STATE OF SOUTH DAKOTA
Nils Boe, Governor

STATE GEOLOGICAL SURVEY
Duncan J. McGregor, State Geologist

Special Report 31

GROUND WATER SUPPLY FOR THE CITY OF CANTON, SOUTH DAKOTA

by
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Science Center
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INTRODUCTION

Present Investigation

This report contains the results of a special investigation by the South Dakota State Geological Survey from July 10 to August 21, 1964, in and around the city of Canton, Lincoln County, South Dakota (fig. 1). The purpose of the investigation was to assist the city in locating future water supplies. Canton now obtains its water from five wells, four of which are producing from sandstones of the Dakota Group from an average depth of 436 feet, and one which is producing from a Pleistocene outwash gravel from a depth of 50 feet. The present wells each have a pump capacity of approximately 75 gallons per minute. All of the wells are within the city limits (fig. 2). The quantity of water produced is not adequate for the city's needs and for this reason the services of the State Geological Survey were requested.

A survey of approximately 80 square miles was made in and around the city of Canton. The survey consisted of geologic mapping, obtaining a well inventory, drilling two rotary test holes, and 56 auger test holes, and collecting 22 water samples for analysis.

As a result of this survey it is recommended that the city further investigate the possibilities of obtaining a large yield well in the surface outwash along the Big Sioux River, or drill additional wells to the Dakota Group while continuing to use the existing wells in the Dakota Group as a supplementary source of water. A buried water-saturated sand was also found west of Canton in the area indicated on figure 3 as the Newton Hills Sand. The sand would probably supply a sufficient amount of water, but the quality of the water is such as to prohibit its use.

The field work and preparation of this report were performed under the supervision of Cleo M. Christensen, ground water geologist for the South Dakota Geological Survey. Robert A. Schoon, geologist-driller, and his assistants, Lloyd R. Helseth and Robert Stach, all of the South Dakota Geological Survey, drilled the rotary test holes in the area. Ronald W. Little, Dwight W. Brinkley, and Robert F. Walsh, operated the jeep auger drill. Keith Hansen and Mike Fresvik also drilled test holes with the Survey's truck-mounted auger drill. Nat Lufkin of the Geological Survey and members of the State Chemical Laboratory analyzed the water samples collected for this project. Thanks are due Blaine O. Rudolph, City Attorney, and other residents in and around Canton, who provided helpful information throughout the project.

Location and Extent of Area

The city of Canton is located in Lincoln County in southeastern South Dakota, and has a population of 2,511 (1960 census). For the most part, the area studied is located in the James Basin division of the Central Lowland physiographic province; however, the highlands south of Canton (Newton Hills) are in the Coteau des Prairies division (fig. 1).

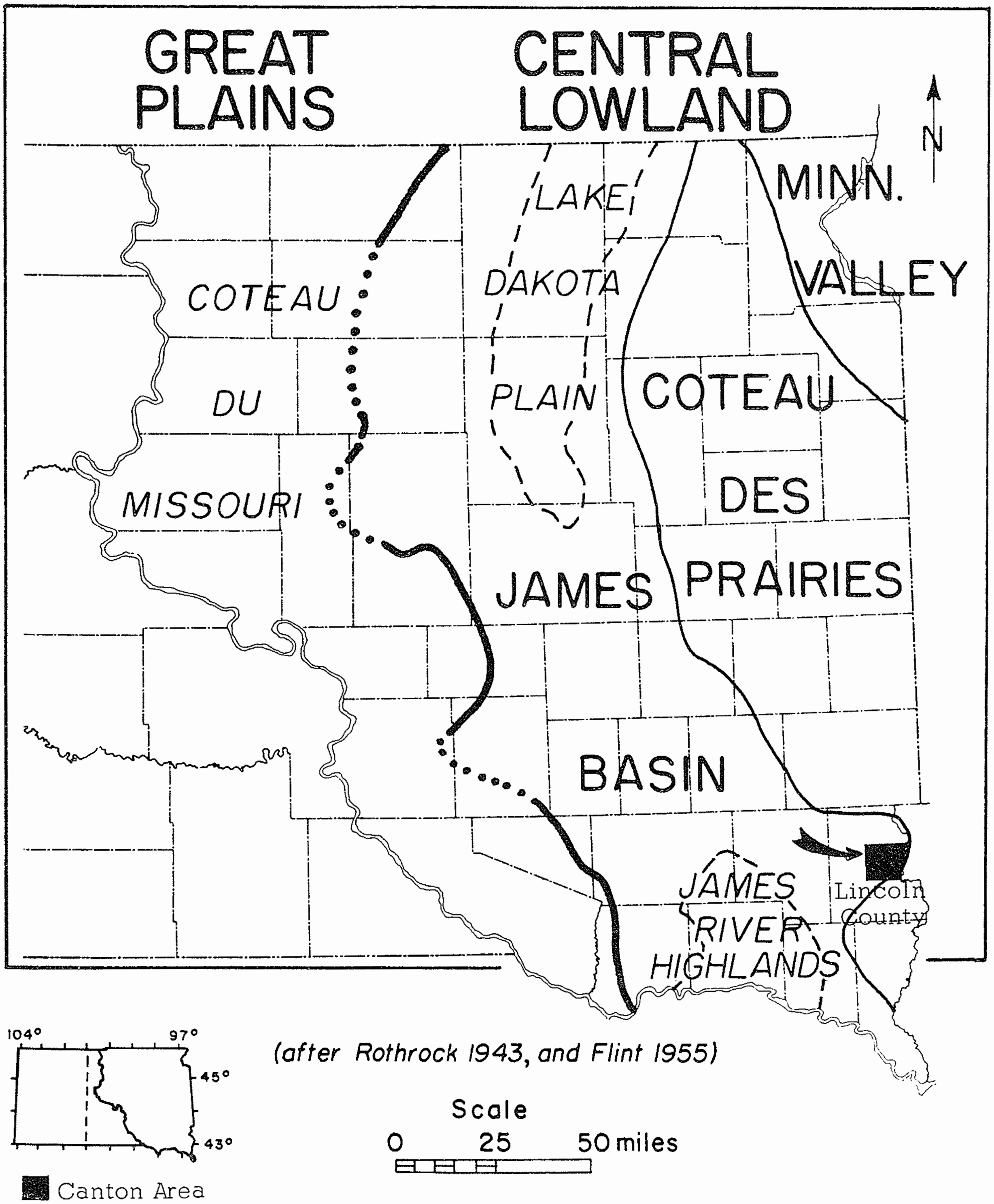

Figure 1.--Map of eastern South Dakota showing major physiographic divisions and location of the Canton area.

