

RECONNAISSANCE OF GEOLOGY AND GROUND WATER
OF SELECTED AREAS IN NORTH DAKOTA

AREAS OF INVESTIGATION

ROLLA-ST. JOHN AREA AND MYLO AREA, ROLETTE COUNTY
MINTO-FOREST RIVER AREA, WALSH COUNTY
POWERS LAKE AREA, BURKE COUNTY
MADDOCK AREA, BENSON COUNTY
HUNTER AREA, CASS COUNTY

BY
J. W. BROOKHART
AND

J. E. POWELL
GEOLOGICAL SURVEY

UNITED STATES DEPARTMENT OF THE INTERIOR

NORTH DAKOTA GROUND WATER STUDIES
NO. 28

PUBLISHED BY
NORTH DAKOTA STATE WATER CONSERVATION COMMISSION

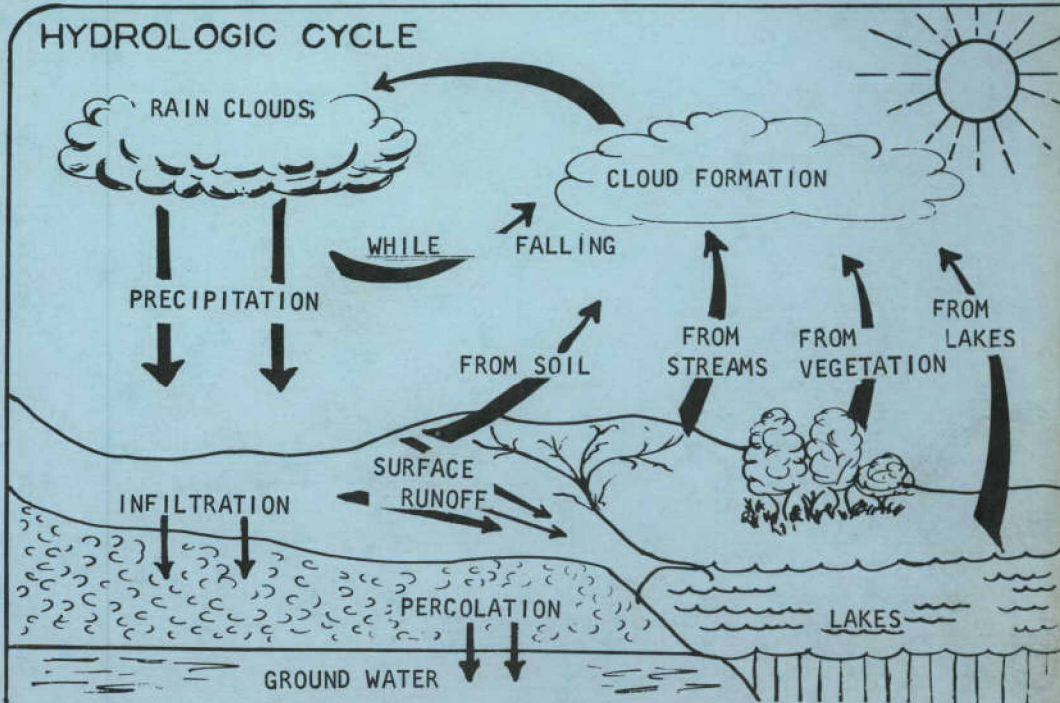
1301 STATE CAPITOL, BISMARCK, NORTH DAKOTA

IN COOPERATION WITH

U. S. GEOLOGICAL SURVEY

1961

HYDROLOGIC CYCLE



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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

-  EXISTING
-  UNDER CONSTRUCTION OR PROPOSED

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RECONNAISSANCE OF GEOLOGY AND GROUND WATER OF SELECTED
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By
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J.E. Powell

ABSTRACT

This report describes reconnaissance investigations in six areas of North Dakota. The areas lie within the Red River Valley, the Drift Prairie, and the Missouri Plateau physiographic regions of the State of North Dakota.

Ground-water conditions in these report areas were studied by means of test drilling and of geologic and ground-water reconnaissance. The initial study of each area was begun at the request of municipalities seeking a water supply or seeking to augment their present water supply. Data contained in this report are being made available to satisfy current needs; later these data will be used in the preparation of county-wide reports.

The investigations disclosed the primary sources of water for domestic, municipal, and farm use are (1) glacial till, where the sand-clay ratio of till within the vicinity of the well assures moderate permeability, (2) saturated sand and gravel lenses completely surrounded by till, (3) sandy zones that are at or near the top of the bedrock and that derive their water from the till or bedrock aquifers, and (4) bedrock aquifers that supply large quantities of highly mineralized water, some that is suitable for human consumption and some that is not.

The Rolla-St. John and Mylo areas in the Drift Prairie physiographic region of Rolette County obtain water from glacial till, sand and gravel lenses within the till, and from a sandy zone in the upper part of the Pierre shale of Late Cretaceous age which is the bedrock of the area. No important aquifer was located by test drilling.

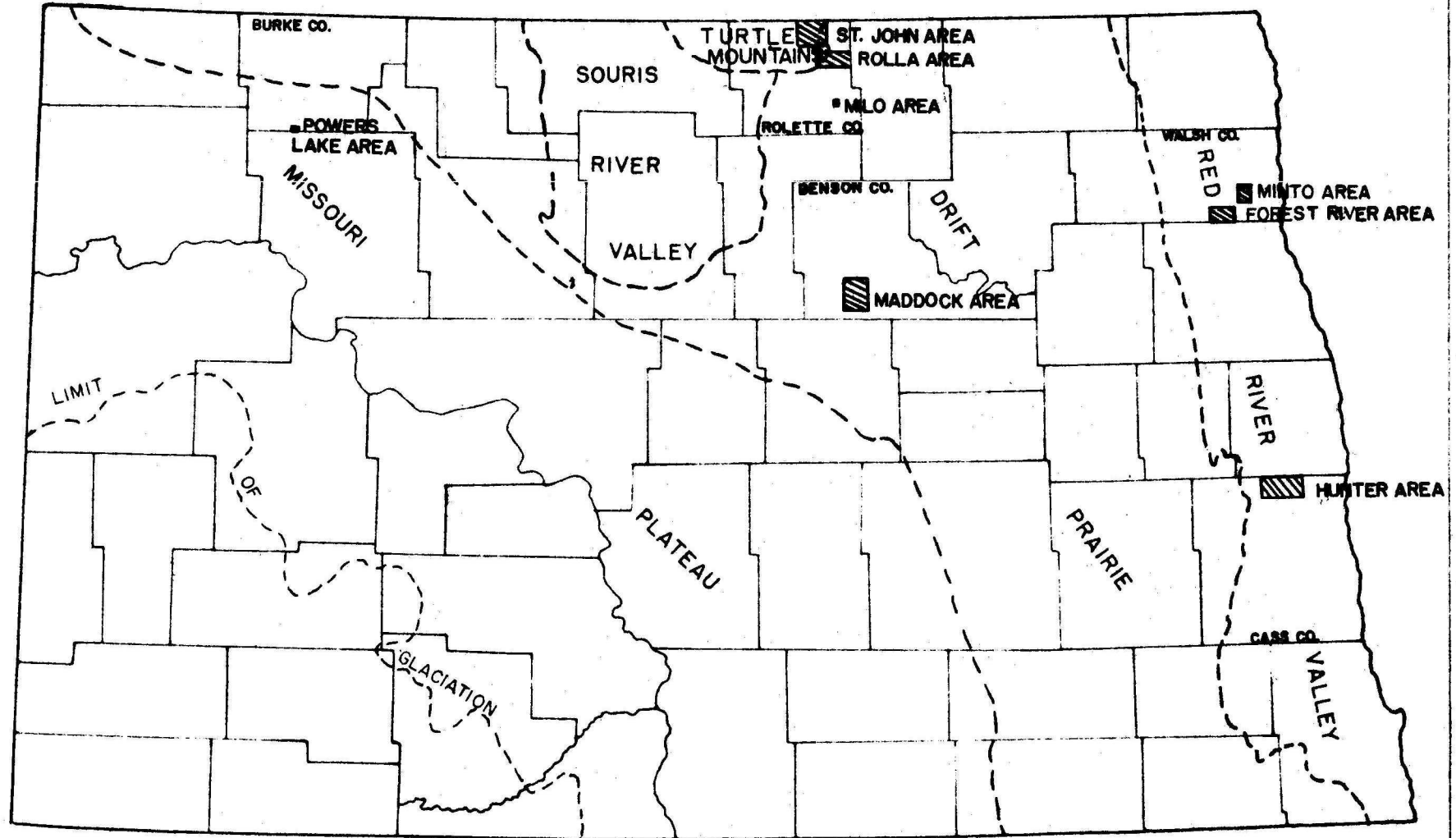
The Minto-Forest River areas in Walsh County obtain water from sediments of glacial Lake Agassiz, sand and gravel lenses in the glacial drift, and from older sandstones beneath the glacial drift. No extensive aquifer was located for municipal use in these areas.

The Powers Lake area in Burke County obtains water from sand deposits in the glacial drift. Moderately to highly mineralized water from the Fort Union formation of Paleocene age, which is bedrock in the area, is the only source or aquifer capable of supplying municipalities. The area lies in the Missouri Plateau physiographic region of the State.

The Maddock area in Benson County is in the Drift Prairie physiographic region of the State. The region's water supply is obtained from alluvial sand and gravel, from sand and gravel lenses in the drift, and sandstone immediately above the Pierre shale. Test holes penetrated a large saturated alluvial sand and gravel deposit which has since been developed as the municipal water supply for the town of Maddock.

The Hunter area in Cass County is in the Red River Valley physiographic region of the State. Most of the water for domestic and farm use is obtained from sand and gravel deposits in the glacial drift; however, water which is highly mineralized and suitable only for stock and laundering is obtained from a sandstone underlying the till. This water has quality characteristics similar to those of samples from the Dakota sandstone elsewhere in the State.

The report contains tables of chemical analyses of ground water of the report areas. Maps show area locations, test hole locations, and geologic cross-sections, and are accompanied by records of wells and test holes and by logs of test holes drilled within the area of investigation.



**PHYSIOGRAPHIC PROVINCES IN NORTH DAKOTA AND LOCATIONS OF AREAS DESCRIBED
IN THIS REPORT.**



(MODIFIED FROM SIMPSON, 1929)

INTRODUCTION

During the last 14 years the U.S. Geological Survey in cooperation with the North Dakota Water Conservation Commission and the North Dakota Geological Survey, in response to requests by a number of towns in North Dakota which were short of water, has made a series of reconnaissance investigations of availability of water.

It is the aim of the cooperative ground water program in North Dakota to increase the scope of these investigations until county-wide reports can be published. In the meantime, however, it is felt that data gathered in the reconnaissance investigations should be published. Included in this report are records of wells and test holes, chemical analyses of some of the ground water, location maps, cross-section of materials penetrated by test drilling, and a brief discussion of the geology and occurrence of ground water in six areas of North Dakota.

Location of the Areas

Because of their proximity, the Rolla and St. John areas in north-eastern Rolette County have been combined and treated as a single area in this report; the Minto and Forest River areas in central Walsh County have been combined for the same reason. However, because they are not continuous, the four are shown as separate areas on figure 1 but are grouped as above and are treated as two areas in this report. Figure 1 shows the location of the six areas.

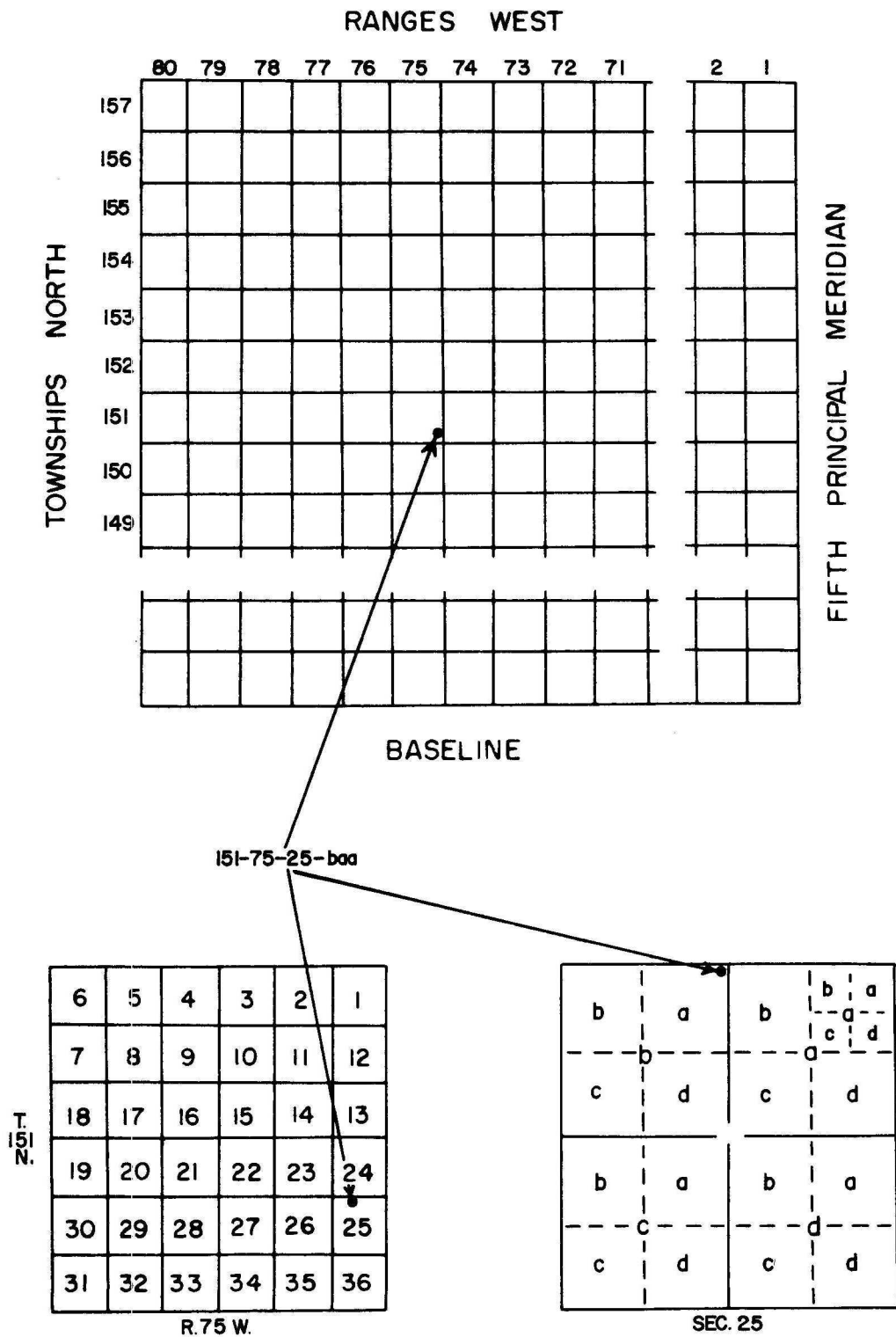
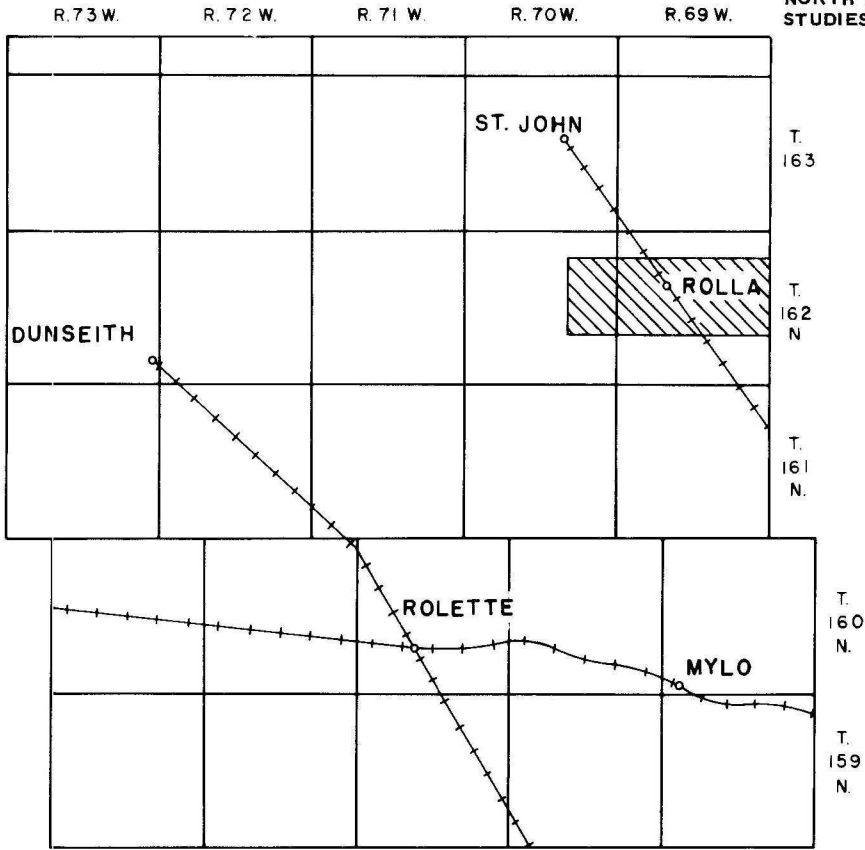


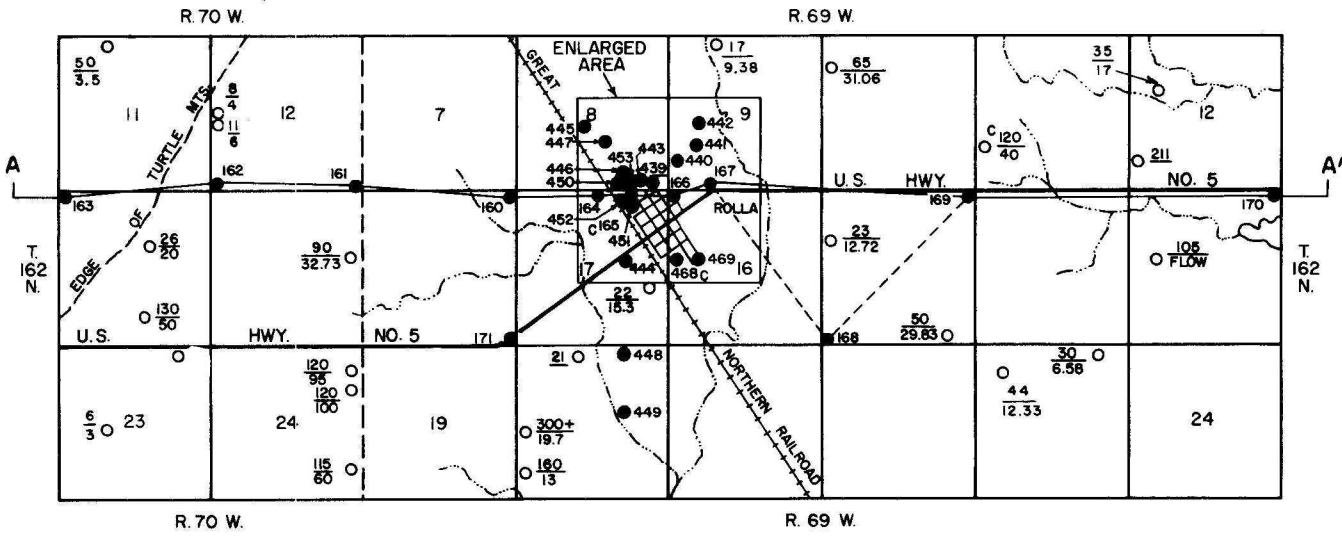
Figure 2 -- Sketch illustrating well-numbering system

Well-Numbering System

The well-numbering system used in this report is illustrated in figure 2 and is based upon the location of the well within the grid established by the U. S. Bureau of Land Management's survey of the area. The first numeral denotes the township north of the base line which extends laterally across the middle of Arkansas; the second numeral denotes the range west of the fifth principal meridian, and the third numeral denotes the section in which the well is located. The letters a, b, c, and d, designate, respectively, the northeast, northwest, southwest, and southeast quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections (10-acre tracts). Consecutive terminal numerals are added when more than one well is located within a given 10-acre tract. Thus, well 155-53-31ccc is in the $SW\frac{1}{2}SW\frac{1}{2}SW\frac{1}{2}$ of sec. 31, T. 155 N., R. 53 W. Similarly, well 162-69-8ddc2 is the second well located in the $SW\frac{1}{2}SE\frac{1}{2}SE\frac{1}{2}$ of sec. 8, T. 162 N., R. 69 W.



EASTERN ROLETTE COUNTY, NORTH DAKOTA, SHOWING LOCATION OF THE ROLLA AREA

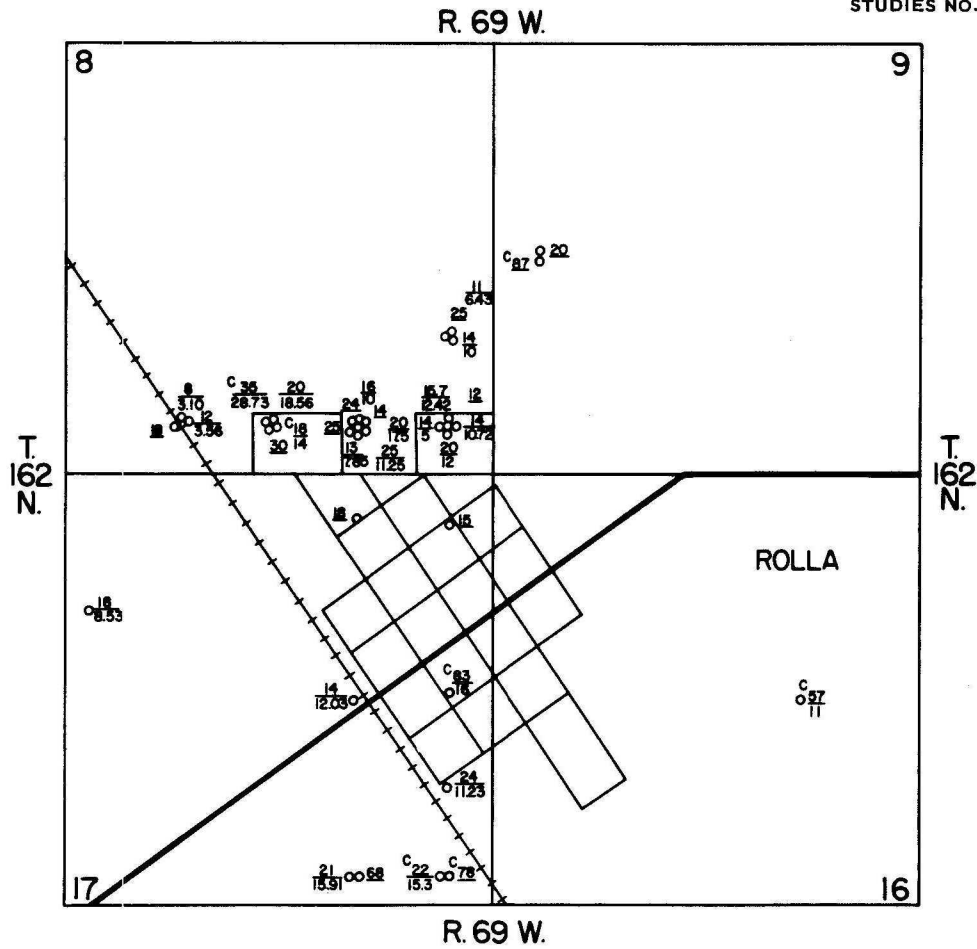


$\frac{120}{40}$ EXISTING WELL:
UPPER NUMBER INDICATES DEPTH OF WELL; LOWER NUMBER INDICATES DEPTH TO WATER. 'C' INDICATES CHEMICAL ANALYSIS.

EXPLANATION
SCALE
3/4 1/2 1/4 0 1/2 MILE
A A'
LOCATION OF GEOLOGIC SECTION

170 ● TEST HOLE
N

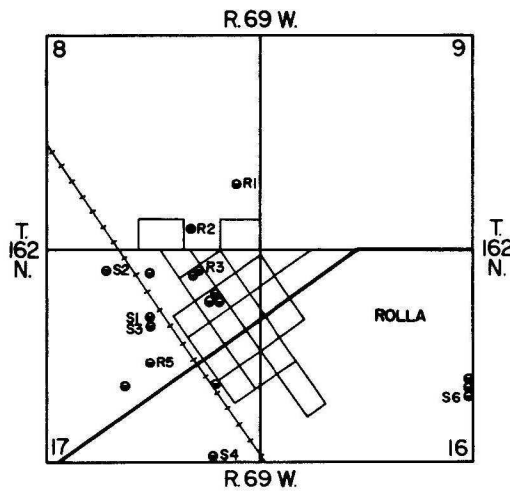
MAP OF THE ROLLA AREA SHOWING LOCATIONS OF TEST HOLES, WELLS, AND GEOLOGIC SECTION



EXPLANATION

○ 57 EXISTING WELL;
 11 EXISTING WELL;
 UPPER NUMBER INDICATES DEPTH OF WELL;
 LOWER NUMBER INDICATES DEPTH TO WATER.
 "C" INDICATES CHEMICAL ANALYSIS.

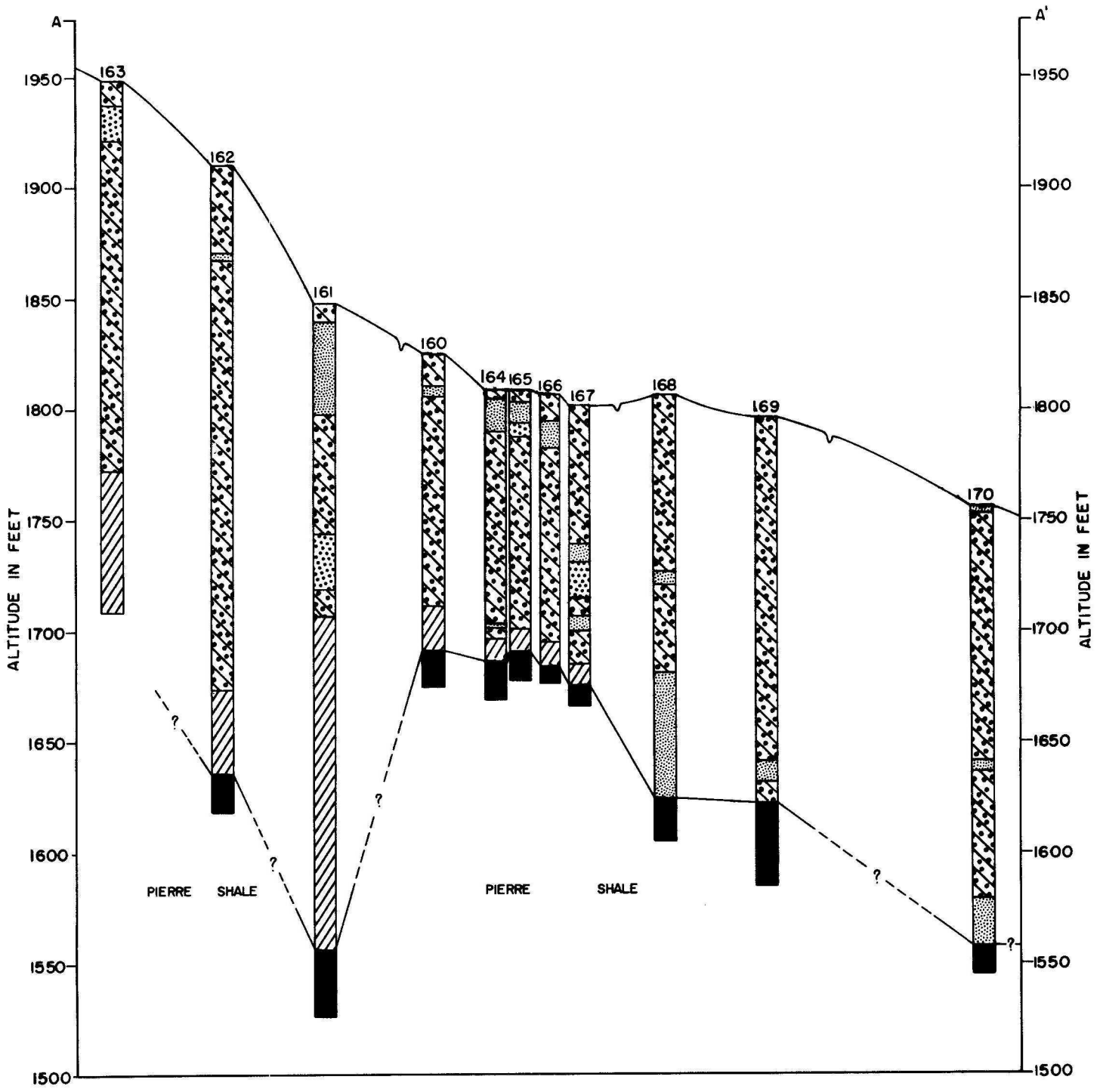
ENLARGED AREA (6X) OF ROLLA AND VICINITY
(SHOWING LOCATIONS OF WELLS)



EXPLANATION

● S4 CITY WELL

ENLARGED AREA (3X) OF ROLLA AND VICINITY
(SHOWING LOCATIONS OF CITY WELLS)



EXPLANATION

- 
 SAND
- 
 TILL
- 
 GRAVEL
- 
 UNDIFFERENTIATED

GEOLOGIC SECTION IN THE ROLLA AREA

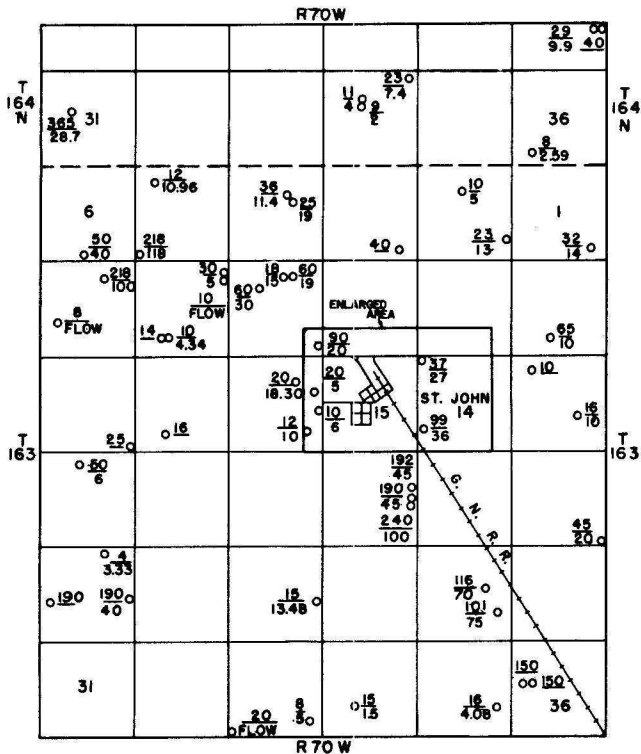
GEOLOGY AND GROUND WATER

Rolla-St. John Areas, Rolette County

The Rolla-St. John areas are in northeastern Rolette County in north-central North Dakota. They are a part of the Western Young Drift Section of the Central Lowland Province of Fenneman (1938, p. 559) and are in the Drift Prairie as designated by Simpson (1929, p. 4). The areas covered by this investigation consist of 69 square miles on the eastern margin of the Turtle Mountains and include: secs. 11 through 14, 23, and 24, T. 162 N., R. 70 W., secs. 7 through 24, T. 162 N., R. 69 W., all of T. 163 N., R. 70 W., secs. 31 through 36 and parts of secs. 25 through 30, T. 164 N., R. 70 W. The topography consists of gently rolling prairie dotted with numerous potholes, swales, and small depressions. Shallow coulees are interconnected in a generally southeasterly trending drainage pattern which eventually reaches Mauvais Coulee and the Devils Lake drainage system.

