GROUND WATER NEAR REYNOLDS, GRAND FORKS AND TRAILL COUNTIES, NORTH DAKOTA

By
H. M. Jensen
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NORTH DAKOTA GROUND WATER STUDIES NO. 47

Prepared by the United States Geological Survey in cooperation with the North Dakota State Water Conservation Commission, and the North Dakota Geological Survey

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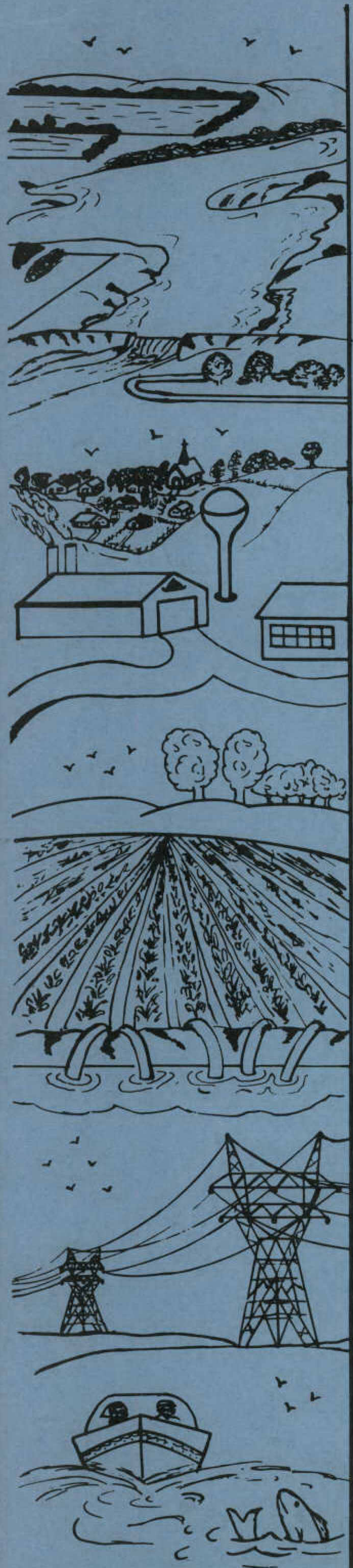

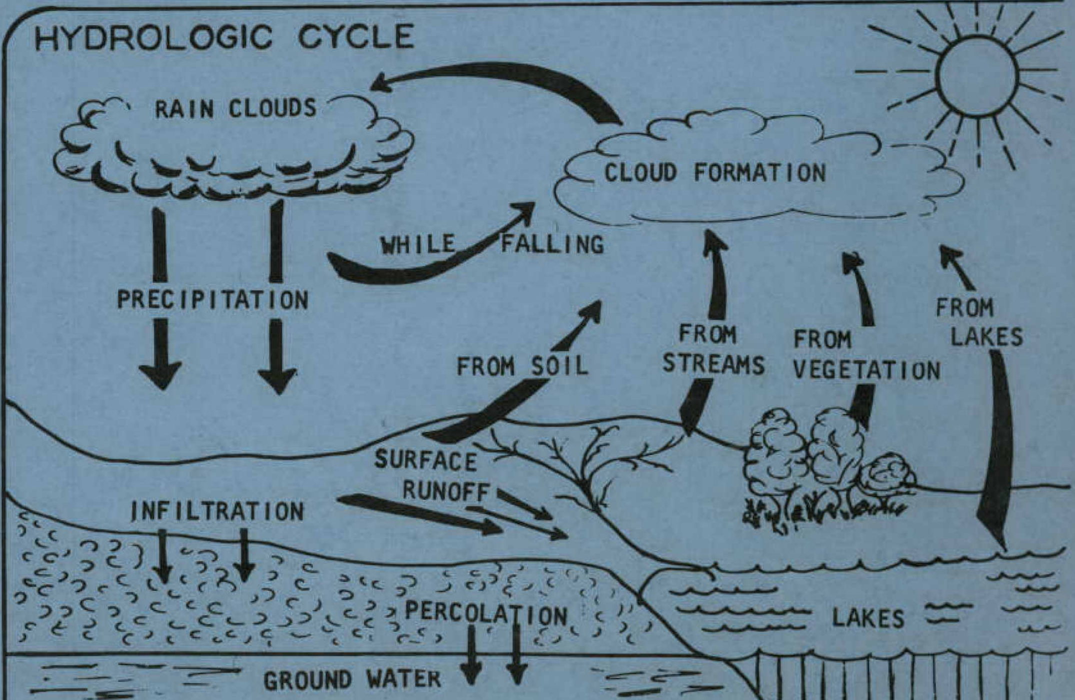

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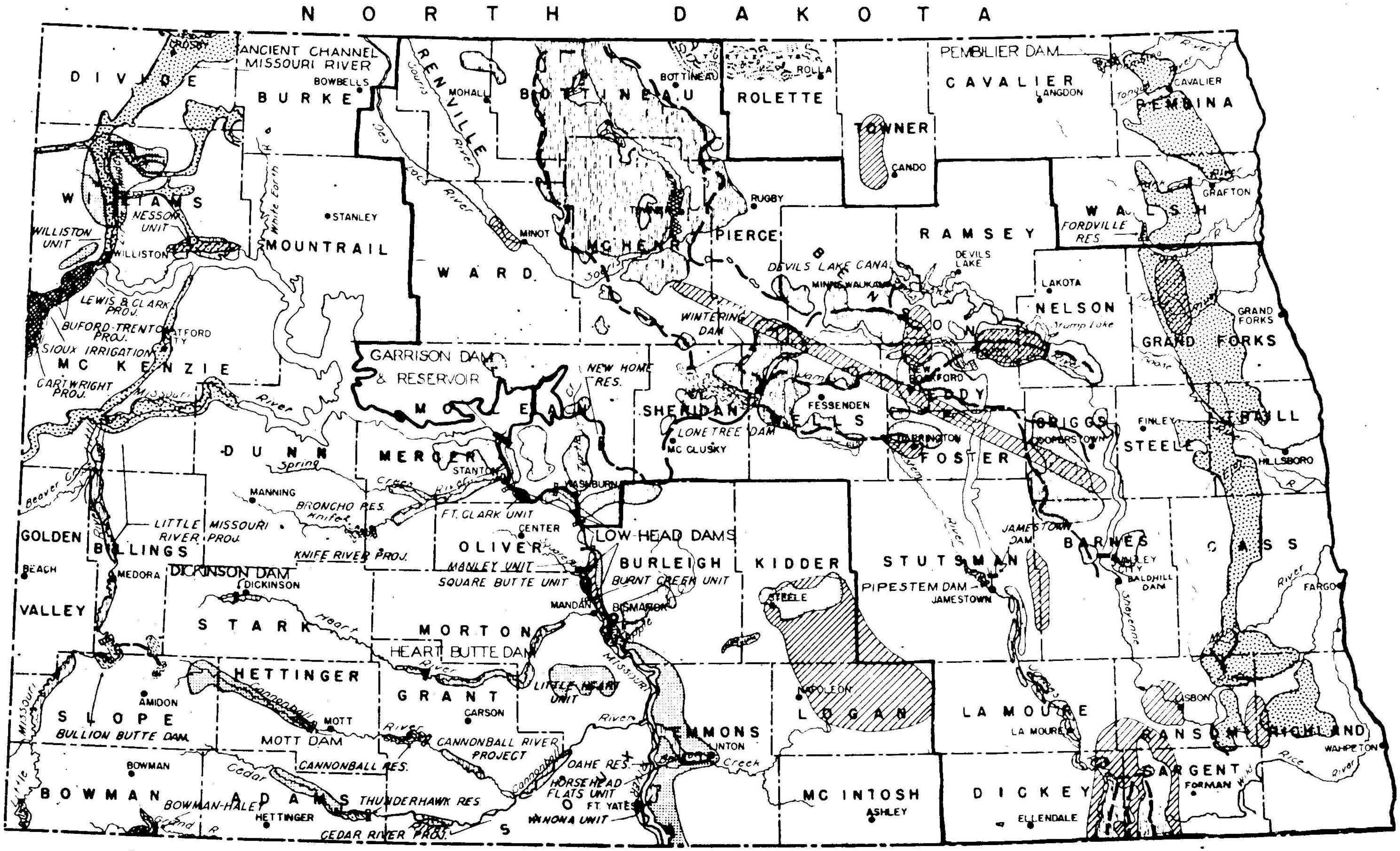