Figure 2. Data map of the Canton area

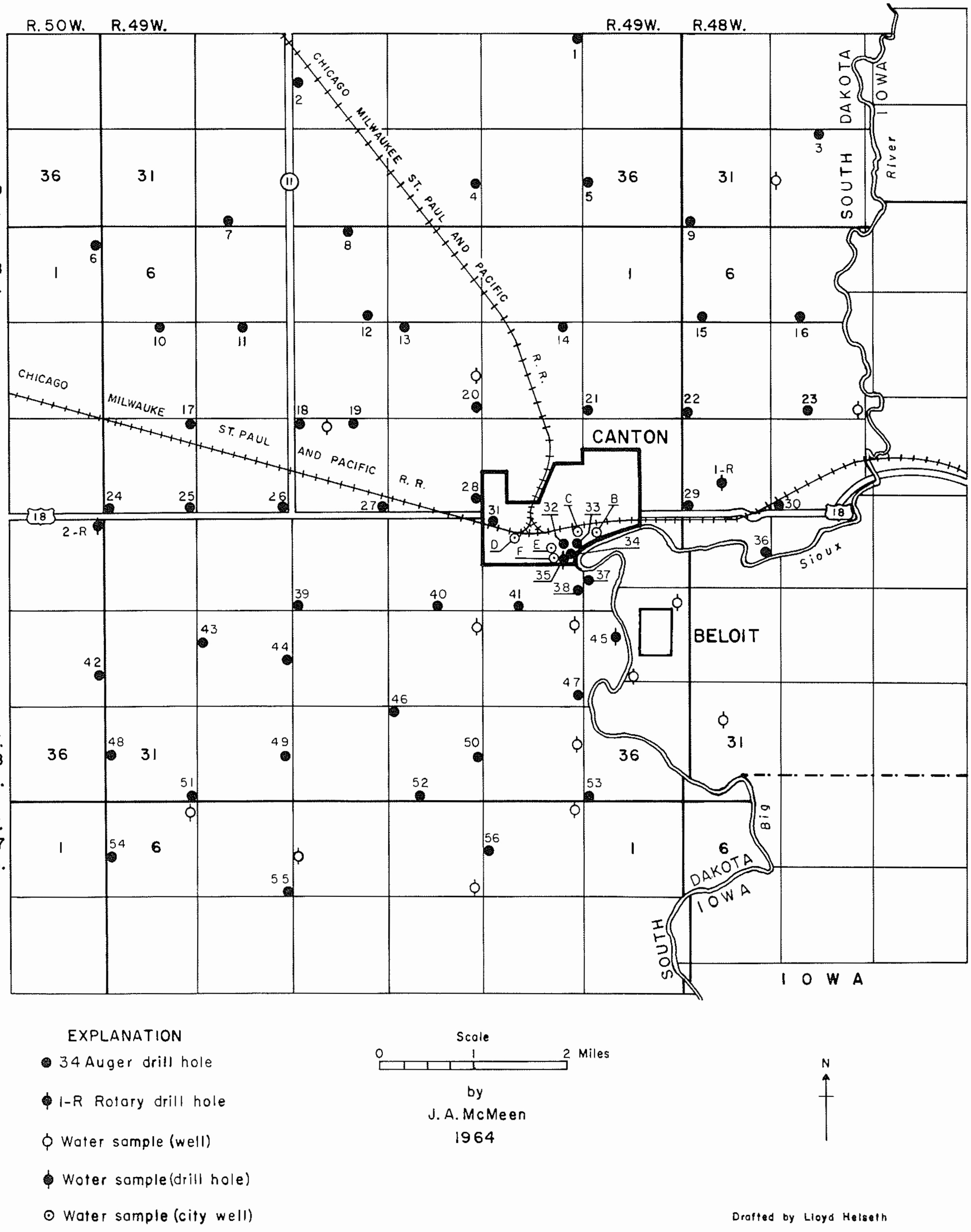

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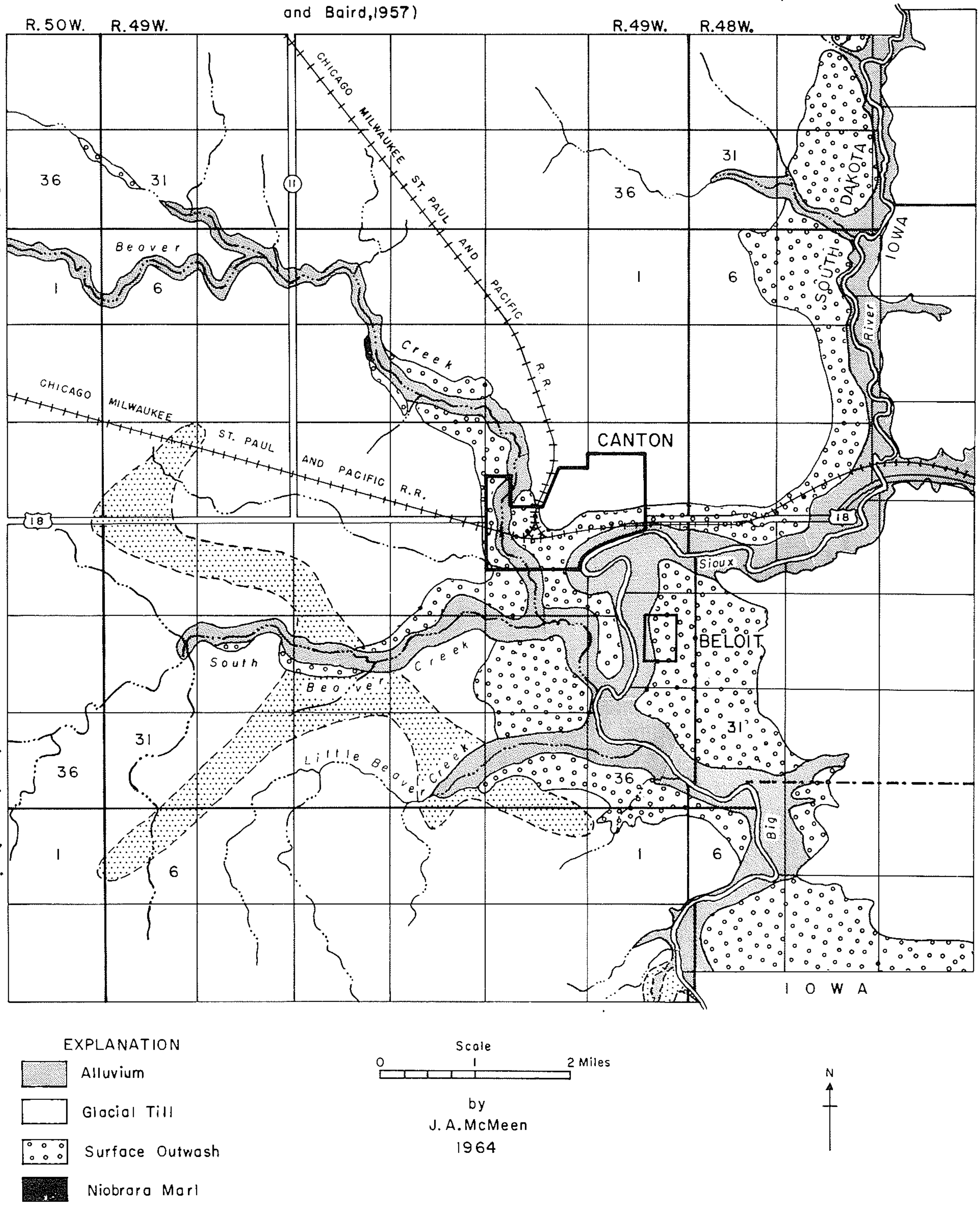
Figure 3. Geologic map of the Canton area (modified from Steece, 1957 and Baird, 1957)



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Climate

The climate is continental temperate, with large daily and seasonal fluctuations in temperature.

The average daily temperature at Canton is 46 degrees F., and the average annual precipitation is 24 inches.

Topography and Drainage

With the exception of the Newton Hills, the topography of the Canton area consists mainly of a gently rolling plain.

Drainage in the area is controlled by the Big Sioux River and its tributaries Beaver Creek, South Beaver Creek, and Little Beaver Creek (fig. 3). All of these tributaries flow in an easterly direction to the Big Sioux River.

GENERAL GEOLOGY

Surficial Deposits

The surficial deposits of the Canton area are chiefly the result of glaciation late in the Pleistocene Epoch. The glacial deposits are collectively termed drift, and can be divided into till and outwash deposits. Till consists of clay and silt randomly mixed with boulders, pebbles, and sand, which were carried and deposited by the ice itself. Outwash is better sorted and consists mainly of pebbles and sand with minor amounts of silt, cobbles, and boulders. Outwash is the material deposited by meltwater streams from the wasting glaciers. Surface outwash material is present in the mapped area along the Big Sioux River and its major tributaries (fig. 3).

Alluvium consists of silt and clay-size particles with minor amounts of sand, deposited by recent streams since the retreat of the glaciers. Alluvium, in the Canton area, is found mainly along Beaver Creek, South Beaver Creek, Little Beaver Creek, and the Big Sioux River (fig. 3).

Exposed Bedrock

One exposure of the Niobrara Marl occurs about 2 miles northwest of Canton along Beaver Creek (fig. 3). This is believed to be the only bedrock exposed in the mapped area.

Subsurface Bedrock

Stratified rocks of Cretaceous age lie beneath the surface deposits in the Canton area. Where present in the subsurface, the Niobrara Marl is found immediately beneath the glacial drift. Where the Niobrara is absent, the Carlile Shale is the first Cretaceous formation encountered below the drift. The Carlile Shale is underlain in descending order by the Cretaceous Greenhorn Limestone, Graneros Shale, and the Dakota Group; and by the

Precambrian Sioux Quartzite that is the basement rock. The Cretaceous rocks are approximately 600 feet thick in the Canton area.

Figure 4 is a contour map showing the approximate configuration of the surface of the bedrock as it would appear if all glacial deposits were removed. This map shows that the surface of the bedrock is variable and is characterized by several topographic highs and lows. In general, however, the bedrock slopes from northwest to southeast.

The Niobrara Marl consists of highly calcareous light to medium blue-gray fossiliferous shale, which contains numerous microscopic white calcium carbonate specks. In the mapped area this marl ranges from 0 to approximately 100 feet thick.

The Carlile Shale consists of medium- to dark-gray bentonitic shale with pyrite concretions, and layers of fine brown siltstone. This formation is approximately 110 feet thick in the Canton area.

The Greenhorn Limestone consists of a layer of hard cream to white limestone containing numerous fossil fragments. This limestone layer is overlain (and possibly underlain) by a layer of dark-gray shale containing numerous small white calcareous specks. The Greenhorn Limestone may attain a thickness of 70 feet in the Canton area.

The Graneros Shale is hard, light- to dark-gray siliceous shale which is approximately 100 feet thick in this area.

The Dakota Group consists of a series of alternating sandstones and shales. Maximum thickness of the Dakota Group is approximately 335 feet in the mapped area.

The sediments of the Dakota Group are underlain by the Sioux Quartzite of Precambrian age, which is a hard, red, siliceous quartzose sandstone.