The average annual precipitation recorded at the United States Weather Bureau station at Rolla is 20.09 inches based upon data gathered during the period 1937 to 1959. The mean annual temperature for the same period was 37.4 degrees.

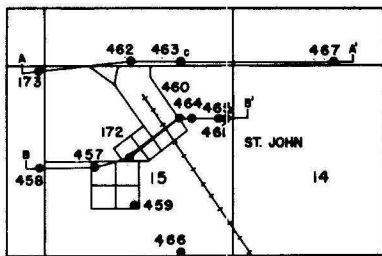
Surface deposits throughout the areas consist of glacial drift in the form of ground moraines. Glacial till constitutes the great bulk of the drift deposits. However, there are other glacial deposits in the areas such as the eskers or low gravel ridges which were mapped in the vicinity of Rolla. (See Fig. 3) Samples from the test drilling indicate that the till is approximately 55 percent clay and 45 percent sand, gravel and boulders. In 27 test holes known to have penetrated it completely, the average thickness of the deposits of glacial drift is 173 feet.



EXPLANATION

116 WELL LOCATION; UPPER NUMBER (116) INDICATES DEPTH OF WELL. LOWER NUMBER (170) INDICATES DEPTH TO WATER.

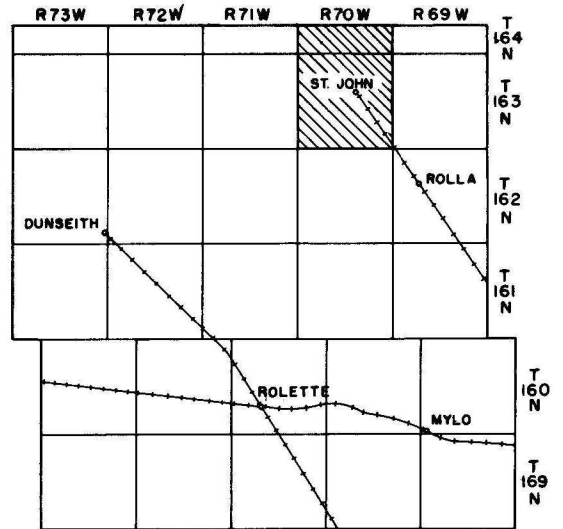
MAP OF THE ST. JOHN AREA SHOWING LOCATION OF WELLS



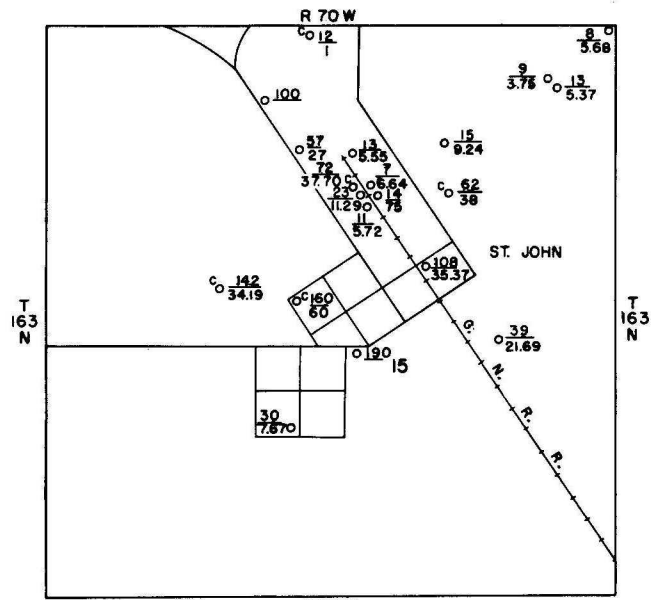
EXPLANATION

LOCATION OF GEOLOGIC SECTION TEST HOLE

ENLARGED AREA (2X) ST. JOHN AND VICINITY (SHOWING LOCATIONS OF TEST HOLES AND GEOLOGIC SECTIONS)



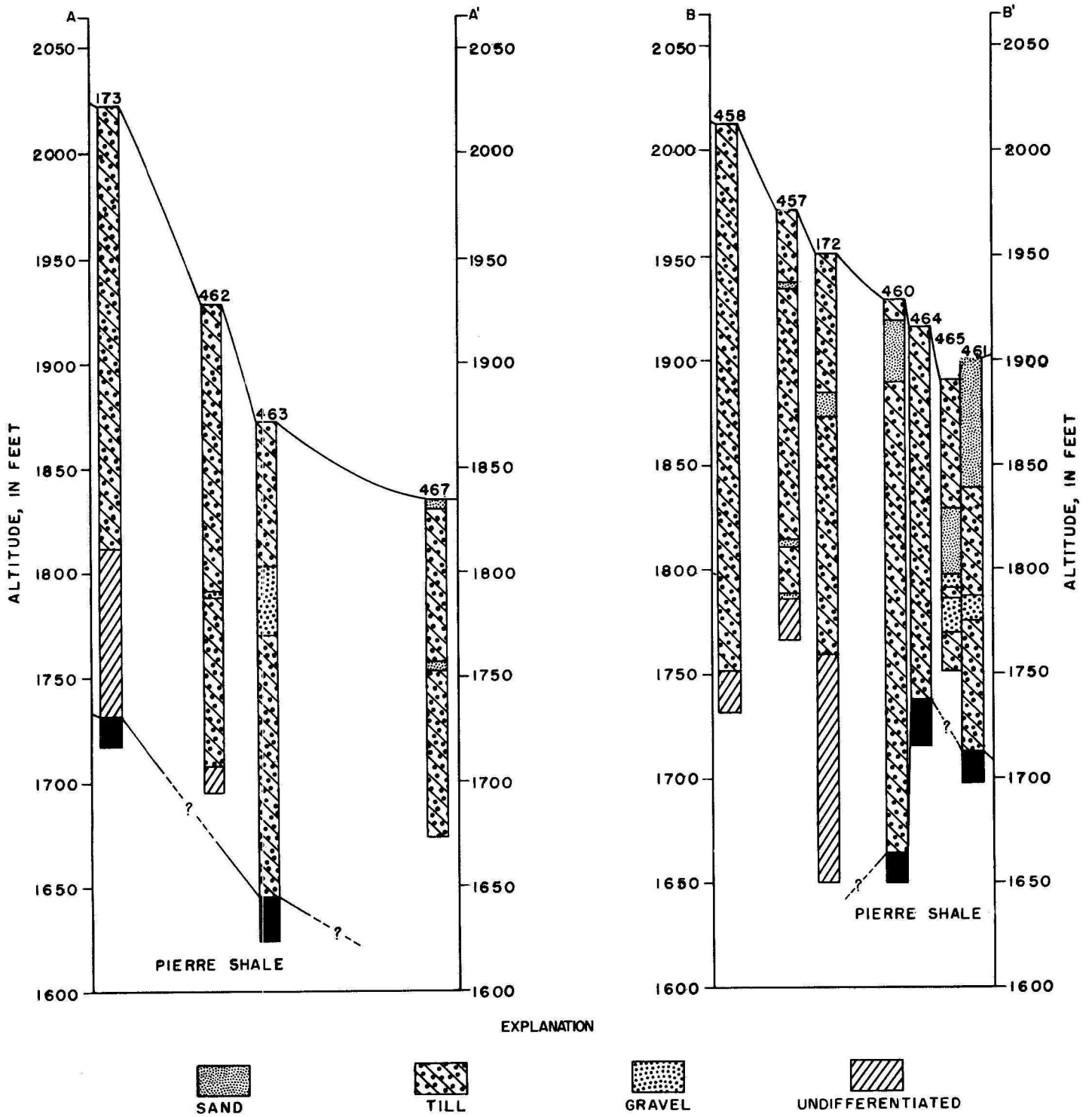
EASTERN ROLETTE COUNTY, NORTH DAKOTA SHOWING LOCTION OF THE ST. JOHN AREA



EXPLANATION

112 WELL LOCATION; UPPER NUMBER (112) INDICATES DEPTH OF WELL. LOWER NUMBER (11) INDICATES DEPTH TO WATER. LETTER 'C' INDICATES CHEMICAL ANALYSIS.

SECTION 15 ENLARGED (6X) (SHOWING LOCATIONS OF WELLS)



GEOLOGIC SECTIONS IN THE ST. JOHN AREA

Twelve of the test holes drilled in the areas penetrated a formation that was not positively identified from the drill samples. Ten of these test holes were drilled in a small area in the vicinity of Rolla. (See fig. 3.) Possibly this zone, which is classed as undifferentiated, is an older till; however, it is more likely that it is an outlier of the Fort Union formation which crops out in the Turtle Mountains 4 miles to the west (Simpson, 1929, p. 214). The similarity of the main constituents of the undifferentiated zone to the materials that make up the Fort Union formation (clay, shale, sand, and gravel) further suggest that they may be the same formation. In the St. John area also the undifferentiated material is penetrated.

The Pierre shale is the bedrock in the entire region. It was penetrated by all test holes that were drilled completely through the glacial drift and through the undifferentiated zone. According to the log of the Sun Oil Co. Wm. Wayne No. 1 (162-69-20ac) the thickness of the Pierre shale at the well is 896 feet. (Oral communication, 1956, S. B. Anderson. North Dakota Geological Survey.)

Aquifers contained within the glacial till supply most of the wells in the Rolla-St. John areas. Generally, the wells produce only small quantities of water (1 to 6 gpm) but are adequate for farm and domestic needs. The production of wells of this type is controlled by the sand-clay ratio of the till in the vicinity of the well site; where the till is sandy, it will yield more water than where it is composed primarily of clay.

A few wells produce water from sand and gravel lenses that are completely surrounded by glacial till. These deposits differ considerably in thickness and in lateral extent. Generally they have no surface expression and can be located only by test drilling. Wells of rather

high initial yield might be developed in the sand and gravel deposits of the glacial till; however, the yield of wells that penetrate aquifers completely surrounded by till will decrease rapidly as the aquifers become unwatered. Recharge through the glacial till to such aquifers is quite slow and pumping rates must not exceed recharge if production is to be maintained. The older wells that supply the city of Rolla are believed to obtain water from deposits of this type.

At many locations in the areas, the till is composed mainly of clay and will not yield sufficient water to supply individual farms. Where this situation occurs, the wells are continued through the till and water is obtained from sandy zones at or near the bedrock surface.

Sixteen samples of water were collected from wells in the Rolla-St. John areas; analyses of the samples are listed in table 1. Generally ground water in the areas is moderately to highly mineralized and is quite hard. Alkaline earths and alkali sulfates are the prominent dissolved minerals.

The iron content of water from all of the wells sampled exceeded the maximum concentration (0.3 ppm) specified by the U. S. Public Health Service in Drinking Water Standards (1946) for drinking water used on interstate carriers. Iron concentrations in water samples ranged from 0.37 to 7.8 ppm and averaged about 3.0 ppm. Thus, sufficient iron is present in water from most of the wells to cause staining of laundry and of plumbing fixtures and to impart to the water an objectionable taste.

TABLE 1.--CHEMICAL ANALYSES OF GROUND WATER

Analyses by State Laboratories, Bismarck, N. Dak.
Results in parts per million

Location No.	Owner or name	Depth of well (feet)	Date of collection	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO ₃)
<u>162-69</u>								
8dcd1	Mrs. C. Jolliffe	35	1-30-52	.4	101	44	....	237
8dcd6	Tom Haggar	18	10- 4-51	.4	130	50	....	266
9cbcl	F. Gelpheus	87	10- 4-51	.6	74	60	4.8	378
11cbc	Marlin Kyle	120	12- 4-50	.6	19	43	285	540
16bcc	Test hole 468	...	12-30-52	2.6	120	....	499	564
16bda	Bruce Theel	57	10- 4-51	1.6	183	78	119	273
17aab4	Test hole 165	...	1-20-50	4.8	68	43	282	322
17ada	Rolla Creamery	83	10- 4-51	3.6	185	92	244	405
17daa1	G. Jorgenson	22	3-16-51	4.4	206	121	124	520
17daa2	Jorgenson & Keegan	78	12-30-52	3.4	163	108	94	551
<u>163-70</u>								
10dcd	Test hole 463	247	2-27-52	4.8	172	98	255	261
15aca2	Mrs. P. LeBeau	62	10- 4-51	7.7	484	182	127	540
15acb1	City of St. John	72	10- 4-51	7.8	122	126	154	125
15baa	C. Guedesse	12	3-29-51	.4	276	288	152	718
15bdc	Mrs. R. Byrnes	142	10- 4-51	3.2	254	95	....	354
15bdd2	St. John School	160	.....	1.2	290	110	154	490

IN THE ROLLA-ST. JOHN AREAS, ROLETTE COUNTY

Carbonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids	Hardness as CaCO ₃			Percent sodium	pH
						Calcium	Magnesium	Noncarbonate		
...	.....	44	...	87	513	430	236	0	8.4
17	.....	69	.2	174	706	530	284	0	8.5
19	118	4	...	....	658	430	98	2.5	8.4
...	130	114	.2	4.3	1,140	224	.....	74	7.6
...	845	28	...	2.1	2,060	300	.....	80	7.2
...	745	20	...	4.3	1,420	780	556	26	8	
...	664	12	...	8.6	1,410	360	96	64	8.1	
...	960	30	...	8.6	1,930	841	508	40	8	
...	798	18	...	2.1	1,790	1,010	580	22	7	
...	546	22	...	2.1	1,490	850	398	20	7.3	
...	1,000	26	...	130	1,820	832	618	41	7.9	
...	1,710	18	...	....	3,070	1,960	1,520	13	8.2
...	987	16	...	4.3	1,540	820	718	29	8	
...	1,480	29	.4	34	1,880	2,980	1,290	16	7.7	
...	688	4	...	2.1	1,400	102	.....	0	7.9
...	1,050	11	...	2.1	2,110	1,180	774	23	7.6	

TABLE 2.--RECORDS OF WELLS AND TEST HOLES

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

Type of well: Dr, drilled; Du, dug; Dv, driven

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
<u>162-69</u>					
8caa	Test hole 445	130	5	Dr	7-12-51
8dbc	Test hole 447	30	5	Dr	7-16-51
8dcc1	J. Jolliffe	8	40	Du	.....
8dcc2	M. D. Ferris	12	36	Du	1949
8dcc3	Louis Betrube	18	..	Du	1946
8dcd1	Mrs. C. Jolliffe	35	36	Du	1939
8dcd2	Paul Wilkie	20	40	Dr	.....
8dcd3	Sidney Harris	30	..	Du	.....
8dcd4	Test hole 446	60	5	Dr	7-13-51
8dcd5	Test hole 450	40	5	Dr	7-21-51
8dcd6	Tom Haggar	18	48	Du	.....
8dcd7	Test hole 453	130	5	Dr	7-28-51
8dda1	Rolla test R 1	24	..	..	1927
8dda2	Otto Yepson	25	48	Du	1923
8dda3	Helen Dressler	11	18	Du	.....
8dda4	J. MacKinnon	14	36	Du	1937
8ddc1	Test hole 439	30	5	Dr	7- 2-51
8ddc2	Test hole 443	170	5	Dr	7- 6-51
8ddc3	Oliver Olson	13	42	Du	.....
8ddc4	L. G. Nerpel	24	8	Dr	.....
8ddc5	Wm. Mayo	25	22	Du	1929
8ddc6	Rolla test R 2	...	..	..	1927
8ddc7	V. Boucher	20	42	Du	1948
8ddc8	Jack Laird	16	36	Du	1910
8ddc9	Ed Lentz	25	12	Du	.....
8ddc10	C. Plante	14	2.5	Dv	.....

IN THE ROLLA-ST. JOHN AREAS, ROLETTE COUNTY

Date of measurement: Date given is date water level was measured for measured depths to water; it is the date of report for reported depths to water.

Use of water: D, domestic; FP, fire protection; Ind, industrial; Irr, irrigation; N, none; Obs, observation well; PS, public supply; S, stock; T, test hole.

Depth to water below land surface (feet)	Date of measurement	Use	Aquifer	Altitude of land surface (feet)	Remarks
.....	.....	T	.....	1,828	See log.
.....	.....	T	.....	1,820	Do.
3.10	7-10-51	S	.....	.....
3.56	7-10-51	D	Gravel	.....	Water adequate, hard.
.....	.....	D	Gravel	.....	Water hard, good for drinking.
28.73	7-10-51	D	Gravel	.....	Water adequate, hard, good for drinking, see chemical analysis.
18.56	7-10-51	N	.....	.....	Abandoned.
.....	.....	S	.....	.....	Water adequate for 25 head of cattle.
.....	.....	...	.....	.....	See log.
.....	.....	...	.....	.....	Do
14	7-10-51	D	Gravel	.....	Low water level in 1949, see chemical analysis
.....	.....	...	.....	1,816	See log.
.....	.....	D	Gravel	.....	Water hard.
.....	
6.43	7- 9-51	D	.....	.....	Water hard.
10	7- 9-51	D	Gravel	.....	Water medium hard.
.....	.....	...	.....	1,810	See log.
.....	.....	...	.....	1,845	Do
7.85	7- 9-51	...	Gravel	.....	Water adequate, hard.
.....	.....	D	.....	.....	Do
11.25	7- 9-51	S	.....	.....	Water adequate, medium hard.
.....	
17.5	7- 9-51	D	Gravel	.....	Water adequate, hard.
10	7- 9-51	D	Gravel	.....	Water medium hard.
.....	.....	...	Gravel	.....	Water reported very good, hard.
.....	.....	D	Gravel	.....	Water adequate, medium, soft.

TABLE 2.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
<u>162-69--Continued</u>					
8ddd1	John Halone	15.7	4.5	Dr	.....
9ddd2	G. Albrecht	14	12	Du	1948
8ddd3	J. Jensen	20	6	Dr,Dv	1930
8ddd4	Henry Disrud	14	24	Dr	1930
8ddd5	Raymond Jones	12	..	Dv	1947
9bab	Ed LaFrance	17	8	Dr	.....
9cba	Test hole 442	40	5	Dr	7- 5-51
9cbcl	F. Gelpheus	87	1.25	Dv	.....
9cbc2	Do	20	..	Du	.....
9cbd	Test hole 441	40	5	Dr	7- 4-51
9ccb	Test hole 440	150	5	Dr	7- 3-51
9cdc	Test hole 167	135	5	Dr	7-20-49
10bbc	-----	65	4	Dr	.....
11cbc	Marlin Kyle	120	4	Dr	1915
12bca	Sam Johnson	35	3	Du	1906
12ccb	Geo. Johnson	211	..	Dr	1949
13aaa	Test hole 170	210	5	Dr	7-27-49
13bcd	Floyd Drewry	105	5	Dr	.....
15aaa	Test hole 169	210	5	Dr	7-25-49
15bcb	R. Mundy	23	36	Du	.....
15ccc	Test hole 168	200	5	Dr	7-21-49
15ddc	G. Fagerlund	50	4	Dr	.....
16acl	City of Rolla	106	8	Dr	1940
16ac2	City of Rolla test hole	105	8	Dr	1940
16ac3	City of Rolla test S 6	105	8	Dr	1940
16bbb	Test hole 166	130	5	Dr	7-19-49
16bcc	Test hole 468	100	5	Dr	9-18-51
16bcd	Test hole 469	95	5	Dr	9-19-51
16bda	Bruce Theel	57	4	Dr	.....

IN THE ROLLA-ST. JOHN AREAS, ROLETTE--Continued

Depth to water below land surface (feet)	Date of measurement	Use	Aquifer	Altitude of land surface (feet)	Remarks
12.42	7-10-51	...	.....	.....	Water adequate, hard.
5	7-10-51	D	Gravel, sand	.....	Water adequate, medium hard.
12	7-10-51	D	Gravel	.....	Water adequate, hard.
10.72	6-26-51	D	Gravel, sand	.....	Water reported good taste, hard.
.....	.....	D	Gravel	.....	Water adequate, medium hard.
9.38	7- 6-51	S	.....	.....
.....	.....	...	.....	1,813	See log.
.....	.....	...	Gravel, sand	.....	See chemical analysis.
.....	.....	...	Gravel	.....	Water adequate.
.....	.....	...	.....	1,819	See log.
.....	.....	...	.....	1,811	Do
.....	.....	...	.....	1,802	Do
31.06	6- 3-50	...	.....	.....
40	7- 3-51	D,S	Sand	.....	Water adequate, hard.
17	7- 3-51	D,S	Gravel	.....	Water hard, See chemical analysis.
.....	.....	...	Sand, gravel	.....	See log.
.....	.....	...	.....	1,756	Do
Flows	.....	D	.....	.....	Water adequate, hard, flows occasionally.
.....	.....	...	.....	1,797	See log.
12.72	7-25-51	D,S	.....	.....	Water hard, adequate.
.....	.....	...	.....	1,807	See log.
29.83	7-25-51	S	.....	.....	Water adequate.
7	1940	...	Sand, gravel	.....	Drawdown 8 feet when pumping 150 gpm. See log.
5	4-20-49	FP	Sand, gravel	.....	Water adequate, hard, unfit for drinking.
7	1940	FP	Sand, gravel	.....	See log, Water adequate, hard, unfit for drinking.
.....	.....	...	.....	1,807	See log.
.....	.....	...	.....	.....	Do, see chemical analysis.
.....	.....	...	.....	.....	Do
11	7-10-51	D,S	.....	.....	Water adequate for 100 head of cattle, hard. See chemical analysis

TABLE 2.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
162-69-Continued					
17aa1	City of Rolla	70	8	Dr	1940
17aa2	Do	90	...	..	....
17aa3	Do	34	240	Du	....
17aaa	L. H. Marcotte	15	1½	Dv	1950
17aab1	B. Vindedhal	18	8	Du	1947
17aab2	Rolla test S 5	70	...	Dr	1940
17aab3	Rolla test R 3	107	10	Dr	1927
17aab4	Test hole 165	130	5	Dr	7-18-49
17abaa1	City of Rolla	35	240	Du	1935
17aba2	Test hole 451	40	5	Dr	7-23-51
17aba3	Test hole 452	40	5	Dr	7-25-51
17abb1	Test hole 164	140	5	Dr	7-15-49
17abb2	Rolla test S 2	70	..	..	1940
17abd1	Rolla test S 1	44	..	..	1940
17abd2	Rolla test S 3	158	..	..	1940
17ac	City of Rolla	70	..	Dr	1940
17aca	Rolla test R 5	42	..	..	1927
17acd	Test hole 444	140	5	Dr	7-10-51
17ad	Rolla test	44	..	Dr	1940
17ada	Rolla Creamery	83	6	Dr	1946
17adb	Rolla Oil Co.	14	30	Du	1950
17add	Galbrechts Service	24	4	..	.....
17bad	-----	18	8	Dr	.....
17da1	J. J. Keegan	22	..	Du	.....
17da2	Rolla test S 4	77	..	Dr	1940
17daa1	G. Jorgenson	78	4	Dr	1951
17daa2	Jorgenson and Keegan	22	..	..	.....
17dab1	Do	21	30 x 30	Du	.....
17dab2	Do	68	4	Dr	1932
18aaa	Test hole 160	150	5	Dr	7- 6-45
18ddd	Test hole 171	210	5	Dr	7-29-49
20aba	Test hole 448	140	5	Dr	7-17-51
20acd	Test hole 449	40	5	Dr	7-20-51
20baa	Bill Wayne	21	48	Du	.....
20cbb	-----	300	..	Dr	.....

IN THE ROLLA-ST. JOHN AREAS, ROLETTE COUNTY--Continued

Depth to water below land surface (feet)	Date of measurement	Use	Aquifer	Altitude of land surface (feet)	Remarks
.....	.....	...	.....	.....	See log
.....	.....	...	.....	.....	Abandoned.
21.87	4-20-49	PS	.....	.....	Water adequate, hard.
.....	.....	D	Gravel	.....	Do
.....	.....	D	Gravel	.....	Water adequate, hard, can be pumped dry.
.....	.....	...	.....	.....	Well filled. See log.
.....	.....	...	.....	.....	Insufficient water, well abandoned. See log.
.....	.....	...	.....	1,809	See log; chemical analysis
.....	.....	PS	Gravel	.....	See log of test hole 451
.....	.....	Obs	Gravel	1,813	See log.
.....	.....	Obs	.....	1,811	Do
.....	.....	...	.....	1,809	Do
.....	.....	...	.....	.....	Do
.....	.....	...	.....	.....	Do
.....	.....	...	.....	.....	Do
.....	.....	...	.....	.....	Do
.....	.....	...	.....	.....	Do
.....	.....	...	.....	1,807	Do
.....	.....	...	.....	.....	Do
16	7- 8-46	Ind	Sand, gravel	.....	See chemical analysis
12.03	7-11-51	...	Sand, clay	.....	Water inadequate.
11.23	7-10-51	D, Ind	.....	.....	Water adequate, hard.
8.53	7-10-51	...	.....	.....
15.3	4-20-49	...	.....	.....	Water very hard, unfit for drinking.
10	1940	...	Sand, gravel	.....	Drawdown 5 feet after 5 hours pumping 18gpm See log.
.....	.....	...	Sand, gravel	.....	See chemical analysis.
15.3	.....	...	.....	.....	Do
15.91	7-27-51	...	.....	.....	Water hard, rusty inadequate. Abandoned.
.....	.....	D, S	Sand	.....	Produced 400 gph until plugged, water hard, rusty.
.....	.....	...	.....	1,825	See log.
.....	.....	...	.....	1,836	Do
.....	.....	...	.....	1,884	See log.
.....	.....	...	.....	1,803	Do
.....	.....	...	.....	.....	Pumps dry in half a day, hard.
19.7	7- 5-51	...	.....	.....	Farm vacant.