NORTH DAKOTA STATE WATER CONSERVATION COMMISSION

WATER RESOURCES DEVELOPMENT PLAN

LANDS UNDER IRRIGATION

AREAS CONSIDERED IRRIGABLE

AREAS BEING INVESTIGATED

PROPOSED FOR INVESTIGATION

DAM & RESERVOIR SITES: EXISTING; UNDER CONSTRUCTION OR PROPOSED

PROPOSED CANALS

GARRISON DIVERSION CONSERVANCY DISTRICT BOUNDARY

GROUNDWATER AQUIFERS

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North Dakota State Water Conservation Commission
1301 State Capitol, Bismarck, North Dakota

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CONTENTS

ILLUSTRATIONS

TABLES

GROUND WATER NEAR REYNOLDS, GRAND FORKS AND TRAILL COUNTIES, NORTH DAKOTA

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INTRODUCTION

Part of the ground-water program in North Dakota consists of the study of ground-water resources available for municipal development. Ground-water investigations are made of small areas surrounding towns that have requested aid from either the North Dakota State Water Conservation Commission or the North Dakota Geological Survey.

This investigation describes the occurrence and availability of ground water for public and domestic use for the city of Reynolds. The study included test drilling, an inventory of selected wells, evaluation of geologic, hydrologic, and quality of water data, and preparation of this report. The test holes were drilled with a hydraulic-rotary drilling machine owned by the North Dakota State Water Conservation Commission.

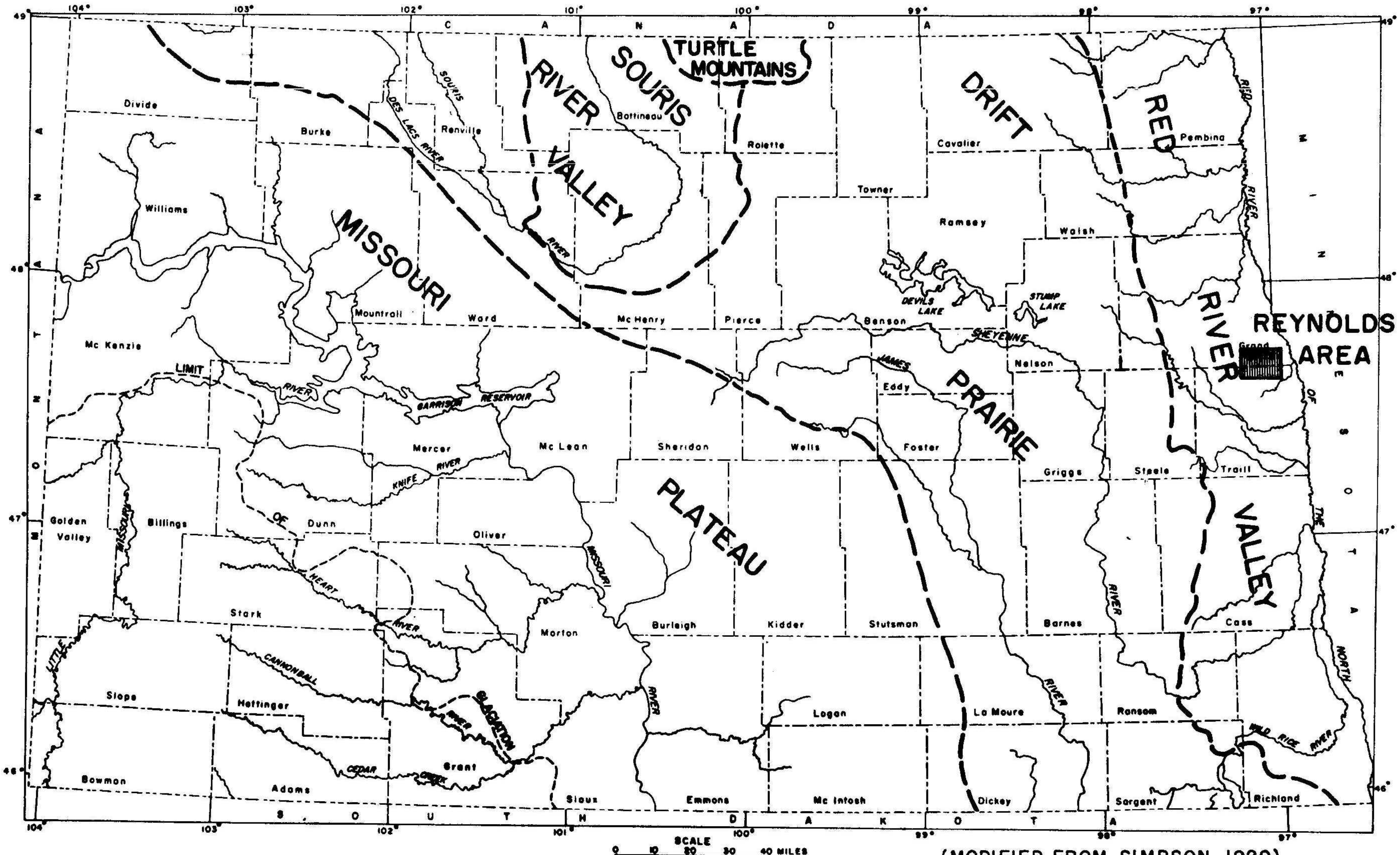
The results of previous investigations within a 25-mile radius of Reynolds are contained in publications by Dennis (1947), Dennis and Akin (1950), Jensen (1961), and Adolphson (1961). These investigations also describe geologic and hydrologic conditions encountered in the development of ground-water supplies in the Red River Valley.

GEOGRAPHY

Reynolds is located along the boundary of Grand Forks and Traill Counties in east-central North Dakota. (See fig. 1.) Its population in 1960 was 133. The report area is in the Red River Valley physiographic province defined by Simpson (1929, p. 4-7). The valley lies in the ancient lake bottom of glacial Lake Agassiz. The area has a nearly flat surface broken only by a series of northwesterly-trending ridges that rise above the general surface of the plain. They are, for the most part, beach ridges that were formed in Lake Agassiz and they represent, at least in part, the successive shorelines of the lake as it receded northward. There are four such ridges in the Reynolds area (Upham, 1896).

Drainage in the region is intermittent. Cole Creek and its minor distributaries drain the northern part of the report area. Elsewhere, water is ponded in sloughs, marshes, or distributed to the drainage system by agricultural drains.

The climate of the region is sub-humid; the average annual precipitation is about 20 inches. The region has fertile soil which, coupled with sufficient rainfall, sustains high yields of small grains, potatoes, and sugar beets.



(MODIFIED FROM SIMPSON, 1929)

FIGURE I--PHYSIOGRAPHIC PROVINCES OF NORTH DAKOTA AND LOCATION OF THE REYNOLDS AREA.