OCCURRENCE OF GROUND WATER

Principles of Occurrence

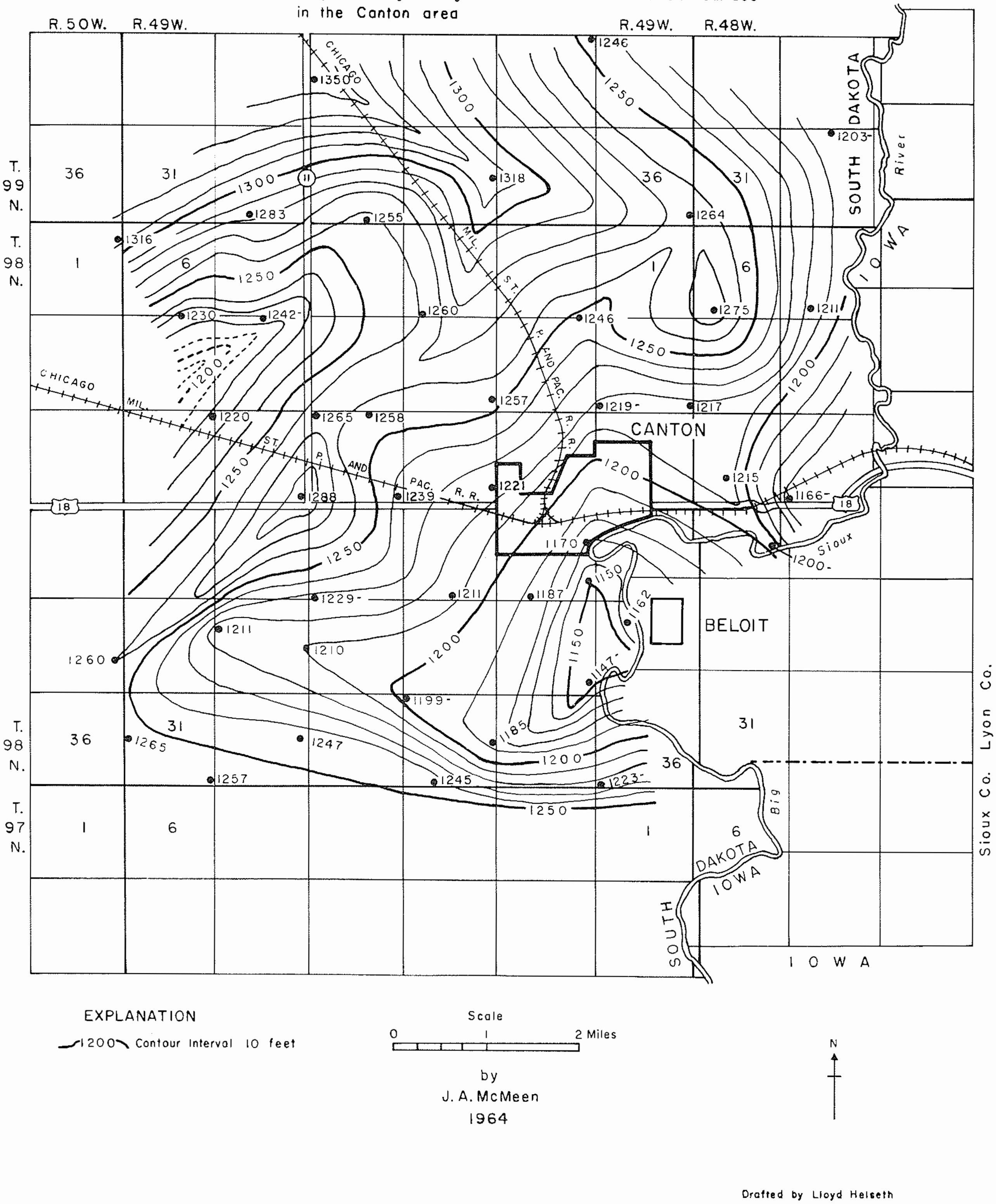
Despite the common belief that ground water is found in "veins" crisscrossing the land in a discontinuous maze, it is known that water occurs almost everywhere in the ground, at a depth below the surface which varies from a few feet to several tens or even hundreds of feet. The top of this zone of water saturation is known as the water table.

Almost all ground water is derived from precipitation. Rain or melting snow either percolates directly downward to the water table and becomes ground water, or drains off as surface water. Surface water either evaporates, escapes to the ocean by streams, or percolates downward to the ground water table.

Recharge is the addition of water to an aquifer (water-bearing material), and is accomplished by downward percolation from the ground surface, downward percolation from surface bodies of water, and lateral underflow of water in transient storage.

Discharge, the removal of ground water from an aquifer, is accomplished by evaporation and transpiration of plants, seepage upward or

Figure 4. Map showing configuration of buried bedrock surface in the Canton area



laterally into surface bodies of water such as springs, and lateral underflow of water in transient storage.

The volume of water capable of being stored in a saturated material is equal to the volume of voids or pore space of the material. A measurement of the capability of a material to store water is called porosity. Porosity is the ratio of the volume of voids to the volume of rock. The shape and arrangement of grains in a material affects the porosity greatly, but size of the grains has little effect. Therefore, if two identical containers are considered, one filled with sand and the other filled with gravel, and if the sand and gravel have the same shape and packing, both would hold approximately the same quantity of water. Sands and gravels usually have porosities that range from 20-40 percent; whereas, sandstones normally have porosities of 15-25 percent. The lower porosity of sandstones results from closer packing and cementation of the grains.

The rate at which water will drain or pass through material under pressure is a function of the permeability of the substance. Water will pass through a material with interconnected pores, but will not pass through material with unconnected pores, even if the latter material has a higher porosity. Therefore, permeability and porosity are not synonymous terms. As an example, glacial till may have high porosity but yield only small amounts of water because of low permeability.

The ratio of the volume of water that will drain from a material by gravity, to the volume of the material is called specific yield. Values for specific yields vary from zero for plastic clays to nearly the total value of the porosity for coarse sands and gravels.

Ground Water in Alluvium

The alluvium along Beaver Creek, South Beaver Creek, Little Beaver Creek, and the Big Sioux River in the Canton area (fig. 3) was deposited by recent streams and consists of clay and silt with minor amounts of sand and gravel. That part of this alluvium that is below the water table holds large quantities of water, but will not yield water readily because of low permeability.

Ground Water in Glacial Deposits

Till does not yield water readily because of its highly unsorted nature and low porosity and permeability.

Glacial outwash deposits, because they are better sorted and contain less clay and silt-size particles, yield water much more readily than till.

No buried outwash was found in the Canton area. However, the area is quite extensively covered by surficial outwash deposits which occur below the alluvium along Beaver Creek, South Beaver Creek, Little Beaver Creek, and the Big Sioux River (fig. 3).

Ground Water in Bedrock

The Niobrara Marl is a known water producer in some areas of the State, and in the Canton area it supplies water to a few farm wells. However, the wells producing from this formation have a relatively low yield, and usually the water is of a poor quality.

The sandstones of the Dakota Group are the only other bedrock from which water is readily obtained in the Canton area, and at present they are the main source of water for the city of Canton. Wells completed in these sandstones are at a depth of 250 feet to 585 feet in the mapped area, and the water obtained from them is of a good quality.

Quality of Ground Water

Precipitated water is nearly pure before it reaches the ground; however, all ground water contains minerals which are obtained (1) from the atmosphere, (2) from soil and underlying deposits as the water percolates downward to the water table, and (3) from deposits below the water table in which the water is circulating. In general it can be said that the more dissolved minerals a water contains, the poorer its quality. Table 1 is a comparison of various waters in the Canton area with the city water presently in use and with the Public Health Standards for drinking water. Table 1 shows that the water produced from the deeper city wells (samples B, C, D, E, table 1) exceeds the recommended limits (A, table 1) only in iron. However, the iron content is still so low as to cause no problem. The water from the one shallow city well (sample F, table 1) is hard water and is high in magnesium, sulfate, manganese, and total solids. In general it is of a very poor quality.

The water produced from sandstones of the Dakota Group (samples 1 and 2, table 1) is of much better quality than that obtainable from either the sand lenses (samples 3-7) or the Newton Hills Sand (samples 8 and 9). Samples 3, 4, and 5 are high in calcium, magnesium, sulfate, and total solids, and samples 6 and 7 are high only in total solids. Samples 8 and 9 are high in magnesium, sulfate, and total solids, and thus must be classified as a poor quality water. In addition, all the waters taken from the sand lenses (samples 3-7) and the Newton Hills Sand (samples 8 and 9) are extremely hard.

The quality of the water from the surficial outwash deposits (samples F and 10-22) in the area is somewhat variable. Samples 10, 12, 14, 15, 16, 18, 19, 21, and 22 are all fairly good waters. However, samples 12, 16, 18, 21, and 22 exceed the recommended limits for iron; sample 16 is also high in nitrate. The excess iron in these waters can, however, be removed with proper treatment. The remainder of the waters (samples 11, 13, 17, and 20) taken from the surficial outwash in the area are undesirable because of high concentrations of magnesium, sulfate, nitrate, and total solids. These waters come from terrace deposits that are near the upper part of the surficial outwash. This fact evidently is a contributing factor in influencing the quality of water within the deposits.