TABLE 2.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
<u>162-69 - Continued</u>					
22ccb	M. Fagerlund	160	4	Dr	.....
23aab	B. Mac Donald	30	4.5	Dr	.....
23bbd	Mutize	44	4	Dr	.....
<u>162-70</u>					
11bab	Lewis Wilkie	50	30	Du	1930
12cbb1	Joe Dionne	8	..	Du	.....
12cbb2	Charles McCloud	11	..	Du	1934
12ccc	Test hole 162	290	5	Dr	7- 9-49
12ddd	Test hole 161	320	5	Dr	7- 7-49
13add	Wm. Schindler	90	4	Dr	1935
14ac	Alex Martin	26	36	Du	1934
14bbb	Test hole 163	240	5	Dr	7-12-49
14dcb	J. B. Sangrait	130	..	Dr	.....
23aab	J. Laurdeore	137	..	Du	1929
23cab	Ernest Jeanotte	6	..	Du	.....
24aad	John Genard	120	4	Dr	1925
24ada	J. W. Jeanotte	120	..	Dr	1936
24dda	Pat Jeanotte	115	..	Dr	1912
<u>163-70</u>					
1ddc	Herman Garceau	32	..	Dr	.....
2bda	O. Mathiason	10	..	Du	1919
2dda	Mrs. Pete Lebeau	23	..	Du	1930
3ddc	M. Tingolest	40	..	Dr	1920
4ac	W. Lassonde	36	24	Dr	1908
4acd	-----	25	..	Du	1941
5bbd	Marcus Bryant	12	30	Du	.....
5ccc	A. Turcotte	218	4	Dr	1950
6cdd	Anton Sundin	50	4	Dr	.....
7abd	R. Johnston	218	4	Dr	1948
7cbd	H. W. Hileman	8	48	Du	1949
8aad1	James Ward	30	42	Du	.....
8aad2	Do	10	42	Du	1933
8c db	Grace Haas	14	36	Du	.....
8cdb2	Do	10	44.5	Du	1948

IN THE ROLLA-ST. JOHN AREAS, ROLETTE COUNTY--Continued

Depth to water below land surface (feet)	Date of measurement	Use	Aquifer	Altitude of land surface (feet)	Remarks
13	7- 5-51	D,S	Sand	.....	Water adequate.
6.58	7- 3-51	D,S	.....	.....	Water hard.
12.33	7- 3-51	S	.....	.....	Water rusty color.
3.5	7-25-51	S	.....	.....	Water hard.
4	6-24-51	N	.....	.....
6	7-24-51	D,S	.....	.....	Water medium,hard,adequate.
.....	.....	...	.....	1,910	See log.
.....	.....	.....	.....	1,848	Do
32.73	7-23-51	D,S	.....	.....	Water hard, adequate.
20	6-24-51	...	.....	.....	Community well.
.....	.....	...	.....	1,949	See log.
50	7-24-51	D,S	Gravel	.....	Water medium hard,adequate.
75	6- -49	D,S	.....	.....	Water unfit for drinking.
3	6- -49	S	.....	.....	Water hard.
95	7- -51	D,S	.....	.....	Water hard,rusty,adequate.
100	7- -51	D,S	.....	.....	Water medium hard.
60	7- -51	D,S	.....	.....	Water hard.
14	6- -49	S	.....	.....	Water hard, unfit for drinking.
5	7- -49	D,S	.....	.....	Water medium hard,adequate.
13	6- -49	D	.....	.....	Water adequate.
.....	.....	D,S	.....	.....	Water medium,soft,adequate.
11.4	7-18-51	...	.....	.....	Water hard, adequate.
19	7- -51	D,S	Sand	.....	Do
10.96	7-18-51	S	.....	.....	Not used for drinking.
118	7- -51	D,S	.....	.....	Water hard, adequate.
40	7- -51	D	.....	.....	Water hard, inadequate.
100	7- -51	D,S	Gravel	.....	Water hard, adequate.
Flows	7- -51	S	Clay	.....
5	7- -51	S	.....	.....	Water hard, adequate, reported poor for drinking.
Flows	7- -51	D	Gravel	.....	Water hard, adequate.
.....	.....	D,S	Gravel	.....	Do
4.34	7-18-51	S	Gravel	.....	Do

TABLE 2.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
<u>163-70 -- Continued</u>					
9abc	John Billgren	18	18	Du	1936
9abd	Do	60	4	Dr	1940
9bdb	Ed Johnson	60	..	Dr	1929
9ddd	Jack Caries	90	..	Dr	.....
10cdd	Test hole 462	232	5	Dr	8-28-51
10dcd	Test hole 463	247	5	Dr	8-31-51
11dcc	Test hole 467	162	5	Dr	9-15-51
12cd	E. Mathiason	65	..	Dr	.....
13bbd	C. Christianson	10	..	Du	.....
13dbd	Emile Foussard	16	..	Du	1889
14bbb	Amie DesRoches	37	..	Du	1937
14ccb	W. DesRoches	99	..	Du	1928
15aaa	Mrs. A Slater	8	40	Du	.....
15aac1	Ed Davis	9	48	Du	.....
15aac2	Warren Kane	13	36	Du	.....
15abc	Alex Langen	13	36	Du	.....
15abd	Louis Guilbert	15	36	Du	.....
15aca1	Test hole 460	280	5	Dr	8-17-51
15aca2	Mrs. P. LeBeau	62	..	Dr	.....
15acb1	City of St. John	72	4	Du	1935
15acb2	Howard James	23	36	Du	1950
15acb3	H. Anderson	11	48 x 48	Du	.....
15acb4	Do	7	48 x 48	Du	.....
15acb5	Mrs. J. S. Carey	14	..	Du	1949
15acd	Great Northern Railroad	108	6	Dr	.....
15adal	Test hole 461	203	5	Dr	8-22-51
15ada2	Test hole 465	140	5	Dr	9-11-51
15adb	Test hole 464	200	5	Dr	9-10-51
15ba	E. G. Byrnes	100 f	..	Dr	9-10-51
15baa	C. Guedesse	12	42	Du	1945
15bad	E. S. Marcil	57	36	Du	1938
15bdc	Mrs. R. Byrnes	142	6	Dr	.....
15bad1	Test hole 172	300	5	Dr	8- 1-49
15bdd2	St. John School	160	4	Dr	1933

IN THE ROLLA-ST. JOHN AREAS, ROLETTE COUNTY--Continued

Depth to water below land surface (feet)	Date of measure- ment	Use	Aquifer	Altitude of land surface (feet)	Remarks
15	7- -51	D	Sand	.....	Water hard, adequate, good drinking.
19	7- -51	S	Gravel	.....	Water hard, adequate.
30	7- -51	D,S	.....	.....	Water medium hard,adequate.
20	6- -49	S	.....	.....	Water hard, adequate, iron taste.
.....	.....	...	.....	1,929	See log.
.....	.....	...	.....	1,873	See log, chemical analysis.
.....	.....	...	.....	1,839	Do
10	6- -49	D,S	.....	.....	Water hard,rusty,unfit for drinking.
.....	.....	S	.....	.....	Water hard,unfit for drinking
10	6- -49	D,S	.....	.....	Water hard, adequate.
27	6- -49	D,S	.....	.....	Water hard,adequate,rusty.
36	6- -49	...	Gravel	.....	Water hard.
5.68	7-12-51	D	.....	.....	Water hard.
3.75	7-21-51	S	.....	.....
5.37	7-12-51	...	.....	.....	Water unfit for drinking.
5.55	7-11-51	D	Gravel	.....	Water hard, adequate.
9.24	7-11-51	S	.....	.....
.....	.....	...	.....	1,930	See log.
38	7- -51	D	Gravel, sand	.....	Water hard,adequate, see chemical analysis.
37.70	7-11-51	D	.....	.....	Water not used for drinking. See chemical analysis.
11.29	7-21-51	D	Sand	.....	Water hard,not used for drinking.
5.72	7-21-51	Irr	.....	.....	Watering garden.
6.64	7-21-51	...	.....	.....	Well abandoned.
7.5	4-22-49	D,S	.....	.....	Water hard, adequate.
35.37	7-11-51	S	.....	.....	Used by stockyards.
.....	.....	...	.....	1,901	See log.
.....	.....	...	.....	1,891	Do
.....	.....	...	.....	1,916	Do
.....	.....	...	.....	.....	Water very hard, adequate.
1	4-22-49	D,S	Gravel	.....	Water adequate. See chemical analysis.
27	7- -51	D,S	Gravel	.....	Water hard, adequate.
34.19	7-11-51	D	Sand	.....	Water hard, inadequate, pumps dry. See chemical analysis
.....	.....	...	.....	1,951	See log.
60	4- -49	D	.....	.....	Water hard, adequate. See chemical analysis.

TABLE 2.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
<u>163-70 - Continued</u>					
15cab	Test hole 457	205	5	Dr	8- 8-51
15cad1	Mrs. M. Richard	30	40	Du	.....
15cad2	Test hole 459	180	5	Dr	8-16-51
15dab	E. DesRoches	39	..	Du	1939
15dbb	Pat Torttin	190	4	Dr	.....
15dcd	Test hole 466	230	5	Dr	9-12-51
16aaa	Test hole 173	305	5	Dr	8- 4-49
16aca	C. B. Puffer	20	36	Du	.....
16ad	Do	20	..	Du	.....
16daa1	Test hole 458	280	5	Dr	8-13-51
16daa2	Vernon Albertson	10	..	Du	1947
16ddb	Harmon Dillon	12	..	Du	1951
17cdb	Clarence Evenden	10	40	Du	1947
18ddd	Phillip Belgarde	25	..	..	.....
19ba	W. Hillgardner	50	18	Dr	.....
22add	Harvey James	192	4	Dr	1941
22daa1	A. Belgarde	190	4	Dr	.....
22daa2	Do	240	..	Dr	.....
24ddd	John Coghlen	45	30	Du	1929
26acd	Peter Lo	116	4	Dr	1928
26dac	Jacob Urschel	101	4	Dr	1916
28daa	J. St. Germaine	15	48	Du	.....
30aba	Jerome Wilke	4	24	Du	.....
30cbb	Bill Vivier	190	8	Dr	.....
30daa	Martin Vivier	190	8	Dr	.....
33ccc	Albert Allick	20	48	Du	1947
33dd	Bernard Dolan	8	..	Du	1944
34cac	Mrs. E. Bittner	15	..	Du	1937
35dac	Edward Bittner	16	36	Du	.....
36bcc	A. T. Disrud	150	4	Dr	1921
36bcd	O. A. Knutson	150	..	Dr	1929
<u>164-70</u>					
25daa1	U.S. Immigration and Custom office	29	30	Du	1932
25daa2	George Marcil	40	4	Dr	.....
31bdc	C. M. Bryant	365	..	Dr	1910
34aa	Paul Leblance	23	32 x 32	Du	.....
34bd1	John McGillis	11	..	Du	1941
34bd2	A. Baudoin	9	..	Du	1900
36ccd	-----	8	36	Du	.....

IN THE ROLLA-ST. JOHN AREAS, ROLETTE COUNTY --Continued

Depth to water below measure- land surface ment (feet)	Date of measure- ment	Use	Aquifer	Altitude of land surface (feet)	Remarks
.....	.....	...	.....	1,973	See log.
7.67	7-12-51	D	Gravel	.....	Water hard, adequate.
.....	.....	...	.....	1,953	See log.
21.69	7-20-51	D,S	.....	.....	Water hard, adequate.
.....	.....	S	.....	.....	Water hard.
.....	.....	...	.....	1,963	See log.
.....	.....	...	.....	2,023	Do
18.30	7-20-51	D,S	Clay	.....	Water hard, adequate.
5	6- -49	D,S	.....	.....	Do
.....	.....	...	.....	2,013	See log.
6	6- -49	S	.....	.....	Water hard.
10	7- -51	D	Clay	.....	Water hard, inadequate.
.....	.....	D	Clay	.....	Do
.....	.....	...	.....	.....	Water hard, unused.
6	7- -51	D,S	.....	.....	Water hard, adequate.
45	7- -50	D,S	Gravel	.....	Water hard,adequate, rusty.
45	7- -51	...	.....	.....	Water hard, rusty, unused.
100	6- -49	D,S	.....	.....	Water hard, adequate, rusty
20	6- -49	D,S	.....	.....	Water hard, adequate.
70	6- -49	D,S	.....	.....	Do
75	6- -49	D,S	.....	.....	Do
13.48	6-19-51	S	.....	.....	Water hard,
3.33	7-20-51	D	.....	.....	Water hard, adequate.
.....	.....	N	.....	.....
40	7- -51	S	.....	.....	Water adequate for 70 head of sheep. Hard rusty.
Flows	7- -51	D,S	Gravel	.....	Water adequate.
.5	6- -49	S	.....	.....	Water unfit for drinking, supply adequate, hard.
1.5	6- -49	D	.....	.....	Community well,hard, adequate.
4.08	7-19-51	S	Gravel	.....	Water hard, adequate.
.....	.....	D,S	.....	.....	Do
.....	.....	D,S	.....	.....	Water hard, adequate, rusty.
9.9	7-13-51	D	Gravel	.....
.....	.....	...	.....	.....	Water soft, individuals in St. John get water here.
28.7	.....	D,S	.....	.....	Water hard, adequate for 20 head of cattle.
7.4	7-28-49	D,S	.....	.....
4	6- -49	...	.....	.....	Water soft, adequate.
2	6- -49	D,S	.....	.....	Water medium hard, adequate.
2.59	7-12-51	S	.....	.....

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY

162-69-8caa
Test hole 445

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, brown.....	½	½
	Sand, very coarse, gray-brown and coarse gravel, clayey.....	2½	3
	Gravel, fine to coarse, and fine sand.....	30	33
	Clay, gray, and fine to medium gravel.....	40	73
	Clay, gray, and fine gravel.....	33	106
	Sand, medium, gray, and fine gravel, clayey	12	118
Pierre shale	Shale, gray.....	12	130

162-69-8dbc
Test hole 447

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Sand, very fine to coarse, light-brown, clayey.....	3	5
	Gravel, medium to coarse.....	13	18
	Clay, light-brown, and fine to medium gravel	1	19
	Clay, gray, and fine gravel.....	11	30

162-69-8dcd4
Test hole 446

Till and associated sand and gravel deposits			
	Road fill.....	2	2
	Sand, very fine to very coarse, light- brown, clayey.....	8	10
	Sand, medium to very coarse, brown, and fine gravel, clayey.....	15	25
	Gravel, very fine to medium, and shale pebbles.....	13	38
	Clay, gray, and fine to medium gravel, and shale pebbles.....	18	56
	Clay, light-brown, and fine to medium gravel, and shale pebbles.....	4	60

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-8dcd5
Test hole 450

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Sand, fine to coarse, light-brown, clayey	2	4
	Gravel, fine to medium.....	4	8
	Sand, very coarse, and fine gravel.....	9	17
	Clay, gray, and fine to medium gravel, and shale pebbles.....	23	40

162-69-8dcd7
Test hole 453

Till and associated sand and gravel deposits			
	Sand, fine to coarse, light-brown.....	3	3
	Sand, fine to very coarse, light-brown, and fine gravel.....	6	9
	Gravel, fine to medium, and very coarse angular sand, and shale pebbles.....	7	16
	Clay, gray, and fine to medium gravel, and shale pebbles.....	14	30

162-69-8ddcl
Test hole 439

Till and associated sand and gravel deposits			
	Topsoil, black.....	$\frac{1}{2}$	$\frac{1}{2}$
	Gravel, fine to coarse.....	$4\frac{1}{2}$	5
	Gravel, fine to medium, and medium to very coarse sand, slightly clayey...	15	20
	Clay, gray, and fine to medium gravel, and shale pebbles.....	10	30

162-69-8ddc2
Test hole 443

Till and associated sand and gravel deposits			
	Sand, coarse, silty, gray-brown, and medium gravel, very clayey.....	3	3
	Gravel, fine to medium and coarse sand...	43	46
	Clay, gray, and fine to medium gravel....	32	78
	Sand, very coarse, gray-brown, and fine gravel, and shale pebbles.....	13	91
	Sand, very coarse, gray, and fine gravel, and shale pebbles.....	24	115
	Clay, sandy, gray, and shale pebbles.....	13	128
Undifferentiated			
	Shale, gray-brown.....	36	164
Pierre shale			
	Shale, gray.....	6	170

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-9cba
Test hole 442

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Gravel, fine to coarse, and very fine to very coarse sand; clay, light-brown in the last 2 feet.....	7	7
	Gravel, fine to coarse, light-brown, and medium to very coarse sand, clayey.....	13	20
	Clay, light-brown, and coarse gravel, and shale pebbles.....	6	26
	Clay, gray, and fine to coarse gravel, and shale pebbles.....	14	40

162-69-9cbd
Test hole 441

Till and associated sand and gravel deposits			
	Topsoil brown.....	1	1
	Sand, gray, and fine gravel, very clayey.	2	3
	Gravel, fine to coarse.....	24	27
	Clay, gray, and fine to medium gravel, and shale pebbles.....	13	40

162-69-9ccb
Test hole 440

Till and associated sand and gravel deposits			
	Gravel, fine to coarse, and very coarse sand.....	15	15
	Clay, sandy, gray-brown, and fine to medium gravel, and shale pebbles.....	77	92
Undifferentiated			
	Shale, gray-brown.....	29	121
Pierre shale			
	Shale, gray.....	29	150

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-9cdc
Test hole 167

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, light-brown, and fine to medium gravel, and fragmental gypsum.....	14	16
	Clay, gray, and fine to medium gravel, and shale pebbles.....	46	62
	Sand, medium to very coarse, and fine to medium gravel, and shale pebbles.....	8	70
	Gravel, fine to coarse, and medium sand, and shale pebbles.....	15	85
	Clay, gray-brown, and fine to medium gravel, and shale pebbles.....	5	90
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	4	94
	Sand, very coarse, gray, and fine gravel, and shale pebbles.....	7	101
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	15	116
Undifferentiated	Shale, light-brown.....	10	126
Pierre shale	Shale, gray.....	9	135

162-69-13aaa
Test hole 170

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Sand, very fine to very coarse, silty, gray, clayey.....	1	3
	Clay, light-brown, and fine to medium gravel.....	19	22
	Clay, gray, and fine to medium gravel...	92	114
	Sand, very coarse, gray, and fine to medium gravel, clayey.....	5	119
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	11	130
	Clay, sandy, gray, and coarse gravel, and shale pebbles.....	46	176
	Sand, very coarse, gray, and fine gravel, and shale pebbles.....	21	197
Pierre shale	Shale, gray.....	13	210

TABLE 3.--LOGS OF TEST HOLES IN ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-15aaa
Test hole 169

<u>Formation</u>	<u>Material</u>	<u>Thickness (feet)</u>	<u>Depth (feet)</u>
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, light-brown, and fine to medium gravel.....	16	17
	Clay, gray, and fine to medium gravel...	69	86
	Clay, very silty, sandy and pebbly, gray; probably till but may be in part lacustrine deposits.....	14	100
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	54	154
	Sand, very coarse, gray, and fine gravel, and shale pebbles.....	9	163
	Clay, gray, and fine to medium gravel, and shale pebbles.....	10	173
Pierre shale	Shale, gray.....	37	210

162-69-15ccc
Test hole 168

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel.....	14	15
	Clay, sandy, gray, and coarse gravel....	41	56
	Clay, sandy, gray-brown, and fine to medium gravel.....	17	73
	Clay, gray, and fine to medium gravel, and shale pebbles.....	6	79
	Sand, very coarse, and fine to medium gravel, and shale pebbles.....	6	85
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	39	124
	Sand, coarse to very coarse, and fine to medium gravel, and shale pebbles.....	57	181
Pierre shale	Shale, gray.....	19	200

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-16bbb
Test hole 166

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Clay, sandy, light-brown, and fine to medium gravel.....	12	12
	Sand, medium to very coarse, light-brown, and fine to medium gravel and shale pebbles.....	12	24
	Clay, gray, and fine to medium gravel, and shale pebbles.....	31	55
	Clay, gray-brown, and fine to medium gravel, and shale pebbles.....	5	60
	Clay, gray, and medium gravel, and shale pebbles.....	51	111
Undifferentiated			
	Shale, light-brown.....	11	122
Pierre shale			
	Shale, gray.....	8	130

162-69-16bcc
Test hole 468

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel.....	11	12
	Sand, very coarse, gray, and fine gravel, and shale pebbles.....	18	30
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	21	51
	Gravel, fine to medium, gray, and coarse sand, and shale pebbles.....	31	82
	Sand, very coarse, gray, and fine gravel, and shale pebbles.....	18	100

162-69-16bcd
Test hole 469

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine gravel	13	14
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	6	20
	Sand, medium to very coarse, gray, and fine gravel, clayey, and the coarser fraction consisting of shale fragments	29	49
	Sand, medium to very coarse, gray, and fine to medium gravel, clayey, and the coarser fraction consisting of shale fragments.....	21	70
	Sand, very coarse, and fine to medium gravel, and the coarser fraction consisting of shale fragments.....	22	92
	Gravel, medium to coarse.....	3	95

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-17aab4
Test hole 165

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, light-brown, and medium to very coarse sand, and very fine gravel, and shale pebbles.....	3	5
	Sand, medium to very coarse, light-brown, and fine gravel, and shale pebbles.....	10	15
	Gravel, fine to medium, and medium sand, and shale pebbles.....	6	21
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	20	41
	Clay, gray-brown, and fine to medium gravel, and shale pebbles.....	11	52
	Clay, gray, and fine to medium gravel, and shale pebbles.....	55	107
Undifferentiated			
	Shale, light-brown.....	10	117
Pierre shale			
	Shale, gray.....	13	130

162-69-17aba2
Test hole 451

Till and associated sand and gravel deposits			
	Road fill.....	3	3
	Topsoil, black.....	1	4
	Sand, medium to very coarse, brown, and fine gravel, clayey, and the coarser fraction consists of shale fragments...	13	17
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	10	27
	Gravel, fine to medium, and very few shale fragments.....	7	34
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	6	40

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-17aba3
Test hole 452

<u>Formation</u>	<u>Material</u>	<u>Thickness (feet)</u>	<u>Depth (feet)</u>
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, sandy, light-brown, and fine to medium gravel.....	2	4
	Sand, medium to coarse, brown, and fine gravel, slightly clayey.....	3	7
	Sand, very fine to very coarse, light- brown, very clayey.....	7	14
	Clay, sandy, gray, and fine gravel, and shale pebbles.....	7	21
	Sand, medium to very coarse, gray, and fine to coarse gravel, clayey, and the coarser fraction consisting of shale fragments.....	7	28
	Clay, sandy, gray, and fine gravel, and shale pebbles.....	11	39
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	1	40

162-69-17abbl
Test hole 164

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	3	4
	Sand, medium to coarse, light-brown, and fine gravel, and the coarser fraction consisting of shale fragments.....	15	19
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	30	49
	Clay, sandy, gray-brown, and fine to medium gravel and shale pebbles.....	8	57
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	48	105
	Sand, coarse, gray, and fine gravel, clayey, and the coarser fraction consisting of shale fragments.....	2	107
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	5	112
Undifferentiated			
	Shale, light-brown.....	10	122
Pierre shale			
	Shale, gray.....	18	140

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-17acd
Test hole 444

<u>Formation</u>	<u>Materials</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Gravel, fine to coarse, and very coarse sand, clayey.....	14	14
	Clay, gray, and fine to medium gravel, and shale pebbles.....	23	37
	Gravel, fine to medium, gray, clayey, and the coarser fraction consists of shale fragments.....	11	48
	Clay, gray-brown, and fine to medium gravel, and shale pebbles.....	6	54
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	48	102
	Gravel, fine, gray, very clayey, and the coarser fraction consists of shale fragments.....	18	120
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	11	131
Pierre shale	Shale, gray.....	9	140

162-69-18aaa
Test hole 160

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, light-brown, and fine to medium gravel, and shale pebbles.....	11	12
	Clay, gray, and fine to medium gravel, and shale pebbles.....	2	14
	Sand, very coarse, gray, and medium gravel, clayey, and the coarser fraction consists of shale fragments.....	5	19
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	20	39
	Clay, gray-brown, and fine gravel, and shale pebbles.....	31	70
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	20	90
	Clay, gray, and fine to medium gravel, and shale pebbles.....	23	113
Undifferentiated	Sand, very fine, silty, gray; probably drift but may be in part Pierre shale or other bedrock.....	20	133
Pierre shale	Shale, gray.....	17	150

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-18ddd
Test hole 171

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel.....	17	18
	Sand, medium to very coarse, and fine gravel, and the coarser fraction consists of shale fragments.....	21	39
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	17	56
	Clay, sandy, gray-brown, and fine to medium gravel, and shale pebbles.....	15	71
	Clay, gray, and fine to medium gravel, and shale pebbles.....	14	85
	Clay, gray-brown, and medium gravel, and shale pebbles.....	10	95
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	5	100
	Clay, gray, and fine to medium gravel, and shale pebbles.....	44	144
	Silt, sandy and pebbly; probably till but may be in part lacustrine deposits.....	31	175
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	21	196
Pierre shale	Shale, gray.....	14	210

162-69-20aba
Test hole 448

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Sand, coarse, light-brown, and fine to medium gravel.....	2	4
	Sand, very coarse, and fine to coarse angular gravel.....	24	28
	Clay, gray, and medium gravel, and shale pebbles.....	16	44
	Sand, very coarse, gray, and fine to coarse gravel, and the finer fraction consists of shale fragments.....	26	70
	Sand, very coarse, gray, and fine gravel, clayey, and the coarser fraction consists of shale fragments.....	11	81
	Clay, gray, and fine gravel, and shale pebbles.....	43	124
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	7	131
Pierre shale	Shale, gray.....	9	140

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-69-20acd
Test hole 449

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	3	3
	Sand, medium to very coarse.....	5	8
	Gravel, fine, and the finer fraction consists of shale fragments.....	15	23
	Clay, gray, and fine to medium gravel, and shale pebbles.....	17	40

162-70-12ccc
Test hole 162

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, silty, light-brown, and fine gravel	18	19
	Clay, silty, gray, and fine gravel, and shale pebbles.....	20	39
	Sand, coarse, gray, and fine gravel, clayey, and shale pebbles.....	3	42
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	8	50
	Clay, gray, and fine to medium gravel, and shale pebbles.....	40	90
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	8	98
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	14	112
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	55	167
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	59	226
	Clay, sandy, gray-brown, and fine to medium gravel, and shale pebbles.....	9	235
Undifferentiated			
	Clay, silty, gray-brown, sandy and pebbly; probably till but may be in part lacustrine deposits.....	8	243
	Clay, sandy, gray, and fine gravel, and shale pebbles.....	30	273
Pierre shale			
	Shale, silty, gray.....	17	290

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-70-12ddd
Test hole 161

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel.....	7	8
	Sand, medium to very coarse, light-brown, and fine gravel, clayey.....	6	14
	Sand, medium to very coarse, gray-brown, clayey and the coarser fraction consists of shale fragments.....	26	40
	Sand, very coarse, gray-brown, and fine gravel clayey, and the coarser fraction consists of shale fragments.....	10	50
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	32	82
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	21	103
	Gravel, fine to medium, and very coarse sand, clayey, and the coarser fraction consists of shale fragments.....	25	128
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	13	141
Undifferentiated			
	Clay, sandy, gray-brown, and fine gravel; could be either till or bedrock.....	9	150
	Clay, silty, gray, and very fine sand, and fine gravel; could be either till or bedrock.....	30	180
	Clay, silty and pebbly, gray, and very fine sand.....	35	215
	Clay, silty, gray, and fine sand, and fine gravel; could be either till or bedrock.....	75	290
Pierre shale			
	Shale, gray.....	30	320

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

162-70-14bbb
Test hole 163

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, sandy, light-gray, and fine to medium gravel.....	2	4
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	7	11
	Gravel, medium to coarse, and shale pebbles	3	14
	Gravel, fine to medium, and very coarse sand.....	13	27
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	129	156
	Clay, sandy, gray-brown, and fine to medium gravel, and shale pebbles.....	12	168
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	7	175
Undifferentiated			
	Clay, silty and sandy, light-brown and very fine to fine gravel; could be either till or bedrock.....	42	217
	Clay, silty, gray, and very fine sand; could be either till or bedrock.....	23	240

163-70-10cdd
Test hole 462

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	24	25
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	21	46
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	28	74
	Clay, sandy, gray, and medium gravel, and shale pebbles.....	62	136
	Gravel, fine to medium, clayey.....	2	138
	Clay, gray, and very coarse sand, and fine gravel, and shale pebbles.....	80	218
Undifferentiated			
	Clay, sandy, gray-brown and fine gravel, and about one-half the material consists of shale fragments; could be either till or bedrock.....	14	232

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

163-70-10dcd
Test hole 463

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	16	18
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	49	67
	Gravel, fine to medium, and medium to very coarse sand.....	8	75
	Gravel, medium.....	15	90
	Gravel, coarse.....	10	100
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	20	120
	Clay, sandy, gray, and fine to medium gravel, and about one-half the material consists of shale fragments.....	105	225
Pierre shale	Shale, gray.....	22	247

