	SE	Oman's Agate Shop	----------	----	-	30	Pc	D	15.24	10- 9-66	610	18	Supplies 2 houses.
29-2	SW	SE	A. Serrohin	H. O. Rice	1940	-	32	Pc	D	---	----	610	6	
32-1	NW	SW	E. Biace	DeRonco	1963	6	118	Pc	D	---	----	660	---	Supplies residence and beef herd.

TABLE 2.— RECORDS OF SPRINGS

Number	Location in section ¼	¼	Owner	Use	Source	Altitude	Yield in gpm	Date sampled	Hardness ($CaCO_3$) in mgl	Iron (Fe) in mgl	Specific Conductance (Micromohs at 25°C)	pH	Temperature (°C)	Remarks
45N 38W 17-1	SW	NW	C. J. Rybak	Fish hatchery	Rock	1560	200±	11- 3-66	125	<0.1	225	7.7	6.7	Several openings.
46N 46W 5-1	SE	NW	Gogebic Co. Road Comm.	No apparent use	Drift	1515	5±	11- 1-66	65	<0.1	135	6.7	7.2	Spring in center of pool 3' in diameter.
48N 46W 17-1	NW	NE	Keweenaw Land Assn.	Public supply	Drift	1160	1	10-27-66	34	<0.1	65	6.1	8.3	2' concrete tile sunk 2' in ground.
48N 46W 19-1	SE	SE	H. Saari	Domestic & stock	Drift	1190	--	10- 7-66	85	0.7	180	6.0	--	Concrete crib and cover, piped to buildings.
48N 48W 2-1	SW	SW	Gogebic Co. Road Comm.	Public supply	Drift	1140	10±	10-27-66	102	<0.1	180	7.2	7.2	3' concrete collector, plus several small natural seeps in hillside.
49N 45W 9-2	NE	SW	Keewenaw Land Assn.	Some public use	Drift	960	1	10- 8-66	15	<0.1	<50	5.6	8.9	Barrel sunk in ground, water bubbles up through fine white sand.
49N 46W 9-1	SE	SE	Kimberly-Clark, Inc.	Domestic & stock	Drift	860	20	11- 1-66	100	<0.1	185	6.7	6.7	3' metal culvert with cover sunk in ground, pipe line to mink ranch.

<= Less than.

TABLE 3.--DRILLERS' WELL LOGS

Explanation

Altitudes estimated from topographic maps.
Figures given are in feet.

TOWNSHIP 44 NORTH; RANGE 38 WEST

44N 38W 16-1
U. S. Forest Service
Imp Lake Campground No. 1 (north)
NW¼ NW¼ Section 16
Altitude: 1725

	Thickness of unit	Bottom of unit
Red clay and small stones	20	20
Sand and gravel	59	79

44N 38W 16-2
U. S. Forest Service
Imp Lake Campground No. 2 (south)
NW¼ NW¼ Section 16
Altitude: 1725

	Thickness of unit	Bottom of unit
Red clay with small stones	21	21
Sand	52	73
Sand and gravel	3	76

44N 38W 16-3
U. S. Forest Service
Imp Lake Tower
SW¼ NW¼ Section 16
Altitude: 1850

	Thickness of unit	Bottom of unit
Red clay with small stones	16	16
Hardpan with large boulders	72	88
Sand	88	176
Sand and gravel	3	179

44N 38W 16-4
U. S. Forest Service
Imp Lake Picnic Ground
NW¼ NW¼ Section 16
Altitude: 1725

	Thickness of unit	Bottom of unit
Red clay	52	52
Sand	11	63
Sand and gravel	2	65

44N 38W 24-1
Mich. Highway Dept.
NE¼ SE¼ Section 24
Altitude: 1660

The deepest of 4 bridge borings at the U. S. 2 crossing of the South Branch of the Paint River

	Thickness of unit	Bottom of unit
Peat	4	4
Medium gray sand	8	12
Medium red sand	6	18
Coarse red sand	26	44
Very fine red sand and silt, compact	4	48
Silt	4	52
Very fine red sand and silt, trace of red clay, compact	3	55
Very fine red sand and silt, compact	5	60
Medium red sand	2	62
Ledge rock or boulder at 62		

TOWNSHIP 44 NORTH; RANGE 39 WEST

44N 39W 32-1
Mich. Highway Dept.
NE¼ SE¼ Section 32
Altitude: 1715

	Thickness of unit	Bottom of unit
Sand	37	37
Gravel	3	40
Sand	28	68
Clay	2	70
Sand	6	76
Clay	36	112