WELL-NUMBERING SYSTEM

All wells and test holes referred to in this report have been assigned numbers indicating thier location within the land subdivisions surveyed by the U.S. Bureau of Land Management. The first numeral within the number indicates the township, the second the range, and the third the section in which the well or test hole is located. The lower case letters (a,b,c,d) following the section number designate the quarter section, quarter-quarter section, and quarter-quarter-quarter section (10-acre tract). If more than one well is located in a 10-acre tract, consecutive numerals are added after the lower case letters. The well-numbering system is illustrated in figure 2.

STRATIGRAPHY AND GROUND-WATER OCCURRENCE

Stratigraphic Relations

The stratigraphy in the Reynolds area was determined from study of subsurface samples collected at 5-foot depth intervals during test drilling. The location of the test holes is shown on figure 3. The stratigraphic section is composed of two main rock types: (1) glacial drift and (2) bedrock formations. The glacial drift of Pleistocene age is subdivided into two main units: (1) deposits of Lake Agassiz, consisting of (a) lacustrine silt and clay deposits, and (b) beach or shore deposits, and (2) till and associated sand and gravel deposits. Granite of Precambrian age was penetrated in one test hole. Overlying the granite at some places are rocks of Cambrian and (or) Ordovician age.

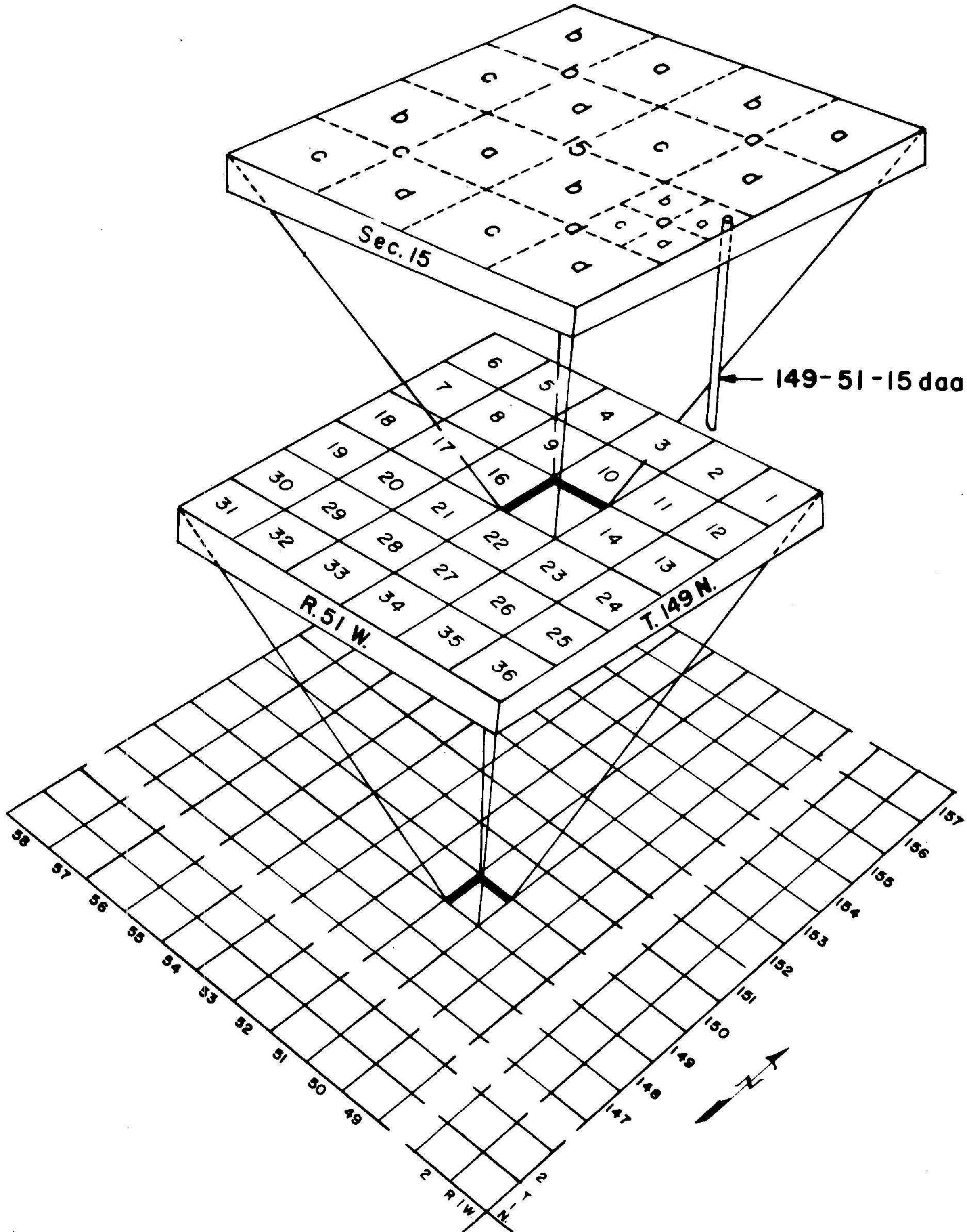


FIGURE 2--SYSTEM OF NUMBERING WELLS AND TEST HOLES.