Table 1.--Chemical analyses of water samples from the Canton area.

D, Dakota; B, Beaver Creek outwash; L, sand lens; N, Newton Hills Sand; S, Big Sioux outwash

Sample	Source	Parts Per Million											
		Calcium	Sodium	Magne-sium	Chlorides	Sulfate	Iron	Manga-nese	Nitrate	Fluoride	pH	Hardness $CaCO_3$	Total Solids
A		---	---	50	250	500*	0.3	0.05	10.0	0.9-1.7**	---	----	1000*
B	D	61	181	21	25	222	0.2	0.0	1.5	1.3	7.3	241	706
C	D	70	138	24	37	229	0.5	0.0	1.5	1.3	7.4	277	739
D	D	72	155	23	38	220	0.5	0.0	1.5	1.4	7.3	276	719
E	D	84	130	28	33	232	0.9	0.0	0.0	1.2	7.2	327	716
F	S	238	59	102	8	826	0.0	1.1	0.3	0.5	7.4	1014	1603
1	D	14	---	7	12	83	0.0	----	-----	----	8.0	65	714
2	D	23	171	5	5	119	0.0	----	0.08	1.3	7.9	75	630
3	L	522	---	171	26	1068	0.0	----	-----	----	7.3	2000	2218
4	L	510	---	67	10	1020	0.0	----	-----	----	7.6	1550	1970
5	L	285	---	75	32	480	0.0	----	-----	----	7.4	1020	1355
6	L	250	---	43	---	291	0.0	----	-----	----	7.3	900	1208
7	L	360	---	24	---	303	Trace	----	-----	----	7.0	1000	1290
8	N	365	10	183	13	1434	Trace	0.0	26	0.0	6.9	1756	2754
9	N	523	35	165	16	1802	1.8	0.6	3.6	0.4	7.6	1984	3090
10	B	75	---	22	0	88	0.0	0.0	0.7	0.0	7.8	276	386
11	S	391	---	79	0	536	0.0	----	-----	----	7.1	1300	1580
12	S	139	10	52	0	341	0.6	0.0	5	0.4	7.4	561	878

Table 1.--continued

Sample	Source	Parts Per Million Calcium	Sodium	Magne-sium	Chlorides	Sulfate	Iron	Manga-nese	Nitrate	Fluoride	pH	Hardness $CaCO_3$	Total Solids
13	S	310	---	103	---	536	0.0	----	-----	----	7.2	1200	1442
14	S	200	---	39	---	125	0.0	----	-----	----	7.2	680	962
15	S	124	---	27	---	70	0.0	----	-----	----	7.5	420	597
16	S	85	12	42	17	121	0.9	0.0	11	0.03	7.4	388	656
17	S	225	---	215	4	730	0.04	----	-----	----	7.3	1450	1562
18	S	97	12	34	16	185	1.0	0.0	0	0.02	7.2	381	616
19	S	117	49	42	0	147	0	----	-----	----	---	466	600
20	S	328	60	169	30	1186	0.3	0.0	25	0.0	---	1513	2372
21	S	96	---	24	14	96	5.5	----	-----	----	7.9	337	500
22	S	168	---	41	24	91	0.65	1.23	-----	----	---	590	734

* Modified for South Dakota by State Department of Health (written communication, February 5, 1962).

** Optimum

Samples B - F were analyzed by South Dakota Department of Health.
Samples 2, 8, 9, 10, 12, 16, 18, 19, and 20 were analyzed by State Chemical Laboratory.
Samples 1, 3, 4, 5, 6, 7, 11, 13, 14, 15, 17, 21, and 22 were analyzed by State Geological Survey.

Locations of Water Samples

A. U. S. Dept. of Public Health Drinking Water Standards (1961)
B. Canton City Well No. 1
C. Canton City Well No. 2
D. Canton City Well No. 3
E. Canton City Well No. 4
F. Canton City Well No. 5
1. Ralph Romereim, NESE sec. 10, T. 98 N., R. 49 W.
2. Truman Rhead, NENE sec. 27, T. 98 N., R. 49 W.
3. Lyle Diedrich, SESE sec. 3, T. 97 N., R. 49 W.
4. Steven Short, NENW sec. 16, T. 98 N., R. 49 W.
5. E. Carpenter, SWSE sec. 9, T. 98 N., R. 49 W.
6. Jerald Vandestowe, NWSW sec. 4, T. 97 N., R. 49 W.
7. Lester Toberson, NENE sec. 6, T. 97 N., R. 49 W.
8. Robert Brynjulson, NENE sec. 2, T. 97 N., R. 49 W.
9. Rotary Test Hole No. 2, NENE sec. 24, T. 98 N., R. 50 W.
10. H. W. O'Banion, SESE sec. 15, T. 98 N., R. 49 W.
11. John Sandnes, NWSW sec. 32, T. 99 N., R. 48 W.
12. Norman Sainsland, SESE sec. 8, T. 98 N., R. 48 W.
13. George Wallquist, SENE sec. 35, T. 98 N., R. 49 W.
14. Ray Williams, SESW sec. 25, T. 98 N., R. 49 W., Lyon County, Iowa
15. Ray Williams, NENE sec. 26, T. 98 N., R. 49 W., Lyon County, Iowa
16. Burt Lems, NENE sec. 25, T. 98 N., R. 49 W., Lyon County, Iowa
17. Rotary Test Hole No. 1, NWSE sec. 18, T. 98 N., R. 48 W.
18. Auger Test Hole No. 45, NENW sec. 25, T. 98 N., R. 49 W.
19. John Mullinix, SENW sec. 31, T. 98 N., R. 48 W.
20. C. Froke, SWSW sec. 17, T. 98 N., R. 48 W.
21. Auger Test Hole No. 36, NESE sec. 19, T. 98 N., R. 48 W.
22. Auger Test Hole No. 35, SENE sec. 23, T. 98 N., R. 49 W.

CONCLUSIONS AND RECOMMENDATIONS

Two aquifers exist in the Canton area which may produce water of adequate quantity and quality for a municipal supply. These aquifers are the sandstones of the Dakota Group, at a depth of approximately 450-585 feet and the outwash deposits along the Big Sioux River, at a depth of about 30-70 feet.

The water from the Dakota Group is of very good quality in the Canton area. Because of the nature of the aquifer, however, it is difficult to construct a well that will produce more than 75-100 gallons of water per minute.

The outwash along the Big Sioux River constitutes an aquifer of major significance in eastern South Dakota, and large yield wells can be developed in this aquifer in areas where the outwash material consists of water-saturated medium to coarse sand and gravel. Several test holes were drilled in this outwash, and the aquifer appears to have the greatest potential at the south edge of Canton, below the city water works in sections 23 and 24 near auger test holes 35 and 37. It must be mentioned here that, although wells of good yield (200 to 500 gpm) could probably be constructed in the vicinity of auger test holes 35 and 37, the quality of water that would be obtained from these wells would not be as good as the waters from the Dakota Group. An analysis from auger test hole 35 (table 1, sample 22) shows the water to contain enough iron and manganese to require treatment before use. In addition, the water from this aquifer is somewhat harder than that now being obtained from the deep wells within the city.

It is recommended that the city investigate the possibility of obtaining several large yield wells within the Big Sioux aquifer by the following procedure: Hire a reputable well drilling firm to (1) construct a test well in SE$\frac{1}{4}$ sec. 23 or SW$\frac{1}{4}$ sec. 24, T. 98 N., R. 48 W., that penetrates the complete thickness of glacial deposits; (2) drill three observation wells spaced approximately 50, 100, and 200 feet from the test well; (3) require licensed engineers to perform a pump test for a minimum of 72 hours and collect water samples. Such a procedure will allow accurate predictions of water quantity and quality, rate of recharge, and sustained yield from the aquifer.

If it is found through such an investigation that wells in this aquifer would not be satisfactory for use in supplying the city with water, then it is recommended that a sufficient number of additional deep wells be developed in the sandstones of the Dakota Group at sites convenient to water mains and pumping stations. These wells should be deep enough to penetrate all the sandstones of the Dakota Group. Each permeable zone (sandstone layer) within the Dakota Group should be sampled and tested for water quality as it is encountered. The poorer quality water should be sealed off and kept from entering the production well. Well construction should be accomplished by a competent licensed well driller.

The city officials should consult the State Water Resources Commission, Pierre, to obtain a permit to drill a well, and the State Department of Health with regard to biological and chemical acceptability of the water.

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APPENDIX A

Logs of Auger Test Holes in the Canton Area

(for location see figure 2)

Test Hole Location: Letters stand for quarter section, first number for section, second for township north, third for range west.