TOWNSHIP 45 NORTH; RANGE 38 WEST

45N 38W 29-1
U. S. Forest Service
Marion Lake Campground No. 4
NW¼ SE¼ Section 29
Altitude: 1630

	Thickness of unit	Bottom of unit
Hardpan (clay)	15	15
Sand and gravel	61	76

45N 38W 29-2
U. S. Forest Service
Marion Lake Campground No. 5
NW¼ SE¼ Section 29
Altitude: 1620

	Thickness of unit	Bottom of unit
Sandy clay	40	40
Sand and silt	20	60
Clear sand	14	74
Quicksand at 87 feet, pulled back to 74		

45N 38W 34-1
U. S. Forest Service
Taylor Lake Campground
SE¼ SW¼ Section 34
Altitude: 1680

	Thickness of unit	Bottom of unit
Rocky sand and gravel	20	20
Rock and hardpan	43	63
Loose sand and gravel	31	94

TOWNSHIP 45 NORTH; RANGE 39 WEST

45N 39W 27-1
U. S. Forest Service
Toumey Nursery
SE¼ NW¼ Section 27
Altitude: 1600

	Thickness of unit	Bottom of unit
Sand	34	34

TOWNSHIP 45 NORTH; RANGE 44 WEST

45N 44W 2-1
U. S. Forest Service
SW¼ SW¼ Section 2
Altitude: 1585

Test hole by U. S. Geological Survey power auger.

	Thickness of unit	Bottom of unit
Brown sand, fine, silty	5	5
Brown sand, fine, silty, a few pebbles	5	10
Sandy clay, water	21	31
Refusal at 31 ft., probably a boulder.		

Formation too fine to yield water through a sand point. Large diameter dug well should furnish a domestic supply.

45N 44W 13-1
U. S. Forest Service
NW¼ NW¼ Section 13
Altitude: 1605

Test hole by U. S. Geological Survey power auger.

	Thickness of unit	Bottom of unit
Brown sandy loam	2	2
Brown sand, fine	20	22
Brown sand, very fine, silty	10	32
Brown sand, very fine, very silty, a few small pebbles	5	37
Coarse sand, water	28	65
Medium sand, some fine sand	7	72
Stopped drilling at 72.		

The coarse sand between 37 and 65 feet should yield a good supply.

TOWNSHIP 46 NORTH; RANGE 41 WEST

46N 41W 23-1
U. S. Forest Service
NE¼ NW¼ Section 23
Altitude: 1520

Test hole by U. S. Geological Survey power auger.

	Thickness of unit	Bottom of unit
Sand and gravel, brown, clay coated some cobbles	5	5
Sand, clay bound, tight; gravel, clay, brown	5	10
Claybound sand, gravel and cobbles dark brown, tight	5	15
Claybound sand, gravel and cobbles, brown	5	20
Claybound sand, gravel and cobbles, brown	2	22
No recovery, claybound sand on auger stem	6	28
Water at 28 feet		
Sand, clay coated, some gravel reddish brown	4	32
Sand, clay coated reddish brown	5	37
Sand, clay coated reddish brown, some cobbles	5	42
Clay with large cobbles	2	44
Refusal at 44 ft. boulder or ledge.		

Material probably too fine to allow the successful use of a sand point.

TOWNSHIP 46 NORTH; RANGE 42 WEST

46N 42W 21-1
Mich. Highway Dept.
NW¼ SE¼ Section 21
Altitude: 1455

Bridge boring at U. S. 2 crossing of the Slate River.

	Thickness of unit	Bottom of unit
Sand	2	2
Sand, gravel, stones and boulders	21	23
Boulder or bedrock at 23		

TOWNSHIP 46 NORTH; RANGE 43 WEST

46N 43W 4-1
U. S. Forest Service
NW¼ NW¼ Section 4
Altitude: 1500

Test hole by U. S. Geological Survey power auger.

	Thickness of unit	Bottom of unit
Gravel, fine to medium; sand silt	10	10
Gravel, coarse sand	17	27

A sand point would probably produce a domestic supply.

46N 43W 4-2
U. S. Forest Service
NW¼ NW¼ Section 4
Altitude: 1500

Test hole by U. S. Geological Survey power auger.

	Thickness of unit	Bottom of unit
Medium brown sand, silty	2	2
Fine to medium sand, some silt, water	15	17
Gravel, sand, silty	10	27
Sand, fine gravel, silty	15	42
Refusal at 42 ft., very coarse gravel, boulder or ledge		

Material too fine to allow use of a sand point.