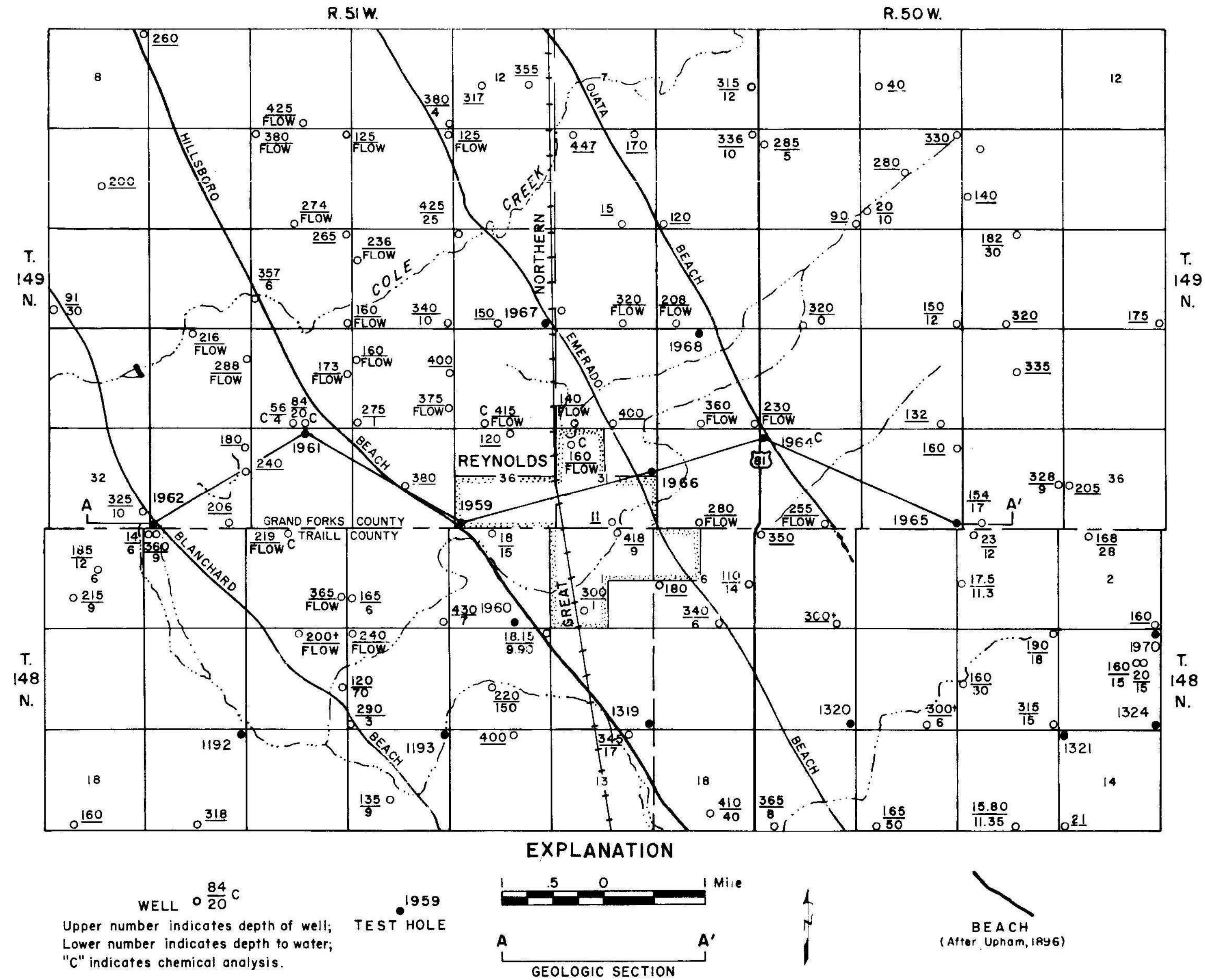


FIGURE 3--MAP OF THE REYNOLDS AREA SHOWING LOCATION OF WELLS, TEST HOLES, BEACHES, AND GEOLOGIC SECTION

The youngest bedrock formations immediately underlying the glacial drift are undifferentiated rocks of Cretaceous age. (See table 1 and figure 4.)

Glacial Drift

Deposits of Lake Agassiz

Lacustrine silt and clay deposits.--The lacustrine silt and clay deposits are relatively impermeable and do not yield ground water to wells in the report area. The deposits act as an upper confining bed of artesian aquifers in the till and associated sand and gravel deposits and in the bedrock.

Beach or shore deposits.--In the Reynolds area beach or shore deposits are the only known source of water for wells in the deposits of Lake Agassiz. The deposits consist of silt, fine to coarse sand, and some gravel; their areal extent is small. The greatest thickness of beach or shore deposits penetrated in the test drilling was 11 feet in test hole 1960 (148-51-2dcd) and additional test drilling would be necessary to determine if there are thicker deposits. It is probable that parts of some of the deposits extend to some depth below the top of lacustrine sediments of the lake plain, although this was not confirmed in this investigation. The thickness of the deposits differs also with the height of the beach or shore feature above the lake plain.

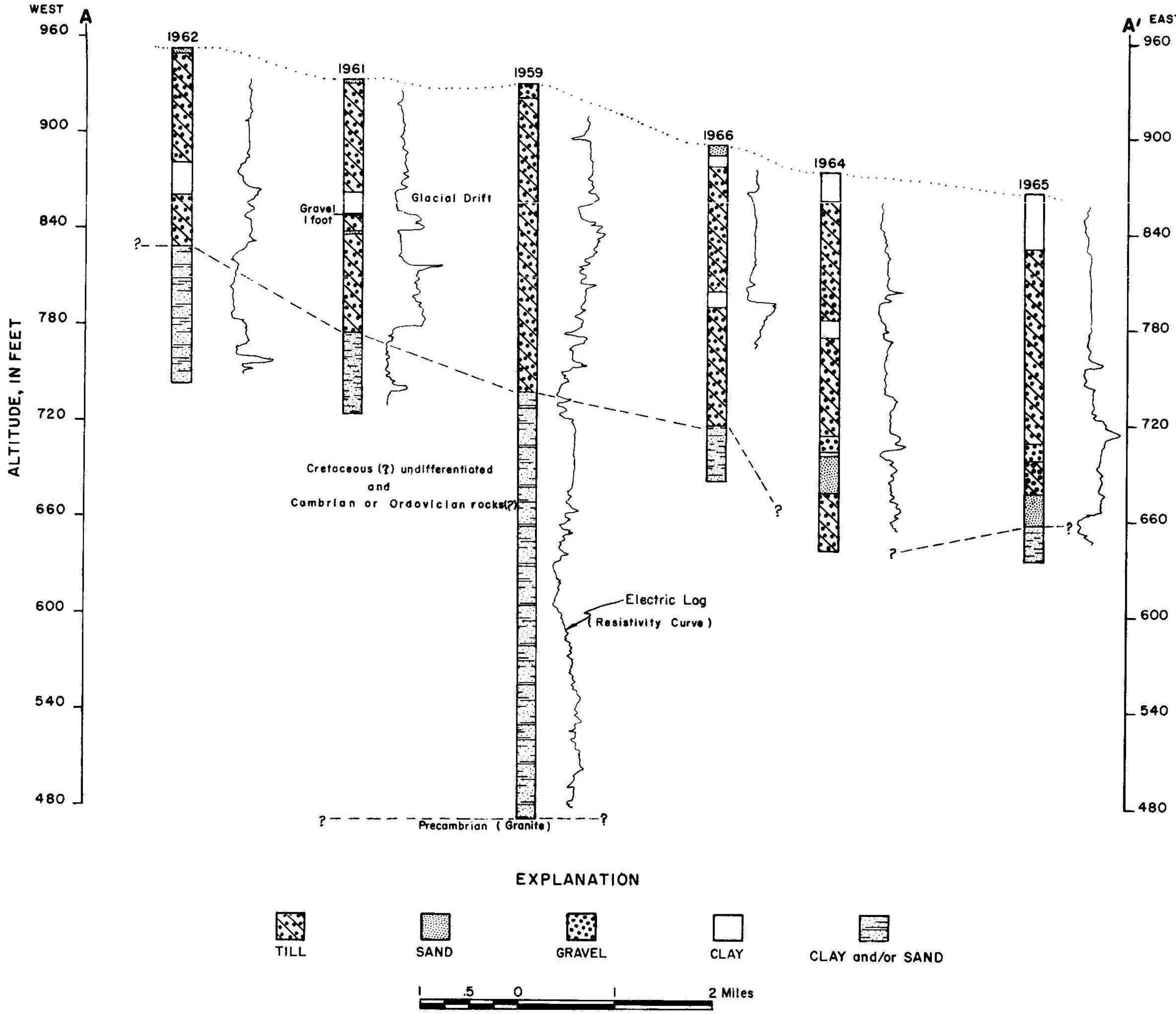


FIGURE 4--GEOLOGIC SECTION IN THE REYNOLDS AREA

Wells yield ground water from a thin saturated zone at the base of the beach or shore deposits. The water is hard and sometimes contains excessive iron but it is used for most domestic purposes. Seasonal fluctuation of ground-water levels, however, causes some of the wells to go dry in summer. If deposits that extend substantially below the lake plain are located, they might yield a more permanent water supply to wells. Because the areal extent of the deposits is small and because they generally are thin, they are not likely to contain sufficient water for a municipality.

Till and Associated Sand and Gravel Deposits

The lower unit of the glacial drift consists of till and associated sand and gravel deposits. The till is a heterogeneous mixture of clay, silt, sand, gravel, and boulders that has been subjected to little or no sorting by wind or water prior to its deposition. Because the till is composed of unsorted materials and because the larger spaces are generally filled with finer materials, till does not ordinarily yield water to wells.