163-70-11dcc
Test hole 467

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Sand, coarse, light-brown and fine gravel..	2	4
	Clay, sandy, light-brown and fine to medium gravel, and shale pebbles.....	12	16
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	36	52
	Clay, sandy, light-brown, and medium gravel, and shale pebbles.....	25	77
	Sand, coarse, light-brown, and fine gravel.	3	80
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	40	120
	Clay, gray, and very coarse sand, and fine to medium gravel, and abundant shale pebbles	42	162

TABLE 3. --LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

163-70-15acal
Test hole 460

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Road fill.....	2	2
	Clay, sandy, light-brown, and fine gravel	8	10
	Sand, fine to very coarse, light-brown, silty and clayey.....	17	27
	Sand, very coarse, gray, and fine gravel, clayey, and the coarser fraction consists of shale fragments.....	13	40
	Clay, very sandy, gray, and fine to medium gravel, and shale pebbles.....	14	54
	Clay, sandy, gray-brown, and fine to medium gravel, and shale pebbles.....	10	64
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	52	116
	Clay, sandy, gray-brown, and fine to medium gravel, and shale pebbles.....	21	137
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	41	178
	Clay, very sandy, gray, and fine gravel, and shale pebbles.....	87	265
Pierre shale	Shale, gray.....	15	280

163-70-15adal
Test hole 461

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Sand, very fine to very coarse, light-brown, very clayey.....	19	20
	Sand, medium to coarse, gray, silty and clayey.....	25	45
	Sand, medium to very coarse, gray, and fine gravel, clayey, and the coarser fraction consists of shale fragments.....	17	62
	Clay, sandy, gray, and fine gravel, and shale pebbles.....	52	114
	Gravel, fine, gray, and coarse sand, very clayey, and the coarser fraction consists of shale fragments.....	12	126
	Clay, sandy, gray, and fine gravel, and shale pebbles.....	34	160
	Clay, very sandy, gray, and fine to medium gravel, and shale pebbles.....	28	188
Pierre shale	Shale, gray.....	15	203

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

163-70-15ada2
Test hole 465

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, very sandy, light-gray, and fine gravel.....	3	4
	Clay, sandy, light-brown and fine to medium gravel.....	9	13
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	22	35
	Clay, very sandy, gray and fine to medium gravel, and shale pebbles.....	27	62
	Sand, medium to very coarse, gray, and fine, to medium gravel, clayey, and the coarser fraction consists of shale fragments.....	8	70
	Sand, very coarse, and fine gravel.....	12	82
	Sand, very coarse, gray, and fine gravel, clayey, and the coarser fraction consists of shale fragments.....	11	93
	Gravel, fine, and very coarse sand, and this material consists of about one-half shale fragments.....	7	100
	Clay, very sandy, gray, and fine gravel, and shale pebbles.....	5	105
	Gravel, fine to coarse, and very few shale fragments.....	16	121
	Clay, very sandy, gray, and fine to medium gravel, and shale pebbles.....	19	140

163-70-15adb
Test hole 464

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	21	22
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	56	78
	Clay, sandy, gray-brown, and fine to medium gravel, and shale pebbles.....	10	88
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	17	105
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	17	122
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	56	178
Pierre shale	Shale, gray.....	22	200

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

163-70-15bdd1
Test hole 172

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, sandy, light-brown, and fine gravel, and shale pebbles.....	19	21
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	45	66
	Sand, very coarse, gray, and fine gravel, clayey, and the coarser fraction consists of shale fragments.....	11	77
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	49	126
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	23	149
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	41	190
Undifferentiated			
	Clay, gray, and very coarse sand, and fine gravel, and abundant shale fragments; could be either till or bedrock.....	110	300

163-70-15cab
Test hole 457

Till and associated sand and gravel deposits			
	Clay, sandy, light-brown, and fine gravel, and shale pebbles.....	23	23
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	12	35
	Sand, very coarse, gray, and fine gravel, clayey.....	2	37
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	56	93
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	12	105
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	52	157
	Sand, medium to very coarse, gray, and fine gravel, clayey, and the coarser fraction consists of shale fragments.....	4	161
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	22	183
	Sand, medium to very coarse, gray, and fine gravel, clayey, and about one-half the material consists of shale fragments.....	2	185
Undifferentiated			
	Clay, sandy, gray-brown, and fine gravel, and abundant shale fragments; could be either till or bedrock.....	20	205

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

163-70-15cad1
Test hole 459

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, clack.....	1	1
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	15	16
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	51	67
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	17	84
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	54	138
	Clay, very sandy, light-brown, and fine gravel, and the material consists of about one-half shale fragments.....	18	156
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	15	171
Pierre shale	Shale, gray.....	9	180

163-70-15dcd
Test hole 466

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, very sandy, light-brown, and fine to medium gravel, and shale pebbles.....	27	29
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	93	122
	Clay, sandy, gray-brown, and fine gravel, and shale pebbles.....	11	133
	Clay, sandy, light-gray, and fine gravel, and shale pebbles.....	1	134
	Clay, sandy, gray-brown, and fine gravel, and shale pebbles.....	24	158
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	58	216
Pierre shale	Shale, gray.....	14	230

TABLE 3.--LOGS OF TEST HOLES IN THE ROLLA-ST. JOHN AREAS
ROLETTE COUNTY -- Continued

163-70-16aaa
Test hole 173

<u>Formation</u>	<u>Material</u>	<u>Thickness (feet)</u>	<u>Depth (feet)</u>
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	33	35
	Clay, sandy, gray, and fine to medium gravels and shale pebbles.....	159	194
	Clay, sandy, light-gray, and fine to medium gravel, and shale pebbles.....	16	210
Undifferentiated			
	Clay, sandy, gray, and fine gravel, and abundant shale fragments; could be either till or bedrock.....	80	290
Pierre shale			
	Shale, gray.....	15	305

163-70-16daal
Test hole 458

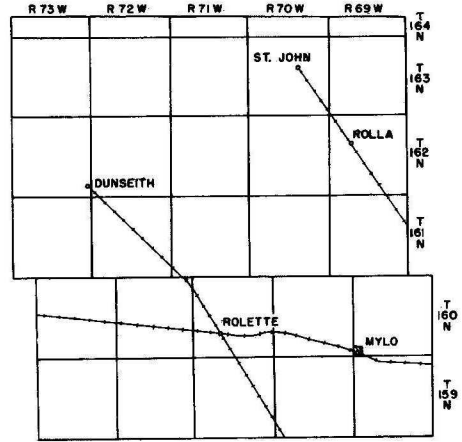
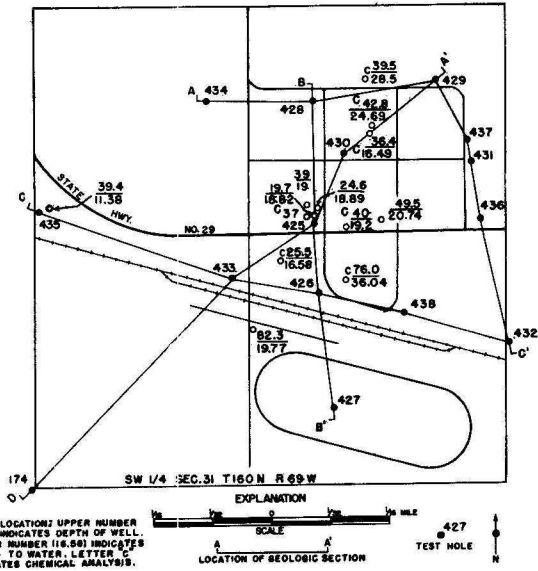
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-brown, and fine gravel, and shale pebbles.....	26	27
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	100	127
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	31	158
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	103	261
Undifferentiated			
	Clay, very sandy, gray, and fine gravel, and abundant shale fragments; could be either till or bedrock.....	19	280

Mylo Area, Rolette County

The Mylo area is in the eastern part of Rolette County in north-central North Dakota. It is a part of the Western Young Drift section of the Central Lowland Province of Fenneman (1938, p. 559) and is in the Drift Prairie as designated by Simpson (1929, p. 4). The area covered by this investigation totals 2 square miles and includes: sec. 1, T. 159 N., R. 70 W., and sec. 31, T. 160 N., R. 69 W.

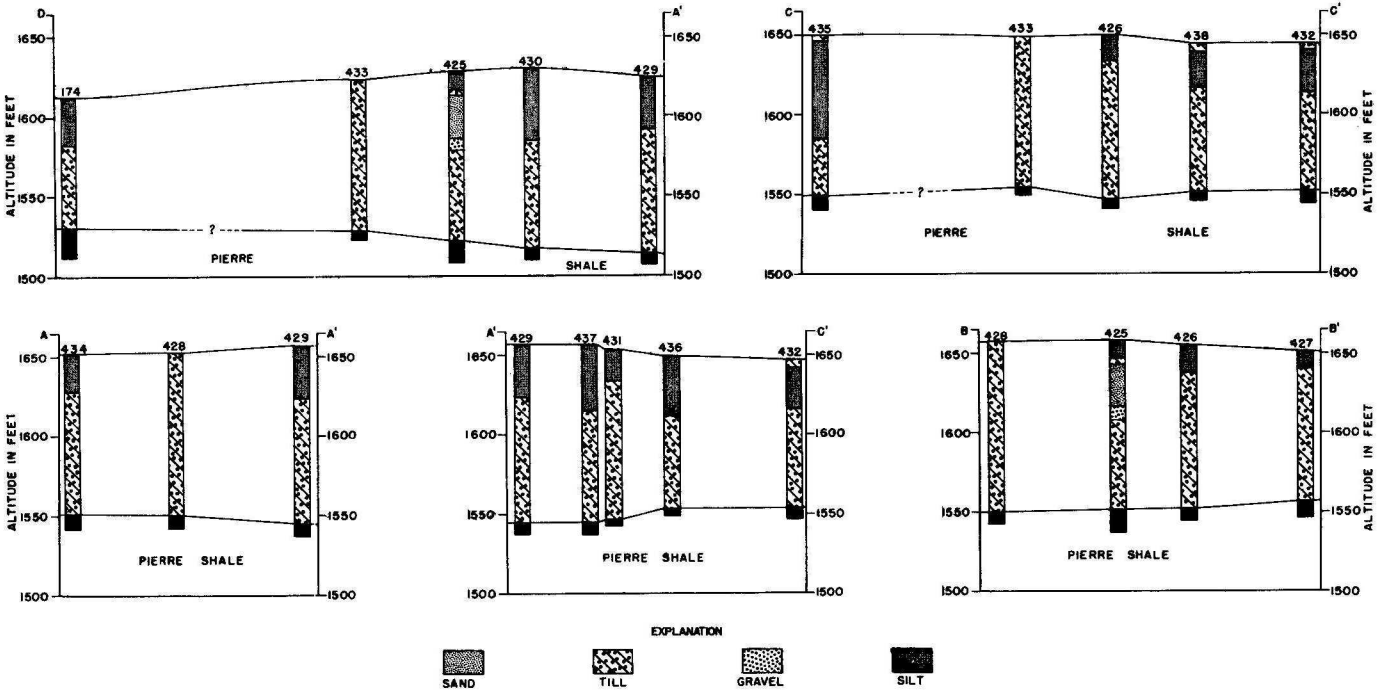
The average annual precipitation recorded at the United States Weather Bureau station at Rolla, approximately 12 miles north of Mylo, is 20.09 inches based upon data gathered during the period 1937 to 1959. The mean annual temperature for the same period was 37.4 degrees.

Surficial deposits in the Mylo area consist entirely of glacial drift. These drift deposits resemble each other in appearance but differ somewhat in texture and composition. They may be classified into the following three groups: (1) till, a heterogeneous mixture of unstratified material ranging in size from clay to boulders, with clay the predominant constituent; (2) evenly laminated clay, silt, and very fine sand; and (3) poorly bedded, poorly sorted sand and gravel. These three types of deposits tend to grade into each other which makes identification of test-hole cuttings and location of interfaces between the materials very difficult. The mechanics of their deposition is not known other than that they are probably partly of ice-contact and partly of glacio-lacustrine origin. The bed of an extinct glacial lake terminates just north of the village of Mylo, but it does not have the smooth well drained appearance of other glacial lake beds in North Dakota. This may indicate that numerous stagnant ice masses occupied the lake basin during parts of its lifetime and contributed to the glacial deposits in the vicinity of Mylo.



EASTERN ROLETTE COUNTY, NORTH DAKOTA, SHOWING LOCATION OF THE MYLO AREA

MAP OF THE MYLO AREA SHOWING LOCATIONS OF TEST HOLE, WELLS & GEOLOGIC SECTIONS



GEOLOGIC SECTIONS IN THE MYLO AREA

MAP SHOWING LOCATIONS OF TEST HOLES, WELLS, AND GEOLOGIC SECTIONS IN THE MYLO AREA

The Pierre shale constitutes the bedrock for the entire area. Inasmuch as this formation does not yield water readily to wells, water-well drilling is customarily terminated when the Pierre shale is penetrated. At the locations of the 15 test holes drilled in the Mylo area (see fig. 4), the shale occurs at an average depth of 101 feet below land surface. The Pierre shale is gray and is poorly indurated. It is not known to crop out in the Mylo area.

The majority of wells in the Mylo area are completed in the glacial drift. Inasmuch as the glacial drift is composed largely of till and contains a large proportion of clay, only small supplies can be obtained from individual wells. Only one well in the area is reported to obtain water from the Pierre shale.

Chemical analyses of samples collected from 8 wells in the Mylo area are listed on table 4. Water from wells in the area is generally hard and is moderately to highly mineralized. All of the wells sampled, except that supplying the village of Mylo, contained excessive iron concentrations. Water from only three of the wells had less than the recommended maximum concentration of sulfate in drinking water according to U. S. Public Health Service (1946) Standards, and water from two of the wells was found to have excessive nitrate concentrations. Water containing more than about 40 ppm of nitrate may cause cyanosis ("blue baby" disease) in infants when used in feeding formulas and for drinking (Comly, 1945).

Test drilling in the Mylo area did not reveal the presence of an extensive aquifer and it is probable that any ground-water development in the area will be limited to low-capacity wells.

TABLE 4.--CHEMICAL ANALYSES OF GROUND WATER

Analyses by State Laboratories, Bismarck, N. Dak.
Results in parts per million

Location No.	Owner or name	Depth of well (feet)	Date of collection	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
<u>160-69</u>							
31cab1	Arnold Boxstrom	40	1-30-52	0.4	271	108	15
31cac1	Village of Mylo	37	9-17-51	.1	125	47	....
31cac2	Raymond Schell	40	9-17-51	12	70	16	4.8
31cac3	Everett Wielander	36	9-17-51	1.6	243	80	23
31cac4	Arnold Boxstrom	43	4-18-52	4.2	113	98	34
31ccal	Walter Wielander	82	4-18-52	3.8	46	170	780
31cdb1	Ted Johnson	76	12- 4-50	1.4	30	52	420
31cdb2	Everett Wielander	26.	9-17-51	1.8	74	21	....

IN THE MYLO AREA, ROLETTE COUNTY

Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Nitrate (NO ₃)	Dissolved solids	Hardness as CaCO ₃	Percent sodium	pH
215	....	735	108	65	1,410	1,120	2.9	8.1
332	....	14	72	4.3	594	504	...	7.8
310	....	.....	...	....	413	244	3.8	7.8
352	....	566	40	65	1,370	936	5	7.7
364	....	388	40	2.1	1,040	684	9.7	8.1
574	46	1,230	480	2.1	3,040	813	68	8.6
534	9.6	658	32	4.3	1,470	292	76	8.4
271	....	.....	10	....	378	292	....	7.8

TABLE 5.--RECORDS OF WELLS AND TEST HOLES

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

Type: Dr, drilled

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
<u>159-70</u>					
1aaa	Test hole 174	100	5	Dr	1949
<u>160-69</u>					
31caa	Test hole 429	120	5	Dr	1951
31cab1	Arnold Boxstrom	39.5	24	Dr	1920 ?
31cab2	Test hole 428	110	5	Dr	1951
31cacl	Village of Mylo	37	8	Dr	1946
31cac2	Raymond Schell	40	9	Dr	1948
31cac3	Everett Wielander	36.4	24	Dr	1910 ?
31cac4	Arnold Boxstrom	42.8	24	Dr	1950
31cac5	Village of Mylo	24.6	24	Dr	1928
31cac6	Do	19.7	12	Dr	1910 ?
31cac7	Raymond Schell	49.5	8	Dr	....
31cac8	Test hole 425	120	5	Dr	1951

IN THE MYLO AREA, ROLETTE COUNTY

Date of measurement: Date given is date measured for measured depths to water; it is the date of report for reported depths to water.

Use of water: D, domestic; PS, public supply, S, stock; T, test hole.

Depth to water below land surface (feet)	Date of measurement	Use	Remarks
.....	.....	T	Hole refilled. Shale at 82 feet. See log.
28.50	6-11-51	T S	Hole refilled. Shale at 113 feet. See log. Supply reported inadequate; aquifer in drift: Measuring point, top of wood curbing, .8 feet above land surface. See chemical analysis.
.....	.....	T	Hole refilled. Shale at 103 feet. See log.
.....	.....	PS	Aquifer in drift, sand. See chemical analysis
19.20	6-13-51	S	Supply reported inadequate; aquifer in drift. Measuring point, plank under pump base, .25 feet above land surface. See chemical analysis.
16.49	6- 8-51	D	Aquifer in drift; measuring point, top wood curbing, .8 feet above land surface. See chemical analysis.
24.69	6- 8-51	D	Aquifer in drift. Measuring point, top wood curbing .7 feet above land surface. See chemical analysis.
18.89	6- 8-51	...	Aquifer in drift: Measuring point, edge of hole in concrete slab above well at land surface.
18.82	6-21-51	...	Aquifer in drift. Measuring point, edge galvanized curbing at land surface.
20.74	6-13-51	S	Water reported hard; aquifer in drift. Measuring point, top galvanized curbing at land surface.
.....	.....	T	Hole refilled. Shale at 106 feet.

TABLE 5.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date or year completed
<u>160-69 - Continued</u>					
31cac9	Mylo Implement Co.	39	6	Dr	1951
31cac10	Test hole 430	120	5	Dr	1951
31cad1	Test hole 431	110	5	Dr	1951
31cad2	Test hole 437	120	5	Dr	1951
31cad3	Test hole 436	100	5	Dr	1951
31cba	Test hole 434	110	5	Dr	1951
31cbcl	Frank Bauck	39.4	40	Dr	1915 ?
31cbc2	Test hole 435	110	5	Dr	1951
31ccal	Walter Wielander	82.3	24	Dr	1941
31cca2	Test hole 433	100	5	Dr	1951
31cda	Test hole 438	100	5	Dr	1951
31cdb1	Ted Johnson	76	24	Dr	1915
31cdb2	Everett Wielander	25.5	24	Dr	1925 ?
31cdb3	Test hole 426	110	5	Dr	1951
31cdc	Test hole 427	100	5	Dr	1951
31dcb	Test hole 432	100	5	Dr	1951

IN THE MYLO AREA, ROLETTE COUNTY -- Continued

Depth to water below land surface (feet)	Date of measure- ment	Use	Remarks
19	.....	D	Aquifer in drift. Water reported similar to that from 160-69-31cacl.
.....	.....	T	Hole refilled. Shale at 112 feet.
.....	.....	T	Hole refilled. Shale at 106 feet. See log.
.....	.....	T	Hole refilled. Shale at 112 feet. See log.
.....	.....	T	Hole refilled. Shale at 94 feet. See log.
.....	.....	T	Hole refilled. Shale at 100 feet. See log.
11.38	6- 9-51	...	Water reported soft. Measuring point, top galvanized curbing, at land surface.
.....	.....	T	Hole refilled. Shale at 102 feet. See log.
19.77	6- 8-51	...	Aquifer in drift. Measuring point, top wood curbing, 1.9 feet above land surface. See chemical analysis. Depth reported as 85 ft.
.....	.....	T	Hole refilled. Shale at 94 feet. See log.
.....	.....	T	Hole refilled. Shale at 94 feet. See log.
36.04	6- 8-51	D	Aquifer may be in Pierre shale. Well reported deeper when drilled. Measuring point, top wood curbing, .7 feet above land surface. See chemical analysis. Well reported to have been 120 feet deep when drilled.
16.58	6- 8-51	...	Aquifer in drift. Measuring point, edge hole in concrete slab above well, 1.3 feet above land surface. See chemical analysis.
.....	.....	T	Hole refilled. Shale at 104 feet. See log.
.....	.....	T	Hole refilled. Shale at 95 feet. See log.
.....	.....	T	Hole refilled. Shale at 93 feet. See log.

TABLE 6.--LOGS OF TEST HOLES IN THE MYLO AREA, ROLETTE COUNTY

159-70-1aaa
Test hole 174

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Silt, sandy, and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	15	16
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits.....	14	30
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	52	82
Pierre shale	Shale, gray.....	18	100

160-69-31caa
Test hole 429

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	18	19
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits	15	34
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	79	113
Pierre shale	Shale, gray.....	7	120

160-69-31cab2
Test hole 428

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, sandy, light-brown and fine gravel.....	1	3
	Sand, very coarse, light-brown, and fine gravel, clayey.....	1	4
	Clay, sandy, light-brown, and fine to medium gravel, and shale pebbles.....	20	24
	Clay, sandy, gray, and fine to medium gravel and shale pebbles.....	79	103
Pierre shale	Shale, gray.....	7	110

TABLE 6.--LOGS OF TEST HOLES IN THE MYLO AREA
ROLETTE COUNTY -- Continued

160-69-31cac8
Test hole 425

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	11	12
	Clay, very sandy and silty, light-brown and fine to medium gravel.....	4	16
	Sand, very fine to very coarse, and fine gravel, clayey, and shale fragments.....	26	42
	Gravel, fine to medium, and medium to very coarse sand.....	8	50
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	56	106
Pierre shale	Shale, gray.....	14	120

160-69-31cac10
Test hole 430

Till and associated sand and gravel deposits			
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	26	26
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits.....	19	45
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	67	112
Pierre shale	Shale, gray.....	8	120

160-69-31cad1
Test hole 431

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	17	19
	Clay, sandy and silty, gray, and fine to medium gravel, and shale pebbles.....	87	106
Pierre shale	Shale, gray.....	4	110

TABLE 6.--LOGS OF TEST HOLES IN THE MYLO AREA
ROLETTE COUNTY -- Continued

160-69-31cad2
Test hole 436

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	20	22
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits	16	38
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	56	94
Pierre shale	Shale, gray.....	6	100

160-69-31cad3
Test hole 437

Till and associated sand and gravel deposits			
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	27	27
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits.....	15	42
	Clay, sandy, gray, and fine to medium gravel and shale pebbles.....	70	112
Pierre shale	Shale, gray.....	8	120

160-69-31cba
Test hole 434

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	22	23
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	77	100
Pierre shale	Shale gray.....	10	110

TABLE 6.-- LOGS OF TEST HOLES IN THE MYLO AREA
ROLETTE COUNTY -- Continued

160-69-31cbc2
Test hole 435

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, very sandy, light-brown and fine gravel	3	4
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	13	17
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits	48	65
	Clay, sandy, gray and fine to medium gravel, shale pebbles.....	37	102
Pierre shale	Shale, gray.....	8	110

160-69-31cca2
Test hole 433

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, very sandy, light-brown, and fine gravel, and shale pebbles.....	17	18
	Clay, sandy, gray, and fine to medium gravel and shale pebbles.....	76	94
Pierre shale	Shale, gray.....	6	100

160-69-31cda
Test hole 438

Till and associated sand and gravel deposits			
	Topsoil, black.....	2	2
	Clay, silty, light-brown, and very fine sand	3	5
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	9	14
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits	14	28
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	66	94
Pierre shale	Shale, gray.....	6	100

TABLE 6.--LOGS OF TEST HOLES IN THE MYLO AREA
ROLETTE COUNTY -- Continued

160-69-31cdb3
Test hole 426

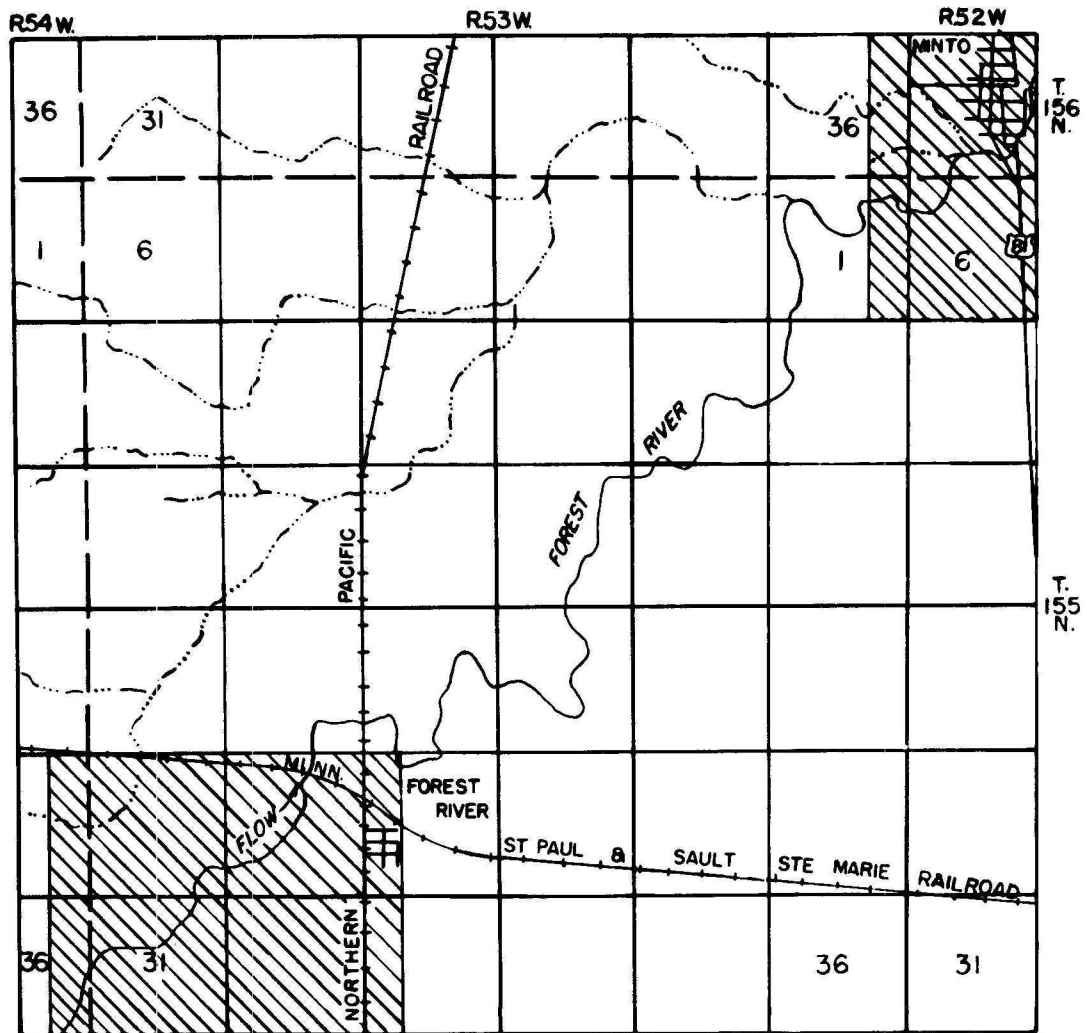
<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	16	17
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	87	104
Pierre shale	Shale, gray.....	6	110

160-69-31cdc
Test hole 427

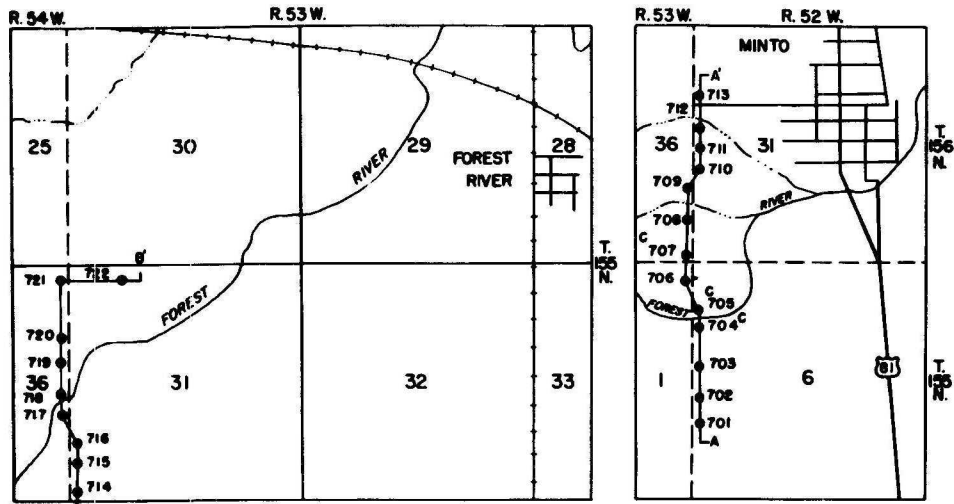
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	11	12
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	83	95
Pierre shale	Shale, gray.....	10	105

160-69-31dcb
Test hole 432

Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, very sandy, light-brown and coarse gravel	3	4
	Silt, sandy and pebbly, clayey, light-brown; probably till but may be in part lacustrine deposits.....	12	16
	Silt, sandy and pebbly, clayey, gray; probably till but may be in part lacustrine deposits	15	31
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	62	93
Pierre shale	Shale, gray.....	7	100



MAP SHOWING LOCATIONS OF THE MINTO AND FOREST RIVER AREAS



EXPLANATION

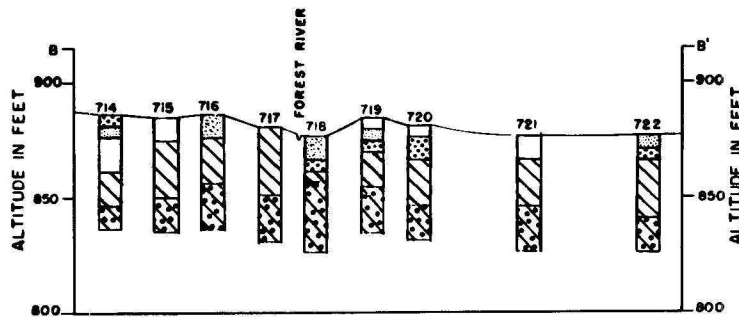
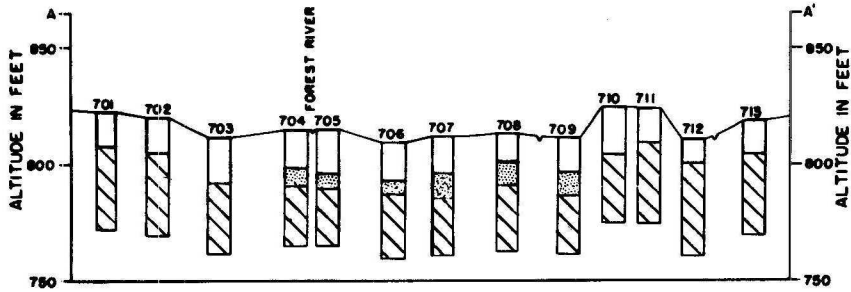


TEST HOLE
LETTER C INDICATES
CHEMICAL ANALYSIS

LOCATION OF GEOLOGIC SECTION



MAPS OF MINTO AND FOREST RIVER AREAS SHOWING LOCATIONS OF TEST HOLES AND GEOLOGIC SECTIONS



EXPLANATION



GEOLOGIC SECTIONS IN THE MINTO AND FOREST RIVER AREAS
ENLARGED (2 X)

MAP SHOWING LOCATIONS OF TEST HOLES AND GEOLOGIC SECTIONS IN THE MINTO-FOREST RIVER AREAS

Minto-Forest River Areas, Walsh County

The Minto-Forest River areas are in southeastern Walsh County in northeastern North Dakota. They are a part of the Western Young Drift section of the Central Lowland Province of Fenneman (1938, p.559) and are in the Red River Valley area as designated by Simpson (1929, p. 4). The areas of investigation total about 7½ square miles.