	Thickness of unit	Bottom of unit
46N 43W 16-4		
Mich. Highway Dept.		
NE¼ NW¼ Section 16		
Altitude: 1500		
Bridge boring at U. S. 2 crossing of Presque Isle River		
Sandy	1	1
Red sand	2	3
Red clay	2	5
Compact stony gravel, trace of sand	11	16
Compact stony gravel	11	27
TOWNSHIP 46 NORTH; RANGE 45 WEST		
46N 45W 4-2		
Gogebic County Road Comm.		
SW¼ SW¼ Section 4		
Altitude: 1560		
Test hole by U. S. Geological Survey power auger.		
Red clay	2	2
Sandy brown clay (water at 7')	11	13
Refusal at 13 ft. Boulder or ledge, moved 20 ft. west refusal at 14 ft. maybe ledge. Material too fine to allow use of sand point. A 3X3X7 foot dug well supplies a hunting camp at this location.		
46N 45W 30-1		
Gogebic County Forest		
SE¼ SE¼ Section 30		
Altitude: 1635		
Test hole by U. S. Geological Survey power auger.		
Blue sandy clay	1	1
Red clay, very little sand, wet	12	13
Red clay, trace of fine gravel, very little sand, water	6	19
Red clay, trace of sand; coarse gravel or rocks water	15	34
Refusal at 34 ft. Material too fine to allow use of sand point.		
TOWNSHIP 46 NORTH; RANGE 46 WEST		
46N 46W 3-1		
Andrew Keranen		
SE¼ SW¼ Section 3		
Altitude: 1520		
Topsoil	1	1
Gravel	19	20
TOWNSHIP 47 NORTH; RANGE 41 WEST		
47N 41W 13-1		
U. S. Forest Service		
NE¼ SW¼ Section 13		
Altitude: 1260		
Test hole by U. S. Geological Survey power auger.		
Red Clay	8	8
Clay and boulders, a little sand	12	20
Refusal at 20 ft. Clay too fine and tight to screen.		
TOWNSHIP 47 NORTH; RANGE 42 WEST		
47N 42W 6-1		
Sam Davey		
SE¼ NE¼ Section 6		
Altitude: 1300		
Topsoil	2	2
Clay	20	22
Sand and gravel	26	48
Sandstone	17	65
47N 42W 21-1		
Mich. Dept. of Conservation (Gogebic Lake State Park)		
SE¼ NW¼ Section 21		
Altitude: 1300		
Sandy red clay	30	30
Boulders and red clay	5	35
Sand, water bearing, will not pump	4	39
Clay and many boulders, thin water bearing strata	17	56
Gravel, fine, water bearing	1	57
Red clay	1	58
Sand and gravel, fine, water bearing	2	60
Very hard, no water	½	60½
47N 42W 21-2		
Mich. Dept. of Conservation (Gogebic Lake State Park)		
Altitude: 1300		
Clay, red, stoney	10	10
Stratas of clay, hard, gravelly, with pockets of clay, soft.	25	35
Sand and gravel, fine, water	½	35½
Clay, hard, gravelly, with pockets of clay, soft	18½	54
Sand, water bearing	½	54½
Stones, large, hard stratas of mud between	9½	64
Sand, water bearing	½	64½
Mud under sand, then stones, large	1½	66
47N 42W 21-3		
Mich. Dept. of Conservation (Gogebic Lake State Park)		
SW¼ NW¼ Section 21		
Altitude: 1300		
Sand, Clay, boulders, red	15	15
Clay, hard gravelly	10	25
Hard strata, mud between boulders	10	35
Clay, hard, gravelly	5	40
Gravel, water	1	41
Mud pocket	½	41½
Strata, hard, stony	2	43½
Sand and gravel, water	½	44
Clay and boulders	3	47
Sand, water	½	47½
Clay and boulders	2½	50
Sand, water	1	51
Clay and boulders	4	55
47N 42W 23-1		
Wayne Nyman		
NW¼ NW¼ Section 23		
Altitude: 1310		
Clay	18	18
Gravel	6	24
Clay	5	29
Gravel	5	34
TOWNSHIP 48 NORTH; RANGE 44 WEST		
48N 44W 22-1		
U. S. Forest Service		
NW¼ NW¼ Section 22		
Altitude: 1340		
Test hole by U. S. Geological Survey power auger.		
Medium to fine brown sand	1	1
Red Clay	7	8
Fine sand, water	7	15
Medium, sand, fine gravel, silt	8	23
Refusal, boulder, or ledge at 23'. Sample from bit dark blue gritty clay or weathered bedrock. Material too fine to allow use of sand point.		
48N 44W 23-1		
Mich. Highway Dept.		
NW¼ NW¼ Section 23		
Altitude: 1315		
Bridge boring at M-28 crossing of Presque Isle River.		
Red sand	5	5
Red sand and clay	4	9
Sand and gravel	1	10
Stiff red clay and a little gravel	7	17
Red sand	6	23
Coarse sandy gravel	2	25
Red clay	1	26
Sand	1	27
Red clay (easy to penetrate)	14	41
Red sand	3	44
Stiff red clay	9	53
TOWNSHIP 48 NORTH; RANGE 46 WEST		
48N 46W 19-2		
Herman Soari		
SE¼ SE¼ Section 19		
Altitude: 1200		
Test hole by U. S. Geological Survey power auger.		
Topsoil, loam	2	2
Clay, red, dry	5	7
Fine red sand, silty, water	8	15
Gravel, clay, water	8	23
Refusal at 23 feet clay and gravel. Material probably too fine to allow use of a sand point.		
TOWNSHIP 48 NORTH; RANGE 47 WEST		
48N 47W 9-1		
J. Krenzel		
NE¼ SE¼ Section 9		
Topsoil	2	2
Sand	5	7
Quicksand	11	18
Medium gravel	17	35
Bedrock	2½	37½
48N 47W 10-1		
Gogebic Co. Road Comm.		
NW¼ SW¼ Section 10		
Altitude: 1090		
Test hole by U. S. Geological Survey power auger.		
Red clay, coarse gravel, a little fine sand	38	38
Refusal at 38 ft., probably ledge. A sand point probably would produce enough water for a domestic supply.		