Test Hole 1
Location: NWNW 25-99-49
Elevation: 1,369 feet

0- 14	clay, buff, pebbles, moist
14- 29	clay, brown, pebbles, moist
29- 44	clay, buff, pebbles, moist
44- 74	sand, buff, fine, 30% clay, saturated
74- 84	sand, buff, coarse, 30% clay
84-123	clay, gray, pebbles, moist
123-130	Niobrara Marl

* * * * *

Test Hole 2
Location: NWSW 28-99-49
Elevation: 1,408 feet

0- 9	clay, brown, pebbles, moist
9-16	clay, dark brown, pebbles, moist
16-58	clay, gray, pebbles, moist
58-64	Niobrara Marl

* * * * *

Test Hole 3
Location: NWNE 32-99-48
Elevation: 1,285 feet

0- 2	sand, brown, silty
2- 7	sand, brown, fine to medium
7-25	sand, brown, fine to coarse, and gravel, saturated
25-36	clay, gray-brown
36-84	clay, gray-brown, sandy, very fine to medium

* * * * *

Test Hole 4
Location: NESE 34-99-49
Elevation: 1,378 feet
Depth to water: 8 feet

0- 5	clay, brown, pebbles
5-25	clay, buff, saturated, pebbles
25-31	clay, brown, pebbles
31-35	clay, gray, pebbles
36-60	clay, gray, 25% sand, fine to very fine
60-79	Niobrara Marl

* * * * *

Test Hole 5
Location: NWSW 36-99-49
Elevation: 1,359 feet

0- 6	clay, brown, pebbles
6- 7	clay, gray-brown, pebbles
7- 9	clay, silty
9-30	till, gray-brown, saturated
30-40	clay, gray-brown, 25% sand, fine, saturated
40-60	clay, gray, pebbles, compact, saturated

* * * * *

Test Hole 6
Location: NENE 1-98-50
Elevation: 1,359 feet

0-19	clay, buff, pebbles, moist
19-42	clay, gray, pebbles, moist
42-45	Niobrara Marl

* * * * *

Test Hole 7
Location: SWSW 32-99-49
Elevation: 1,320 feet
Depth to water: 9 feet

0-15	alluvium, saturated
15-37	clay, gray-brown (25-75% sand), fine, saturated
37-45	Niobrara Marl

* * * * *

Test Hole 8
Location: NWNE 4-98-49
Elevation: 1,350 feet
Depth to water: 30 feet

0- 1	clay, reddish-brown
1- 17	clay, brown, pebbles
17- 21	clay, dark brown, pebbles
21- 42	clay, gray, pebbles, saturated
42- 95	clay, gray, 50% sand, fine
95-115	Carlile Shale

* * * * *

Test Hole 9
Location: SWSW 31-99-48
Elevation: 1,328 feet
Depth to water: 26 feet

0- 25	clay, brown, pebbles
25- 32	clay, buff, saturated
32- 43	clay, buff, and sand (trace of)
43- 47	clay, gray-brown, compact, and sand, fine (trace of)
47- 50	clay, gray, compact, and sand, fine (trace of)
50- 64	clay, gray, compact, pebbles
64-105	Carlile Shale?

* * * * *

Test Hole 10
Location: NWNE 7-98-49
Elevation: 1,340 feet
Depth to water: 23 feet

0-25	clay, brown, pebbles, saturated
25-45	clay, brown, 25% sand, fine to very fine
45-60	clay, gray, 25% sand, fine to very fine
60-70	Niobrara Marl

* * * * *

Test Hole 11
Location: NWNE 8-98-49
Elevation: 1,340 feet
Depth to water: 30 feet

0- 1	topsoil, black

(continued on next page)

Test Hole 11--continued

1- 5	loess
5-30	clay, brown, pebbles
30-60	clay, brown, 25% sand, fine, saturated
60-66	clay, gray-brown, 25% sand, fine
66-70	clay, gray, 50% sand, fine
70-98	clay, gray

* * * * *

Test Hole 12
Location: SESE 4-98-49
Elevation: 1,287 feet

0- 9	clay, black, pebbles, moist
9-22	clay, black, sandy, coarse, saturated
22-75	clay, black to gray, pebbles, moist-saturated
75-80	bedrock?

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Test Hole 13
Location: NWNW 10-98-49
Elevation: 1,310 feet
Depth to water: 14 feet

0- 5	clay, black, pebbles
5-15	clay, dark brown, pebbles
15-20	clay, brown, 50 % sand, medium to fine, saturated
20-30	sand, medium to fine, 25% clay, brown
30-45	sand, fine to coarse, 25% clay, brown, saturated
45-50	clay, brown, 25% sand, fine to medium, saturated
50-60	Niobrara Marl

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Test Hole 14
Location: NENE 11-98-49
Elevation: 1,334 feet
Depth to water: 5 feet

0-10	clay, brown, pebbles, saturated
10-30	clay, brown, 50% sand, very fine to medium
30-60	clay, gray, compact, 50% sand, fine to medium
60-80	sand, fine to medium, 25% clay, gray, compact
80-88	clay, gray, 50% sand, very fine
88-95	Niobrara Marl

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Test Hole 15
Location: SESW 6-98-48
Elevation: 1,330 feet
Depth to water: 16 feet

0- 2	clay, brown
2-14	clay, brown, pebbles
14-30	clay, buff, pebbles, saturated
30-40	clay, light-brown, 25% sand, fine
40-55	clay, gray-brown, pebbles
55-63	Niobrara Marl

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Test Hole 16
Location: SESW 5-98-48
Elevation: 1,290 feet
Depth to water: 15 feet

0- 2	topsoil, black, silt and clay
2-13	clay, brown, pebbles
13-20	clay, light brown to yellow, pebbles
20-30	clay, yellow, 50% sand, fine to very fine
30-41	clay, light brown to yellow, 50% sand, fine to very fine
41-50	clay, gray-brown, sandy, very fine
50-65	clay, gray, sandy, very fine
65-79	clay, gray (may be bedrock)

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Test Hole 17
Location: NENE 18-98-49
Elevation: 1,337 feet

0- 9	clay, buff, pebbles, moist
9- 14	clay, buff, 20% sand, pebbles, moist
14- 18	clay, olive-gray, pebbles, moist
18- 64	clay, gray, pebbles, moist
64-117	sand, gray, fine to medium, 20% clay, saturated
117-140	Carlile Shale

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Test Hole 18
Location: NWNW 16-98-49
Elevation: 1,340 feet

0-75	clay, buff, pebbles, moist
75-85	Niobrara Marl

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Test Hole 19
Location: NWNE 16-98-49
Elevation: 1,335 feet
Depth to water: 17 feet

0- 9	clay, brown, pebbles
9-17	clay, dark brown, pebbles
17-27	sand, fine to very fine, 25% clay, brown
27-31	sand, brown, fine to medium, 10% clay
31-33	rocks, brown, large, clayey, sandy
33-50	sand, fine to medium, 25% brown clay
50-77	clay, brown, sandy, fine to very fine
77-84	Niobrara Marl

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Test Hole 20
Location: SESE 10-98-49
Elevation: 1,270 feet

0- 5	clay, black, pebbles
5-13	clay, 10% sand
13-19	Carlile Shale

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Test Hole 21
Location: SWSW 12-98-49
Elevation: 1,308 feet
Depth to water: 7 feet

0- 1	clay, black, pebbles
1-16	clay, buff, pebbles
16-18	clay, brown, pebbles
18-50	clay, gray
50-89	clay, gray, sandy, fine

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Test Hole 22
Location: SWSW 7-98-48
Elevation: 1,296.5 feet
Depth to water: 12 feet

0- 1	clay, dark brown, pebbles
1- 3	clay, brown, pebbles
3- 7	clay, buff, pebbles
7-26	clay, yellow, pebbles, saturated

(continued on next page)

Test Hole 22--continued

26-30	clay, yellow-gray, pebbles
30-35	clay, gray, pebbles
35-45	clay, gray, 50% sand, fine to very fine
45-72	clay, gray, 25% sand, fine to very fine
72-80	clay, gray, compact
80-94	Niobrara Marl

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Test Hole 23
Location: SESW 8-98-48
Elevation: 1,296 feet

0- 1	topsoil, black
1-24	clay, brown, pebbles
24-28	gravel, could not penetrate

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Test Hole 24
Location: SWSW 18-98-48
Elevation: 1,353.5 feet

0- 26	clay, brown, pebbles
26- 68	clay, brown, 25% sand, fine to very fine
68-100	clay, gray, 50% sand, very fine, saturated
100-115	sand, buff, fine to medium, saturated (Newton Hills Sand)

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Test Hole 25
Location: SESE 18-98-49
Elevation: 1,337 feet
Depth to water: 10 feet

0- 1	clay, black, pebbles
1- 6	clay, brown, pebbles
6-11	clay, buff, 50% sand, very fine
11-20	clay, buff, 50% sand, medium
20-27	clay, brown, 50% sand, fine
27-37	clay, dark brown, compact, pebbles, small
37-40	clay, dark brown, 50% fine sand
40-46	clay, gray, 50% sand, fine
46-79	clay, gray, 50% sand, very fine

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Test Hole 26
Location: SESE 9-98-49
Elevation: 1,328 feet

0-22	clay, brown, pebbles
23-35	clay, gray, pebbles
35-40	clay, gray, 25% sand, fine, saturated
40-64	Niobrara Marl

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Test Hole 27
Location: SESE 10-98-49
Elevation: 1,285 feet
Depth to water: 27 feet

0- 2	topsoil, brown
2-24	clay, buff, pebbles
24-42	clay, brown, rocks
42-46	clay, gray
46-54	Carlile Shale

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Test Hole 28
Location: SESE 11-98-49
Elevation: 1,270 feet
Depth to water: 8 feet

0- 1	topsoil, black
1- 8	clay, brown, pebbles
8-17	clay, reddish-brown, 25% sand, fine to medium
17-23	sand, brown, medium, 25% clay
23-34	sand, brown, medium, 25% clay
34-40	sand, gray, 50% clay
40-48	clay, gray, compact
48-49	Carlile Shale?