Stratified sand and gravel deposits associated with the till were deposited by glacial melt water. Most of these deposits, which are ordinarily somewhat isolated, contain ground water and are small aquifers. The deposits are generally not exposed and can be detected only by test drilling. Test holes 1964 (149-50-33bbb) and 1965 (149-50-34ddd) penetrated the most extensive stratified deposits known in the area (table 1).

The water in some aquifers is under sufficient artesian head to cause wells to flow at the surface. In other wells the water surface resulting from pressure gradient is below ground level. In test hole 1964 (149-50-33bbb) the hydrostatic pressure was great enough to cause water to flow at ground level. Sand and gravel deposits in the till are a source of supply for many farmsteads.

Ground water from the sand and gravel deposits associated with the till is generally very hard and has a high dissolved-solids content. It is used primarily for general domestic and farm purposes and is not of suitable quality for municipal use without expensive treatment.

Bedrock

Older Rocks

The oldest rocks in the Reynolds area are of Precambrian age. Test hole 1193 (148-51-15aaa) penetrated a hard granite composed of red feldspar, quartz, and mica. Test hole 1959 (149-51-36ccc) probably also reached the granite, but sample recovery was not adequate to positively identify the formation. Precambrian rocks are not a source of ground water in the area.

Rocks of Cambrian and (or) Ordovician age probably underlie parts of the area. Test hole 1193 penetrated a thin section of sandstone and limestone, probably Cambrian or Ordovician in age. The sandstone is pink to white and consists of very fine to coarse-grained quartz particles cemented with calcium carbonate. The limestone is white, cream, and pink and is very fine-textured. The areal extent of the Cambrian and (or) Ordovician rocks is unknown, but they are probably absent at test hole 1959. Possibly these formations yield some water to the deep wells in the area.

Cretaceous Rocks Undifferentiated

Overlying the Cambrian and (or) Ordovician formations are rocks of Cretaceous age. Positive identification of particular units or formations could not be made from the drilling samples; in this report, therefore, the Cretaceous rocks are undifferentiated. They consist of light to dark-gray clay, silt, shale, and sand. One of the formations of Cretaceous age that probably underlies the report area, the Dakota Sandstone, contains an artesian aquifer, but the depth to and the thickness of the formation could not be determined from the test drilling. In the Reynolds area the Dakota Sandstone probably consists of silty and very fine-grained sandy clay.

Flowing wells and wells that have artesian head range in depth from about 100 to over 400 feet in the report area (table 2 and figure 3). Most of the artesian wells more than 200 feet deep probably tap the Dakota Sandstone; however, high hydrostatic heads are common in glacial-drift aquifers and perhaps may exist in wells penetrating water-bearing zones of the Cambrian and (or) Ordovician rocks.

The Dakota Sandstone yields water that has a high dissolved-solids content. Other Cretaceous rocks, largely composed of shale and clay, are generally impermeable and are not aquifers in the report area.

QUALITY OF WATER

The quality of water for public supply and domestic use commonly is evaluated in relation to standards of the U.S. Public Health Service for drinking water. The standards, adopted in 1914 to protect the health of the traveling public, were revised several times in subsequent years. The latest revisions by the U.S. Public Health Service (1961), approved by the Secretary of Health, Education and Welfare, are, in part, as follows:

Constituent	Maximum concentration ppm
Iron (Fe)	0.3
Manganese (Mn)	.05
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)	1.7 a/
Nitrate (NO_3)	45
Dissolved solids	500

a/ Based on a 5-year record of average maximum daily air temperatures at Hillsboro, North Dakota.

Chemical analyses of water from wells in the Reynolds area are listed in table 3. A comparison of recommended limits with mineral concentrations found in the well waters shows at least 3 of the recommended limits are exceeded in the individual analyses.

High mineral concentrations in the water generally affect the taste and (or) color and make the water objectionable for public supply. Because a more suitable water was not available, water containing more than the recommended concentration of certain chemical constituents has been used in some areas, including North Dakota, for many years without reported ill effects. The high concentration of nitrate found in water from well 149-51-27dcc is, however, potentially dangerous and may cause cyanosis in infants when used in feeding formulas and for drinking (Comly, 1945). Generally, well water in the report area is very hard and has a high dissolved-solids content; poor quality of the water has forced most residents to haul water for drinking and culinary purposes from sources outside the report area.

SUMMARY AND CONCLUSIONS

Two general sources of ground water are available in the Reynolds area; they are glacial drift and bedrock. Small amounts of ground water are available from the deposits of Lake Agassiz. The water is drawn from relatively shallow farm or domestic wells in beach or shore deposits. The deposits contain a thin saturated zone at their base; water levels in wells fluctuate seasonally and some wells go dry in the summer. In the report area, the deposits are not a likely source of sufficient water for municipal supplies.

Stratified sand and gravel deposits associated with till also contain small amounts of ground water. The yield of wells in the deposits is limited by the small areal extent and the thinness of the deposits.

The water is hard, has a high dissolved-solids content, and is used only for general domestic and farm purposes.

The bedrock formations include rocks of Precambrian, Cambrian and (or) Ordovician, and Cretaceous age. Precambrian rocks (granite) are not aquifers in the area. Other bedrock units may yield ground water to wells. The Dakota Sandstone is probably responsible for the high hydrostatic head in many wells.

The general geologic and hydrologic conditions in the vicinity of Reynolds are not favorable for development of supplies of good-quality ground water. An aquifer in the Dakota Sandstone of Cretaceous age and (or) aquifers in sand and gravel deposits associated with the till might yield sufficient water to properly constructed wells for a municipal supply; however, the quality of water is inferior to the U.S. Public Health Service standards used for evaluating public and domestic water supplies. If economical methods for the demineralization of saline or brackish water are developed, the ground-water sources in the Reynolds area could be useful for public supplies.

TABLE 1.--Logs of test holes

148-50-8ddd
Test hole 1320
Altitude: 881 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	4	4
	Clay, silty, yellow; oxidized	12	16
	Clay, silty, gray; shale pebbles and few cobbles (till)	93	109
	Clay, silty, gray; fine and medium gravel and a lot of cobbles (till)	52	161
	Clay, sandy, light-gray	53	214
Cretaceous undifferentiated:			
	Clay, shaly, gray	6	220

148-50-11aaa
Test hole 1970
Altitude: 860 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	1	1
	Clay, plastic and smooth, mottled yellow, brown, light-gray, oxidized	15	16
	Clay, smooth and plastic, olive-gray	26	42
	Clay, silty, olive-gray to medium-dark-gray; sand, granule and pebble-size limestone fraction (till)	101	143
	Clay, silty, medium to dark-gray; sand, granule and pebble size limestone fraction (till)	44	187
	Clay, olive-gray to medium-dark-gray; limestone and shale pebbles (till)	16	203
Cretaceous undifferentiated:			
	Clay, tough, moderate-brown, grayish-brown, and brownish-gray	7	210

TABLE 1.--Logs of test holes -- Continued

148-50-11ddd
Test hole 1324
Altitude: 860 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	4	4
	Clay, smooth, yellow	13	17
	Clay, smooth, gray	121	138
	Clay, sandy and silty, gray; fine and medium limestone and shale gravel - some cobbles (till)	42	180
	Gravel, fine and medium; some light-gray clay	13	193
Cretaceous undifferentiated:			
	Clay, tough, gray	19	212
	Clay, shaly, gray	8	220

148-50-14bbb
Test hole 1321
Altitude: 870 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	1	1
	Clay, smooth, yellow	12	13
	Clay, smooth, blue	114	127
	Clay, sandy, gray; fine and medium limestone gravel (till)	46	173
Cretaceous undifferentiated:			
	Clay, shaly, gray	16	189