TABLE 3.--DRILLERS' WELL LOGS.--Continued

	Thickness of unit	Bottom of unit
48N 47W 23-1		
Gogebic Co. Road Comm.		
NE¼ NE¼ Section 23		
Altitude: 1180		
Test hole by U. S. Geological Survey power auger.		
Topsoil, muck	1	1
Red clay	12	13
Red clay and gravel, a little fine sand	8	21
Refusal at 21 ft. Not enough water to develop a small domestic supply.		
48N 47W 25-1		
Gogebic Co. Airport		
NW¼ SW¼ Section 25		
Altitude: 1230		
Clay, red	15	15
Sand, red	6	21
Coarse sand, gray	3	24
Hardpan, red	1	25
TOWNSHIP 49 NORTH; RANGE 45 WEST		
49N 45W 17-1		
Connor Land & Lumber Co.		
NE¼ NE¼ Section 17		
Altitude: 1110		
Test hole by U. S. Geological Survey power auger.		
Gravel, brown sand, clay coated, and silt	6	6
Fine sand, silty water	11	17
Clay at 17 feet, stopped drilling. Formation too fine to allow use of a sand point.		
TOWNSHIP 49 NORTH; RANGE 46 WEST		
49N 46W 10-1		
Gogebic County		
NE¼ NW¼ Section 10		
Altitude: 640		
Well has been abandoned because of high chlorides and poor yield.		
Red clay	20	20
Sand and clay	5	25
Clay	5	30
Clay or hardpan	5	35
Hardpan	47½	82½
Sandstone	107½	190
49N 46W 15-1		
U. S. Forest Service		
NW¼ NW¼ Section 15		
Altitude: 880		
Dry hole.		
Sand and gravel	5	5
Clay	5	10
Clay and fine pebbles	5	15
Clay and very fine rock	5	20
Clay and fine rock	10	30
Fine gravel	5	35
Gravel	10	45
Clay and gravel	10	55
Sand, fine	5	60
Sand, fine and clay	20	80
Clay	15	95
49N 46W 16-1		
U. S. Forest Service		
SE¼ NE¼ Section 16		
Altitude: 900		
Dry hole.		
Sand, fine	28	28
Clay	7	35
49N 46W 32-1		
Gogebic Range Ski Club		
SE¼ NW¼ Section 32		
Altitude: 1200		
Test boring at proposed construction site.		
Silt, some very fine sand, trace of roots and rock fragments medium dark brown, medium dense	1.7	1.7
Silt, some fine sand, trace of rock fragments reddish brown, dense	4.0	5.7
Fine sand, some silt, trace of rock, fragments, reddish brown, moist, medium dense	10.8	16.5
Water level after boring completed 8 ft.		
TOWNSHIP 49 NORTH; RANGE 48 WEST		
49N 48W 29-1		
Oman's Agate Shop		
SW¼ SE¼ Section 29		
Altitude: 610		
Clay	18	18
Bedrock	12	30
49N 48W 29-2		
Albert Serrohin		
SW¼ SE¼ Section 29		
Altitude: 610		
Topsoil	6	6
Red rock	26	32