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Test Hole 29
Location: SWSW 18-98-48
Elevation: 1,252 feet
Depth to water: 20 feet

0- 1	loess
1-11	gravel and sand

(continued on next page)

Test Hole 29--continued

11-45	sand, fine to medium, gravelly
45-75	clay, gray, sandy, very fine

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Test Hole 30
Location: SWSW 17-98-48
Elevation: 1,250 feet
Depth to water: 7 feet

0- 1	sand, medium, gravelly
1- 7	alluvium
7- 9	light gray lake sediments (alluvium?)
9-10	clay, gray, rocks
10-18	clay, gray, 50% sand, fine
18-30	clay, gray, compact
30-50	clay, gray, 50% sand, very fine
50-84	sand, very fine, 25% clay, gray

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Test Hole 31
Location: NWNW 23-98-49
Elevation: 1,255 feet
Depth to water: 7 feet

0-14	alluvium
14-30	clay, 50% sand, fine to coarse
30-35	sand, fine to medium, 25% clay
35-39	clay, 25% sand, fine to medium
39-50	Niobrara Marl

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Test Hole 32
Location: NWNE 23-98-49
Elevation: 1,235 feet (topo. sheet)

0- 4	alluvium, fill, black clay
4- 9	silt, brown, clayey, damp
9-36	silt and clay, brown, sandy, some fine gravel, saturated
36-54	clay, gray, hard
54-65	sand and silt, some clay, much water
65-69	Carlile Shale

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Test Hole 33
Location: NWNE 23-98-49
Elevation: 1,235 (topo. sheet)

0-13	alluvium, silt, clayey and sandy, dark gray, dry
13-14	sand, fine, silty
14-21	sand, fine, silty, wet, some clay, brown, coarse
21-24	sand and fine gravel, wet
24-29	gravel, fine to medium, subangular to subrounded, saturated
29-34	no cuttings, drills like fine saturated sand
34-44	sand, coarse to fine gravel, clayey
44-49	clay, silty and sandy, not many cuttings
49-52	sand, fine, clayey and silty
52-68	silt, sandy, very clayey
68-74	bedrock (Carlile Shale?)

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Test Hole 34
Location: NWNE 23-98-49
Elevation: 1,235 feet

0-10	alluvium, silt and sand, fine gravel, black
10-20	sand, medium to coarse, and gravel, fine to medium; completely saturated, dirty black
20-35	gravel, fine to medium, angular, dirty black water, some coarse gravel
35-53	no cuttings--blue-gray clay on augers in this interval
53-77	sand, medium to coarse and gravel, medium to coarse, gray, much water
77-80	no sample--hard drilling, till or bedrock

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Test Hole 35
Location: NWNE 23-98-49
Elevation: 1,235 feet (topo. sheet)
Depth to water: 14 feet

0- 4	clay, black, damp, plastic; grit at 5 feet
4- 9	sand, pebbly, dirty, oxidized; dry
9-14	sand, pebbly, clayey, oxidized; moist
14-19	sand, gravelly, clayey, oxidized; moisture increasing
19-29	gravel, pebble-size, sandy, brown-gray; moist
29-34	gravel, pebble-size, clayey, sandy, unoxidized; moist

(continued on next page)

Test Hole 35--continued

34-49	no return
49-54	sand, coarse, clayey, gray, saturated; tough at 52 feet
54-59	sand, coarse, clayey, gray, saturated; harder at 58 feet
59-64	sand, coarse, clayey, gray, saturated; rocks at 62 feet
64-69	sand, coarse, clayey, gray, saturated
69-74	sand, coarse, clayey, gray, saturated; rocks at 71 feet
74-79	sand, coarse, clayey, gray, saturated; tough at 76 feet
79-82	sand, coarse, clayey, gray, saturated; tough to 83 feet
82-83	Carlile Shale

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Test Hole 36
Location: NWNE 19-98-48
Elevation: 1,235 feet
Depth to water: 18 feet

0- 4	alluvium, sand, fine, blackish-brown to dark brown
4- 9	sand, fine, gravel intermixed, blackish yellow-brown
9-14	sand, fine, gravel intermixed, blackish-yellow, saturated, yellowish-brown
14-19	sand, fine, coarse sand, 50% gravel
19-29	sand, coarse, gravel, yellowish-brown, saturated
29-34	sand, fine to coarse, yellowish-brown, saturated
34-39	sand, fine to coarse, some gravel, saturated

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Test Hole 37
Location: NWSW 24-98-49
Elevation: 1,239 feet
Depth to water: 12 feet

0- 2	sand, brown, silty
2- 7	sand, medium to coarse, clay
7-27	sand, medium to coarse, gravelly (pea-size)
27-40	sand, coarse, 15% clay
40-45	sand, fine to medium, 25% clay, gray
45-79	sand, very fine, 25% clay, gray

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Test Hole 38
Location: SESE 23-98-49
Elevation: 1,240 feet (topo. sheet)
Depth to water: 44 feet

0- 4	sand, clayey, oxidized; yellowish-brown, moist
4- 9	sand, coarse, pebbly, tough at 8 feet
9-19	gravel, dirty, dry; few rocks
19-24	sand, clayey, oxidized, wet; becomes brown-gray
24-34	sand, clayey, pebbly, brownish-gray, wet
34-39	clay, sandy, brown to brownish-gray, wet
39-74	clay, gray, sandy, water; drills like clay from 62 feet
74-89	water (mud), no solids; drills like clay
89-90	plastic clay-shale (Carlile Shale)

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Test Hole 39
Location: SWSW 21-98-49
Elevation: 1,309 feet

0-40	clay, brown, pebbles
40-45	clay, gray-brown, pebbles
45-50	clay, gray-brown, 25-50% sand, very fine
50-80	sand, light brown, fine, clayey (Newton Hills Sand)

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Test Hole 40
Location: SWSE 22-98-49
Elevation: 1,253 feet
Depth to water: 8 feet

0-15	alluvium, saturated
15-25	clay, black, 50% sand, medium to fine
25-30	sand, fine to medium, 25% clay, black, saturated
30-42	sand, fine to coarse, clayey, gray, saturated
42-65	Niobrara Marl

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Test Hole 41
Location: SESW 23-98-49
Elevation: 1,240 feet
Depth to water: 16 feet

0- 8	alluvium

(continued on next page)

Test Hole 41--continued

8-16	clay, gray, compact, pebbles
16-40	clay, gray, 50% sand, fine
40-53	sand, very fine to fine, 25% clay, gray
53-64	Niobrara Marl

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Test Hole 42
Location: NESE 25-98-50
Elevation: 1,295 feet

0-10	clay, brown, pebbles
10-25	clay, brown, 50% sand, fine to medium
25-30	clay, brown, 25% sand, very fine to medium sand
30-35	clay, gray-brown, 25% sand, very fine to medium
35-45	Niobrara Marl

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Test Hole 43
Location: SWNW 29-98-49
Elevation: 1,280 feet
Depth to water: 22 feet

0- 1	topsoil, brown
1- 6	gravel
6-30	sand, medium to fine, gravelly, medium, 20% clay
30-45	clay, brown, 50% sand, fine to medium
45-69	clay, gray, 50% sand, fine to medium
69-75	Niobrara Marl

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Test Hole 44
Location: NESE 29-98-49
Elevation: 1,290 feet

0- 3	alluvium
3- 5	clay, dark brown
5-15	clay, dark brown, gravelly, fine, sandy, coarse
15-17	clay, brown, pebbles
17-20	clay, brown, 50% sand, fine to medium
20-43	clay, gray, 50% sand, fine to medium
43-45	sand, gray, fine to medium, 25% clay (Newton Hills Sand)
45-80	sand, gray, fine to medium, 10% clay
80-90	Niobrara Marl