TABLE 1.--Logs of test holes -- Continued

148-51-2dcd
Test hole 1960
Altitude: 961 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Sand, fine to coarse, rounded, poorly sorted; silty in top 1 foot	11	11
	Clay, very silty, light-olive-gray to olive-gray (reworked till)	9	20
	Clay, silty and sandy, light-olive-gray and olive-gray; shale pebbles (till)	91	111
	Sand, coarse to very coarse; fine gravel	2	113
	Clay, silty to sandy, tough, olive-gray; limestone and shale pebbles (till)	3	116
	Gravel, fine; sand, fine to coarse; some light-olive-gray, silty, clay	8	124
	Clay, sandy to gravelly, olive-gray; shale pebbles (till)	26	150
	Clay, silty to sandy, brownish-gray, and light-olive-gray (till)	50	200
Cretaceous undifferentiated:			
	Clay, silty, light-olive-gray	10	210

148-51-12ddd
Test hole 1319
Altitude: 908 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	2	2
	Clay, smooth, light-gray	9	11
	Clay, smooth, gray	93	104
	Clay, silty to sandy, gray; fine and medium limestone gravel and shale pebbles (till)	44	148
	Sand, fine to coarse; with some gray clay	11	159
	Clay, smooth, gray	9	168
	Gravel, fine and medium; with very fine silty sand	23	191
	Clay, smooth, bluish-gray	13	204
Cretaceous undifferentiated:			
	Clay, shaly, gray	6	210

TABLE 1.--Logs of test holes -- Continued

148-51-15aaa
Test hole 1193
Altitude: 943 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Clay, yellow, smooth	10	12
	Clay, light-gray, smooth	73	85
	Clay, gray; gravel, fine to medium shale pebbles (till)	85	170
Cretaceous undifferentiated:			
	Clay, shaly, light-gray	288	458
Ordovician and (or) Cambrian:			
	Limestone, lithographic, white and light-red, indurated; fine to coarse pink and white sandstone cemented with calcium carbonate	8	466
Precambrian:			
	Granite	2	468

148-51-17aaa
Test hole 1192
Altitude: 955

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	1	1
	Clay, smooth, yellow	15	16
	Clay, sandy, gray	54	70
	Clay, smooth, blue	25	95
	Clay, sandy, gray; fine and medium limestone and shale gravel (till)	80	175
Cretaceous undifferentiated:			
	Clay, shaly, gray	14	189

149-50-29baa
Test hole 1968
Altitude: 876 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	1	1
	Clay, silty, dark-yellowish-orange to olive-gray	25	26
	Clay, silty, light-olive-gray to olive-gray; limestone and shale fragments (till)	67	93
	Clay, silty, olive-gray	10	103
	Sand, very fine to medium, subangular to subrounded - predominantly quartz with abundant limestone and shale grains	27	130
	Clay, silty to sandy, olive-gray; limestone and shale fragments (till)	48	178
	Clay, very silty and slightly sandy, olive-gray; contains more gravel size limestone fragments than above (till)	32	210

149-50-31add
Test hole 1966
Altitude: 893 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Sand, very fine to very coarse; predominantly quartz with limestone fragments	7	7
	Clay, silty, yellowish-gray	7	14
	Clay, silty to sandy, cohesive, olive-gray; shale and limestone pebbles (till)	78	92
	Clay, silty, olive-gray	10	102
	Clay, very gravelly, olive-gray; angular to subrounded limestone and shale fragments (till)	34	136
	Clay, silty and sandy, olive-gray; limestone and shale pebbles; with some grayish-green, sandy clay (till)	40	176
Cretaceous undifferentiated:			
	Clay, silty, tough and cohesive, olive-gray to light-olive-gray	34	210

TABLE 1.--Logs of test holes -- Continued

149-50-33bbb
Test hole 1964
Altitude: 875 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, silty, yellowish-brown	17	18
	Clay, silty, cohesive, olive-gray; limestone pebbles (till)	74	92
	Clay, silty, olive-gray	11	103
	Clay, silty to sandy, olive-gray; shale pebbles (till)	43	146
	Clay, as above, light-olive-gray (till)	18	164
	Gravel, fine to coarse; subrounded to round limestone fragments	11	175
	Clay, light-olive-gray	2	177
	Sand, fine to coarse to very coarse, subrounded to round quartz grains; some fine gravel - hole flowed water	23	200
	Clay, gray with much fine to coarse gravel and coarse sand (very gravelly till)	36	236

(Abandoned hole at 236 feet, angular, sharp pieces of granite.)

TABLE 1.--Logs of test holes -- Continued

149-50-34ddd
Test hole 1965
Altitude: 864 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, black	3	3
	Clay, silty to sandy, yellowish-brown to dark-yellowish-orange, oxidized	17	20
	Clay, light-olive-gray to olive-gray; contains thin sand stringers	15	35
	Clay, silty, olive-gray; shale pebbles and limestone fragments (till)	89	124
	Clay, silty and sandy, tough, light-olive-gray; shale pebbles and limestone fragments (till)	32	156
	Gravel, fine to coarse; abundant limestone fragments and shale pebbles	11	167
	Clay, silty to sandy, light-olive-gray; limestone and shale pebbles (till)	21	188
	Sand, medium, well sorted, subrounded; quartz grains predominant with limestone and shale grains prevalent; some light-olive-gray, silty clay	20	208
Cretaceous undifferentiated:			
	Clay, silty to sandy, light-olive-gray	2	210
	Clay, silty, cohesive, grayish-black	21	231

TABLE 1.--Logs of test holes -- Continued

149-50-36ccc
Test hole 1959
Altitude: 931 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Gravel, fine to coarse; fine to coarse sand	9	9
	Clay, silty and sandy, dark-greenish-gray; shale pebbles and lignite fragments (till)	84	93
	Clay, silty and sandy, olive-gray (till)	38	131
	Clay, tough, dusky-yellowish-brown; limestone pebbles, lignite fragments (till)	16	147
	Clay, yellowish-brown upper part and olive-gray lower part; shale granules and lignite fragments (till)	46	193
Cretaceous undifferentiated:			
	Clay, silty, sandy, tough and cohesive, olive-gray; gravel and shale pebbles from above	112	307
	Clay, silty and sandy, dark-greenish-gray; shale pebbles and limestone fragments from above	54	361
	Clay, cohesive, light-olive-gray to light-brownish-gray; faint laminations	98	459
Precambrian(?):			
	Granite; one rock chip - light-gray to greenish-gray, biotite flakes. (bit bounces and drill column cracks.)		459

TABLE 1.--Logs of test holes -- Continued

149-51-24ddd
Test hole 1967
Altitude: 894 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, silty, yellow	1	1
	Sand, fine to very coarse, angular to subrounded quartz grains	2	3
	Clay, silty, yellowish-brown to dark-yellowish-orange	3	6
	Clay, silty and sandy, light-olive-gray to olive-gray; limestone and shale pebbles (till)	77	83
	Clay, silty, olive-gray	9	92
	Sand, fine to very coarse (limestone and shale grains predominant); some granule gravel	2	94
	Clay, silty, sandy, and gravelly, light-olive-gray (till)	52	146
	Clay, silty and tough, grayish-black	42	188
	Clay, silty to sandy, light-olive-gray; limestone and shale granules (till)	22	210

149-51-33ccc
Test hole 1962
Altitude: 952 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Sand, fine to coarse, unsorted subangular to rounded quartz grains, oxidized	4	4
	Clay, silty to slightly sandy; shale grains and granules (till)	68	72
	Clay, silty, olive-gray	20	92
	Clay, silty to sandy, olive-gray; shale pebbles and limestone fragments (till)	33	125
Cretaceous undifferentiated:			
	Clay, silty, tough, laminated in part, greenish-black	52	177
	Clay, silty to very sandy, dusky-yellowish-brown; limestone particles	33	210

TABLE 1.--Logs of test holes -- Continued

149-51-34abb
Test hole 1961
Altitude: 933 ft

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, sandy, black	1	1
	Sand, fine to coarse; fine gravel	2	3
	Clay, silty and sandy, dark-yellowish-orange, oxidized (till)	19	22
	Clay, sandy to silty, olive-gray (till)	50	72
	Clay, silty, olive-gray, very cohesive	13	85
	Gravel, fine; sand, fine to coarse	1	86
	Clay, sandy, olive-gray (till)	10	96
	Sand, fine to medium, angular to subrounded	2	98
	Clay, sandy, olive-gray; limestone and shale pebbles (till)	61	159
Cretaceous undifferentiated:			
	Clay, silty and cohesive, olive-gray; contains white calcareous inclusions	51	210

TABLE 2.--Records of wells

Depth of well and depth to water: Measured depths are given in feet, tenths, and hundredths; reported depths are given in feet.