The average annual precipitation recorded at the United States Weather Bureau station at Grafton, about 10 miles north of Minto, is 21.06 inches based upon data gathered during the period 1891 to 1959. The mean annual temperature for the same period was 37.5 degrees.

The areas covered in this investigation lie entirely within the basin of glacial Lake Agassiz which covered the Red River Valley. Upham (1896) mapped the extent of glacial Lake Agassiz in the United States and southern Manitoba. His monograph includes maps and descriptions of the physiographic and geologic features in the vicinity of Minto and Forest River. The areas have little relief and the major topographic features are the youthful stream valleys cut in the glacial Lake Agassiz sediments. Clay and silt are the predominant constituents of the lake deposits; they overlie glacial till throughout the areas. The till is a heterogeneous mixture of clay, silt, sand and gravel; clay is the major constituent. Under the till are much older sandstones and shales of Cretaceous or Paleozoic age.

Small quantities of ground water are obtained from dug or bored wells in the sediments of glacial Lake Agassiz and somewhat larger amounts are obtained from wells penetrating the sand and gravel lenses in the glacial drift. Very highly mineralized water may be obtained from wells penetrating the older sandstones under the glacial drift.

Thirteen test holes were drilled near Minto and nine near Forest River in an attempt to find an aquifer that would be suitable for a municipal supply for the city of Grafton. Figure 5 shows the location of these test holes and cross sections of the material penetrated. Some sand and gravel were present in each section; however, they did not form a large enough aquifer to yield a municipal water supply.

Chemical analyses of water from test holes 704, 705, and 707 are shown on table 7. The iron content was much in excess of the recommended maximum for drinking water in all of the samples analyzed and the water was very hard. These samples were all obtained from wells penetrating alluvial deposits.

TABLE 7.--CHEMICAL ANALYSES OF GROUND WATER

Analyses by State Laboratories, Bismarck, N. Dak.
Results in parts per million

Location No.	Owner or name	Depth of well (feet)	Date of collection	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO ₃)
155-52-6bcb	Test hole 704	23	8-11-53	7	63	51	117	376
155-52-6bbc	Test hole 705	23	5-22-53	6	203	76	7	527
156-53-36ddd	Test hole 707	26	5-22-53	10	155	66	30	565

IN MINTO-FOREST RIVER AREAS, WALSH COUNTY

Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids	Hardness as CaCO ₃)		Percent sodium
					Calcium, magnesium	Noncar- bonate	
99	150	.2	11	874	368	60	41
60	224	.3		1,100	820	388	2
50	134	.2		1,010	656	192	9

TABLE 8.--LOGS OF TEST HOLES IN THE MINTO-FOREST RIVER AREAS
WALSH COUNTY

155-52-6bbc
Test hole 705

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Alluvium	Silt, gray.....	18	18
	Sand, fine to medium, and abundant Recent snail shells.....	7	25
Lake Agassiz Deposits	Clay, medium-gray.....	25	50

155-52-6bcb
Test hole 704

Alluvium	Clay, silty, light-brown.....	16	16
	Sand, fine to coarse.....	7	23
Lake Agassiz deposits	Clay, medium-gray.....	27	50

155-52-6bcc
Test hole 703

Lake Agassiz deposits	Silt, sandy light-gray; may be in part alluvium.....	20	20
	Clay, medium-gray.....	30	50

155-52-6cbb
Test hole 702

Lake Agassiz deposits	Silt, clayey, yellowish-gray.....	15	15
	Clay, medium-gray.....	35	50

155-52-6cbc
Test hole 701

Lake Agassiz deposits	Topsoil, silty, dark-gray.....	2	2
	Silt, light-yellow.....	13	15
	Clay, medium-gray.....	35	50

155-53-1aaa
Test hole 706

Alluvium	Silt, light-gray.....	17	17
	Sand, fine to coarse.....	6	23
Lake Agassiz deposits	Clay, medium-gray.....	27	50

TABLE 8.-- LOGS OF TEST HOLES IN THE MINTO-FOREST RIVER AREAS
WALSH COUNTY -- Continued

155-53-31bba
Test hole 722

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Alluvium	Sand, very coarse, and fine gravel.....	5	5
	Gravel, fine, clayey, dark-gray.....	5	10
	Clay, dark-gray, and coarse sand.....	5	15
Lake Agassiz deposits	Clay, medium-gray.....	20	35
Till and associated sand and gravel deposits	Clay, sandy, light-gray, and fine gravel.	15	50

155-53-31cbc
Test hole 716

Alluvium	Sand, very coarse, and fine gravel.....	10	10
Lake Agassiz deposits	Clay, silty, medium-gray.....	20	30
Till and associated sand and gravel deposits	Clay, silty, light-gray, and fine gravel.	20	50

155-53-31ccb
Test hole 715

Lake Agassiz deposits	Silt, sandy, light-brown.....	10	10
	Clay, sandy, medium-gray.....	25	35
Till and associated sand and gravel deposits	Clay, light-gray, and fine gravel.....	15	50

155-53-31ccc
Test hole 714

Alluvium	Gravel.....	5	5
	Sand, fine.....	5	10
Lake Agassiz deposits	Clay, medium-gray.....	15	25
	Silt, clayey, light-gray.....	15	40
Till and associated sand and gravel deposits	Clay, light-gray, and fine gravel.....	10	50

TABLE 8.--LOGS OF TEST HOLES IN THE MINTO-FOREST RIVER AREAS
WALSH COUNTY -- Continued

		155-54-36aaa Test hole 721	
<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Silt, yellowish-gray.....	10	10
	Clay, medium-gray.....	20	30
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine gravel.	20	50
		155-54-36ada Test hole 720	
Alluvium			
	Silt, dark-brown.....	5	5
	Gravel, fine.....	5	10
	Gravel, medium.....	5	15
Lake Agassiz deposits			
	Clay, medium-gray.....	20	35
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine gravel.	15	50
		155-54-36add Test hole 719	
Alluvium			
	Silt, sandy, interbedded.....	5	5
	Sand, coarse to very coarse.....	5	10
	Gravel, medium.....	5	15
Lake Agassiz deposits			
	Clay, medium to dark-gray; some carbonaceous material.....	15	30
Till and associated sand and gravel deposits			
	Clay, silty, light-gray, and fine to medium gravel.....	20	50
		155-54-36daal Test hole 717	
Alluvium			
	Clay, silty, and gravelly, black.....	10	10
Lake Agassiz deposits			
	Clay, medium-gray.....	20	30
Till and associated sand and gravel deposits			
	Clay, silty, light-gray, and fine gravel.	20	50

TABLE 8.--LOGS OF TEST HOLES IN THE MINTO-FOREST RIVER AREAS
WALSH COUNTY -- Continued

		155-54-36daa2 Test hole 718	
<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Alluvium	Soil, sandy, dark-brown.....	5	5
	Sand, medium to coarse, and fine gravel..	5	10
	Gravel, fine.....	5	15
Lake Agassiz deposits	Clay, silty, light-gray.....	5	20
Till and associated sand and gravel deposits	Clay, silty, light-gray, and fine to medium gravel; highly calcareous.....	30	50
156-52-31bcb Test hole 713			
Lake Agassiz deposits	Silt, yellowish-gray.....	15	15
	Clay, medium-gray.....	35	50
156-52-31bcc Test hole 712			
Lake Agassiz deposits	Silt, yellowish-gray.....	10	10
	Clay, medium-gray.....	40	50
156-52-31cbb1 Test hole 710			
Lake Agassiz deposits	Topsoil, silty, dark-gray.....	5	5
	Silt, light yellowish-gray.....	15	20
	Clay, medium-gray.....	30	50
156-52-31cbb2 Test hole 711			
Lake Agassiz deposits	Silt, yellowish-gray.....	15	15
	Clay, medium-gray.....	15	30
	Clay, yellowish-gray.....	5	35
	Clay, medium-gray.....	15	50

TABLE 8.--LOGS OF TEST HOLES IN THE MINTO-FOREST RIVER AREAS
WALSH COUNTY -- Continued

156-53-36dad
Test hole 709

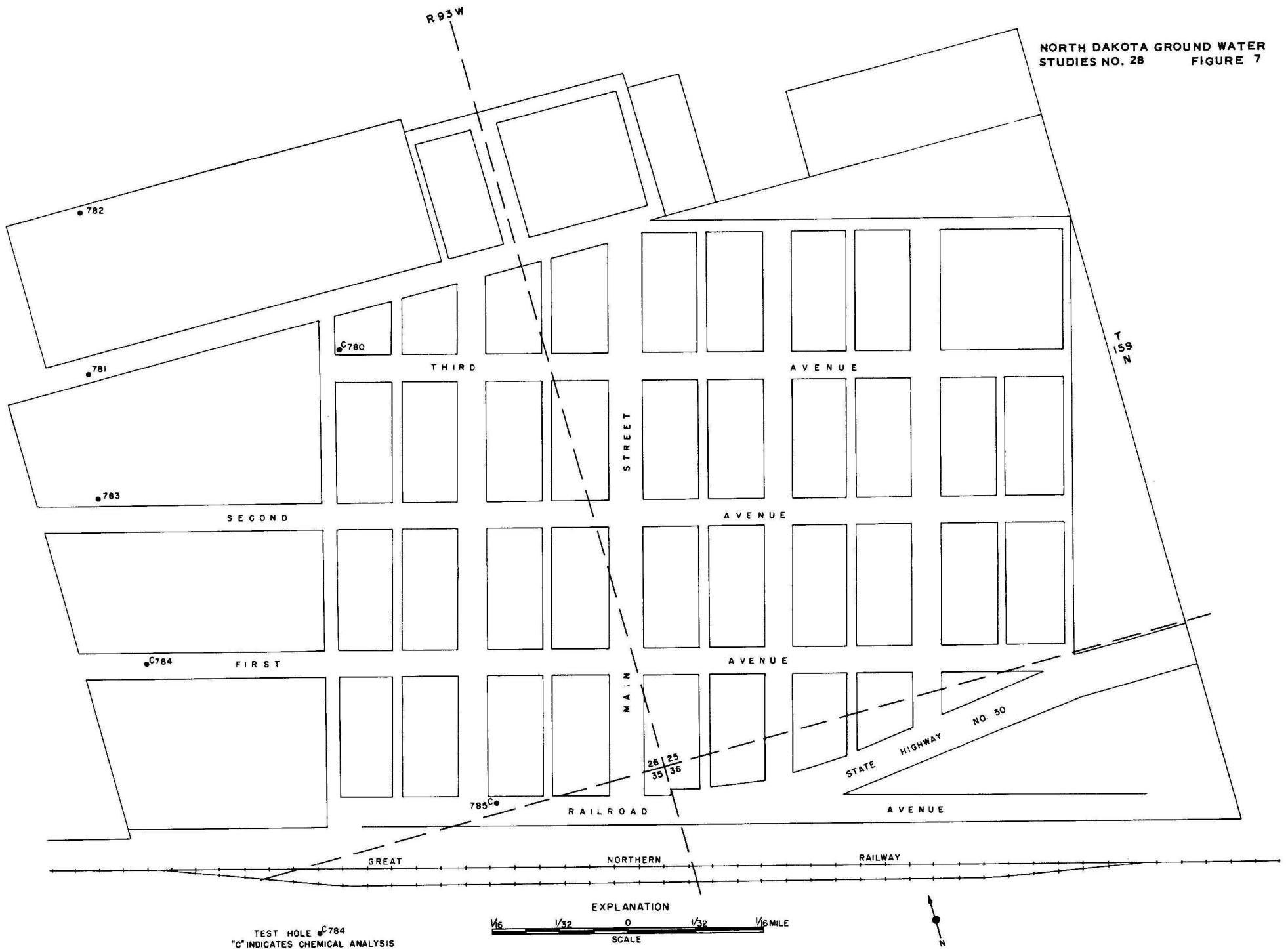
<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Alluvium	Silt, gray.....	10	10
	Silt, sandy, black.....	5	15
	Sand, silty, some carbonaceous material..	10	25
Lake Agassiz deposits	Clay, medium-gray.....	25	50

156-53-36dda
Test hole 708

Alluvium	Silt, gray and brown.....	12	12
	Sand, clayey.....	3	15
	Sand, fine to coarse, and fine grave, and some Recent snail shells.....	7	22
Lake Agassiz deposits	Clay, medium-gray.....	28	50

156-53-36ddd
Test hole 707

Alluvium	Silt, light-brown and gray.....	15	15
	Sand, medium to coarse, and some Recent snail shells.....	11	26
Lake Agassiz deposits	Clay, medium-gray.....	24	50



MAP SHOWING LOCATIONS OF TEST HOLES IN THE POWERS LAKE AREA

Powers Lake Area, Burke County

Powers Lake is in southwestern Burke County in northwestern North Dakota. It is a part of the Western Young Drift section of the Central Lowland Province of Fenneman (1938, p. 559) and is in the Missouri Plateau region as designated by Simpson (1929, p. 4). The area covered during the investigation included parts of secs. 25, 26, 35, and 36, T. 159 N., R 93 W. The investigation consisted of test drilling and collection of water samples for chemical analysis and was limited to the confines of the city of Powers Lake. Six test holes were drilled and water samples were collected from three of them. Logs of test holes are included in table 10 and results of water analyses are shown in table 9. Locations of test holes are shown on figure 6.

The average annual precipitation recorded by the United States Weather Bureau at Bowbells, about 30 miles northeast of Powers Lake, is 17.60 inches based upon data gathered during the period 1925 to 1959. The mean annual temperature for the same period was 38.1 degrees.

Surface deposits in the Powers Lake area consist of glacial till of Pleistocene age. The till is composed of clay, sand, and gravel in varying amounts; clay is the predominant constituent.

The bedrock in the area is the Fort Union formation of Paleocene age which consists of interbedded clay, sand, gravel, shale, and lignite. Because it was not possible to distinguish between the glacial till and the bedrock in the drill cuttings, the contact between till and bedrock is not delineated. As a consequence, formation names are not included in logs of test holes.

No extensive aquifer was located as a result of the test drilling in the Powers Lake area. Small to moderate supplies of ground water are

available from sand deposits in the glacial drift. However, since the drift aquifers are discontinuous and small in areal extent, it is doubtful that permanent supplies of any magnitude can be obtained from them.

Larger permanent supplies of moderately to highly mineralized but generally soft water are available from the Fort Union formation. Water-bearing zones in this formation consist of beds of sand, gravel, and lignite. The lignite beds probably cover a wide area but the beds of sandstone or sand and gravel are discontinuous and gradational. Throughout a broad area, however, they may be hydraulically connected. Although the permeability of the Fort Union formation as a whole is limited by the presence of clay in its component beds, it is the only water-bearing material in the area capable of yielding water in amounts sufficient for a municipal supply.

Chemical analyses on four samples from three test holes drilled in the area indicate relatively soft water with fairly high sulfate, sodium, and bicarbonate concentrations.

TABLE 9.--CHEMICAL ANALYSES OF GROUND WATER

Analyses by State Laboratories, Bismarck, N. Dak.
Results in parts per million

Location No.	Owner or name	Date of collection	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)
<u>159-93</u>							
26dda	Test hole 780 <u>1/</u>	8-53	1.1	0	60	450	14
26ddc	Test hole 784 <u>2/</u>	8-53	.2	24	92	720	15
Do	Do <u>3/</u>	8-53	.6	18	96	740	16
26ddd	Test hole 785 <u>4/</u>	8-53	.8	25	148	362	12

1/ Sample from 112 to 126 feet.

2/ Sample taken after short period of pumping, depth from 82 to 126 feet.

3/ Sample taken after considerable period of pumping, depth from 82 to 126 feet.

4/ Sample from 82 to 106 feet.

IN THE POWERS LAKE AREA, BURKE COUNTY

Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids	Hardness as CaCO ₃	pH
661	49	410	11	.5	27	1,280	60	8.7
824	59	856	25	.5	10	2,240	116	8.9
920	21	892	11	.5	3	2,280	114	8.9
560	59	400	8	.1	6.6	1,160	173	8.8

TABLE 10.--LOGS OF TEST HOLES IN THE POWERS LAKE AREA, BURKE COUNTY

159-93-26dab
Test hole 781

<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Topsoil, sandy, black.....	1	1
Sand, fine to coarse, and fine gravel.....	23	24
Clay, very sandy, light greenish-gray, and fine to medium gravel, and shale pebbles.....	22	46
Clay, sandy, medium-gray, and streaks of light-gray..	61	107
Sand, coarse, clayey, and fine gravel, and the coarser fraction consists of shale fragments.....	9	116
Clay, sandy, gray, and fine to medium gravel.....	14	130

159-93-26dac
Test hole 782

Topsoil, black.....	1	1
Sand, medium to coarse, and coarse gravel.....	15	16
Clay, sandy, light greenish-gray.....	14	30

159-93-26dda
Test hole 780

Topsoil, black.....	3	3
Sand, medium to coarse, and fine to medium gravel....	12	15
Clay, yellowish-gray, and fine to medium gravel, and shale pebbles.....	11	26
Clay, sandy, light greenish-gray, and medium gravel..	22	48
Clay, sandy, dark-gray.....	64	112
Sand, fine to medium, clayey, and fine gravel, and the coarser fraction consists of shale fragments...	14	126
Clay, very sandy, dark-gray.....	24	150

159-93-26ddb
Test hole 783

Topsoil, black.....	2	2
Sand, silty, and fine to medium gravel.....	4	6
Clay, yellowish-gray, and fine to medium gravel, and shale pebbles.....	2	8
Clay, gray, and fine to medium gravel, and shale pebbles.....	8	16
Gravel, fine to medium.....	2	18
Clay, light greenish-gray.....	12	30

TABLE 10.--LOGS OF TEST HOLES IN THE POWERS LAKE AREA
BURKE COUNTY -- Continued

159-93-26ddc
Test hole 784

<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Topsoil, black.....	1	1
Sand, very coarse, and fine gravel.....	11	12
Clay, gray, and fine to medium gravel, and shale pebbles.....	7	19
Sand, medium to coarse, and fine to medium gravel, and the coarser fraction consists of shale fragments.....	5	24
Clay, sandy, light-gray.....	16	40
Clay, sandy, medium-gray.....	10	50
Clay, smooth, medium-gray.....	17	67
Sand, fine, clayey.....	5	72
Clay, sandy, medium-gray.....	10	82
Sand, fine to coarse, and fine gravel, and the coarser fraction consists of shale fragments.....	12	94
Sand, very coarse, and fine gravel, and the coarser fraction consists of shale fragments.....	32	126
Clay, medium-gray.....	14	140

159-93-26ddd
Test hole 785

Topsoil, black.....	1	1
Sand, fine to coarse, and fine to medium gravel.....	16	17
Clay, sandy, light-gray.....	41	58
Sand, fine, clayey.....	6	64
Clay, hard, gray.....	18	82
Sand, fine to coarse, clayey, and the coarser fraction consists of shale fragments.....	24	106
Lignite.....	20	126
Clay, gray.....	12	138
Sand, fine to coarse.....	6	144
Clay, light-gray.....	4	148
Sand, fine to medium.....	5	153
Clay, gray, and fine to medium gravel.....	5	158
Sand, medium to coarse, and fine gravel; drills hard as though it may be cemented.....	12	170
Clay, gray, and fine to medium gravel.....	7	177
Clay, hard, light-gray.....	3	180

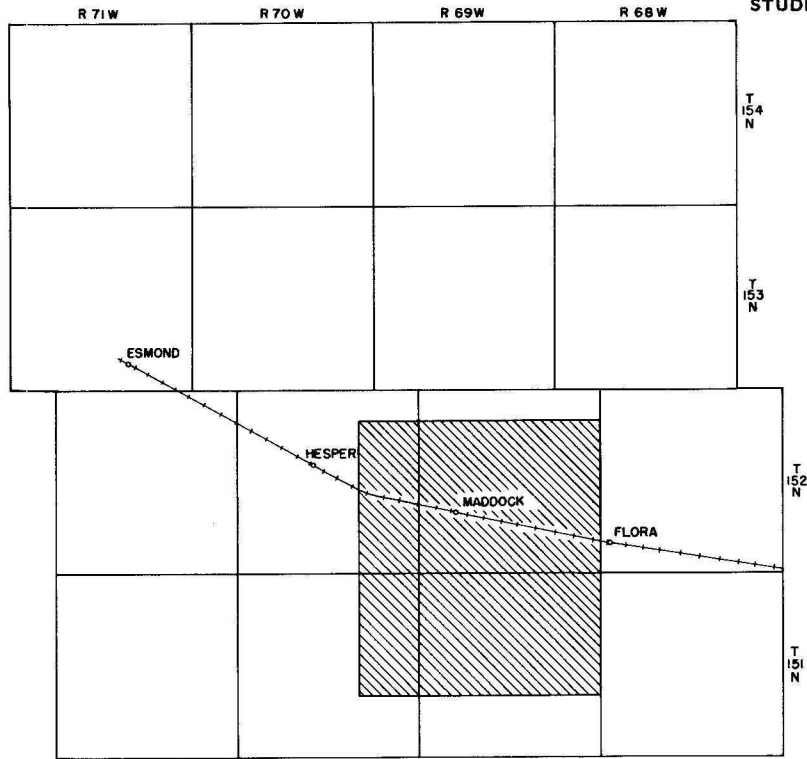
Maddock Area, Benson County

The Maddock area is in the south-central part of Benson County in north-central North Dakota. It is a part of the Western Young Drift section of the Central Lowland Province of Fenneman (1938, p. 559) and is in the Drift Prairie as designated by Simpson (1929, p. 4). The report area consists of 108 square miles and includes: secs. 7 through 36, T. 152 N., R. 69 W., secs. 1 through 24, T. 151 N., R. 69 W., secs. 7 through 36, T. 152 N., R. 70 W., and secs 1 through 24, T. 151 N., R 70 W.

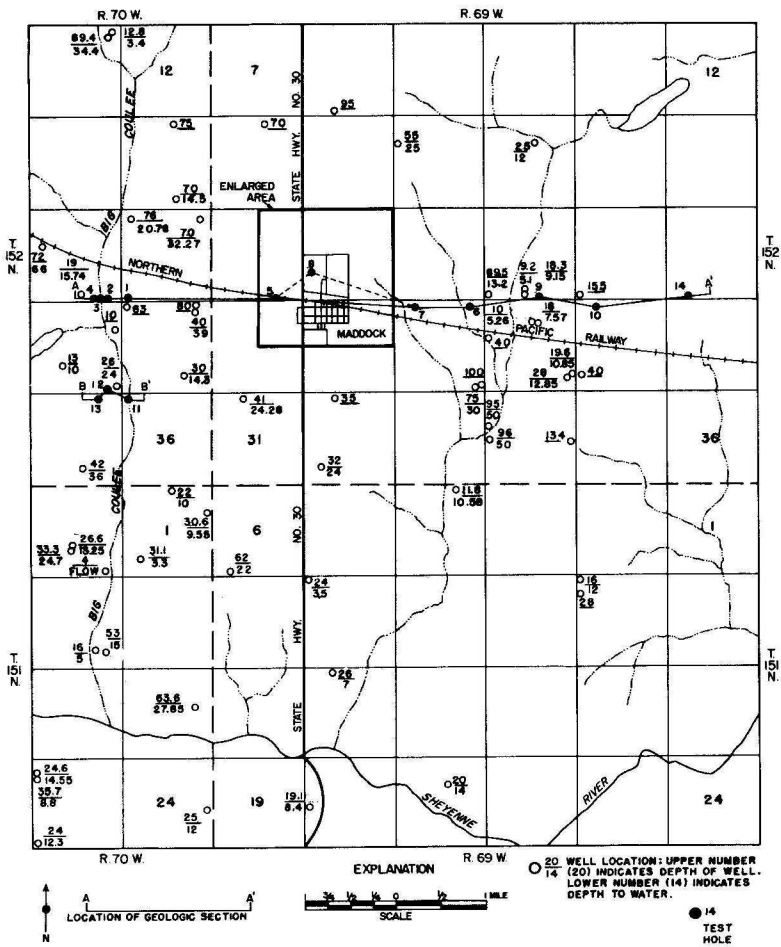
The average annual precipitation recorded at the United States Weather Bureau station at the Agricultural School in Maddock is 12.43 inches based upon data gathered during the period 1914 to 1959, and where the mean annual temperature during the same period was 40.0 degrees. Most of the precipitation falls during the growing season.

The topography of the Maddock area consists of gently rolling prairie dotted with potholes and small depressions. The surface rises gradually northward, and drainage is effected by two major streams that flow southward into the Sheyenne River, which in turn flows eastward through the southern part of the area.