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Test Hole 45
Location: NENW 25-98-49
Elevation: 1,230 feet
Depth to water: 11 feet

0- 4	alluvium
4- 6	sand, brown, fine to medium
6- 9	clay
9-14	sand, fine to medium
14-25	sand, fine to coarse, clayey
25-30	rocks, large, sandy
30-68	clay, gray, 50% sand, fine to medium
68-74	Niobrara Marl

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Test Hole 46
Location: NWNW 34-98-49
Elevation: 1,292.5 feet
Depth to water: 20 feet

0- 3	clay, brown, pebbles
3-16	clay, buff, pebbles
16-25	clay, brown, pebbles
25-47	clay, gray, compact, pebbles
47-53	sand, fine to very fine, clayey, gray (Newton Hills Sand)
53-80	sand, very fine to fine, 10% clay, gray
80-99	sand, fine to medium, 50% clay

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Test Hole 47
Location: SESE 26-98-49
Elevation: 1,226 feet
Depth to water: 4 feet

0- 3	clay, brown, pebbles
3-10	clay, dark brown
10-14	clay, brown, 50% sand, fine to medium
14-18	clay, brown, 50% sand, very fine to medium
18-26	sand, coarse, clayey, brown, and gravel, fine
26-31	sand, medium to very fine, 50% clay, gray
31-47	sand, fine to very fine, 50% clay, gray
47-79	sand, very fine, 25% clay, gray

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Test Hole 48
Location: SWNW 31-98-49
Elevation: 1,330 feet

0-20	clay, brown, pebbles
20-35	clay, gray-brown, pebbles
35-75	clay, gray-brown, 25% fine to medium sand
75-90	Niobrara Marl

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Test Hole 49
Location: NESE 32-98-49
Elevation: 1,307 feet
Depth to water: 14 feet

0- 1	topsoil, black
1-45	clay, brown, pebbles
45-50	clay, gray
50-60	clay, gray, 50% sand, very fine
60-65	Carlile Shale

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Test Hole 50
Location: NESE 34-98-49
Elevation: 1,270 feet

0-15	alluvium
15-35	clay, black, 25% sand, fine to medium
35-50	clay, gray, 50% sand, fine to medium
50-75	sand, fine to medium, 25% clay, gray
75-85	sand, medium, gravelly, fine
85-90	Niobrara Marl

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Test Hole 51
Location: SESE 31-98-49
Elevation: 1,340 feet
Depth to water: 25 feet

0-25	clay, brown, pebbles
25-33	clay, gray-brown, pebbles
33-40	clay, brown-gray, 50% sand, fine to medium
40-83	sand, brown, very fine to coarse, 10% clay (Newton Hills Sand)
83-95	Carlile Shale

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Test Hole 52
Location: SWSW 34-98-49
Elevation: 1,310 feet
Depth to water: 42 feet

0- 3	alluvium
3-10	clay, brown, pebbles
10-20	clay, gray-brown, pebbles
20-25	clay, gray-brown, 50% sand, fine
25-55	clay, gray, 25% sand, fine, saturated
55-60	sand, fine to medium, 25% clay, brown (Newton Hills Sand)
60-65	sand, brown, fine to coarse, clayey

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Test Hole 53
Location: SWSW 36-98-49
Elevation: 1,307 feet
Depth to water: 45 feet

0- 2	clay, black, pebbles
2-30	clay, dark-brown, pebbles
30-36	clay, gray-brown, pebbles
36-45	clay, gray, pebbles
45-84	clay, gray, sandy, very fine, silty

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Test Hole 54
Location: NWSW 6-97-49
Elevation: 1,360±20 feet (topo. sheet)

0-35	clay, brown, pebbles
35-60	clay, brown, 50% sand, fine
60-65	sand, fine to medium, 25% clay, brown (Newton Hills Sand)
65-78	sand, fine to coarse, 25% clay, brown
78-85	Niobrara Marl

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Test Hole 55
Location: SESE 5-97-49
Elevation: 1,445±20 feet (topo. sheet)

0- 3	topsoil, gray
3-12	clay, buff, pebbles
12-24	clay, buff, pebbles, moist

(continued on next page)

Test Hole 55--continued

24-32	clay, dark-brown, pebbles, moist
32-53	clay, gray, pebbles, moist
53-59	Niobrara Marl

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Test Hole 56
Location: SWNW 2-97-49
Elevation: 1,475±20 feet (topo. sheet)

0-14	clay, buff, pebbles, moist
14-47	clay, buff, pebbles, moist-saturated
47-69	Niobrara Marl

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APPENDIX B

Logs of Rotary Test Holes in the Canton Area

(for location see figure 2)

Test Hole Location: Letters stand for quarter section, first number for section, second for township north, third for range west.

Test Hole 1-R
Location: NESW 18-98-48
Elevation: 1,280 feet

0-22	clay, buff, sandy
22-45	clay, gray, sandy
45-65	gravel, pea-size
65-70	Carlile Shale

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Test Hole 2-R
Location: NENE 24-98-50
Elevation: 1,355±5 feet (topo. sheet)

0- 2	topsoil
2- 10	clay, buff, chalk rock, easy drilling
10- 20	clay, buff, hard drilling
20- 32	sand, fine
32- 60	clay, buff, sandy
60- 85	clay, gray, silty
85- 92	rocks
92-100	clay, gray, sticky, tough
100-105	clay, buff, sandy
105-125	sand, quartz (Newton Hills Sand)

APPENDIX C

Table 2.--Records of wells in the Canton area

Well location: Letters stand for quarter section, first number for section, second for township north, third for range west.
Type of well: Du, Dug; D, Drilled; B, Bored
Water-bearing material: ss, sandstone; l, lake sand; o, outwash; m, marl; sl, sand lens
Use of water: S, stock; D, domestic; S,D, stock and domestic

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
Canton	Roy Scott	D	20	Glacial	o	D
SW-6-97-48	Ernest Steesland	Du	14	Glacial	sl	S,D
NE-6-97-48	E. Steesland	Du	16	Glacial	sl	S
NW-1-97-49	H. Brynjulson	D	300	Dakota	ss	S,D
NE-2-97-49	R. Brynjulson	B	35	?	?	S
SE-3-97-49	L. Diedrich	B	50	Glacial	sl	S,D
SE-3-97-49	R. Skinner	B	30	Glacial	o?	S,D
SW-4-97-49	J. Banbestowe	B	86	Glacial	sl	S,D
NW-4-97-49	K. Hammer	D	80	Glacial	sl	S
NE-5-97-49	R. Kuehl	B	45	Glacial	sl	S
SW-5-97-49	A. Van Bockern	D	120	Glacial	l	S
SE-6-97-49	Holm Brothers	B	50	Glacial	sl	S,D
NE-6-97-49	L. Torberson	B	27	Glacial	sl?	S
NE-7-97-49	J. Larsen	D	135	Glacial	sl	S
NW-8-97-49	R. Oakland	D	140	Glacial	sl	S
SW-9-97-49	A. Egeland	D	118	Glacial	o	S
NE-9-97-49	R. Olson	D	160	Glacial	o?	S

Appendix C-Records of wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
NW-9-97-49	Wallquist Bros.	D	64	Glacial	sl	S
SE-10-97-49	M. Ness	B	12	Glacial	sl?	S
NE-10-97-49	F. Olson	D	210	Glacial	sl	S
NW-11-97-49	C. Lundstron	D	508	Dakota	ss	S,D
NE-12-97-49	H. Johnson	B	50	Glacial	o	S,D
SE-1-97-50	R. Oakland	D	40	Glacial	sl	S
SW-1-97-50	C. Renli	B	32	Glacial	sl	S
NE-1-97-50	E. Thompson	B	70	?	?	S
SW-12-97-50	O. Hunt	D	119	Glacial	sl	S
NW-12-97-50	E. Tuntland	D	100	Glacial	sl	S
SE-12-97-50	H. Vander Meer	D	146	Glacial	sl	S
NE-4-98-48	C. Larson	D	200	Glacial	sl	S
SW-5-98-48	M. Mathison	B	15	Glacial	sl	S,D
SW-6-98-48	R. McVay	D	250	Dakota?	ss	S,D
NW-6-98-48	D. Sandness	B	65	Glacial	sl	S
SE-7-98-48	M. Syverud	B	55	Glacial	sl	S
NW-7-98-48	B. Veldkamp	D	60	Glacial	sl	S
SE-8-98-48	N. Salnsland	D	90	Glacial	o	S,D
NW-8-98-48	E. Stengel	Du	40	Glacial	o	S
SE-16-98-48	Teach Brothers	B	125	Glacial	sl	S,D
SW-17-98-48	C. Froke	-	-	Glacial	o	-
NW-17-98-48	M. Carpenter	B	25	Glacial	o	S,D