TABLE 4.--PUMP TEST RESULTS

Well Number	Aquifer Pc = Precambrian Gd = Glacial drift	Yield (gal/min)	Drawdown (feet)	Duration of test (Hours)	Specific Capacity (gal/min/ft/drawdown)
44N42W 6-1	Gd	6	0	30	6.0
45N38W 29-1	Gd(Sand, gravel)	20	1.5	--	13.3
29-2	Gd(Sand)	28	1.5	--	18.7
34-1	Gd(Sand, gravel)	25	8.0	--	3.1
45N39W 27-2	Gd(Sand)	15	0	3	15.0
28-1	Gd(Sand, gravel)	40	15	0.5	2.7
45N43W 17-1	Gd(Gravel)	15	3	8	5.0
45N44W 3-1	Gd(Sand, gravel)	5	0	8	5.0
46N42W 3-1	--	25	0	2	25.0
46N43W 16-2	Gd	242	16	8	15.1
47N42W 6-1	Pc	3	12	2	0.3
47N45W 16-1	Gd(Gravel)	200	12.7	3	15.7
47N46W 20-1	Gd	320	15	4	21.0
20-2	Gd(Sand, gravel)	350	7.3	4	4.7
48N47W 25-1	Gd(Sand)	5	12	24	0.4
31-3	Gd(Gravel)	125	2	--	62.5
34-4	Gd(Gravel)	250	3.5	8	70.0

TABLE 5.--FIELD ANALYSES OF WELL WATER

Well Number	Aquifer Pc = Precambrian Gd = Glacial drift	Date	Hardness ($CaCO_3$) in mgl	Iron (Fe) in mgl	Chloride (Cl) in mgl	Specific Conductance (Micromohs at 25°C)	pH	Temperature (°C)
44N 38W 15-1	Gd	10-24-66	100	<0.1	---	170	8.0	7.4
16-1	Gd	10-24-66	65	0.6	---	90	7.0	7.8
16-2	Gd	10-24-66	50	>4.0	---	125	7.0	7.8
16-4	Gd	10-24-66	50	0.2	---	110	6.9	7.8
44N 39W 32-1	Gd	9- 7-66	50	<0.1	---	100	7.4	6.7
44N 41W 3-1	Gd	10-28-66	200	2.0	10	380	7.7	--
3-4	Gd	10-28-66	100	<0.1	---	180	8.0	--
44N 42W 6-1	Gd	10-25-66	135	4.0	---	280	7.8	7.8
45N 38W 29-1	Gd	10-24-66	85	0.7	---	150	7.9	7.8
29-2	Gd	10-24-66	100	0.2	---	170	8.0	7.8
34-1	Gd	10-24-66	65	0.1	---	115	8.5	8.3
45N 39W 15-1	Gd	10-25-66	115	0.2	---	220	7.9	6.7
22-1	Gd?	11- 3-66	115	<0.1	---	240	8.0	--
45N 40W 35-1	Gd	9- 7-66	65	---	---	145	7.0	--
35-2	Gd?	9- 7-66	100	<0.1	---	50	7.2	--
45N 41W 27-1	Gd	10-25-66	475	<0.1	100	850	7.5	--
34-1	Gd	10-25-66	135	<0.1	---	220	7.8	--
45N 42W 21-1	Gd?	10-29-66	115	2.5	---	225	7.5	7.2
25-1	Gd?	10-25-66	115	1.0	---	230	7.8	7.8
45N 44W 3-1	Gd	10-10-66	100	3.0	---	190	7.5	7.2
46N 42W 3-1	--	9- 7-66	200	<0.1	---	430	7.8	--
46N 43W 27-1	Gd	10-25-66	100	<0.1	---	170	8.0	8.3
46N 45W 4-1	Gd	10-10-66	65	---	---	120	6.8	10.0
46N 46W 3-2	Gd	11- 1-66	235	<0.1	---	450	7.8	--
11-1	Gd	11- 1-66	153	<0.1	---	360	6.0	--
47N 41W 3-1	Gd?	9- 7-66	100	2.0	---	50	7.8	--
47N 42W 23-1	Gd	10-31-66	170	0.3	---	330	7.8	--
26-1	Gd?	9- 7-66	185	<0.1	---	325	7.8	--
48N 45W 16-2	Gd	10-26-66	135	<0.1	10	255	7.1	7.4
48N 47W 8-1	Gd	10-27-66	238	<0.1	---	460	7.5	--
9-1	Gd	10- 8-66	115	<0.1	250	660	8.0	--
49N 45W 9-1	Gd?	10- 8-66	30	>4.0	---	70	6.2	--
49N 48W 32-1	Pc	10-27-66	85	<0.1	400	1,000	7.9	--

<= Less than.
>= More than.