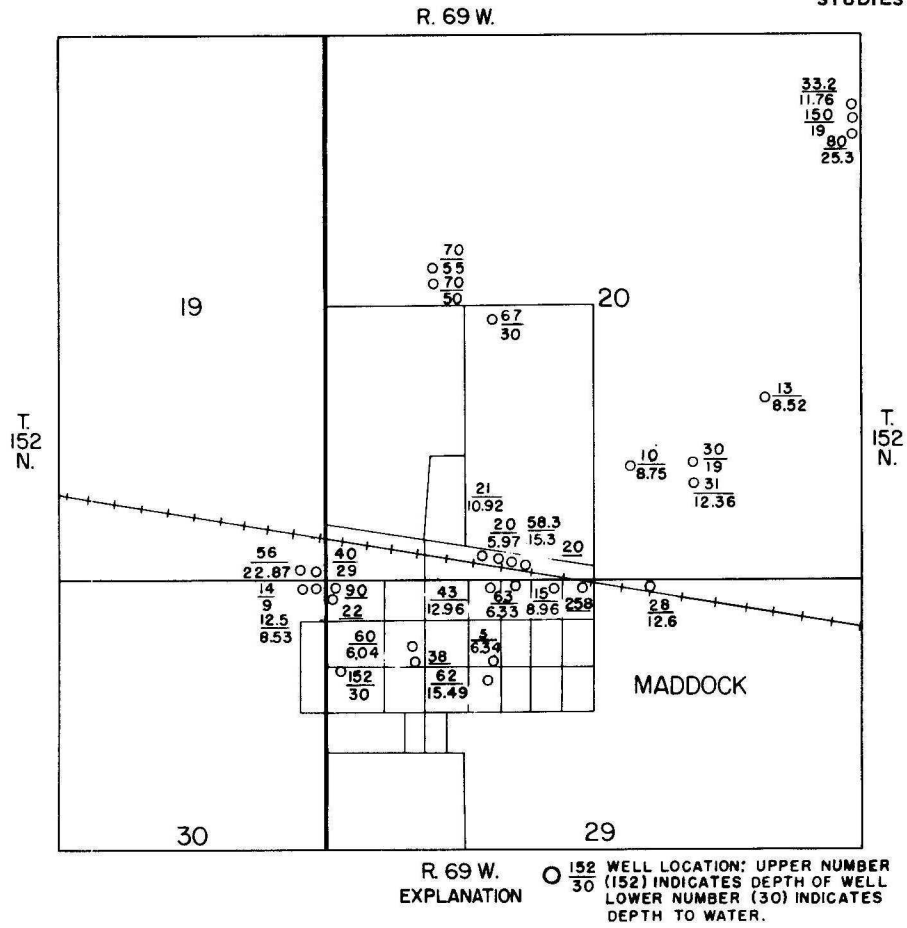
The surface deposits of the Maddock area consist of glacial drift in the form of ground moraines. Relief in the area is very moderate, generally only about 30 feet. The glaciated surface has been only slightly modified by stream erosion except where the Sheyenne River and its major tributaries have incised comparatively deep valleys. The glacial drift is composed largely of shale derived for the most part from the underlying Cretaceous formations. The tendency of this material to slump and creep when it becomes frost free has probably modified the hills to the extent of making their slopes more gentle than they were when originally formed. The thickness of the glacial drift deposits differs considerably throughout the area.



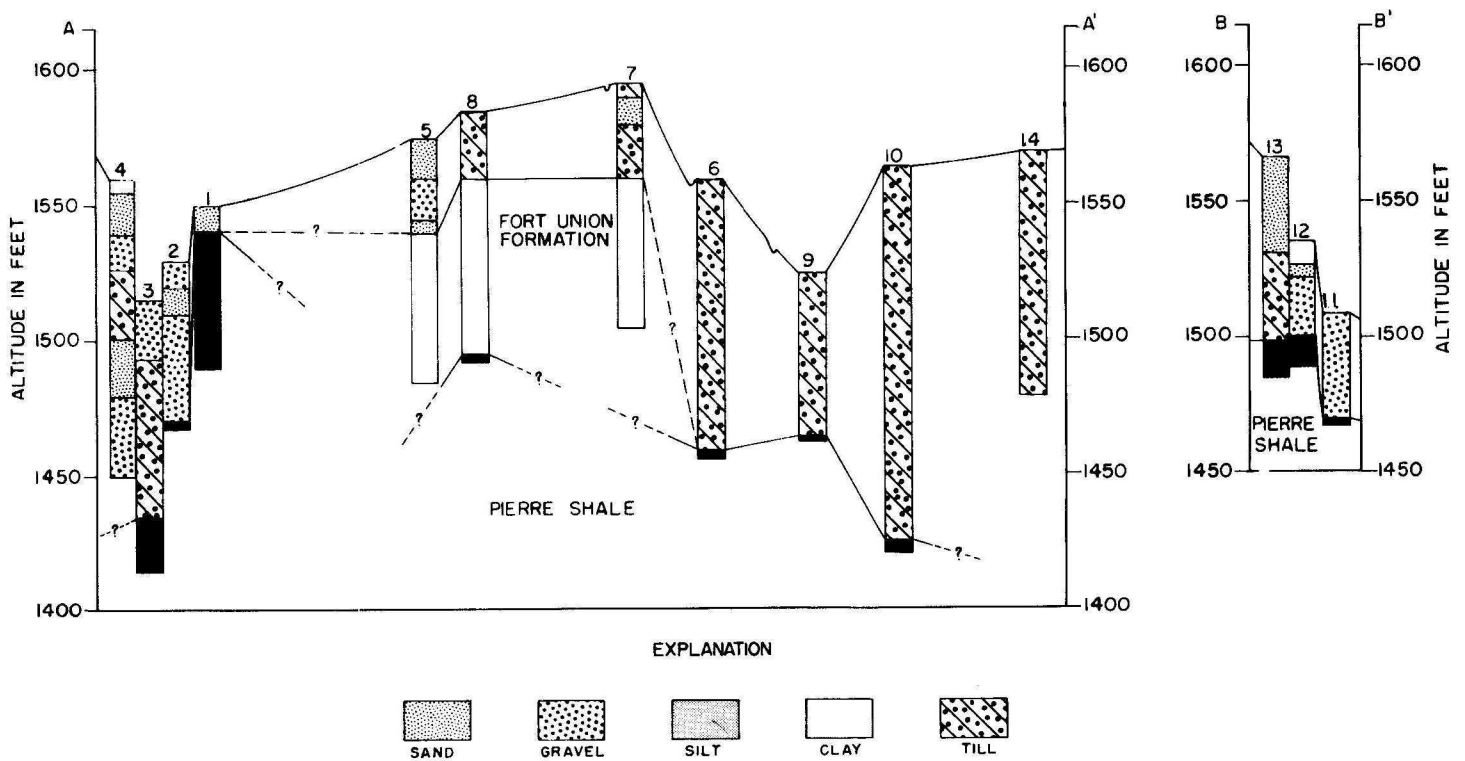
SOUTH-CENTRAL BENSON COUNTY, NORTH DAKOTA, SHOWING LOCATION OF THE MADDOCK AREA



MAP OF THE MADDOCK AREA SHOWING LOCATIONS OF TEST HOLES, WELLS, AND GEOLOGIC SECTIONS



ENLARGED AREA (4X) OF MADDOCK AND VICINITY (SHOWING LOCATIONS OF WELLS)



GEOLOGIC SECTIONS IN THE MADDOCK AREA

At the locations of the test holes (see fig. 7), the thickness of these deposits ranged from 25 feet to 139 feet and averaged 67 feet.

At the sites of test holes 7, 8, and 9 (see fig. 7), a formation believed to be the Fort Union of Paleocene age was penetrated directly beneath the deposits of glacial drift. The formation is composed of interbedded sand, gravel, clay and lignite, with clay the predominant constituent. One of these test holes is within the city limits of Maddock, one is east and one is west of the city. As the Fort Union (?) formation was not penetrated by test drilling in other parts of the area, it is believed that the city of Maddock is situated on an erosional remnant of that formation. Inasmuch as the test drilling pattern did not cover the entire report area, it is not known whether the Fort Union formation is present at other locations.

The Pierre shale constitutes the bedrock throughout the area, except for the small part where the Fort Union formation is believed to be present. At scattered points where it is exposed in road cuts, the Pierre shale is blue gray, poorly indurated, and has a pronounced rectangular cleavage which causes it to weather into blocks or sheets. Near the surface the shale is discolored by limonitic stains and tends to fade to gray. According to the log of the Shell Oil Company, Eilert Spidahl No. 1 oil-test hole (152-69-21ad), the thickness of the Pierre shale $1\frac{1}{2}$ miles north-east of Maddock is 850 feet (Carlson, 1955). As the Pierre shale is relatively impermeable, water-well drilling in the area customarily is terminated at its upper boundary.

The bulk of ground-water supplies in the Maddock area are obtained from sand and gravel within the glacial till or at the base of

the till and immediately above the Pierre shale. Aquifers of this type supply water in sufficient quantity for farm and domestic use except during periods of prolonged drought. Wells penetrating such deposits range in depth from about 12 to 250 feet. Larger supplies of ground water may be obtained from the alluvial gravel deposits of the Sheyenne River valley and the alluvial deposits in relatively deep tributary valleys. At some places sand and gravel lenses in the till are absent and drilling is continued to the top of the Pierre shale, where sandy layers may furnish moderate supplies of rather highly mineralized but soft water.

The most favorable location for a ground-water development for the city of Maddock is Big Coulee, approximately 2 miles west of the city. Test holes 2, 3, and 4 were drilled across Big Coulee and each hole penetrated alluvial deposits of sand and gravel. The respective thicknesses of sand and gravel at the sites of these test holes were 59 feet, 16 feet, and 79 feet.

In 1947 the city of Maddock contracted for the installation of a well in the vicinity of these test holes. In November of that year an aquifer test was made at the city well. Calculations based upon data gathered during the test indicated the coefficient of transmissibility to be 590,000 gallons per day per foot. This figure is very favorable for a sand and gravel deposit of this type and indicates that the aquifer is quite permeable and should yield water readily. This well has been the source of supply for the city of Maddock since 1947.

TABLE 11.--RECORDS OF WELLS AND TEST HOLES

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

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

Location No.	Owner or name	Depth (feet)	Diameter (inches)	Type	Date completed
<u>151-69</u>					
4aba	L. T. Lommen	11.8	30	Du	1936
6ccd	Ole Albertson	62	..	Dr	1916
8bbb	Orin Tweten	24	48	Du	....
11bbb	M. Shaffer	16	48	Du	1905
11bbc	J. R. Maddock	28	36	Du	1905
17bab	Henry Wisness	26	60	Du	1918
20cbb	Victor Hakanson	19.1	36	Du	1929
21acb	L. T. Lommen	20	48	Du	1896
<u>151-70</u>					
1abb	Phillip Stromberg	22	..	Du	....
1ada	Anton Fosson	30.6	48	Du	1930
1cca	Paul Wold	31.1	..	Du	1906
2cad1	Anton Green	33.3	..	Du	....
2cad2	Do	26.6	..	Du	....
2ddc	Mr. Iverson	4	..	Du	....
11ddb	N. Halvorson	53	4	Dr	....
11dca	Anton Berqoust	16	..	Du	1939
13adc	Erwin Petzke	63.6	..	Dr	....
23bbc1	Dahlstrom Bros.	24.6	30	Dr	....
23bbc2	Do	35.7	30	Dr	1937
23ccc	Roland Nelson	24	30	Dr	....
24daa	J. Hakanson	25	..	..	....

IN THE MADDOCK AREA, BENSON COUNTY

Date of measurement: Date given is date water level was measured for measured depths to water it is the date of report for reported depths to water.

Use of water: D, domestic; Ind, industrial, Irr. irrigation; N. none; PS public supply; RR, railroad; T, test hole;

Depth to water below land surface (feet)	Date of measurement	Use	Aquifer	Remarks
10.58	6-19-46	D,S	Sand	Water reported hard; potable but unfit for drinking.
22	S	Sand	Water reported hard.
3.5	D	Sand	Water reported to be of poor quality.
12	N	Sand	Water unfit for use.
....	D,S	....	Water potable but hard.
7	S	Sand	Water too hard for domestic use. Has high alkaline content.
8.4	S	Sand	Water reported hard, alkaline. Unfit for human consumption; quicksand 17-22 feet.
14	D,S	Sand	Water reported good.
10	D,S	....	Water reported hard.
9.55	S	Gravel	Water reported hard.
3.3	S	Sand	Do.
24.7	S	Gravel	Do.
13.25	N	....
Flow	S	....	Adequate supply.
15	S	Gravel	Do.
5	D,S	Sand	Water potable but hard.
27.85	S	Sand	Water reported hard.
14.55	D	Sand	Water reported soft.
8.8	D,S	....	Do.
12.3	S	....	Water reported hard; alkaline.
12	D	....	Water reported hard.

TABEL 11.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter (inches)	Type	Date completed
<u>152-69</u>					
8cdc	J. Pfeifer	95	4.5	Dr	....
15acb	A. O. Bakken	25	30	Du	....
16bcb	B. Hawkinsted	55	4	Dr	1921
18abb	P. Rangen	70	4	Dr	....
19cdc	Test hole 5	90	5	Dr	1946
19ddd1	Mrs. A. K. Gilbertson	40	24	Dr	1908
19ddd2	G. A. Neilson	56	15	Dr	1908
20aad1	A. O. Johnson	33.2	42	Du	1938
20aad2	Do	150	4	Dr	1914
20aad3	Do	80	30	Dr	1936
20bcd1	H. F. Legried	70	24	Dr	1930
20bcd2	Do	70	24	Dr	1930
20cab	R. Bergsgaard	67	..	Dr	1928
20cbc	Test hole 8	90	5	Dr	1946
20cdcl	Louis Bratvold	20	6	Dr	1939
20cdc2	Do	58.3	24	Dr	1931
20cdc3	City of Maddock	20	120	Du	1900
20cdc4	Herman Nelson	21	30	Dr	1907
20dac	E. B. Spidahl	13	30	Dr	....
20dca1	Agriculture School	30	72	Dr	1929
20dca2	Do	31	30	Dr	1913
20dcb	E. M. Speidahl	10	48	Du	....
22ccc	T. Tandeki	89.5	36	Dr	1929
22cdd1	Do	9.2	30	Du	....
22cdd2	Do	18.3	30	Du	....
22dcc	Test hole 9	61	5	Dr	1946
23ccc	William J. Maddock	155	2	Dr	1907
24ccd	Test hole 14	80	5	Dr	1946
26bba	Test hole 10	140	5	Dr	1946
26ccb	G. Ashford	40	5	Dr	1915
27acb1	Northern Pacific RR	18	120	Du	1905
27acb2	Morris Jacobson	10	30	Du	1936
27bcc	Do	40	36	Du	1940
27dda1	R. Scott	19.6	..	Du	....

IN THE MADDOCK AREA, BENSON COUNTY -- Continued

Depth to water below measure- land surface ment (feet)	Date of measure- ment	Use	Aquifer	Remarks
.....	.....	D,S	Sand	Water reported soft, inadequate for domestic use.
12	6-20-46	S	....	Water reported hard, inadequate for domestic use.
25	6-20-46	S	Sand	
.....	.....	D,S	Gravel	Water reported soft.
.....	.....	T	....	Hole refilled. See log.
29	6- 6-46	S	....	Water hard, unfit for domestic use.
22.87	6- 6-46	D,S	Sand, gravel	Water hard, inadequate supply.
11.76	6-21-46	S	Sand	Water unfit for human consumption.
19	6-21-46	N	Sand	Water reported hard.
25.3	6-21-46	D,S	Gravel	Do.
55	6-21-46	S	....	Water unfit for human consumption. See log.
50	6-21-46	S	....	Water reported salty.
30	6- 7-46	D,S	....	Water reported not very hard.
.....	.....	T	....	Hole refilled. See log.
.....	.....	D,S	....	See log.
15.3	6-19-46	S	....	Water unfit for drinking.
5.97	6- 5-46	PS	....	Water unfit for domestic use.
10.92	6- 5-46	D,S	Sand	Water reported hard.
8.52	6- 5-46	D	....
19	6- 5-46	PS	Sand	Water reported hard.
12.36	6- 5-46	PS	Sand	Do.
8.75	6-19-46	S	Sand	Water unfit for drinking.
13.2	6-19-46	S	Clay	Water reported very hard.
5.1	6-19-46	N	Sand	Water reported hard.
9.15	6-19-46	S	....	Do.
.....	.....	T	....	Hole refilled. See log.
.....	5- 5-46	D,S	....	Flowing well. Yields 1.7 gpm. See log.
.....	.....	T	....	Hole refilled. See log.
.....	.....	T	....	Do.
.....	.....	D,S	Sand, gravel	Water reported hard but potable.
7.57	5-16-46	RR	Gravel	Gravel reported to bottom.
5.26	5-16-46	S	Sand	Gravel and sand reported from 20 to 10 feet.
.....	.....	S	....	Two feet of topsoil, 38 feet of till. Water poor
10.85	6-19-46	S	Gravel	Water reported hard, unfit for drinking.

TABLE 11.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter (inches)	Type	Date completed
<u>152-69 - Continued</u>					
27dda2	Do	28	30	Du	....
28aab	Test hole 6	99	5	Dr	1946
28bba	Test hole 7	91	5	Dr	1946
28ddd1	H. Sundet	75	24	Dr	1925
28ddd2	Do	100	6	Dr	1920
29abb	I. Johnson	28	36	Du	1926
29baa1	Maddock School	258	5	Dr	1918
29baa2	J. H. Johnson	15	46	Du	1940
29bab1	Maddock School	63	30	Dr	1922
29bab2	Do	43	5	Dr	1918
29bac1	Mrs. Anna A. Olson	15	42	Du	1930
29bac2	C. O. Christianson	62	18	Dr	....
29bbb1	C. T. Madsen	90	24	Dr	1915
29bbb2	Do	22	36	Du	1915
29bbc	Herman Rice	152	4	Dr	1913
29bbd1	C. O. Christianson	60	12	Dr	1920
29bbd2	V. Johnson	38	..	Dr	1938
29bdd1	C. Westby	56	42	Du	1940
29bdd2	Do	214	6	Dr	1940
29bdd3	Do	60	48	Du	1916
30aaa1	S. R. Swenson	14	48	Du	1900
30aaa2	Do	12.5	42	Du	1910
31bab	Herman Rice	41	42	Du	1930
32bab	Leo Spriggs	35	24	Dr	1900
32cca	M. Knottarud	32	12	Dr	1928
34bcc	A. C. Sundet	95	6	Dr	1928
34cbb	Do	96	6	Dr	1922
34daa	Melvin Hagen	134	3	Dr	1941

IN THE MADDOCK AREA, BENSON COUNTY -- Continued

Depth to water below land surface (feet)	Date of measure- ment	Use	Aquifer	Remarks
12.85	6-19-46	D,S	Gravel	Water potable but too hard for wash- ing clothes.
.....	.....	T	....	Hole refilled. See log.
.....	.....	T	....	Do.
30	6-19-46	S	Sand	Water unfit for domestic use.
.....	.....	D	Sand	Water reported soft, potable
12.6	6-19-46	D,S	Sand	Water reported soft.
.....	.....	N	....	Dry test hole; drilled in shale most of way
8.96	6- 6-46	N	Sand	Water unfit for drinking.
6.33	6- 5-46	PS	Sand	Do.
12.96	6- 5-46	N	....	Water supply inadequate but good quality.
6.34	6- 7-46	S	....	Water unfit for domestic use.
15.49	6- 5-46	Irr	....	Water used for watering garden.
.....	.....	N	Sand	Water supply inadequate. Blue clay from surface to 90 feet, a little sand at 90 feet
.....	.....	Ind	Gravel	Water reported hard.
30	6- 5-46	D	....	Water reported soft.
6.04	6- 5-46	N	....
.....	.....	D	....	Water reported hard.
.....	.....	S	Gravel	Water reported alkaline.
.....	.....	N	....	Test hole, blue clay and till to bottom.
46.14	6-21-46	S	Sand	Water unfit for domestic use.
9	6- 6-46	S	....	Water unfit for drinking, and quite hard.
8.53	6- 6-46	S	....	Do.
24.28	6- 5-46	S	Sand	Water reported good quality.
.....	.....	D,S	Sand	Do.
24	6- 19-46	D,S	Sand	
50	6-19-46	D,S	Sand	Water reported soft.
50	6-19-46	D,S	Sand	Do.
.....	.....	D,S	Shale	Water reported hard.

TABLE 11.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter (inches)	Type	Date completed
<u>152-70</u>					
11aal	C. Backstrom	12.8	..	Du	....
11aa2	Do	89.4	..	Dr	....
13abb	Harry Hetler	75	3	Dr	....
13dc	T. T. Sabie	72	24	Dr	1920
23bc	J. M. Hellesvig	72	24	Dr	1929
23dcc	Ed Foss	19	24	Du	1935
23dcd1	Test hole 3	100	5	Dr	1946
23dcd2	Test hole 4	120	5	Dr	1946
23ddc	Test hole 2	61	5	Dr	1946
24aa	P. Backstrom	70	6	Dr	....
24bb	L. Hoberg	76	24	Dr	....
24ccc	Test hole 1	60	5	Dr	1946
25aab1	Jens Neilson	80	6	Dr	1928
25aab2	Do	40	48	Du	1928
25bbb	City of Maddock	63	10	Dr	1947
25dca	Ed Westby	30	18	Dr	1900
26ada	J. G. Georgeson	10	1.5	Dv	1939
26cac	P. A. Sorlie	13	1.25	Dv	1916
26ddd	B. Benson	26	36	Du	1936
26ddc	Test hole 12	47	5	Dr	1946
35aba	Test hole 13	81	5	Dr	1946
35dcb	A. Johansen	42	24	Dr	....
26bbb	Test hole 11	41	5	Dr	1946

IN THE MADDOCK AREA, BENSON COUNTY -- Continued

Depth to water below land surface (feet)	Date of measure- ment	Use	Aquifer	Remarks
3.4	.....	D	Shale	
34.4	.....	D,S	....	Water reported soft.
.....	.....	S	Gravel	Water reported salty.
14.5	6-20-46	D,S	Sand	Water reported hard.
66	6-20-46	D,S	Sand	Do
15.74	6-5-46	D,S	Sand	
.....	.....	T	....	Hole refilled. See log.
.....	.....	T	....	Do.
.....	.....	T	....	Hole refilled. See log.
32.27	6-20-46	D,S	....	Water reported soft.
20.78	6-20-46	D,S	Sand	Do.
.....	.....	T	....	Hole refilled. See log.
.....	.....	D,S	Sand	Water reported too hard for washing clothes.
39	6-21-46	S	....	Do.
.....	.....	PS	....
14.3	6-6-46	S	Gravel	Water reported hard.
.....	.....	D,S	Gravel	Gravel from surface down to 9 feet.
10	6-20-46	D,S	Sand, gravel	Water reported soft. Sand and gravel to bottom.
24	6-20-46	D,S	Gravel	Do.
.....	.....	T	....	Hole refilled. See log.
.....	.....	T	....	Do.
36	6-20-46	D,S	....	Water reported hard. See log.
.....	.....	T	....	Hole refilled. See log.

TABLE 12.--LOGS OF TEST HOLES IN THE MADDOCK AREA, BENSON COUNTY

152-69-19dcd
Test hole 5

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Sand, fine to medium, clayey brown.....	15	15
	Gravel, fine to medium, and shale pebbles...	15	30
	Sand, fine, angular, gypsiferous, clayey, brown.....	5	35
Fort Union formation			
	Sand, fine, gypsiferous, clayey, gray.....	55	90

152-69-20cbc
Test hole 8

Till and associated sand and gravel deposits			
	Clay, very sandy, yellow, and fine to medium gravel.....	9	9
	Clay, sandy, gray, and fine to medium gravel and shale pebbles.....	16	25
Fort Union formation			
	Sand, fine, angular, gypsiferous, light-gray	65	90
Pierre shale			
	Shale, gray.....	2	92

152-69-22dcc
Test hole 9

Till and associated sand and gravel deposits			
	Clay, silty, yellow, and fine to medium gravel	10	10
	Clay, sandy, gray, and fine to medium gravel and shale pebbles.....	50	60
Pierre shale			
	Shale, gray.....	1	61

152-69-24ccd
Test hole 14

Till and associated sand and gravel deposits			
	Clay, silty, yellow and fine to medium gravel.....	7	7
	Clay, sandy, gray, and fine to medium gravel	83	90

TABLE 12.--LOGS OF TEST HOLES IN THE MADDOCK AREA
BENSON COUNTY -- Continued

152-69-26bba
Test hole 10

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Clay, silty, yellow, and fine gravel.....	11	11
	Clay, sandy, gray and fine to medium gravel, and shale pebbles.....	128	139
Pierre shale	Shale, gray.....	5	144

152-69-28aab
Test hole 6

Till and associated sand and gravel deposits			
	Clay, silty, yellow, and fine gravel.....	10	10
	Clay, sandy, gray and fine to medium gravel and shale pebbles.....	90	100
Pierre shale	Shale, gray.....	4	104

152-69-28bba
Test hole 7

Till and associated sand and gravel deposits			
	Clay, silty, light-gray, and fine gravel highly calcareous.....	5	5
	Sand, poorly sorted, silty, brown.....	10	15
	Clay, sandy, gray, and fine gravel.....	20	35
Fort Union formation	Sand, fine, angular, gypsiferous, gray.....	55	90

152-70-23dcd1
Test hole 3

Till and associated sand and gravel deposits			
	Topsail, silty, light-brown.....	5	5
	Gravel, fine, fairly well sorted, clayey, gray.....	16	21
	Clay, light-gray, and fine to medium gravel and shale pebbles.....	59	80
Pierre shale	Shale, gray.....	20	100

TABLE 12.--LOGS OF TEST HOLES IN THE MADDOCK AREA
BENSON COUNTY -- Continued

		152-70-23dcd2 Test hole 4	
<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Clay, light-gray.....	5	5
	Sand, medium to coarse, brown.....	5	10
	Sand, coarse, and fine gravel, and the coarser fraction consists of shale fragments	10	20
	Gravel, very coarse, clayey, brown.....	7	27
	Gravel, fine, and coarse sand, light-brown...	6	33
	Clay, silty, light-brown and fine gravel.....	7	40
	Clay, silty, gray and fine gravel.....	19	59
	Sand, fine to medium, gray.....	21	80
	Gravel, fine to medium gray.....	30	110
152-70-23ddc Test hole 2			
Till and associated sand and gravel deposits			
	Gravel, poorly sorted, clayey, brown.....	10	10
	Sand, medium to coarse, brown.....	10	20
	Gravel, fine to medium, brown.....	10	30
	Gravel, medium to coarse, brown.....	29	59
Pierre shale	Shale, gray.....	2	61
152-70-24ccc Test hole 1			
Till and associated sand and gravel deposits			
	Sand, medium to coarse, brown.....	9	9
Pierre shale	Shale, gray.....	51	60
152-70-26ddc Test hole 12			
Till and associated sand and gravel deposits			
	Clay, sandy, brown.....	9	9
	Sand, fine to medium, brown.....	5	14
	Gravel, well sorted, angular, clean, brown...	21	35
Pierre shale	Shale, gray.....	12	47

TABLE 12.--LOGS OF TEST HOLES IN THE MADDOCK AREA
 BENSON COUNTY -- Continued

152-70-35aha
 Test hole 13

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Sand, medium, silty, brown.....	20	20
	Sand, medium, and fine gravel, and the coarser fraction consists of shale..... fragments.....	15	35
	Clay, silty, gray, and fine to medium gravel, and shale pebbles.....	33	68
Pierre shale			
	Shale, gray.....	13	81

152-70-36bbb
 Test hole 11

Till and associated sand and gravel deposits			
	Topsoil, silty, gray, and fine gravel.....	5	5
	Gravel, coarse, sandy, brown.....	34	39
Pierre shale			
	Shale, gray.....	2	41

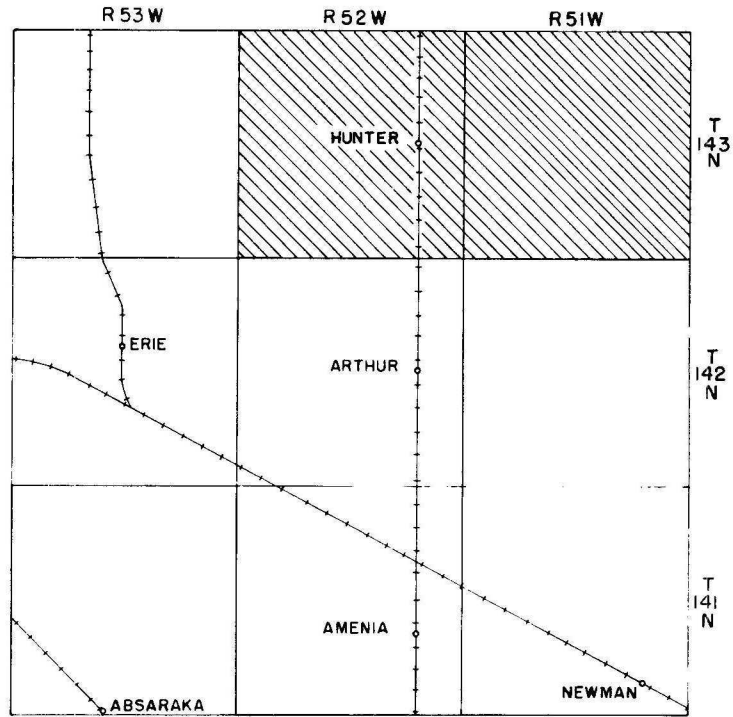
Hunter Area, Cass County

The Hunter area is in the north-central part of Cass County in southeastern North Dakota. It is a part of the Western Young Drift section of the Central Lowland Province of Fenneman (1938, p. 559) and is in the Red River Valley area as designated by Simpson (1929, p. 4). The area studied during the investigation totals 72 square miles and includes; all of T. 153 N, Rs. 51 and 52 W.