Appendix C-Records of wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
SW-17-98-48	G. McVay	D	265	Dakota	ss	S,D
SW-17-98-48	F. Simunek	B	30	Glacial	o	S,D
NW-18-98-48	G. Mathison	D	359	Dakota	ss	S
SE-18-98-48	K. Taft	B	37	Glacial	o?	S,D
NW-31-98-48	J. Mullinix	B	26	Glacial	o	S
NW-1-98-49	W. Lennon	D	80	Glacial	o	S
NW-1-98-49	C. Sullestad	B	85	Glacial	o?	S
SE-2-98-49	R. Abbott	D	500	Dakota	ss	S,D
NE-2-98-49	A. Brandsma	B	90	Glacial	o?	S
NW-2-98-49	G. Eisland	D	425	Dakota	ss	S,D
NE-3-98-49	C. Knutsen	D	425	Dakota	ss	S,D
SE-3-98-49	R. Romereim	D	285	Dakota	ss	S,D
SE-5-98-49	N. Olson	Du	66	Glacial	sl	S
SE-6-98-49	L. DeVitt	B	65	Glacial	o?	S
NW-7-98-49	C. Hurley	B	65	Glacial	o	S
SE-7-98-49	O. Johnson	B	72	Glacial	o?	S
NE-8-98-49	C. Rikansrud	D	431	Dakota	ss	S,D
SE-9-98-49	E. Carpenter	B	40	Glacial	o	S,D
SE-10-98-49	A. Paulson	B	62	Glacial	o	S
SE-10-98-49	R. Romereim	D	300	Dakota	ss	S,D
SW-11-98-49	F. Vander Brink	D	200	Niobrara	m	S,D
NW-12-98-49	J. Espland	B	40	Glacial	o?	S

Appendix C - Records of wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
SE-12-98-49	C. Knutsen	B	45	Glacial	o?	S
NW-12-98-49	C. Kuehl	B	85	?	?	S
SE-13-98-49	T. Monen	B	18	Glacial	o?	S, D
NW-14-98-49	L. Johnson	B	20	Glacial	o	D
NE-14-98-49	J. Vanlaar	D	365	Dakota	ss	S, D
SE-15-98-49	H. O'Banion	B	32	Glacial	sl	D
SE-16-98-49	L. Antrim	B	60	Glacial	o?	S
SE-16-98-49	L. Antrim	B	30	?	?	S
SE-16-98-49	K. Hovik	B	30	Glacial	sl?	S
NW-16-98-49	S. Short	D	50	Glacial	sl	S
NE-17-98-49	A. Crosby	B	60	Glacial	sl	S
NW-17-98-49	J. Hurley	B	65	Glacial	o	S
SE-18-98-49	D. French	B	40	Glacial	sl	S
NW-18-98-49	N. Peterson	Du	65	Glacial	sl?	S
SW-18-98-49	F. Simunek	B	30	Glacial	o	D
SW-19-98-49	O. Bren	D	460	Dakota	ss	S, D
NW-19-98-49	E. Tuntland	D	450	Dakota	ss	S, D
SW-20-98-49	B. Oliver	B	68	Glacial	o?	S
NE-20-98-49	O. Rekansrud	D	425	Dakota	ss	S, D
NW-20-98-49	L. Stewart	B	35	Glacial	sl?	S
NW-21-98-49	M. Lier	B	54	Glacial	sl?	S
SE-21-98-49	M. Oliver	B	40	Glacial	sl	S

Appendix C - Records of wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
SW-21-98-49	A. Twedt	B	40	Glacial	sl?	S
NW-22-98-49	G. Jensen	D	250	Dakota	ss	S,D
NE-22-98-49	L. Williams	D	325	Dakota	ss	S,D
SE-23-98-49	O. Vlrickson	D	28	Glacial	o	S,D
SW-24-98-49	F. Miller	D	33	Glacial	sl?	D
SW-25-98-49	R. Williams	-	25	Glacial	o	-
NW-26-98-49	E. Mossefin	D	25	Glacial	sl?	S
NE-26-98-49	H. Thompson	D	20	Glacial	sl?	S,D
NE-26-98-49	R. Williams	-	25	Glacial	o	-
NE-27-98-49	T. Rehead	D	585	Dakota	ss	S,D
SE-27-98-49	A. Ulrickson	D	285	Dakota	ss	S,D
NE-28-98-49	M. Lier	B	30	Glacial	sl?	S
SE-28-98-49	H. Strand	Du	13	Glacial	o	S
SW-30-98-49	G. Grane	B	46	Glacial	sl?	S
NE-31-98-49	H. Strand	Du	28	Glacial	o	S
SE-31-98-49	C. Torberson	B	30	Glacial	o	S
NE-32-98-49	H. Strand	B	25	Glacial	o	S
NE-32-98-49	H. Strand	B	20	Glacial	o	S
SW-33-98-49	H. Hansen	B	28	Glacial	o	S,D
SE-33-98-49	E. Steensland	Du	18	Glacial	o	S,D
SW-34-98-49	V. Hemmington	B	35	Glacial	o	S
NW-34-98-49	L. Holter	B	20	Glacial	o	S

Appendix C - Records of wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
SE-35-98-49	M. Mathison	B	30	Glacial	sl	S
NE-35-98-49	G. Wallquist	B	28	Glacial	sl	S,D
NE-1-98-50	S. Golden	D	45	Glacial	sl	S
NE-1-98-50	C. Larson	B	60	Glacial	o	S
SW-12-98-50	L. Reiners	B	42	Glacial	sl	S
NW-12-98-50	J. Stratmeyer	D	65	Glacial	sl	S
SW-13-98-50	B. Baker	D	387	Dakota	ss	S,D
NW-24-98-50	B. Beck	B	65	Glacial	o	S,D
NE-24-98-50	C. Vande Vende	B	36	Glacial	sl	S,D
NW-25-98-50	A. Severson	B	100	?	?	S
NE-36-98-50	D. Hanson	B	50	Glacial	sl	S
NW-36-98-50	S. Hanson	B	25	Glacial	sl	S
SW-36-98-50	C. Renli	B	25	Glacial	sl	S
NE-36-98-50	E. Strand	B	29	Glacial	sl	S
SE-28-99-48	C. Hilt	D	460	Dakota	ss	S,D
SE-29-99-48	F. Jones	D	320	Dakota	ss	S,D
SW-29-99-48	L. Short	B	90	Glacial	o	S
SE-30-99-48	M. Gorman	D	83	Glacial	o	S
SE-31-99-48	H. Cruse	D	330+	Dakota	ss	S,D
SW-31-99-48	D. Jeul	D	350	Dakota	ss	S,D
NW-31-99-48	M. Ostraat	D	435	Dakota	ss	S,D
SW-32-99-48	I. Moen	D	87	Glacial	sl	S,D

Appendix C - Records of wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
SW-32-99-48	J. Sandness	B	85	Glacial	sl?	S,D
SW-33-99-48	C. Styke	D	360	Dakota	ss	S,D
NW-25-99-49	D. Hicks	D	160	Glacial	sl	S
SE-25-99-49	P. Sivertson	D	440	Dakota	ss	S,D
SW-26-99-49	H. Schwartz	D	70	Niobrara	m	S
NE-27-99-49	T. Carlson	B	65	Glacial	sl	S
NE-27-99-49	T. Carlson	D	430	Dakota	ss	S,D
NW-27-99-49	R. Kennison	D	80	Niobrara	m	S
SW-28-99-49	J. Muller	D	500	Dakota	ss	S,D
SW-29-99-49	L. Eisland	D	100	?	?	S
NE-29-99-49	W. Nelson	D	225	Niobrara	m	S
SW-29-99-49	D. Van Den Top	D	140	Niobrara	m	S
SW-30-99-49	E. Helgeson	B	54	Glacial	sl	S
SE-31-99-49	M. Stenslend	D	47	Glacial	sl	S
NE-32-99-49	O. Fodness	D	488	Dakota	ss	S,D
SW-32-99-49	O. Nordseth	B	26	?	?	S,D
SE-32-99-49	D. Van Den Top	Du	26	Glacial	sl	S
SE-33-99-49	E. Narun	B	18	Glacial	o	S
SW-34-99-49	C. Lems	D	400	Dakota	ss	S,D
SW-35-99-49	R. Abbott	B	500	Dakota	ss	S
NW-35-99-49	C. Enger	B	85	Niobrara	m	S
SE-35-99-49	J. Urben	B	109	Niobrara	m	S

Appendix C - Records of wells--continued

Well Location	Owner or Tenant	Type of Well	Depth of Well (feet)	Geologic Source	Water-bearing Material	Use of Water
SE-36-99-49	A. Bratlie	D	399	Dakota	ss	S,D
SE-25-99-50	A. Eisland	D	80	?	?	S,D
NW-25-99-50	L. Elster	B	100	Niobrara	m	S
SE-25-99-50	R. Elster	D	447	Dakota	ss	S,D
NW-36-99-50	R. Johnson	D	460	Dakota	ss	S,D
SW-36-99-50	P. Larson	D	40	Glacial	sl	S