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
148-50					
2bab	Bert Jensen	168	2	Dr	1908
2ddd	Leonard Haugen	160	3	Dr	....
3bba	Henry Brekke	23	48	Du	....
3cbb	George Mohn	17.5	48	Du	....
5bbb	Matt Von Ruden	350	2	Dr	....
5ddc	Berta Knudson	300 +	2	Dr	....
6cbb	Ole Sondreal	180	..	Dr	....
6daa	Bertel Kvitne	110	2	Dr	1935
6dcd	Ralph Weigel	340	2	Dr	1920
8ddd	Test hole 1320	220½	5	Dr	6-58
9dcd	Howard Brieland	300 +	..	Dr	....
10aaa	Vic Horne	190	3	Dr	1951
10cbb	Milford Hovet	160	2	Dr	1950
10ddd	Thelma and Ordan Hovet	315	2	Dr	1918
11aaa	Test hole 1970	210	5	Dr	10-61
11adb1	Knute Kjelmeland	160	2	Dr	....
11adb2	..do....	20	6	Dr	1922
11ddd	Test hole 1324	220½	5	Dr	6-58
14bbb	Test hole 1321	189	5	Dr	6-58
14ccc	Clara and Emma Hovet	21	8	Du	....
148-51					
1aba	Tony Scholand	418	2	Dr	1947
1cdb	Cora Braste	300	2	Dr	1890
2baa	Joe Renners	18	48	Du	1955
2dcd	Test hole 1960	210	5	Dr	10-19-61
3cbc	Anton Linneman	165	2	Dr	1925
3ddd	Fred Ackerman	430	2	Dr	1938
4baa	Alvis Schultz	219	..	Dr	1953
5bbb1	Chris Landa	360	3	Dr	1950
5bbb2	..do....	14	36	Du	....

and test holes

Use of water: D, domestic; N, none; S, stock; T, test hole.

Type of well: Dr, drilled; Du, dug.

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Remarks
28	....	S	Sand	Supply reported adequate.
.....	....	N	......	
12	....	S	......	
11.30	6-16-58	S	..do..	..Do....
.....	....	N	..do..	
.....	....	N	..do..	Saline
.....	....	S	......	
14	7- 6-60	S	.....	..Do....
6	....	N	..do..	Supply reported inadequate; saline.
.....	....	T	......	See log.
6	....	S	..do..	Saline.
18	....	D,S	......	Supply reported adequate.
30	....	S	..do..	Saline.
15	....	...	..do..	..Do..
.....	....	T	......	See log.
15	....	S	..do..	Supply reported adequate.
15	....	D	Clay	..Do....
.....	....	T	......	See log.
.....	....	T	......	..Do....
.....	....	D	......	
9	....	S	......	Saline.
1	....	N	Sand	..Do....
15	....	S	Gravel	Supply reported adequate.
.....	....	T	......	See log.
6	....	S	Sand	Saline.
7	....	S	..do..	..Do....
Flows	....	S	..do..	Saline; chemical analysis.
9	....	S	..do...	Saline.
6	....	D	..do..	Small domestic supply.

TABLE 2.--Records of wells

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
148-51 (Continued)					
6acc	Hubert Von Ruden	185	3	Dr	....
6cac	Leo Schultz	215	3	Dr	1953
9abb	Alfonse Adams	200 +	..	Dr	1928
9daa	Leo Breidenbach	120	3	Dr	1955
10bbb	Anna Marx	240	2	Dr	1920
10ccc	Joe Linneman	290	2	Dr	1948
11aaa	Vacant	18.15	48	Du	7- 15-58
11caa	William Liddige	220	..	Dr	1950
12ddd	Test hole 1319	210	5	Dr	6 - 7-58
13aab	Helmer Knudsvig	345	2	Dr	1945
14aba	M. Rabinovich	400	2	Dr	1934
15aaa	Test hole 1193	468	5	Dr	8- 24-57
15cad	Louis Berthold	135	2	Dr	1933
17aaa	Test hole 1192	189	5	Dr	8 -21-57
17dcc	Fuglesten Bros.	318	5	Dr	1945
18cdc	Anton Ragenes	160	2	Dr	1920
149-50					
8daa	Kenneth Tweten	315	2	Dr	1925
10cba	Orlando Johnson	40	48	Du	....
14bbd	Clarence Hanson	.....	2	Dr	....
14cbc	Oscar Mahlum	140	2	Dr	....
15aaa	Russel Jenson	330	2	Dr	....
15bdd	Ernest Fladeland	280	2	Dr	....
15ccb	..do....	20	20	Du	1934
16bbc	Trygve Syverson	285	2	Dr	....
16ddd	Helen Helgeson	90	36	Dr	....
17aaa	Russell Tweeten	336	2	Dr	....
17ccc	Ollie Sannes	120	2	Dr	....
18aab	Sam Loyland	170	2	Dr	....
18bba	Dora Cunningham	477	2	Dr	....
18dcd	Torville Evenstad	15	96	Du	....
19ccb	Walter Brekke	...	2	Dr	....
19dcd	Antone Rakoczy	320	2	Dr	....
20ccd	Chester Haugen	208	2	Dr	....

and test holes -- Continued

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Remarks
12	....	S	Sand	Supply reported adequate; saline.
9	....	S	..do..	..Do....
Flows	....	S	..do..	..Do....
70	....	S	..do..	..Do....
Flows	....	S	..do..	..Do....
3	....	S	..do..	..Do....
9.90	....	N	..do..	On beach ridge.
150	....	S	..do..	Saline.
.....	....	T	......	See log.
17	7-19-60	S	..do..	Saline.
.....	....	S	..do..	..Do....
.....	....	T	......	See log.
9	7- 6-60	S	..do..	Saline.
.....	....	T	......	See log.
.....	....	T	......	
.....	....	S	..do..	Saline.
12	....	S	......	..Do....
.....	....	S	......	Supply reported inadequate.
.....	....	S	......	Saline.
.....	....	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	S	..do..	Supply reported inadequate.
10	....	D,S	..do..	
5	....	S	..do..	Supply reported adequate; saline.
.....	....	S	......	..Do....
10	....	...	......	..Do....
.....	....	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	D,S	Gravel	
.....	....	S	......	Saline.
Flows	....	S	......	Supply reported adequate; saline.
Flows	....	S	Sand	..Do....