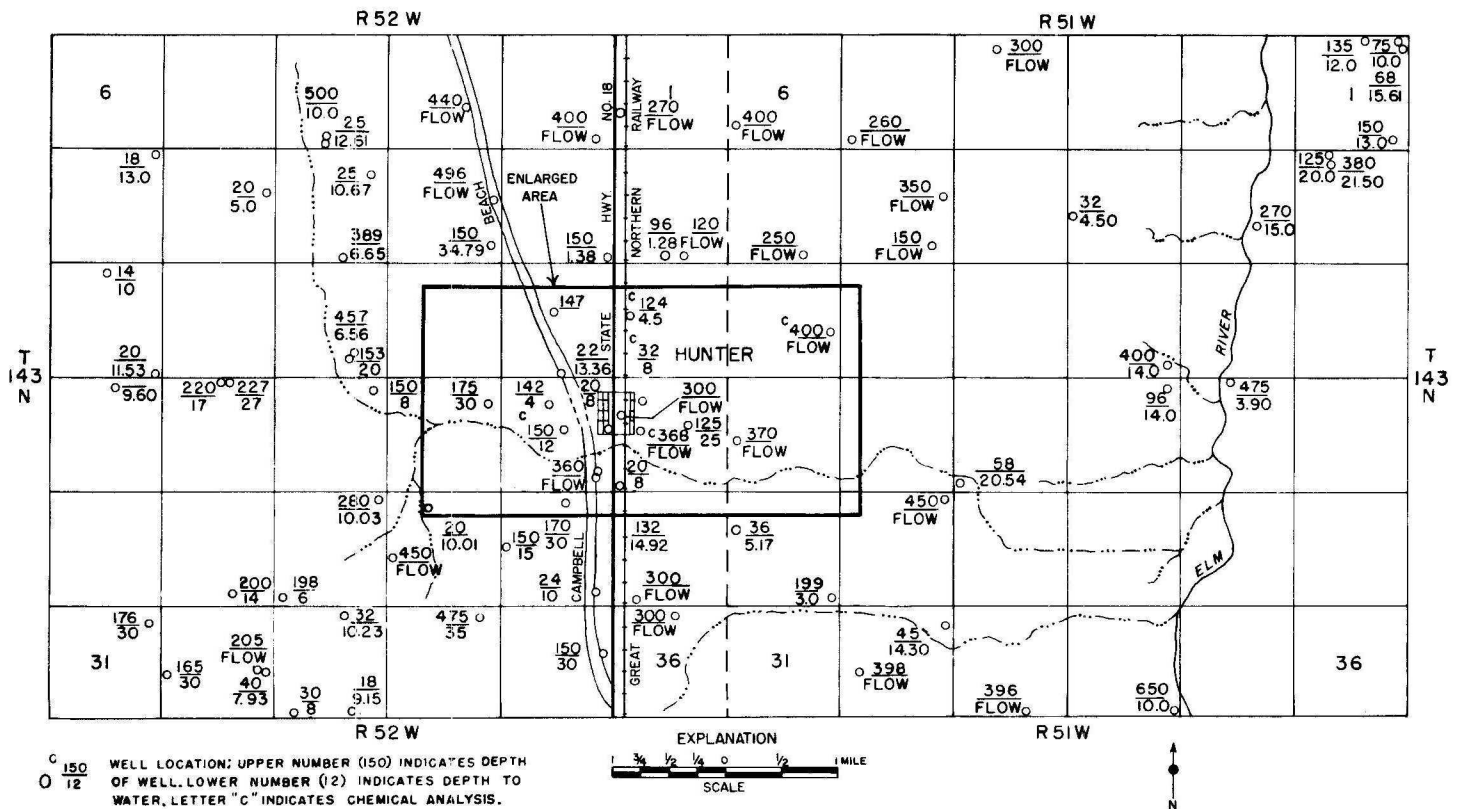
The average annual precipitation recorded at the United States Weather Bureau station at Hillsboro, approximately 17 miles northeast of Hunter is 20.56 inches based upon data gathered during the period 1905 to 1959. The mean annual temperature for the same period was 41.7 degrees.

The Red River Valley is a broad flat glacial-lake plain formerly occupied by glacial Lake Agassiz. In the vicinity of the city of Hunter the plain is flat. The only topographic features worthy of note are beach ridges and the shallow valley of an intermittent stream. The two most prominent beach ridges, Campbell and McCauleyville, trend in a northwest-southeast direction and mark intermediate stages of Lake Agassiz. The Herman Beach, which marks the highest stage reached by Lake Agassiz, is approximately 10 miles west of Hunter.

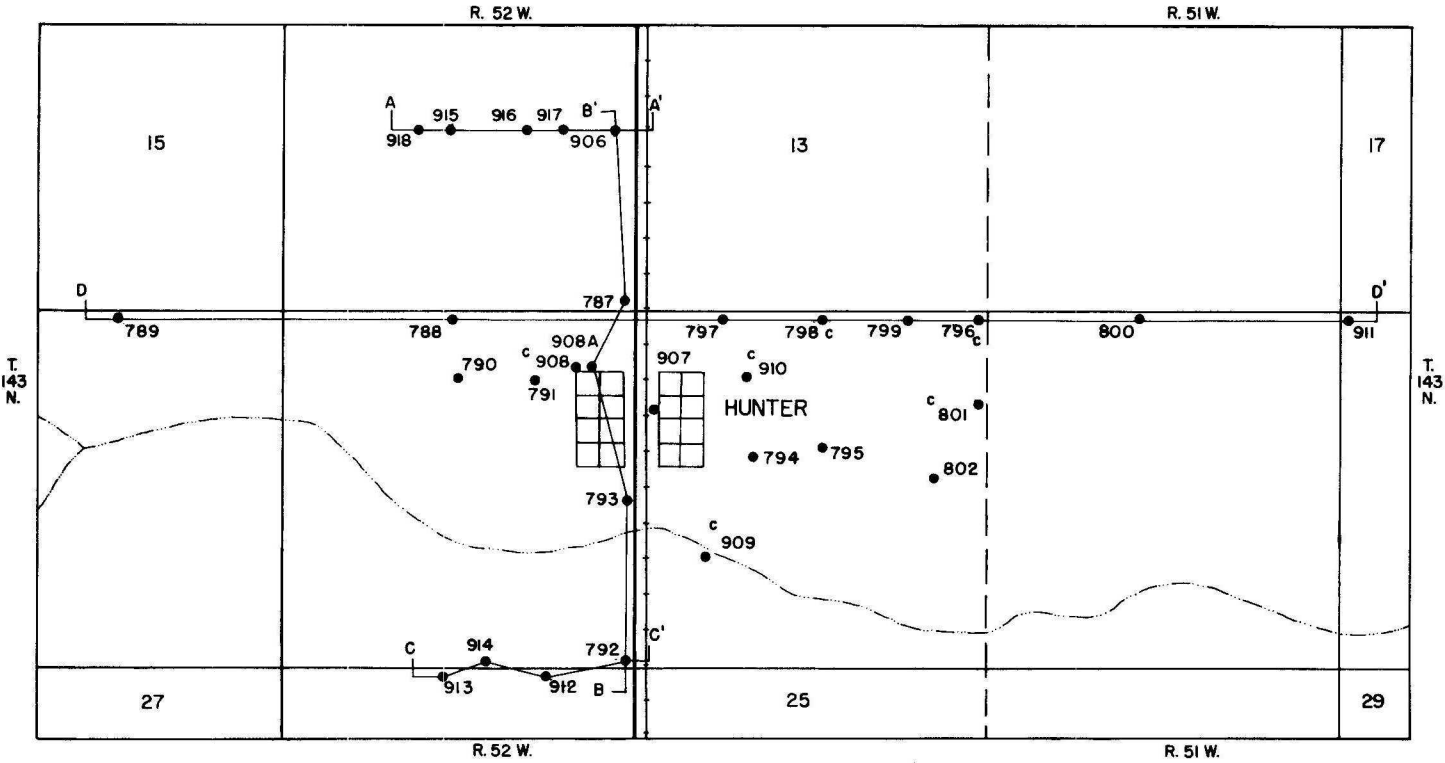
The surface deposits in the Hunter area are composed almost entirely of lake clay and silt. In the small part of the surface area occupied by beach ridges, surface deposits consist of fine silty sand. In the test holes drilled in the area, the thickness of the clay and silt deposits ranged from 3 feet to 94 feet and averaged 49 feet. A thin veneer of clay and silt deposits covers the surface at all test hole locations. At some locations the clay and silt extend to considerable depth, as in test



NORTH-CENTRAL CASS COUNTY, NORTH DAKOTA, SHOWING LOCATION OF THE HUNTER AREA

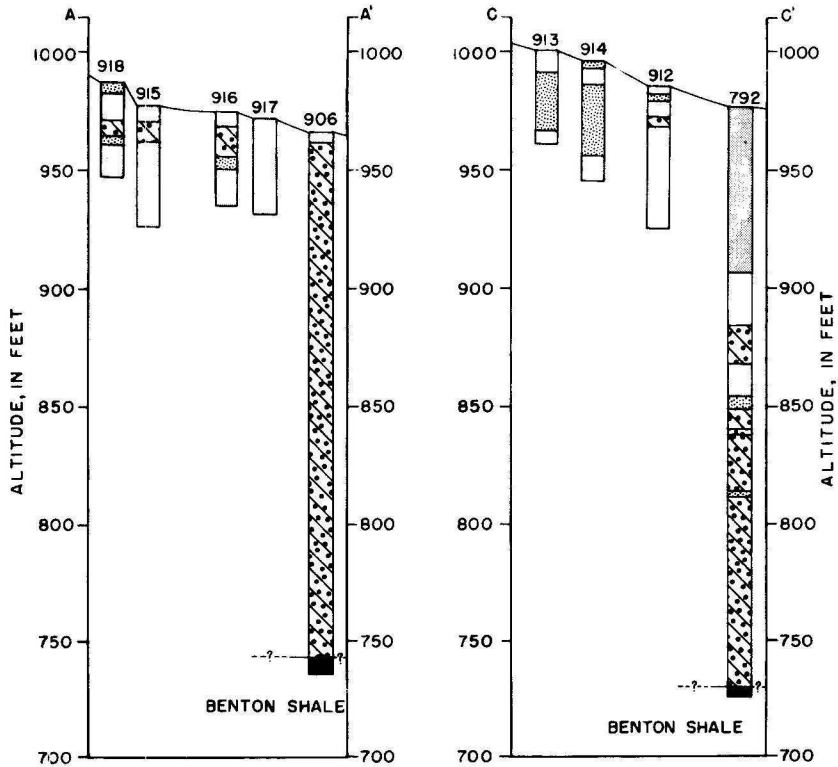


MAP OF THE HUNTER AREA SHOWING LOCATIONS OF WELLS

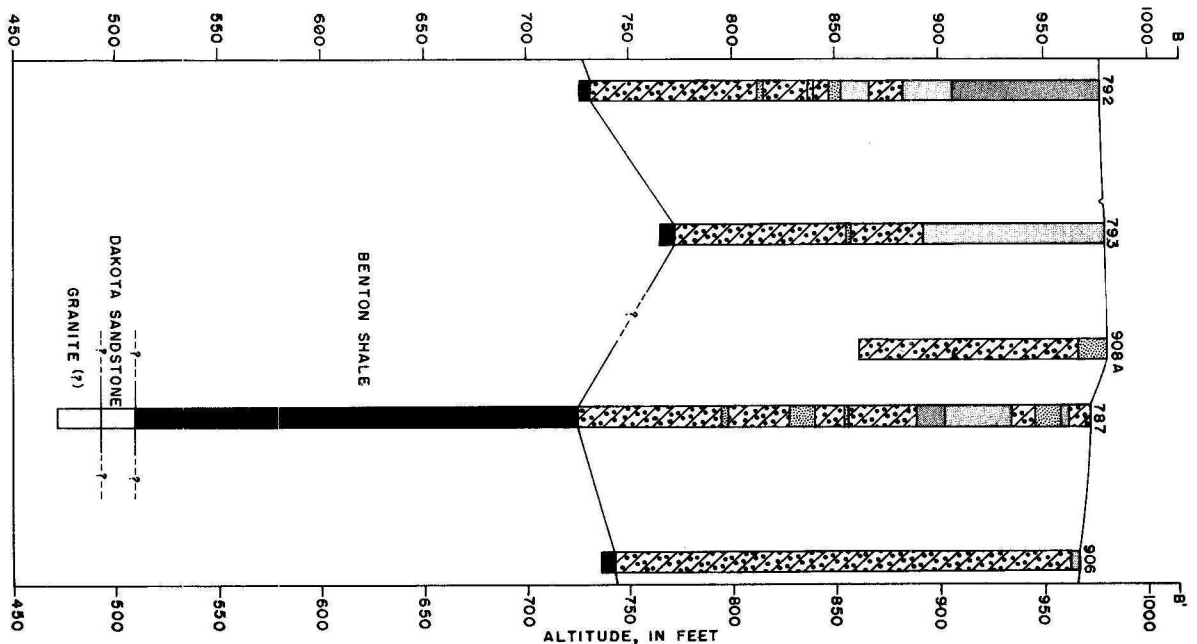
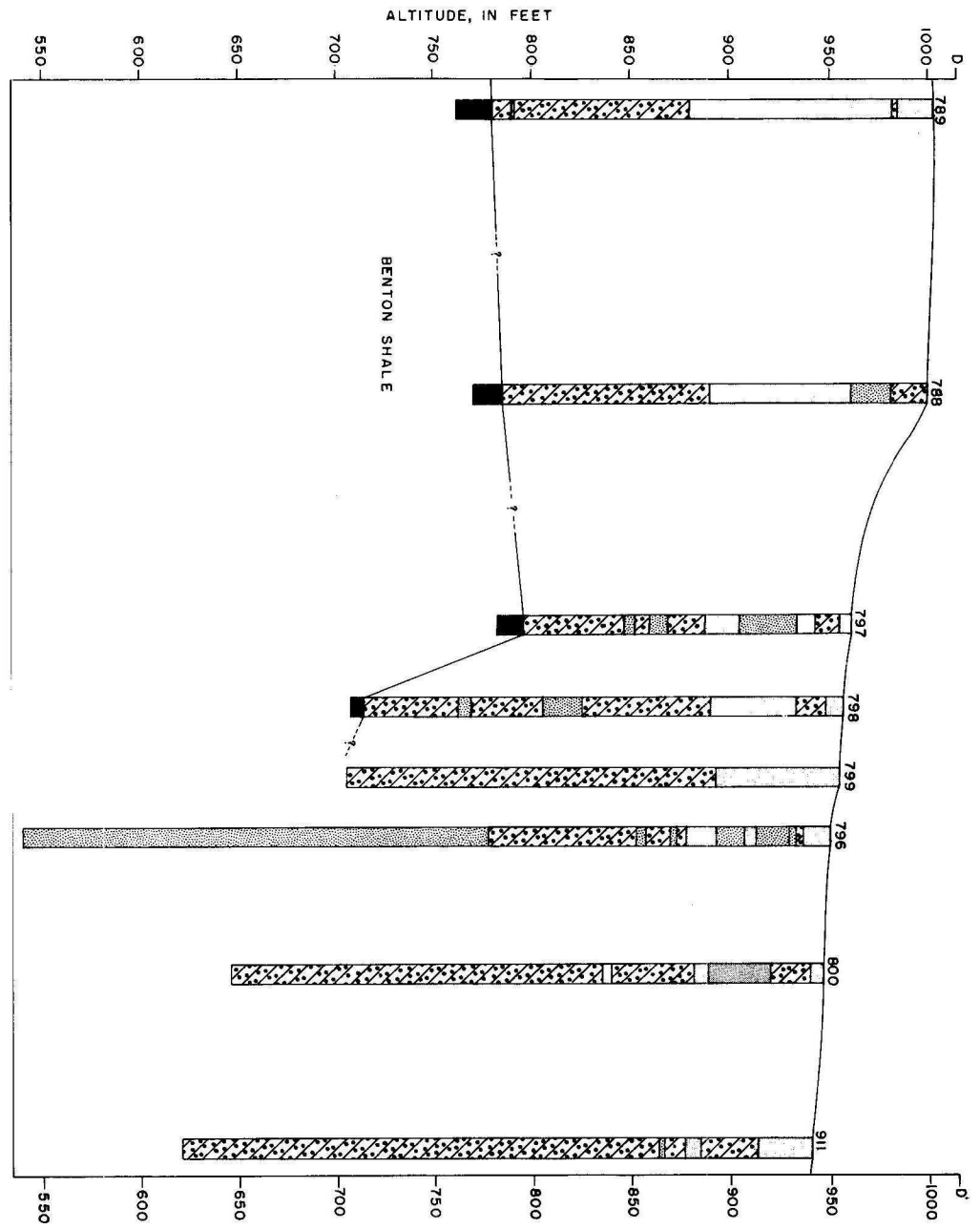


EXPLANATION
 A A' C 909 TEST HOLE: LETTER "C" INDICATES
 LOCATION OF GEOLOGIC SECTION CHEMICAL ANALYSIS.

ENLARGED AREA (3X) OF HUNTER AND VICINITY
 (SHOWING LOCATIONS OF TEST HOLES AND GEOLOGIC SECTIONS)



NORTH DAKOTA GROUND WATER STUDIES NO. 28
FIGURE 9C



EXPLANATION



GEOLOGIC SECTIONS IN THE HUNTER AREA

hole 792 (see fig. 8), where the drill penetrated 163 feet of clay and silt before passing into glacial till. At test hole 789, 18 feet of clay was penetrated at the surface; below this the drill penetrated 2 feet of till, 102 feet of lake clay and silt, and then glacial till again. A total of 13 test holes (see table 15) penetrated two distinct clay and silt units which were separated by deposits of glacial till. These facts indicate that a glacial lake existed in the Red River Valley prior to Lake Agassiz. No oxidized zone was observed in cuttings from the lower till. It is probably, therefore that the area was ice free for only a short time prior to the formation of the older lake. It would be difficult in view of the evidence at hand to place these events precisely in geologic time. The older lake may have been formed prior to the Mankato substage of the Wisconsin stage of Pleistocene glaciation.

The Benton shale of Cretaceous age is present in parts of the area. Eleven test holes (see table 15) were drilled through the glacial drift and into the shale. One test hole, 787, was drilled completely through the shale which was 215 feet thick at that location (143-52-14ddd). The Benton is a grayish-black poorly indurated shale containing numerous shells and shell fragments. When dry the shale splits along very thin bedding planes that are separated by a film of calcareous material.

An examination of the cross sections along section D-D' (see fig. 8) reveals the presence of a valley in the Benton shale. Proceeding along the section from west to east, the shale is present in test holes 789, 788, 787, 797 and 798, but is absent in test holes 799 and 796. Test hole 796 was drilled to a depth of 410 feet and penetrated what is apparently valley alluvium in the form of poorly sorted sand between the depths of

185 feet and 410 feet. The thick deposit of sand occurs below the bottom of the older till. In view of this fact and the fact that pre-Pleistocene deposits of Tertiary age do not occur in eastern North Dakota, it is possible that this valley carried a considerable volume of water during pre-Pleistocene time or during the Pleistocene epoch prior to the Wisconsin stage of glaciation.

The Dakota Sandstone underlies the Benton shale at the site of test hole 787. At this location (143-52-14ddd), the formation is 17 feet in thickness and is composed of well-rounded grains of fine to medium white quartzose sand. Records of wells and quality of water studies indicate that the Dakota sandstone is probably present in a major part if not all of the report area.

A deposit of white kaolinitic clay was reached in test hole 787 at a depth of 478 feet below land surface. Drilling was continued in this material for 22 feet to a depth of 500 feet. It is possible that the kaolinitic clay represents weathered granite and it is probably that this material underlies the entire report area.

The majority of wells in the Hunter area draw their supplies from sand and gravel deposits of glacial drift. Some of these deposits may be in the form of sand and gravel lenses, but usually they are sandy and/or gravelly zones within the glacial till. Ground water obtained from the drift aquifers is ordinarily limited in quantity and is hard. Generally it is adequate for farm and domestic use. Wells of this type range in depth from 10 to 250 feet.

Where it is not possible to obtain a suitable supply of water from the glacial drift, drilling is continued to the Dakota sandstone in an attempt to obtain a flowing well. Flowing wells are scattered throughout

the report area and range in depth from 300 to 500 feet. The shallow flowing wells from the glacial drift probably derive their hydrostatic head from the Dakota sandstone at locations where the Benton shale is absent and the drift deposits are permeable. Water from all flowing wells sampled in the area exhibited the qualitative characteristics associated with water from the Dakota sandstone. Water derived from this aquifer in North Dakota has a high sodium, bicarbonate, sulfate, chloride, and total dissolved solids content. This water is generally used only for laundry and stock watering.

Flouride in concentrations of about 1.0 ppm in water drunk by children is generally believed to be beneficial in the reduction of tooth decay. Concentrations in excess of 1.5 ppm may cause mottling of tooth enamel (Dean, H. T., 1936). Water from two test holes sampled in the Hunter area contained more than the recommended maximum concentration of 1.5 ppm of fluoride and, according to U. S. Public Health Service Drinking Water Standards (1946), would be undesirable for consumption by children. Nitrate concentrations in excess of that recommended safe for infant feeding (Maxcy, Kenneth F., 1950) were exceeded in water from two wells in the Hunter area.

The best source of ground water in the Hunter area is the extensive sand deposit penetrated by test hole 796 (143-52-24aaa). When this deposit was penetrated the test hole began to flow at an estimated rate of 25 gpm. The Benton shale is absent at this location and the water unfortunately exhibits the poor chemical quality associated with waters from the Dakota sandstone. The pressure head that results in flowing wells at this location is due to upward leakage of water from the Dakota sandstone.

In the Hunter area the Benton shale and the kaolinitic clay do not yield water to wells and are not considered to be aquifers.

There are a number of beach ridges in the Hunter area but only one, the Campbell Beach, is a conspicuous topographic feature. A test hole section was drilled across this beach about a mile northwest of Hunter. Examination of the cuttings revealed that the beach consists largely of clay, silt, and very fine sand. Because of the predominance of clay and silt in the beach materials, it is doubtful that they would yield large quantities of water.

TABLE 13.--CHEMICAL ANALYSES OF GROUND WATER

Analyses by State Laboratories, Bismarck, N. Dak.
Results in parts per million

Location No.	Owner or name	Aquifer	Depth of well (feet)	Date of collection	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
<u>143-51</u>								
18daa	B. R. Holes Sr.	Sand	400	10-22-53	.5	20	20	1,180
<u>143-52</u>								
13bcc	L. O. Lane	Sand	124	10-22-53	.6	95	43	162
23aacl	Test hole 908	Sand	40	12- 9-54	...	61	29	92
23acc	Art Rasmussen	Sand	150	10-22-53	.6	60	31	122
24aaa	Test hole 796 <u>1/</u>	Sand	200	1-13-54	.5	40	17	940
Do	Do	Sand	410	1-13-54	.6	34	17	940
24abb	Test hole 798	Sand	250	1-26-54	...	133	58	700
		and gravel						
24ada	Test hole 801	Sand	300	1-13-54	...	73	25	780
24bac	Test hole 910	Sand	120	12- 9-54	.2	74	82	100
24bcd	Hunter Creamery	Sand	364	10-22-53	.4	80	28	1,080
24bbd	B. R. Holes Jr.	Sand	32	10-22-53	.4	274	206	58
24cbd	Test hole 909	Gravel	120	12- 9-54	.3	165	110	52

1/ Two samples taken from test hole 796

IN THE HUNTER AREA, CASS COUNTY

Potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Dissolved solids	Hardness as CaCO ₃	Percent sodium
16	295	...	1,330	761	2.5	39	3,520	133	94
7.8	266	...	168	184	...	2	790	415	45
7	306	8	115	53	.6	7	520	272	42
6	223	...	123	112	...	25	590	274	48
25	311	11	1,060	775	2.2	1.7	3,030	171	91
25	319	19	1,070	636	3.2	2.1	2,900	157	92
20	269	10	583	634	.7	13	2,280	570	72
35	285	...	1,350	733	2	1.8	3,140	284	84
7	229	17	419	39	.5	6	860	522	29
29	217	14	1,340	736	1.3	63	3,500	317	87
9.2	403	...	806	23	...	58	1,630	582	8
9.5	230	...	430	34	.2	...	910	865	11

TABLE 14.--RECORDS OF WELLS AND TEST HOLES

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

Type: Dr, drilled; Du, dug

Location No.	Owner or name	Depth (feet)	Diameter or size (inches)	Type	Date completed
<u>143-51</u>					
1aaa1	Dean Ecker	75	4	Dr	....
1aaa2	Do	68	4	Dr	....
1abb	R. K. Rosenau	135	3	Dr	....
1ddd	L. G. Rodebough	150	4	Dr	....
4bab	Conrad Greisbach	300	3	Dr	....
5ccc	N. M. Pickett	260	3	Dr	1920
6ccb	K. Dickson	400	2	Dr	....
7dcd	C. D. McAuley	250	3	Dr	....
8add	Peter Griestbak	350	3	Dr	....
8ddb	Mrs. Glenda Anderson	150	3	Dr	....
10cbb	Fred Hanson	32	4	Dr	1920
11dbd	Haugen Bros.	270	3	Dr	....
12bab1	Ole Graalum	125	4	Dr	1952
12bab2	Do	380	3	Dr	1915
15ddd	Curtiss Freeman	400	3	Dr	....
18daa	B. R. Holes Sr.	400	3	Dr	....
19baa	Test hole 800	300	5	Dr	10-3-53
19cbb	Murray Baldwin	370	4	Dr	1940
20bbb	Test hole 911	318	5	Dr	6-18-54
21ccc	Christ Hanson	58	48	Dr	....
22aad	Peter Holtse	96	3	Dr	1935
23baa	Gust Johnson	475	2	Dr	....
29aaa	Thomas Buchanan	450	2	Dr	1924
30bcb	A. Otteson	36	60 x 60	Du	....
30ddd	M. J. Lien	199	2	Dr	1948
32aad	Harvey Madsen	45	36 x 36	Du	....
32cba	Lewis Sutton	398	2	Dr	1949
33dcc	E. E. Simonson	396	3	Dr	....
34ddd	W. V. Gathany	650	4	Dr	....

IN THE HUNTER AREA, CASS COUNTY

Date of measurement: Date given is date measured for measured depths to water; it is the date of report for reported depths to water.

Use of water: D, domestic; Ind, industrial; N, none; PS, public supply; S, stock T, test hole

Depth to water below land surface (feet)	Date of measurement	Aquifer	Temperature °F	Altitude (feet)	Use	Remarks
10.0	7- 8-53	Sand	41	.....	D	
15.61	7- 8-53	Sand	41	.....	S	
12.0	7- 8-53	Sand	...	.....	D,S	
13.0	7- 8-53	Sand	41	.....	D,S	
Flow	7- 8-53	Sand	...	.....	S	
Do	6-26-53	Sand	41	.....	D	
Do	6-26-53	....	43	.....	D,S	Salty taste.
Do	6-25-53	....	40	.....	D,S	Do.
Do	6-24-53	....	...	.....	S	Do.
Do	6-24-53	....	...	.....	D,S	Do.
4.50	7- 8-53	....	42	.....	S	Water very hard.
15.0	7- 8-53	....	40	.....	D,S	
20.0	7- 8-53	Sand	41	.....	D,S	
21.50	7- 8-53	....	...	.....	N	Well caved at 60 feet.
14.0	7- 8-53	....	41	.....	D,S	Water has slightly salty taste. See chemical analysis
Flow	6-23-53	....	42	.....	D,S	Water very salty taste.
....	.....	....	...	947	T	Hole refilled. See log.
Flow	7- 2-53	....	44	.....	D,S	Water soft, salty, forms rust.
....	6-18-54	....	...	.941	T	Hole refilled, See log.
20.54	7- 8-53	....	...	.....	D,S	Adequate
14.0	7- 8-53	Sand	42	.....	D,S	Water hard and bitter
3.90	7- 8-53	....	...	.....	D,S	Water is salty, contains iron.
Flow	7- 8-53	....	40	.....	D,S	Water soft and salty.
5.17	6-30-53	....	42	.....	S	Water is hard.
3.0	7- 1-53	Gravel	43	.....	D,S	Adequate.
14.30	7- 1-53	....	42	.....	S	Water reported hard and alkaline.
Flow	7- 1-53	....	41	.....	D,S	Water reported hard and salty.
Do	7- 9-53	....	...	.....	D,S	Water soft and slightly salty
10.0	7- 8-53	....	41	.....	D,S	Adequate.