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
149-50 (Continued)					
21cdd	Einer Saure	320	2	Dr	1959
22ddd	Oscar Jenson	150	2	Dr	1932
23abb	Gilbert Gulson	182	2	Dr	....
23cdd	Brathovde Farming Co.	320	2	Dr	....
24ddd	Ole Hanson	175	2	Dr	1933
26acc	Alma Peterson	335	2	Dr	1895
27ddc	O. A. Johnson	132	2	Dr	1931
29baa	Test hole 1968	210	5	Dr	10-25-61
29cdd	Drees	360	2	Dr	1922
29ddd	Louis and Henry Lazur	230	2	Dr	....
30ccd	Bert Monson	140	2	Dr	1913
30dcc	Carl Eklund	400	2	Dr	1925
31add	Test hole 1966	210	5	Dr	10-25-61
31bbd	Norman Iverson	160 ?	2	Dr	....
31dcc	Martin Olson	11	48	Du	1961
32cdd	Tony Leddige	280	2	Dr	1928
33bbb	Test hole 1964	236	5	Dr	10-22-61
33dcd	Alice Rambeck	255	2	Dr	1933
34aad	Nels Berg	160	2	Dr	1913
34ddd	Test hole 1965	231	5	Dr	10-23-61
35ccd	Fred Gjelsness	154	2	Dr	1921
35daa	Montford Peterson	328	2	Dr	1935
36cbb	Clifford Peterson	205	2	Dr	1935
149-51					
8aaa	Raymond Thompson	260	2	Dr	....
10dcc	Joe Adams	425	2	Dr	....
11ddd	..do....	380	2	Dr	....
12cab	Andrew Holien	317	2	Dr	1915
12dab	F. A. Simon	355	2	Dr	1927
14aaa	Peter Schumacher	125	2	Dr	....
15aaa	Ferd Adams	125	2	Dr	....

and test holes -- Continued

Depth to water below land surface (feet)	Date of measure-ment	Use of water	Aquifer	Remarks
1	....	S	Sand	Supply reported adequate; saline.
12	....	S	......	..Do....
30	1961	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	S	......	..Do....
.....	....	T	......	See log.
Flows	....	S	......	Supply reported adequate; saline.
Flows	....	S	......	..Do....
Flows	....	S	......	..Do....
.....	....	S	......	..Do....
.....	....	T	......	See log.
Flows	....	S	..do..	Supply reported adequate; chemical analysis.
.....	....	S	Clay	Supply reported inadequate.
Flows	....	S	......	Saline.
Flows	....	T	......	See log; chemical analysis.
Flows	....	S	......	Supply reported adequate; saline.
.....	....	S	......	Saline.
.....	....	T	......	See log.
17	1961	S	Sand	Saline; plugged.
9	1961	S	..do..	Supply reported adequate; saline.
.....	....	S	..do..	..Do....
.....	....	S	..do..	Supply reported adequate.
Flows	....	S	..do..	Supply reported adequate; saline.
4	7-18-61	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	S	..do..	..Do....
Flows	....	S	..do..	..Do....
Flows	....	S	..do..	..Do....

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
149-51 (Continued)					
15bbb	Vernon Adams	380	3	Dr	....
15cdd	Francis Schrainer	274	3	Dr	1947
17dbb	Chris Foseth	200	2	Dr	1909
20ccb	Henry Nelson	91	24	Dr	1935
22aaa	James Adams	265	2	Dr	1959
22cbc	Howard Adams	357	2	Dr	1946
22ddd	Max Griggs	160	2	Dr	....
23bcb	Lawrence Adams	236	2	Dr	1952
23ddd	George Adams	340	3	Dr	1915
24bbb	Peter Schumacher	425	3	Dr	....
24cdd	Raymond Adams	150	2	Dr	....
24ddd	Test hole 1967	210	5	Dr	10-25-61
25cdc	James Schaffer	415	2	Dr	1956
26add	Lester Adams	400	2	Dr	....
26bcb	Kenneth Adams	160	2	Dr	1930
26ccc	Clemens Adams	275	3	Dr	1944
26dda	Lewis Schumacher	375	2	Dr	1936
27add	John Adams	173	2	Dr	1940
27cdd	Theodore Ackerman	56	21	Dr	....
27dcc	..do....	84	21	Dr	1949
28ada	Eugene Adams	288	2	Dr	1958
28baa	Carl Breidenbach	216	2	Dr	1949
32dda	Joe Breidenbach	325	2	Dr	....
33aad	E. C. Holiday	180	3	Dr	1961
33add	Albert Ackerman	240	2	Dr	1952
33ccc	Test hole 1962	210	5	Dr	10-20-61
33ddc	William Leddige	206	3	Dr	....
34abb	Test hole 1961	210	5	Dr	10-20-61
35ddb	Julius Ackerman	380	2	Dr	....
36abb	Steve Fetter	120	2	Dr	....
36ccc	Test hole 1959	460	5	Dr	10-18-61

and test holes -- Continued

Depth to water below land surface (feet)	Date of measurement		Aquifer	Remarks
Flows	....	S	Sand	Supply reported adequate; saline.
Flows	....	S	..do..	..Do....
.....	....	S	..do..	..Do....
30	7-12-61	S	..do..	..Do....
.....	....	S	..do..	..Do....
6	7-17-61	S	..do..	..Do....
Flows	....	S	..do..	..Do....
Flows	....	S	..do..	..Do....
10	7-18-61	S	..do..	..Do....
25	7-17-61	S	..do..	..Do....
.....	....	S	..do..	..Do....
.....	....	T	......	See log.
Flows	....	S	..do..	Supply reported adequate; saline; chemical analysis.
.....	....	S	..do..	Supply reported inadequate; saline.
Flows	....	S	..do..	Supply reported adequate; saline.
.....	7-13-61	S	..do..	..Do....
Flows	....	S	..do..	..Do....
Flows	....	S	..do..	..Do....
4	7-13-61	D,S	..do..	Supply reported adequate; saline; chemical analysis.
20	7-13-61	D,S	..do..	..Do....
Flows	....	S	..do..	Supply reported adequate; saline.
Flows	....	S	..do..	..Do....
10	7-19-61	S	..do..	..Do....
10	7-14-61	S	..do..	..Do....
Flows	....	S	..do..	..Do....
.....	....	T	......	See log.
6	6-61	S	..do..	Supply reported adequate; saline.
.....	....	T	......	See log.
.....	....	S	..do..	Supply reported adequate; saline.
.....	....	S	..do..	Supply reported inadequate; saline.
.....	....	T	......	See log.

Results in parts per million except as indicated

Location No.	Owner or name	Date of collection	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)
148-51							
4baa	Alvis Schultz	8 -15-58	.6	487	339	1,044	44
149-50							
31bbd	Norman Iverson	7 - 8-61	.6	342	258	1,022	24.8
33bbb	Test hole 1964	10-22-61	.2	254	86	900	....
149-51							
25cdc	James Schaffer	7 - 8-61	1.2	517	415	1,292	42.4
27cdd	Theodore Ackerman	10-15-61	8.6	390	280	356	15
27dcc	....do....	7 - 8-61	.4	368	780	169	15.2

analyses of ground water

Analyses by State Laboratories, Bismarck, N. Dak.

Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids calculated	Hardness as $CaCo_3$	pH
204	30	1,431	1,011	1.8	1.8	2.4	4,063	826	8.3
260	48	1,271	940	8.0	1.2	2.9	3,738	600	7.6
218	Absent	1,050	1,150	...	33	....	3,754	925	7.6
268	Absent	2,152	1,488	8.0	6.1	2.92	7,470	932	7.5
380	Absent	86	786	1.0	24.0	....	1,890	670	7.6
432	Absent	230	534	1.0	205	.12	2,419	1,148	7.6

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