TABLE 14.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size	Type	Date completed
<u>143-52</u>					
1cbc	Ferdinand Hanson	270	3	Dr	1925
2ddc	Do	400	3	Dr	....
3dbd	Clifford Ingnell	440	3	Dr	....
4cddl	Emma Stibbe	25	48	Du	....
4cdd2	Do	500	4	Dr	1945
7aaa	Robert Schmuser	18	28	Du	1952
8add	Clyde Larson	20	48 x 96	Du	....
9aac	Carl Olson	25	48 x 48	Du	1940
9dcc	Earl Amel	389	3	Dr	....
10add	Axel Rasmussen	496	3	Dr	1934
10dda	Almen Sayer	150	30	Dr	....
11ddd	Irma McLaughlin	150	4	Dr	1923
12cdd	Victor R. Larson	96	2	Dr	....
12dcc	Emil Borre	120	1½	Dr	....
13bcc	L. O. Lane	124	3	Dr	....
14acd	Test hole 916	40	5	Dr	6-23-54
14adc	Test hole 917	40	5	Dr	7- 1-54
14add	Test hole 906	190	5	Dr	6- 9-54
14bdd1	Test hole 915	50	5	Dr	6-23-54
14bdd2	Test hole 918	40	5	Dr	7- 1-54
14bdd3	Ole Liedal	147	2	Dr	....
14dcc	H. T. Anderson	22	30	Du	....
14ddd	Test hole 787	500	5	Dr	8-22-53
16dca1	Prete Bros.	457	2	Dr	....
16dca2	Do	153	3	Dr	....
18abb	Stewart Hudson	14	48	Du	....
18ddd	Roland Doe	20	36	Du	....
19abb	Unknown	..	36	Du	....
20abb1	Chris Richtsmeier	220	3	Dr	1951
20abb2	Do	227	3	Dr	1951
21aaa	Karl Schmuser	150	3	Dr	1941
22aad	Earl Maker	175	3	Dr	1952
22abb	Test hole 789	240	5	Dr	8-29-53

IN THE HUNTER AREA, CASS COUNTY -- Continued

Depth to water below land surface (feet)	Date of measurement	Aquifer	Temperature °F	Altitude (feet)	Use	Remarks
Flow	6-23-53	Sand	...	.....	N	Water salty, affects bowels.
Do	6-23-53	Sand	43	.....	D,S	Flows 3/4 gpm.
Do	6-23-53	Sand	40	.....	D,S	Flows 1.2 gpm.
12.61	6-23-53	Sand	...	.....	D	Inadequate.
10.0	6-23-53	....	...	.....	S	Water salty, affects bowels.
13.0	7- 8-53	Sand and gravel	...	.....	D,S	Water reported soft, good, adequate.
5.0	6-23-53	....	39	.....	D,S	Adequate.
10.67	7- 2-53	Sand	42	.....	S	Located in Lake Agassiz beach ridge. Supply is inadequate, hard, corrosive
6.65	7-23-53	....	...	.....	D,S	Adequate, has slightly salty taste.
Flow	7- 2-53	....	...	.....	D,S	Water soft, salty taste.
34.79	6-23-53	....	46	.....	D,S	Adequate.
1.38	6-23-53	....	41	.....	D,S	Do.
1.28	6-26-53	....	39	.....	D,S	Adequate, slight salty taste.
Flow	6-26-53	....	42	.....	N	Adequate.
4.5	6-26-53	Sand	...	.....	D	Adequate, See chemical analysis
.....	.....	....	...	975	T	Hole refilled. See log.
.....	.....	....	...	973	T	Do.
.....	.....	....	...	967	T	Do.
.....	.....	....	...	978	T	Do.
.....	.....	....	...	988	T	Do.
.....	.....	....	41	.....	S	Adequate.
13.36	6-26-54	Sand	...	.....	D	Well is in beach ridge. Inadequate.
.....	.....	....	...	973	T	Hole refilled. See log.
6.56	6-23-53	....	...	.....	S	Inadequate. Water has salty taste.
20	6-23-53	Sand	...	.....	D,S	Adequate.
10	7- 7-53	Sand	43	.....	D,S	Do.
11.53	7- 8-53	Sand	...	.....	D,S	Do.
9.60	7- 7-53	....	...	.....	...
17	7- 8-53	Sand	41	.....	S	Adequate, water is soft.
27	7- 8-53	Sand	41	.....	D	Do.
8	7- 3-53	Sand	43	.....	D,S	
30	7- 2-53	....	...	.....	D,S	Adequate.
.....	.....	....	...	1,004	T	Hole refilled. See log

TABLE 14.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size	Type	Date completed
<u>143-52 - Continued</u>					
23aac1	Test hole 908	40	5	Dr	6-11-54
23aac2	Test hole 908a	120	5	Dr	6-15-54
23abd	Test hole 791	180	5	Dr	9- 3-53
23acc	Art Rasmussen	150	2	Dr	1940
23add1	Test hole 793	215	5	Dr	9- 9-53
23add2	R. E. Thompson	20	48	Du	1913
23baa	Test hole 788	230	5	Dr	8-28-53
23bad1	Dr. Waydeman	142	3	Dr	1953
23bad2	Test hole 790	225	5	Dr	9- 1-53
23dcc	Test hole 914	50	5	Dr	6-22-54
23ddb1	Emory N. Johnson	132	3	Dr	....
23ddb2	Do	360	3	Dr	....
23ddd	Test hole 792	250	5	Dr	9- 5-53
24aaa	Test hole 796	410	5	Dr	9-14-53
24aab	Test hole 799	250	5	Dr	10- 1-53
24abb	Test hole 798	250	5	Dr	9-26-53
24acc1	Test hole 795	190	5	Dr	9-11-53
24acc2	K. Dickson	125	3	Dr	1943
24ada	Test hole 801	300	5	Dr	10- 7-53
24adc	Test hole 802	200	5	Dr	10-10-53
24bac	Test hole 910	120	5	Dr	6-17-54
24bba	Test hole 797	180	5	Dr	9-25-53
24bbd	Bernard Holes Jr.	32	36	Du	1947
24bcb1	Test hole 907	120	5	Dr	6-11-54
24bcb2	City of Hunter	300	3	Dr	1937
24bcd	Hunter Creamery	364	4	Dr	1941
24bdc	Test hole 794	195	5	Dr	9-10-53
24cbd	Test hole 909	120	5	Dr	6-16-53
24ccc	Mrs. Sophie Otteson	20	52 x 52	Du	....
25ccd	J. W. Juliuson	300	4	Dr	....
26aba	Test hole 912	60	5	Dr	6-22-54
26abb	Art Rasumssen	170	3	Dr	1943
26baa	Test hole 913	40	5	Dr	6-22-54
26bcc	Walter Leidal	150	3	Dr	1933
26ddb	Ed Siegert	24	36	Du	....

IN THE HUNTER AREA, CASS COUNTY -- Continued

Depth to water below land surface (feet)	Date of measure- ment	Aquifer	Temperature °F	Altitude (feet)	Use	Remarks
....	.....	....	...	978	T	Hole refilled. See chemical analysis.
....	.....	....	...	978	T	Do.
....	.....	....	...	981	T	Do.
12	1951	....	...	.....	D	Reported soft,adequate. See chemical analysis
....	.....	....	...	.....	T	Hole refilled. See log.
8	7-10-53	Sand	...	.....	D	Adequate.
....	.....	....	...	.....	T	Hole refilled. See log.
4	7- 2-53	Sand	...	.....	D	
....	.....	....	...	998	T	Hole refilled..See log.
....	.....	....	...	997	T	Hole refilled. See log.
14.92	7- 2-53	....	...	.....	D	Inadequate.
Flow	7- 2-53	....	42	.....	S	Water reported soft, salty.
....	.....	....	...	978	T	Hole refilled. See log.
....	.....	....	...	950	T	Hole refilled. See log, chemical analysis.
....	.....	....	...	955	T	Hole refilled, See log.
....	.....	....	...	957	T	Hole refilled. See log, chemical analysis.
....	.....	....	...	965	T	Do.
25	7- 2-53	....	...	.....	D	Adequate.
....	.....	....	...	952	T	Hole refilled. See chemical analysis.
....	.....	....	...	956	T	Hole refilled. See log.
....	.....	....	...	974	T	Hole refilled. See log, chemical analysis.
....	.....	....	...	962	T	Do.
8	7- 2-53	....	43	.....	D	Water reported very har See chemical analysis
....	.....	....	...	977	T	Hole refilled. See log.
Flow	7- 8-53	....	...	.....	PS	Water is salty.
Do.	7-30-53	Sand	47	.....	Ind.	See chemical analysis.
....	.....	....	...	966	T	Hole refilled. See log, chemical analysis.
....	.....	....	...	970	T	Do.
8	7- 2-53	....	39	.....	D,S	Adequate, hard.
Flow	7- 1-53	....	...	.....	S	Water is salty.
....	.....	....	...	986	T	Hole refilled. See log.
30	7- 2-53	Gravel	42	.....	S	Adequate.
....	.....	....	...	1,001	T	Hole refilled. See log.
15	7-2-53	....	41	.....	S	
10	6-24-53	Clay	42	.....	S	Inadequate

TABLE 14.--RECORDS OF WELLS AND TEST HOLES

Location No.	Owner or name	Depth (feet)	Diameter or size	Type	Date completed
<u>143-52 - Continued</u>					
27bac	Earl Maker	20	48	Du	....
27cbb	Clarence Martin	450	4	Dr	....
28aaa	Bernard Hanson	280	2	Dr	....
28ccc	L. D. Pawlison	198	3	Dr	1949
29dcd	Carl Richtsmeier	200	3	Dr	1940
31aad	D. Martin	176	3	Dr	1952
32cbb	Lynn Worsley	165	3	Dr	1937
32daa1	Wm. Peterson	205	3	Dr	1946
32daa2	Do	40	48	Du	....
33aba	Ray Martin	32	36	Du	....
33ccd	Irving Bratholt	30	36	Du	....
33dcd	Clyde Fisk	18	36	Du	....
34aab	Lyle Ramstad	475	4	Dr	....
35add	Lloyd Williams	150	3	Dr	....
36abb	Fred Williams	300	3	Dr	....

IN THE HUNTER AREA, CASS COUNTY -- Continued

Depth to water below land surface (feet)	Date of measure- ment	Aquifer	Temperature °F	Altitude (feet)	Use	Remarks
10.01	6-24-53	....	42	.....	S	Water reported bitter, inadequate.
Flow	7-29-53	....	43	.....	S	Water reported salty
10.03	6-24-53	....	41	.....	S	Reported very salty, corrosive.
6	6-25-53	....	...	.....	D,S	Adequate.
14	7- 8-53	....	41	.....	D,S	Adequate.
30	7- 8-53	Sand	41	.....	D,S	Do.
30	7- 8-53	Sand	44	.....	D,S	Do.
Flow	7- 8-53	....	42	.....	D	Do.
7.93	7- 8-53	....	...	.....	S	Very hard.
10.23	6-25-53	Gravel	44	.....	D,S	Adequate, hard.
8	6-24-53	....	...	.....	S	Inadequate.
9.15	6-24-53	....	...	.....	S	Inadequate,hard.
35	6-24-53	....	42	.....	D,S	Water is hard, has salty taste.
30	7-1-53	....	42	.....	D,S	Adequate, soft.
Flow	7- 1-53	....	43	.....	D,S	Adequate, soft, salty.

IN THE HUNTER AREA, CASS COUNTY -- Continued

Depth to water below land surface (feet)	Date of measure- ment	Aquifer	Temperature °F	Altitude (feet)	Use	Remarks
10.01	6-24-53	....	42	.....	S	Water reported bitter, inadequate.
Flow	7-29-53	....	43	.....	S	Water reported salty
10.03	6-24-53	....	41	.....	S	Reported very salty, corrosive.
6	6-25-53	....	...	.....	D,S	Adequate.
14	7- 8-53	....	41	.....	D,S	Adequate.
30	7- 8-53	Sand	41	.....	D,S	Do.
30	7- 8-53	Sand	44	.....	D,S	Do.
Flow	7- 8-53	....	42	.....	D	Do.
7.93	7- 8-53	....	...	.....	S	Very hard.
10.23	6-25-53	Gravel	44	.....	D,S	Adequate, hard.
8	6-24-53	....	...	.....	S	Inadequate.
9.15	6-24-53	....	...	.....	S	Inadequate,hard.
35	6-24-53	....	42	.....	D,S	Water is hard, has salty taste.
30	7-1-53	....	42	.....	D,S	Adequate, soft.
Flow	7- 1-53	....	43	.....	D,S	Adequate, soft, salty.

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA, CASS COUNTY

143-51-19baa
Test hole 800

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, smooth, yellowish-gray.....	5	7
Till and associated sand and gravel deposits..			
	Clay, sandy, yellowish-gray and fine to medium gravel.....	20	27
Lacustrine deposits			
	Silt, yellowish-gray, and very fine sand.....	31	58
	Clay, smooth, gray.....	8	66
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine gravel.....	41	107
	Gravel, fine to medium.....	5	112
	Clay, medium-gray, and fine to medium gravel, and shale pebbles.....	68	180
	Clay, sandy, yellowish-gray (?), and fine gravel, and shale pebbles.....	5	185
	Clay, sandy, medium-gray, and fine gravel, and shale pebbles; sample of this material is very poor, drilled easily.....	115	300

143-51-20bbb
Test hole 911

Lake Agassiz deposits			
	Topsoil, black.....	3	3
	Clay, smooth, yellow.....	24	27
Till and associated sand and gravel deposits			
	Clay, yellow, and fine to medium gravel.....	29	56
Lacustrine deposits			
	Clay, smooth, gray.....	8	64
Till and associated sand and gravel deposits			
	Clay, gray, and fine to medium gravel.....	9	73
	Sand, fine to medium silty, and fine gravel...	2	75
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	243	318

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-14acd
Test hole 916

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, smooth, gray.....	4	6
Till and associated sand and gravel deposits			
	Clay, sandy, gray, and fine to medium gravel	12	18
Lacustrine deposits			
	Sand, fine, silty.....	6	24
	Clay, sandy, gray.....	16	40

143-52-14adc
Test hole 917

Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, carbonaceous, black.....	4	6
	Clay, sandy, yellow.....	34	40

143-52-14add
Test hole 906

Lake Agassiz deposits			
	Topsoil, black.....	1	1
	Clay, smooth, yellowish-gray.....	3	4
Till and associated sand and gravel deposits			
	Clay, yellow, and fine gravel.....	23	27
	Clay, sandy, gray, and fine to medium gravel and shale pebbles.....	196	223
Benton shale			
	Shale, gary.....	7	230

143-52-14bdd1
Test hole 915

Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, sandy, brown.....	1	3
	Clay, light-gray.....	3	6
Till and associated sand and gravel deposits			
	Clay, sandy, yellow, and fine gravel.....	8	14
Lacustrine deposits			
	Clay, sandy, gray.....	36	50

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-14bdd2
Test hole 918

<u>Formation Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits		
Topsoil, black.....	2	2
Sand, medium to coarse, and fine to medium gravel.....	3	5
Clay, smooth, light-gray.....	11	16
Till and associated sand and gravel deposits		
Clay, light-gray, and fine gravel.....	6	22
Lacustrine deposits		
Sand, fine, silty, gray.....	4	26
Clay, gray.....	14	40

143-52-14ddd
Test hole 787

Till and associated sand and gravel deposits		
Topsoil, black.....	1	1
Clay, yellowish-gray, and fine gravel.....	9	10
Lake Agassiz deposits		
Clay, gray.....	4	14
Sand, fine to medium.....	13	27
Till and associated sand and gravel deposits		
Clay, sandy, light-gray, and fine gravel....	11	38
Lacustrine deposits		
Clay, smooth, light-gray.....	32	70
Silt, light-gray.....	13	83
Till and associated sand and gravel deposits		
Clay, gray, and fine gravel.....	33	116
Sand, coarse.....	2	118
Clay, gray, and fine to medium gravel.....	14	132
Sand, medium to coarse, and fine gravel.....	12	144
Clay, gray, and fine to medium gravel.....	29	173
Sand, fine to coarse.....	3	176
Clay, gray, and fine to medium gravel, and shale pebbles.....	70	246
Benton shale		
Clay, very fine grained, grayish-black; core from 250-260 feet.....	68	314
Shale (?), sandy, gray.....	13	327
Clay, light-gray.....	7	334
Clay, grayish-brown and some lignite fragments.....	18	352
Clay, dark-gray.....	29	381
Clay, grayish-black.....	4	385
Clay, varying shades of gray; poor samples	76	461
Dakota sandstone		
Sand, fine to medium, quartzose; many well- rounded grains.....	17	478
Granite, decomposed		
Clay, white; probably kaolinitic.....	22	500

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-22abb
Test hole 789

<u>Formation Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits		
Topsoil, black.....	4	4
Clay, silty, yellowish-gray.....	14	18
Till and associated sand and gravel deposits		
Clay, yellowish-gray, and fine gravel.....	2	20
Lacustrine deposits		
Clay, silty, yellowish-gray.....	19	39
Clay, silty, light-gray.....	83	122
Till and associated sand and gravel deposits		
Clay, light-gray to medium-gray, and fine to medium gravel.....	89	211
Gravel, fine to medium.....	1	212
Clay, light-gray, and fine gravel, and shale pebbles.....	10	222
Benton shale		
Shale, fine grained, gray-black.....	18	240

143-52-23aac1
Test hole 908

Lake Agassiz deposits		
Topsoil, black.....	1	1
Clay, sandy, brown.....	2	3
Sand, fine, silty, gray.....	27	30
Gravel, fine, silty.....	10	40

143-52-23aac2
Test hole 908A

Lake Agassiz deposits		
Topsoil, black.....	1	1
Sand, fine brown.....	2	3
Sand, fine, clayey.....	10	13
Till and associated sand and gravel deposits		
Clay, sandy, gray, and fine to medium gravel	107	120

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-23abd
Test hole 791

<u>Formation Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits		
Topsoil, black.....	1	1
Clay, light-gray to white.....	3	4
Sand, light-brown.....	5	9
Sand, fine, light-gray.....	17	26
Clay, sandy, gray.....	9	35
Clay, smooth, gray.....	58	93
Till and associated sand and gravel deposits		
Clay, gray, and fine gravel.....	20	113
Sand, medium to coarse, and fine gravel.....	3	116
Clay, gray, and fine gravel, and shale pebbles	11	127
Sand, silty, clayey.....	4	131
Clay, sandy, light-gray, and fine to medium gravel, and shale pebbles.....	17	148
Clay, gray, and fine to medium gravel, and shale pebbles; hard drilling.....	32	180

143-52-23add
Test hole 793

Lake Agassiz deposits		
Clay, silty, yellowish-gray.....	7	7
Clay, light-gray.....	29	36
Clay, silty, light-gray.....	51	87
Till and associated sand and gravel deposits		
Clay, sandy, gray, and fine gravel, and shale pebbles.....	35	122
Sand medium to coarse.....	2	124
Clay, sandy, light-gray, and fine to medium gravel and shale pebbles.....	83	207
Benton shale		
Clay, dark grayish-black.....	8	215

143-52-23baa
Test hole 788

Till and associated sand and gravel deposits		
Topsoil, black.....	2	2
Clay, weathered, yellowish-gray and fine gravel	16	18
Lake Agassiz deposits		
Sand, very fine to fine.....	20	38
Clay, silty, light-gray.....	72	110
Till and associated sand and gravel deposits		
Clay, sandy, light-gray, and fine gravel, and shale pebbles.....	105	215
Benton shale		
Shale, clayey, very dark-gray.....	15	230

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-23bad
Test hole 790

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits		1	1
	Topsoil, black.....	7	8
	Clay, sandy, yellowish-gray, and fine gravel.		
Lake Agassiz deposits		38	46
	Sand, fine.....	54	100
	Clay, silty, light-gray.....	14	114
	Clay, smooth, gray.....		
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine gravel, and shale pebbles.....	111	225
Benton shale		5	230
	Shale, clayey, dark-gray.....		

143-52-23dcc
Test hole 914

Lake Agassiz deposits		1	1
	Topsoil, black.....	2	3
	Sand, fine to medium silty.....	8	11
	Clay, smooth, light-gray.....	29	40
	Sand, fine, silty.....	10	50
	Clay, sandy, gray.....		

143-52-23ddd
Test hole 792

Lake Agassiz deposits		1	1
	Topsoil, black.....	6	7
	Silt, yellowish-gray.....	63	70
	Silt, medium-gray.....	24	94
	Clay, smooth, medium-gray.....		
Till and associated sand and gravel deposits		16	110
	Clay, light-gray, and fine gravel.....		
Lacustrine deposits		14	124
	Clay, gray.....	5	129
	Sand, coarse, and fine gravel.....		
Till and associated sand and gravel deposits		8	137
	Clay, sandy, light-gray, and fine gravel.....	2	139
	Gravel, fine.....	13	152
	Clay, sandy, light-gray, and fine gravel.....		
	Clay, gray, and fine to medium gravel, and shale pebbles.....	11	163
	Sand, coarse, and fine gravel, and shale pebbles.....	2	165
	Clay, gray, and fine to medium gravel, and shale pebbles.....	81	246
Benton shale		4	250
	Clay, grayish-black.....		

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-24aaa
Test hole 796

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, smooth, yellowish-gray.....	11	13
Till and associated sand and gravel deposits			
	Clay, yellowish-gray, and fine gravel.....	3	16
	Sand, fine to medium, and fine gravel.....	4	20
Lacustrine deposits			
	Sand, fine.....	17	37
	Clay, smooth, gray.....	6	43
	Sand, fine.....	14	57
	Clay, smooth, gray.....	15	72
Till and associated sand and gravel deposits			
	Clay, gray, and fine gravel.....	4	76
	Sand, fine to coarse.....	3	79
	Clay, gray, and fine gravel, and shale pebbles.....	13	92
	Sand, medium to coarse, silty.....	5	97
	Clay, sandy, and fine to medium gravel, boulders, and shale pebbles.....	75	172
	Sand, fine to coarse, silty, and clayey.....	13	185
	Sand, fine to very coarse, poorly sorted....	35	220
	Sand, fine to medium, and boulders.....	65	285
	Sand, fine to very coarse, clayey.....	55	340
	Sand, fine to very coarse, and boulders.....	70	410

Note: The Benton shale was not encountered at
this site.

143-52-24aab
Test hole 799

Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, sandy, yellowish-gray, and a few gravel fragments.....	24	26
	Clay, silty, light-gray.....	36	62
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine gravel....	52	114
	Clay, silty, dark-gray, and fine sand.....	10	124
	Clay, medium-gray, and fine to medium gravel, and shale pebbles.....	126	250

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-24abb
Test hole 798

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, smooth, yellowish-gray.....	6	8
Till and associated sand and gravel deposits			
	Clay, weathered, yellowish-gray, and fine to medium gravel.....	15	23
Lacustrine deposits			
	Clay, silty, light-gray.....	44	67
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine to medium gravel.....	65	132
	Sand, medium to coarse, clayey, and fine gravel	8	140
	Sand, medium to coarse, clean, and fine gravel	5	145
	Sand, medium to coarse, silty, and fine gravel	7	152
	Clay, medium-gray, and fine to medium gravel; poor samples.....	36	188
	Sand, fine, silty.....	7	195
	Clay, medium-gray, and fine to medium gravel, and shale pebbles.....	47	242
Benton shale			
	Shale, clayey, grayish-black; good bit sample	8	250

143-52-24acc
Test hole 795

Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, light-gray.....	4	6
Till and associated sand and gravel deposits			
	Clay, yellowish-gray, and fine to medium gravel.....	15	21
Lacustrine deposits			
	Sand, fine silty, and clayey.....	3	24
	Silt, gray.....	53	77
	Clay, smooth, gray.....	12	89
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine to medium gravel, and shale pebbles.....	89	178
Benton shale			
	Clay, dark grayish-black.....	12	190

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-24ada
Test hole 801

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Topsoil, black.....	1	1
	Clay, smooth, yellowish-gray.....	6	7
Till and associated sand and gravel deposits			
	Clay, sandy, yellowish-gray, and fine gravel	11	18
Lacustrine deposits			
	Silt, yellowish-gray, and very fine sand....	26	44
	Clay, silty, light-gray.....	29	73
Till and associated sand and gravel deposits			
	Clay, medium-gray, becoming dark-gray with increasing depth, and fine gravel and shale pebbles.....	135	208
	Sand, mostly very coarse.....	11	219
	Clay, sandy, medium-gray, and fine to medium-gray; samples are mostly sand and gravel, and probably are not representative of this material.....	81	300

143-52-24adc
Test hole 802

Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, sandy, grayish-orange.....	19	21
	Sand, very fine to fine.....	6	27
	Clay, silty, light-gray.....	36	63
	Clay, smooth, medium-gray.....	9	72
Till and associated sand and gravel deposits			
	Clay, sandy, light-gray, and fine to medium gravel.....	51	123
Lacustrine deposits			
	Clay, silty, medium-gray.....	12	135
Till and associated sand and gravel deposits			
	Sand very coarse, and fine gravel.....	8	143
	Clay, medium-gray, and fine to medium gravel, and shale pebbles.....	40	183
	Sand, medium-coarse, and fine gravel.....	2	185
	Clay, medium-gray, and fine to medium gravel, and shale pebbles.....	10	195
Benton shale			
	Clay, very fine grained, dark-gray, nearly black.....	5	200

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-24bac
Test hole 910

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Till and associated sand and gravel deposits			
	Topsoil, black.....	1	1
	Clay, sandy, yellow, and fine gravel, and shale pebbles.....	9	10
Lake Agassiz deposits			
	Sand, fine, silty, gray.....	34	44
	Clay, smooth, gray.....	45	89
Till and associated sand and gravel deposits			
	Clay, gray, and fine to medium gravel, and shale pebbles.....	31	120

143-52-24bba
Test hole 797

Lake Agassiz deposits			
	Topsoil, black.....	1	1
	Clay, smooth, light-gray.....	5	6
Till and associated sand and gravel deposits			
	Clay, sandy, yellowish-gray, and fine gravel	12	18
Lacustrine deposits			
	Clay, sandy, gray.....	9	27
	Sand, fine, clayey.....	29	56
	Clay, smooth, gray.....	18	74
Till and associated sand and gravel deposits			
	Clay, gray, and fine gravel, and shale pebbles.....	19	93
	Sand, medium to coarse.....	9	102
	Clay, gray, and fine to medium gravel, and shale pebbles.....	9	111
	Sand, silty, clayey.....	5	116
	Clay, gray, and fine to medium gravel and boulders, and shale pebbles.....	51	167
Benton shale			
	Clay, grayish-black.....	13	180

143-52-24bcbl
Test hole 907

Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, sandy, yellow.....	9	11
	Clay, sandy, becoming smooth with depth, gray	85	96
Till and associated sand and gravel deposits			
	Clay, gray, and fine to medium gravel, and shale pebbles.....	24	120

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
CASS COUNTY -- Continued

143-52-24bdc
Test hole 794

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, sandy, yellowish-gray.....	11	13
	Sand, fine, yellowish-gray.....	3	16
	Sand, fine, gray.....	10	26
	Clay, smooth, gray.....	2	28
	Sand, clayey, gray.....	8	36
	Silt, clayey, gray.....	36	72
Till and associated sand and gravel deposits			
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	27	99
	Gravel, fine to medium.....	3	102
	Clay, sandy, gray, and fine to medium gravel, and shale pebbles.....	4	106
	Sand, fine to coarse, clayey.....	4	110
	Clay, sandy, light-gray, and fine to medium gravel, and shale pebbles.....	78	188
Benton shale			
	Clay, dark-grayish-black.....	7	195

143-52-24cbd
Test hole 909

Lake Agassiz deposits			
	Topsoil, black.....	1	1
	Clay, sandy, brown.....	2	3
	Clay, sandy, gray.....	2	5
	Clay, sandy, dark-gray.....	4	9
	Sand, fine, silty.....	16	25
	Clay, smooth, gray.....	59	84
Till and associated sand and gravel deposits			
	Clay, gray, and fine to medium gravel, and shale pebbles.....	36	120

143-52-26aba
Test hole 912

Lake Agassiz deposits			
	Topsoil, black.....	1	1
	Clay, sandy, light-gray.....	2	3
	Sand, fine to coarse, and fine gravel.....	2	5
	Clay, smooth, yellow.....	7	12
Till and associated sand and gravel deposits			
	Clay, yellow, and fine gravel, and shale pebbles.....	4	16
Lacustrine deposits			
	Clay, sandy, light-gray.....	44	60

TABLE 15.--LOGS OF TEST HOLES IN THE HUNTER AREA
 CASS COUNTY -- Continued

143-52-26baa
 Test hole 913

<u>Formation</u>	<u>Material</u>	<u>Thickness</u> (feet)	<u>Depth</u> (feet)
Lake Agassiz deposits			
	Topsoil, black.....	2	2
	Clay, light-gray.....	3	5
	Clay, sandy, yellow.....	4	9
	Sand, fine, silty.....	25	34
	Clay, smooth, gray.....	6	40

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